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TELEPHONE SYSTEM

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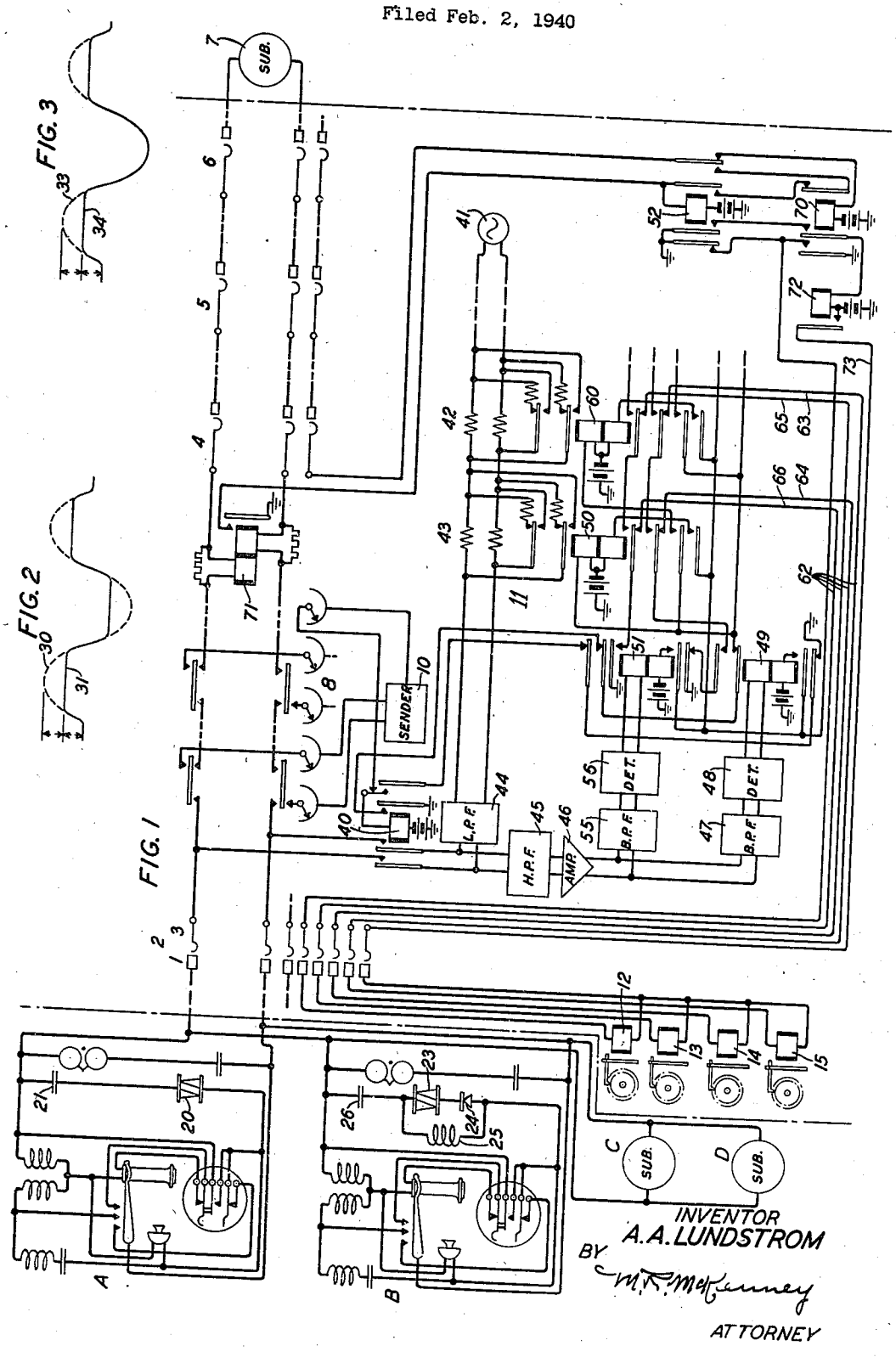

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TELEPHONE SYSTEM

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8 Claims. (Cl. 179—8.5)

This invention relates to telephone systems and particularly to improvements in systems for identifying subscribers on party lines.

An object is to obtain greater effectiveness in the use of identification tests for determining the calling subscribers on party lines.

