June 21, 1927. 1,632,777

H. A. AFFEL

DISTRIBUTION OF INTELLIGENCE

Original Filed Feb. 25, 1922 2 Sheets-Sheet 1

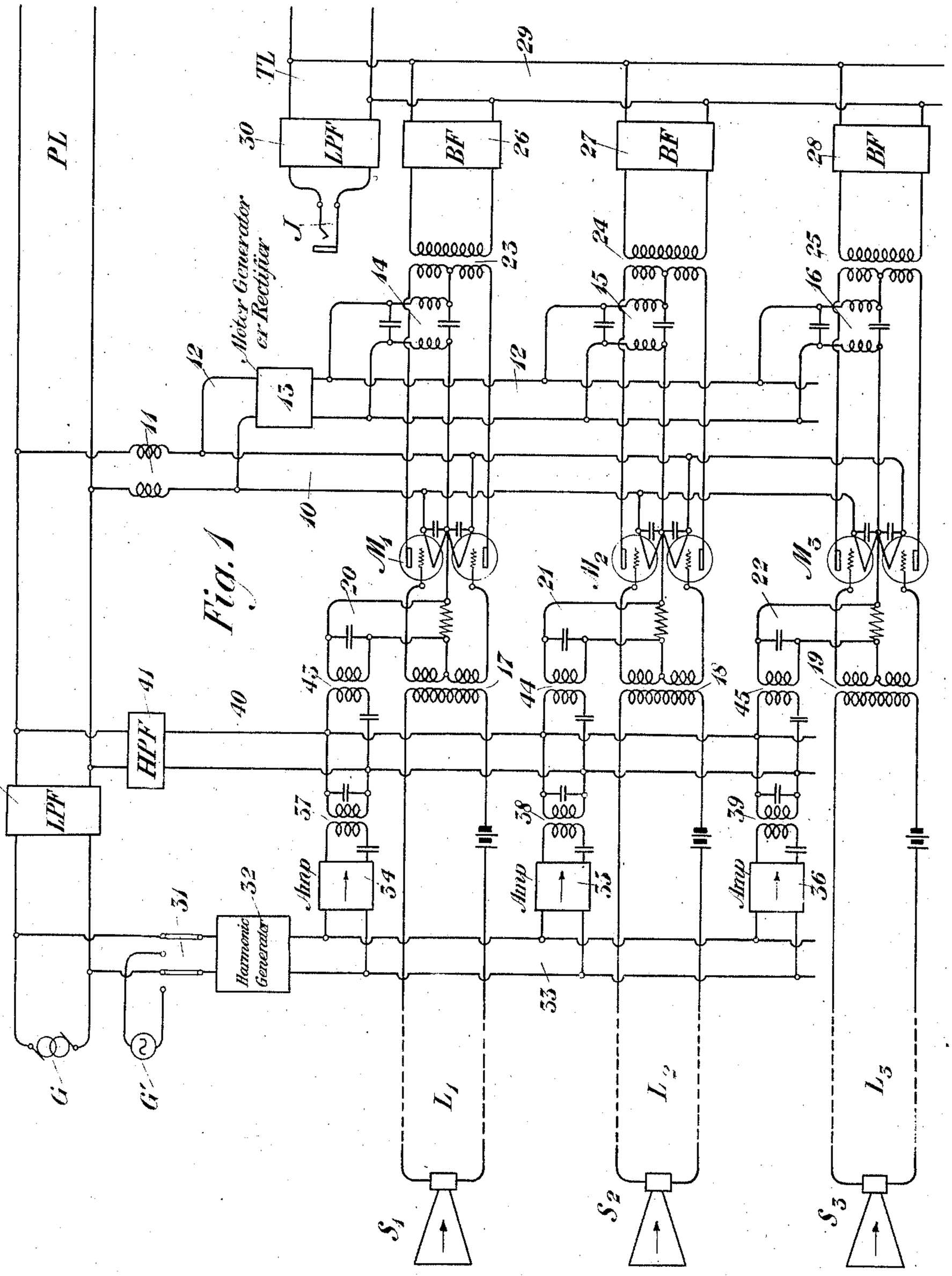

FIG. 1

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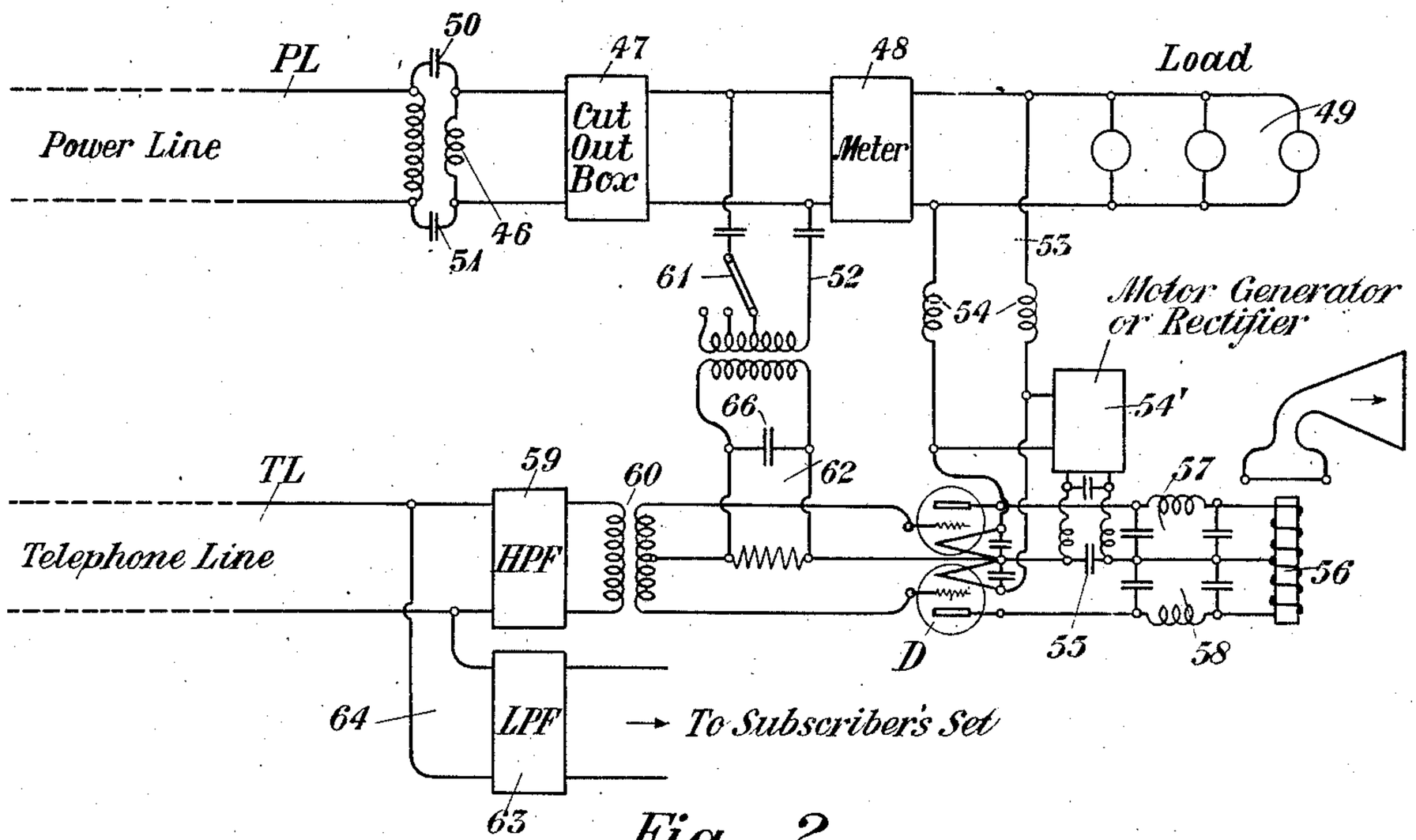