Heretofore arrangements of this kind have been used in which the tests were performed by providing a filter or similar apparatus at each station on a party line which is antiresonant to a particular frequency applied from the central office when a call is made, and equipment provided at the central office for recognizing this condition and thereby identifying the calling party. Other systems employ devices at the different party line stations for producing oscillations on the line, the frequency of which differs according to which station is calling. These oscillations become effective when a party is calling by applying current from a direct current source at the central office for a definite period and the identification is determined by the number of oscillations received during this period. It is also known that copper-oxide rectifiers, thyrite or other similar elements having non-linear resistance characteristics may be utilized for producing current harmonics of varying characters from a sinusoidal alternating current wave, depending on the manner of connecting these elements in circuit combinations with or without other control elements such as resistance, inductance, or capacity elements. The characteristics of these harmonics may, of course, be so chosen that they produce maximum detectable and distinctive voltage characteristics or wave forms as compared with a pure sinusoidal wave from which they originate or as compared with each other. Such wave forms may, for example, be produced in which second or even third or odd harmonics predominate.

It is a feature of the applicant's invention to employ a device at each of the substations of a party line which, in response to the application of a fundamental frequency to the line at the central office when a subscriber calls, produces individually distinctive harmonics of said fundamental frequency for identifying the calling subscriber's station and means for detecting and recording at the central office the effect of the resulting wave forms for corresponding identification.

Another feature of the invention is to employ devices at some of the subscribers' stations on the party line for producing, in addition to any others, second or even harmonics and at other substations for producing only third or odd harmonics and detecting devices at the central office that distinguish between the resulting wave form from said harmonics to identify a calling party.

Another feature of the invention is to employ devices at substations that produce harmonics of the maximum distinctive characteristics obtainable from the fundamental sinusoidal wave transmitted from the central office, that is, the ratio of harmonic energy produced by said devices as compared to the fundamental frequency energy delivered to said devices is the highest obtainable. These devices at the substation may comprise copper-oxide rectifiers, thyrite or other elements of non-linear resistance characteristics variously connected to the line to produce the desired harmonics.

Another feature of the invention is to provide devices at the subscribers' stations that produce wave forms which contain either odd only or even plus any other harmonics of different energy levels for different subscribers' stations on the party line, and devices at the central office for applying a fundamental sinusoidal wave that varies in its energy level in steps so that when a certain party is calling a wave form of a certain energy level may be produced when the corresponding sinusoidal wave of a corresponding energy level is applied at the central office, said wave forms being distinguished at the central office to identify the party calling.

The applicant's invention has been disclosed in the accompanying drawing in which:

Fig. 1 shows a telephone system in which a party line is connected to four party line subscribers' stations and to a central office circuit for detecting and recording a call from any one of these stations; and in which

Figs. 2 and 3 show wave form diagrams indicating voltage characteristics obtained by the devices which contain the harmonics employed to identify calling parties.

Referring now to the drawing, the four parties A, B, C, and D are provided with standard subscriber station telephone circuits to which the applicant's invention has been added. These circuits are connected to a common party line terminating in terminals 1 at the central office in a line finder 2. The brushes 3 and some minor diagrammatic symbols only of this line finder have been shown, as any well-known type of line finder may be employed. This line finder is connected to a first selector 4 that has access to secondary selector switches such as 5 which, in turn, have access to connectors such as 6 through

which connections may be established to called lines such as 7. These switches have only been shown in diagrammatic form as any well-known types may be employed. Line finder 2 has access through a sender selector 8 to a sender 10 of any well-known type for registering the digits representing a called line for control of the succeeding switches to establish a connection to a called subscriber in a manner well known in the art. The sender 10 is provided with means for connecting circuit arrangement 11 which is provided in accordance with the applicant's invention to detect and identify the calling subscriber and record calls on the corresponding registers such as 12, 13, 14, or 15, shown connectable through the line finder 2 to circuits 11 for this purpose.

In regard to the equipments at the stations of parties A, B, C, or D, standard telephone circuits are employed with the applicant's invention added thereto. For the party at station A this invention is represented by a thyrite element 20 or a similar element having non-linear resistance characteristics connected in parallel across the line conductors through the condenser 21 and contacts of the dial and switchhook of the telephone set. This is for the purpose of producing one type of identifying test when the subscriber is calling. At station B, the thyrite element 23 is provided and connection in series with a copper-oxide rectifier 24, and an inductance 25 is connected in shunt of these elements across the line conductors through the condenser 26 and contacts of the associated dial and switchhook of this set. This is for the purpose of providing another type of identifying test when the subscriber at B is calling. At station C the same arrangement of elements is provided as at station A and at station D the same arrangement of elements is provided as at station B except that the operating characteristics of the elements at these two stations are effective only on a lower energy level in a manner to be hereinafter described. The elements at stations A and C, when subjected to alternating currents of a certain energy level from the central office, cause individually distinctive harmonics that are of the odd or third order only of the fundamental frequency applied at the central office and the elements at stations B and D when subject to the same fundamental frequency from the central office cause individually distinctive harmonics that are of the even or second order plus any others.

To produce the third harmonics only, thyrite elements are placed across the line through blocking condensers at stations A and C. The thyrite has a voltage current characteristic which, when an alternating sinusoidal fundamental frequency current is flowing through it, the resultant voltage set up across itself will appear as a sine wave whose positive and negative half cycles are cut off before they reach their full amplitudes (see, for example, Fig. 2). This voltage wave which contains the fundamental frequency and only the third order harmonics thereof is propagating on the subscriber end of the line third order harmonics only which are detected at the central office. Further, at subscriber stations B and D, in addition to the blocking condenser and thyrite, there is located in series with them a copper-oxide rectifier which in series with the thyrite is shunted by an inductance. The function of the rectifier and inductance is to cause a voltage wave to be set up across the line which has the same shape as the sinusoidal fundamental frequency except that only one polarity of half cycle is not allowed to reach its full amplitude (see Fig. 3, for example). This voltage wave contains second or even order harmonics in addition to third order harmonics. The second harmonic terms are larger than the following third order terms but the difference between the third harmonics of stations A and C will not be sufficiently greater than those of stations B and D. Hence, the distinction between stations A and C and stations B and D will be made on the basis on either receiving an odd harmonic alone or an even harmonic whether it be accompanied or not by other harmonics.

In order to produce harmonics which represent a maximum effective distorted voltage wave form as the result of the alternating current supplied at the central office, it has been found that the distinctive elements at the subscribers' stations must be adjusted in regard to their non-linear resistance characteristics so that the resultant wave forms have a peak voltage of one-half of that of the peak voltage as applied at the central office. For example, if reference is made to Fig. 2, the wave form 30 represents the voltage of the fundamental applied alternating current which is, of course, a sinusoidal wave. The most efficiently distorted wave form for the third harmonic is shown at 31 which has a peak value of one-half that of the sinusoidal wave form, but otherwise follows as closely as possible the wave form of the applied voltage and, consequently, represents a most efficiently distorted voltage wave for this harmonic. Similarly, if reference is made to Fig. 3, 33 represents the voltage wave of the fundamental applied alternating current which is, of course, sinusoidal in character and 34 represents the most efficiently distorted voltage wave form for the second harmonic wave which has a peak voltage of one-half of that of the applied voltage during every other half cycle period but otherwise follows as far as possible the wave form of the applied voltage and thus represents the most efficiently distorted voltage wave for this harmonic.

Referring now to the circuits at the central office in particular, if it is assumed that the subscriber at A calls, the line finder 2 is actuated to connect brushes 3 with terminals 1 of the calling party line and a connection is established through the sender selector 8 to an idle sender 10. This sender 10 is then operated to actuate relay 40 over a circuit from battery, winding of relay 40, make-before-break contacts of this relay, through a contact and a brush of the sender selector 8 to a ground that may be momentarily supplied at this time in the sender 10. Relay 40 now locks to a ground supplied through contacts of relays 49 and 51. This in turn causes alternating current from the source 41 to be connected through the attenuation pads 42 and 43, the low-pass filter 44, contacts of relay 40, tip and ring brushes 3 and terminals 1 in the finder 2 over the tip and ring conductors through the loop comprising the condenser 21 and thyrite elements 20 and contacts of the dial and switchhook of the calling subscriber's circuit at A. As the energy level of the applied voltage from the source 41 is at a low level, as determined by the pads 42 and 43, third harmonics will not be produced by the elements 20 of sufficient energy level to be sent back over the line conductors through the high-pass filter 45, the amplifier 46 and the

third harmonic band-pass filter 47 and detector 48 to cause the operation of relay 49 over its upper winding. Consequently, relay 50 will have time to operate in a circuit from battery, upper winding of relay 50, contacts of relays 49, 51 and 40 to ground. This relay 50, in operating, closes a locking circuit for itself from battery, lower winding of this relay and its lower outer armature and front contact to ground at contacts of relay 52. It should now be noted that this relay 50, in operating, removes the pad 43 from the circuit to the alternating current source 41 and thus causes the energy level of the current thereof to be increased. The effect of this increase now causes the element 20 to produce third harmonics of a sufficient energy level to pass through the above-traced circuit to cause relay 49 to operate. Relay 49, in operating, closes a locking circuit for itself from battery through the lower winding and its own contacts to ground at contacts of relay 52. Relay 49 opens the locking circuit for relay 40.