Fig. 2

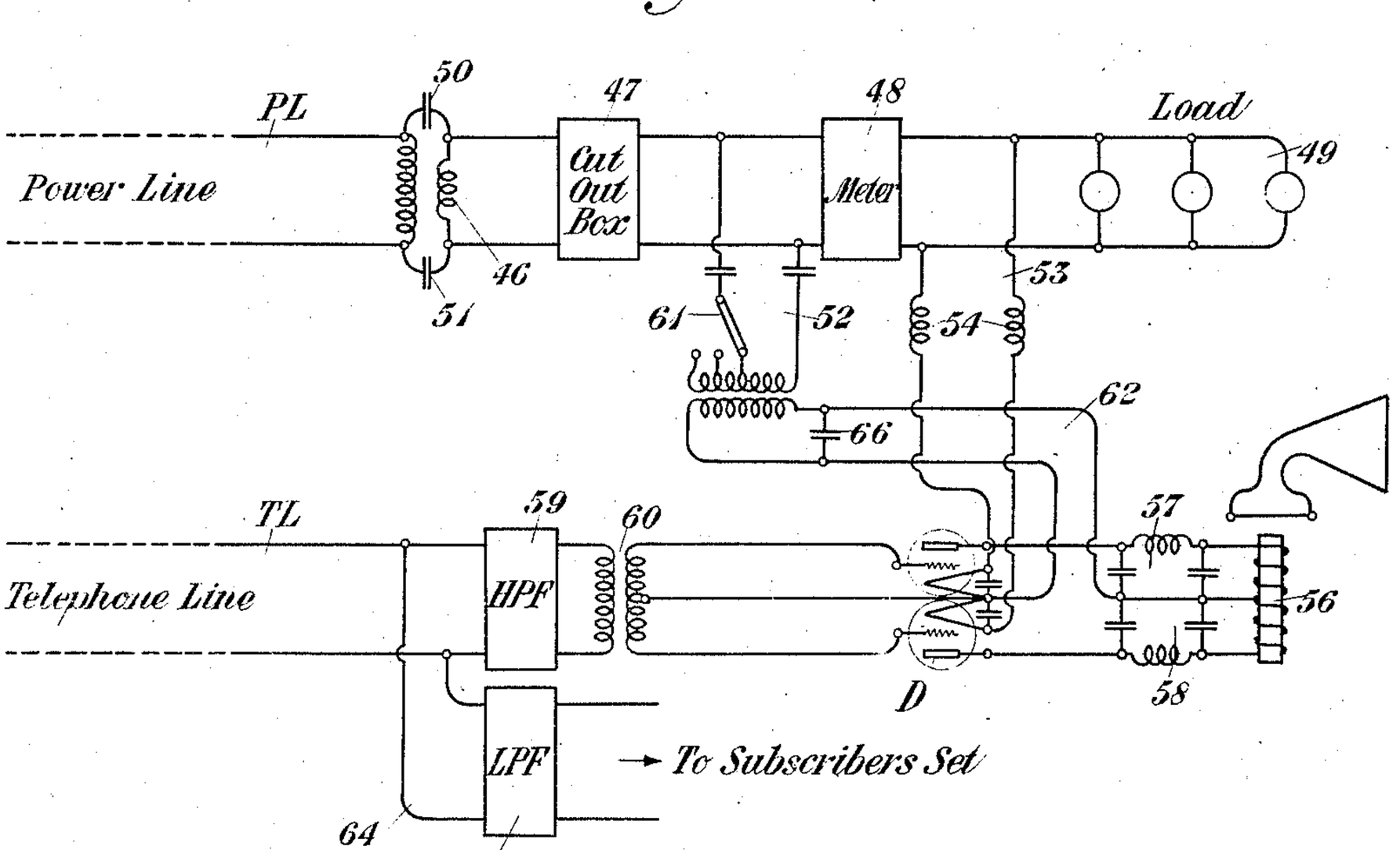

Fig. 3

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UNITED STATES PATENT OFFICE.

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DISTRIBUTION OF INTELLIGENCE.

Application filed February 25, 1922, Serial No. 539,255. Renewed February 9, 1925.

This invention relates to signaling systems and more particularly to systems for the distribution of news, amusement and the like.

The field of communication may be considered to be broadly divided into two classes, first, those communications destined between particular or individual points, and second, broadcast communications involving general dissemination of intelligence among a large number of individuals or points, and which are not confidential. The telephone art has been developed along lines of communication falling into the first class above mentioned. It is the purpose of the present invention, however, to provide a system whereby the telephone art may be applied to communications of the second class.

In carrying out the invention it is proposed to organize a system in which intelligence such as music and news may be transmitted from points at which the intelligence originates to a common distributing point. At the common distributing point the signaling currents representing the various types of intelligence will be translated into carrier frequencies by modulation and by superposing the translated frequencies upon a common transmission network, the several types of intelligence may be simultaneously transmitted to a plurality of receiving stations. By employing carrier currents having a sufficiently high frequency with respect to the width of the band necessary to accurately reproduce the low frequency signaling currents, distortion resulting from ordinary telephonic transmissions will be practically eliminated. Another advantage inherent in the use of carrier currents resides in the fact that by multiplexing the circuits different carrier frequencies may be assigned to the transmission of a number of different forms of amusement and news which are transmitted simultaneously over the system, so that the subscribers will be enabled to choose the particular form of amusement or news desired.

For the transmission of the carrier frequencies from the central distributing point to the subscribers' stations, existing networks such as telephone circuits or power circuits leading to the premises of the individual subscribers may be utilized. In accordance with the present invention the unmodulated carrier frequencies assigned to the several channels will be amplified and transmitted over the power circuit to the substations where they may be used to beat with the side bands to reproduce the original signal. The side bands, on the other hand, being currents of relatively small amplitude, may be transmitted over telephone lines extending to the subscribers' stations.

At the subscriber's station a vacuum tube detector may be employed for detecting the signaling currents from the side bands by beating them with the proper carrier frequencies. The detectors may be supplied with operating currents from the power circuit. In order to select any desired type of intelligence, a simple tuned circuit may be arranged to select any one of several frequencies by means of a suitable switch so that by this simple means the carrier frequency corresponding to the desired type of transmission may be selected from the power circuit and applied to the detector, together with the side bands corresponding to all of the different types of transmission. Only the side band corresponding to the selected carrier will produce an intelligible and audible signal, as the frequencies resulting from beating the other side bands with the carrier will be above audibility. A loud speaker will be provided to be operated by the detected signaling currents.

This method of transmitting the unmodulated carrier frequencies over one circuit, and the side bands over another circuit, has several advantages. For example, by transmitting the carrier frequencies over the power circuit the carrier frequencies may be amplified to practically any desired degree, as has already been pointed out. This is for the reason that the power circuits are not only excellent conductors because of the large quantities of copper employed, but for the further reason that the question of interference from cross-talk in adjacent circuits need not be considered to the same extent as in the case of telephone circuits. Another advantage resides in the fact that by transmitting the unmodulated carrier frequencies over a circuit separate from that carrying the side bands, a very simple selective device may be used to select the desired carrier, and no selection with respect to the side bands becomes necessary. This is an important feature, since to

make a system of this type practical it is necessary that the apparatus at the subscriber's station be simple, rugged and inexpensive.

The invention may now be more fully understood from the following description when read in connection with the accompanying drawings, Figure 1 of which shows the apparatus employed at the central distributing station, and Figs. 2 and 3 of which illustrate two different types of apparatus which may be employed at the subscriber's station.

Referring to Fig. 1, S_1, S_2 and S_3 represent three different points or sources of intelligence, one being, for example, a classical concert, another a popular concert, or lecture, and the third a point at which a news bulletin or other information is recited. Transmitters are provided at each of these points and the transmitters are connected by means of lines L_1, L_2 and L_3 to the main distributing station, at which modulators M_1, M_2 and M_3 are provided. The modulators, as illustrated, are duplex vacuum tube modulators of the type illustrated in Carson Patent 1,343,308, of June 15, 1920, and are arranged to suppress the carrier. The three modulators M_1, M_2 and M_3 have their filaments supplied with heating current from a power circuit PL, over which alternating power currents from a generator G are transmitted. The connection 10, between the filaments of the modulators and the power circuit PL, includes a choke coil 11 to keep the carrier frequencies, which are transmitted over the power circuit in a manner described hereinafter, from being transmitted to the filaments. The plate voltages for the modulators are also obtained from the power circuit PL through a branch 12, which includes a motor generator or a rectifying arrangement schematically indicated at 13. Any well known type of motor generator or rectifier may be used, the purpose of this portion of the apparatus being to change the alternating power currents into direct currents to energize the filament-plate circuits of the tubes. In order to smooth out rectified currents, a simple form of low-pass filter comprising shunt inductance and series capacity may be included in the branch circuits leading from the circuit 12 to the plate connections of each of the modulators, as indicated at 14, 15 and 16.

The modulating signal frequencies from the sources S_1, S_2 and S_3 are impressed upon the modulators from the lines L_1, L_2 and L_3 through transformers 17, 18 and 19, in such a manner as to be serially applied with respect to the grids of the two tubes. The carrier frequencies are supplied to the tubes in parallel with respect to the two grids through connections indicated at 20, 21 and 22. By connecting the circuits in this manner the unmodulated carrier component is suppressed in the output circuits of the modulators and only the side bands will be transmitted through the output transformers 23, 24 and 25. Band filters 26, 27 and 28 are included between these transformers and the common circuit 29, leading to the telephone line TL. These band filters may be of the well known Campbell type and are designed to transmit one side band only for each channel, the other side band being suppressed by the filter. The side bands transmitted from the three channels will, of course, lie in different frequency ranges, the frequency range being determined by the frequency of the carrier supplied to the modulator of each channel. The telephone line TL may, of course, be used for ordinary telephonic communication and in order that it may be connected with other lines, it is terminated in a jack J, as indicated, and a low-pass filter 30 is connected in the line between the jack J and the connection of the circuit 29 to prevent the frequencies in the modulated side bands from being transmitted over the jack to some other telephone line which may be connected to the line TL.

The carrier frequencies to be supplied to the modulators may be obtained from the basic frequency transmitted by the generator G over the power circuit PL, or they may be obtained from a special fundamental carrier source G′, depending upon which way the switch 31 is thrown. The switch 31 is included in a circuit leading to a harmonic generator schematically indicated at 32. This harmonic generator may be of any well known type, such, for example, as a vacuum tube whose circuit is arranged to distort the fundamental frequency applied to its input circuit, thereby producing harmonics in the output circuit in a well known manner. The particular harmonics appearing in the output circuit 33 of the harmonic generator which it is desired to use as carriers may be amplified by amplifiers 34, 35 and 36, and selected by means of sharply tuned circuits 37, 38 and 39 from the undesired harmonics. The amplifiers 34, 35 and 36 may be of any well known type such, for example, as vacuum tube amplifiers.

The harmonics selected by the tuned circuits 37, 38 and 39 are superposed as unmodulated carriers upon a common circuit 40 which is connected through a high-pass filter 41 to the power circuit PL. The filter 41 permits of transmitting the amplified carriers from the circuit 40 to the power circuit, while preventing the low frequencies from the source G from being transmitted into the circuit 40. A low-pass filter 42 may be included in the power circuit as indicated, to prevent the carrier frequencies

from reacting on the generator G. The three carrier frequencies which have been selected and superposed upon the circuit 40 may be selectively transmitted over the circuits 20, 21 and 22 to the modulators M_1, M_2 and M_3 by means of tuned circuits 43, 44 and 45, so that each modulator will have a carrier frequency individual thereto supplied to it, all of the carrier frequencies, however, being transmitted over the power circuit PL. The carrier frequencies are not, however, transmitted over the line TL for the reason that they are suppressed by the modulators, as already stated, and only one side band is transmitted over the telephone line for each channel.

At the subscriber's station, the apparatus may be arranged as shown in Fig. 2. The power circuit PL leads through the transformer 46, cut-out box 47 and meter 48 to a load 49, which may be a series of electric lights or other current-consuming devices. The transformer 46 will ordinarily be designed to transmit only the power frequencies supplied by the generator G, but by arranging by-pass condensers 50 and 51 about the transformer, the carrier frequencies may be passed through the transformer and into the tuned circuit 52.

The detecting apparatus D, at the subscriber's station, comprises a duplex vacuum tube arrangement of the general type illustrated in Carson Patent 1,343,308, of June 15, 1920, and the filament circuit of the detector D is energized from the power circuit PL over a branch 53, including choke coils 54 for the purpose of preventing the carrier frequencies from entering the filament circuit. In some instances, the inductance of the meter 48 will be sufficient to choke out the carrier frequencies. The plate voltage for the detector is also supplied from the power circuit through the branch 53 and a motor generator or rectifier 54′, this apparatus being similar to the corresponding device at the main distributing station. The connection from the motor generator or rectifier 54′ to the plate-filament circuit of the detector D must be shunted by a condenser 55 to form a path of low impedance for the high frequency currents. A loud speaker 56 is included in the output circuit of the detector and a simple low-pass filter arrangement 57, 58 is included in circuit with the windings of the loud speaker 56 to permit the transmission of the detected low frequency signaling currents to the loud speaker, while preventing the high frequencies from passing into the loud speaker circuit. The high frequencies will be shunted from the loud speaker by passing through the condenser 55 and the first shunt condenser of the filters 57 and 58.

The three modulated side bands transmitted over the line TL from the distributing station may be passed through a high-pass filter 59 and a transformer 60, to be impressed upon the input circuit of the detector D serially with respect to the grids of the two tubes of the detector. By means of a switch 61, the tuned circuit 52 may be set for the carrier frequency corresponding to any desired side band and the selected carrier frequency transmitted over a circuit 62 so as to be impressed upon the grids of the two tubes of the detector D in parallel. The selected carrier frequency will beat with all three side bands but will produce an intelligible and audible low frequency band corresponding only to that side band which was originally modulated by the carrier selected. The other side bands will produce frequencies which, if the carriers are properly chosen, will be above audibility. This renders it unnecessary to provide complicated selecting devices such as band filters for selecting the bands themselves. The only filters necessary at the subscriber's station are the high-pass filter 59 and the corresponding low-pass filter 63, included in the circuit 64 leading to the ordinary subscriber's set. In some instances, the latter filter may be omitted, especially where an anti-side tone subscriber's set is provided, the anti-side tone circuit preventing the carrier frequencies which might be detected by the ordinary telephone transmitter from actuating the regular telephone receiver. Even where the filter 63 is provided, both filters 59 and 63 may be economically constructed as they comprise but one inductance and one capacity for each section, and only a few sections need be provided for each filter. This brings the extra apparatus which it is necessary to provide at the subscriber's station in addition to the regular subscriber's set down to a very few and inexpensive elements, to wit: A loud speaking receiver, a simple motor generator or rectifier, two vacuum tubes for a detector, one simple tuned circuit such as may be used in an ordinary amateur's set for radio telegraphy, a high-pass filter, a low-pass filter, and the simple network filter shown at 57—58.

None of these elements is expensive and no adjustment is necessary, the only operation required by the subscriber being the setting of the switch 61 to select the desired frequency.

Even these few elements may be reduced by eliminating the motor generator or rectifier 54 where the circuit shown in Fig. 3 is employed. In this arrangement the carrier frequency selected from the power circuit by means of the tuned circuit 52 is impressed through the circuit 62 upon the output circuit of the detector between the filaments and the plates, as indicated, and no direct current is supplied to the tubes, the carrier frequency itself taking the place of the di-

rect current. The side bands will be impressed upon the input circuit through the transformer serially as before, and the networks 57 and 58 will select the detected low frequency currents to operate the loud speaker 56, the high frequency carrier finding a path of low impedance through the first shunt condensers of the networks 57 and 58, and the tuning condenser 66. Otherwise, the receiving apparatus will be as described in connection with Fig. 2. The operation will, of course, be clear without further discussion.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different form those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a system for transmitting amusement, news and the like, a plurality of sources of intelligence, means to modulate a plurality of carrier frequencies in accordance with intelligence from said sources to produce modulated side bands, means to impress the unmodulated carrier frequencies upon one circuit for transmission to a subscriber's station and means to impress the modulated side bands without the carriers upon another circuit for transmission to the subscriber's station to beat with the unmodulated carrier frequencies transmitted over said first circuit.

2. In a system for transmitting amusement, news and the like, a plurality of sources of intelligence, means to modulate a plurality of carrier frequencies in accordance with intelligence from said sources to produce modulated side bands, means to impress the unmodulated carrier frequencies upon one circuit for transmission to a subscriber's station, means to impress the modulated side bands without the carriers upon another circuit for transmission to the subscriber's station, and means at the subscriber's station for beating the transmitted side bands with a desired carrier to reproduce signaling currents corresponding to the intelligence by which the carrier was modulated at the transmitting station.

3. In a system for transmitting amusement, news and the like, a plurality of sources of intelligence, means to modulate a plurality of carrier frequencies in accordance with intelligence from said sources to produce modulated side bands, means to impress the unmodulated carrier frequencies upon one circuit for transmission to a subscriber's station, means to impress the modulated side bands without the carriers upon another circuit for transmission to the subscriber's station, means at the subscriber's circuit for selecting a desired carrier frequency to the exclusion of the other carrier frequencies, and means for beating the received side bands with the selected carrier frequency to reproduce signaling currents corresponding to the intelligence in accordance with which the selected carrier is modulated at the transmitting station.

4. In a system for the transmission of amusement, news and the like, a plurality of sources of intelligence of different types, means to modulate carrier frequencies in accordance with intelligence from said sources, a power transmission circuit, means to superpose upon said power transmission circuit unmodulated carrier frequencies corresponding to the frequencies modulated by said sources of intelligence for transmission to a receiving station, a telephone circuit over which telephonic communication takes place at ordinary frequencies, and means for selecting modulated side bands corresponding to the several sources of intelligence and superposing them without the carriers upon said telephone circuit for transmission to said receiving station and combination thereat with the carrier currents transmitted over said power circuit.

5. In a system for the transmission of amusement, news and the like, a plurality of sources of intelligence of different types, means to modulate carrier frequencies in accordance with intelligence from said sources, a power transmission circuit leading to a subscriber's station, means to superpose upon said power transmission circuit unmodulated carrier frequencies corresponding to the frequencies modulated by said sources of intelligence, a telephone circuit over which telephonic communication takes place at ordinary frequencies leading to said subscriber's station, means for selecting modulated side bands corresponding to the several sources of intelligence and superposing them without the carriers upon said telephone circuit, and means at the subscriber's station for beating the transmitted side bands with a desired carrier to reproduce signaling currents corresponding to the intelligence by which the carrier was modulated at the transmitting station.

6. In a system for the transmission of amusement, news and the like, a plurality of sources of intelligence of different types, means to modulate the carrier frequencies in accordance with intelligence from said sources, a power transmission circuit leading to a subscriber's station. means to superpose upon said power transmission circuit unmodulated carrier frequencies corresponding to the frequencies modulated by said sources of intelligence, a telephonic circuit over which telephonic communication takes place at ordinary frequencies leading to said subscriber's station, means for selecting modulated side bands corresponding to the several sources of intelligence and superposing them

without the carriers upon said telephone circuit, means at the subscriber's circuit for selecting a desired carrier frequency to the exclusion of the other carrier frequencies, and means for beating the received side bands with the selected carrier frequency to reproduce signaling currents corresponding to the intelligence in accordance with which the selected carrier is modulated at the transmitting station.

7. In a signaling system, a power circuit leading to a subscriber's station and a telephone circuit leading to a subscriber's station, a plurality of modulators, a source of alternating power current for said power circuit, means to produce and select harmonics of the frequencies supplied by said power circuit to be used as carrier frequencies, means to impress said carrier frequencies on said modulators and upon said power circuit, means to impress signaling currents upon said modulators, thereby producing modulated side bands and unmodulated carrier currents, and means to select the modulated side bands to the exclusion of the carrier frequencies and superpose them upon said telephone circuit.

8. In a signaling system, a power circuit leading to a subscriber's station and a telephone circuit leading to a subscriber's station, a plurality of modulators, a source of alternating power current for said power circuit, means to produce and select harmonics of the frequencies supplied by said power circuit to be used as carrier frequencies, means to impress said carrier frequencies on said modulators and upon said power circuit, means to impress signaling currents upon said modulators, thereby producing modulated side bands, means to select the modulated side bands to the exclusion of the carrier frequencies and superpose them upon said telephone circuit, means at the subscriber's station for selecting a desired carrier frequency, and means for beating the transmitted side bands with a selected carrier to reproduce signaling currents corresponding to the intelligence by which the carrier was modulated at the transmitting station.

9. In a signaling system, a power circuit leading to a subscriber's station and a telephone circuit leading to a subscriber's station, a plurality of modulators, a source of alternating power current for said power circuit, means to produce and select harmonics of the frequencies supplied by said power circuit to be used as carrier frequencies, means to impress said carrier frequencies on said modulators and upon said power circuit, means to impress signaling currents upon said modulators, thereby producing modulated side bands, means to select the modulated side bands to the exclusion of the carrier frequencies and superpose them upon said telephone circuit, means at the subscriber's station for selecting a desired carrier frequency to the exclusion of the other carrier frequencies, and means for beating the received side bands with the selected carrier frequency to reproduce signaling currents corresponding to the intelligence in accordance with which the selected carrier is modulated at the transmitting station.

10. In a signaling system, a transmitting station and a receiving station, independent transmission circuits interconnecting said stations and means at the transmitting station for modulating a plurality of carrier frequencies in accordance with signaling currents to produce modulated side bands, means to transmit the unmodulated carrier frequencies to the receiving station over one of said circuits, and means to transmit the modulated side bands exclusive of the carrier frequencies to said receiving station over the other circuit.

11. In a signaling system, a transmitting station and a receiving station, independent transmission circuits interconnecting said stations, means at the transmitting station for modulating a plurality of carrier frequencies in accordance with signaling currents to produce modulated side bands, means to transmit the unmodulated carrier frequencies to the receiving station over one of said circuits, means to transmit the modulated side bands exclusive of the carrier frequencies to said receiving station over the other circuit, and means at the receiving station to beat the side bands transmitted over one of the circuits with a selected carrier frequency transmitted over the other circuit to produce a low frequency signal corresponding to the signal by which the selected carrier was modulated at the transmitting station.

12. In a signaling system, a transmitting station and a receiving station, independent transmission circuits interconnecting said stations, means at the transmitting station for modulating a plurality of carrier frequencies in accordance with signaling currents to produce modulated side bands, means to transmit the unmodulated carrier frequencies to the receiving station over one of said circuits, means to transmit the modulated side bands exclusive of the carrier frequencies to said receiving station over the other circuit, means at the receiving station for selecting any one of the carriers transmitted over the one circuit to the exclusion of the other carrier frequencies, and means for beating the side bands transmitted over the other circuit with the selected carrier to reproduce the signal in accordance with which the selected carrier frequency was modulated at the transmitting station.

13. In a signaling system, an alternating current power circuit and a telephone cir-

cuit, means for transmitting modulated high frequency bands over the telephone circuit, a duplex vacuum tube detector associated with the telephone circuit, means for supplying the operating current for said duplex vacuum tube detector from said alternating power circuit, a loud speaking receiver associated with said detector, and balanced connections to the detector from said power circuit so that fluctuations in the operating current supplied to the detector will balance each other in the two halves of the duplex detector.

14. In a signaling system, an alternating current power circuit and a telephone circuit, means for transmitting modulated high frequency bands over the telephone circuit, a duplex vacuum tube detector associated with the telephone circuit, means for supplying the filament heating currents for said duplex detector from said alternating power circuit, and a loud speaking receiver associated with said detector, and balanced connections to said detector from said power circuit so that fluctuations in the filament heating current supplied to said detector will balance each other in the two halves of the duplex detector.

15. In a transmission system, the method which consists in modulating each of a plurality of carrier frequencies in accordance with different signals, suppressing the carrier current components while transmitting side band components to a receiving station, and beating all of the side bands at the receiving station with an alternating wave corresponding to the carrier frequency for one of the side bands to the exclusion of waves corresponding to the carrier frequencies for other side bands to produce a signal wave within the telephone range corresponding to one of the signals only.

16. In a transmission system, the method which consists in modulating each of a plurality of carrier frequencies in accordance with different signals, suppressing the carrier current components while transmitting side band components to a receiving station, beating all of the side bands at the receiving station with an alternating wave corresponding to the carrier frequency for one of the side bands to the exclusion of waves corresponding to the carrier frequencies for other side bands to produce a signal wave within the telephone range corresponding to one of the signals only, the signal waves corresponding to the other signals being above the telephone range, and selecting the signal wave within the telephone range to the exclusion of the other signal waves.

17. In a transmission system, the method which consists in modulating each of a plurality of carrier frequencies in accordance with separate signals, suppressing the carrier frequency components while transmitting the side bands to a receiving station, impressing frequencies corresponding to the carrier frequencies upon a common circuit at the receiving station, selecting one of said frequencies to the exclusion of the others, and beating the received side bands with the selected frequency to produce a signal wave within the telephone range corresponding to one of the original signals only.

18. In a transmission system in which the signal is transmitted by means of a carrier frequency and is reproduced by a detector at the receiving station, the method which consists in transmitting a plurality of side bands corresponding to different signals without the corresponding carrier components, impressing all of the side bands upon the detector at the receiving station, and simultaneously impressing upon the detector an alternating wave corresponding to the carrier frequency for one of the side bands to the exclusion of waves corresponding to the carrier frequencies for other side bands to produce stepped down bands only one of which is within the telephonic range.

19. In a transmission system, means for modulating each of a plurality of carrier frequencies in accordance with separate signals, means to suppress the carrier frequency components while transmitting the side band components to a receiving station, means whereby an alternating wave corresponding to the carrier frequency for each side band may be produced, and means at the receiving station to beat all of the side bands with an alternating wave corresponding to the carrier frequency of one of the side bands to the exclusion of waves corresponding to other carrier frequencies, thereby to produce a signal wave within the telephone range corresponding to only one of the signals.

20. In a transmission system, means for modulating each of a plurality of carrier frequencies in accordance with separate signals, means to suppress the carrier frequency components while transmitting the side band components to a receiving station, means whereby an alternating wave corresponding to the carrier frequency for each side band may be produced, means at the receiving station to beat all of the side bands with an alternating wave corresponding to the carrier frequency of one of the side bands to the exclusion of waves corresponding to other carrier frequencies, thereby to produce a signal wave within the telephone range corresponding to only one of the signals, and means to suppress frequencies above the telephone range.

21. In a transmission system, means for modulating each of a plurality of carrier frequencies in accordance with separate signals, means to suppress the carrier frequency components while transmitting the

side band components to a receiving station, a circuit at the receiving station upon which are impressed frequencies corresponding to each of the suppressed carriers, means to select from said circuit a frequency corresponding to the carrier of a desired signal, and means to beat all of the side bands with the selected carrier to produce a signal wave within the telephone range corresponding to one of the signals only.

22. In a transmission system, means to transmit a plurality of side bands corresponding to different signals without transmitting the corresponding carriers, a receiving station including a detector, means to impress all of said side bands upon the detector, means whereby an alternating wave corresponding to the carrier frequency for each side band may be produced, and means to impress upon the detector an alternating wave corresponding to one of the suppressed carriers to the exclusion of waves corresponding to other carrier frequencies, thereby to produce a signal wave within the telephone range corresponding to only one of the side bands.

23. In a transmission system, means to transmit a plurality of side bands corresponding to different signals without transmitting the corresponding carriers, a receiving station including a detector, means to impress all of said side bands upon the detector, a circuit at the receiving station upon which are impressed frequencies corresponding to all of the suppressed carriers, means to select from said circuit a frequency corresponding to the carrier of a desired signal and impress said frequency upon the detector to produce a signal wave within the telephone range corresponding to one of the side bands only.

In testimony whereof, I have signed my name to this specification this 24th day of February, 1922.

HERMAN A. AFFEL.