Had the party at station C called instead of the party at A, the element at station C corresponding to element 20 at station A would have been satisfied with the lower energy level of the current from source at 41 and would have operated to produce third harmonics of an energy level sufficient to cause the operation of relay 49 before relay 50 has a chance to operate, and relay 49, in operating, would have opened the energizing circuit for relay 50. On the other hand, if the party at station B had called, the current from the source 41 when first applied would not have been sufficient to produce second plus any other harmonics of an energy level sufficient to operate relay 51 over the path above described as far as through the amplifier 46 and from there on through the band-pass filter 55, detector 56 and upper winding of relay 51. Hence, in this case relay 50 would have operated over its operating circuit as hereinbefore traced to remove the pad 43 from the circuit for the source 41. When this pad was removed, the elements 23, 24 and 25 at station B would produce second harmonics of an energy level sufficient to operate relay 51. Relay 51 would then close a locking circuit for itself from battery through its lower winding and its own contacts to ground at relay 52.

However, the third harmonic from station B may be of sufficient magnitude to operate relay 49 also, but, since relay 51 is operating, it (relay 51) therefore removes ground from the upper outer armature of relay 49 so that it can not register. This also applies to station C because its elements are also arranged to send out second harmonics as well as third harmonics. However, had the subscriber at station D called, the elements 23, 24 and 25 at this station would have immediately sent out second harmonics of a sufficient energy level to operate 51 before relay 50 had a chance to operate and when relay 51 operated it would open the energizing circuit for relay 50. It will, therefore, be seen that in case the subscriber at A calls, relays 49 and 50 will operate; in case the subscriber at C calls, relay 49 only will operate; in case the subscriber at station B calls, relays 51 and 50 will operate; and in case the subscriber at station D calls relay 51 only will operate. It should be mentioned here that in case, for example, two additional parties are provided on the party line, relays 50 and 60 would operate in succession before either relay 51 or 49 operates in order to identify the parties having distortive elements that could not produce harmonics of the required energy levels until both pads 43 and 42 are removed from the circuit for source 41. Additional relays, such as 50 and 60, may be added to remove additional pads of the type shown at 42 and 43 if a larger number of parties are added to the party line.

The relays 51, 49 and 50 will switch one of the leads 62 to be connected to ground, depending on which party is calling. If the party at station A calls, relays 49 and 50, in operating, close a connection for lead 63 from ground, contacts of relays 51, 49, 50 and 60 to lead 63. If the party at station C calls, relay 49 only operates, closes a circuit for lead 64 from ground, contacts of relays 51, 49 and 50 to lead 62. In case the party at B calls, relays 51 and 50 will operate to ground to close a circuit for lead 65 from ground, contacts of relays 51, 50 and 60 to lead 65, and in case the party at D calls, relay 51 only will operate to close a circuit for lead 66 from ground, contacts of relays 51 and 50 to lead 66.

This is all that occurs in the identification circuit at this time. When now the subscriber dials the number, it is recorded in the sender and the sender will then cause a connection to be established through selectors 4 and 5 and connector 6 to the called subscriber 7. This closes the usual connection to ground for the sleeve lead through these switches and thereby causes the operation of relay 70 from battery, winding of relay 70, contacts of relay 52 to this ground on the sleeve. Then when the called subscriber answers, current is reversed in the usual manner to cause the operation of relay 71. The operation of relay 71 closes an obvious circuit for the operation of relay 52. The holding ground for relay 49 or 51 and relay 50, if operated as hereinbefore mentioned, will thereby be removed, but relay 70, in operating, will provide a substitute ground for holding the relay mentioned operated. Relay 52 will now release relay 70, but before this relay releases, a connection is established for the operation of relay 72 from battery through the winding of this relay, contacts of relays 70 and 52 to ground. Relay 72, in operating, closes a connection from battery through its own contacts to lead 73 which, as shown, is connected through a corresponding brush and a terminal of the line finder 2 to one of the registers 12, 13, 14 and 15 and, depending on which lead 63, 64, 65 or 66 is provided with a ground connection, a corresponding register 12, 13, 14 or 15 will operate as it was assumed that the subscriber at A called the lead 63 which will be grounded and, consequently, register 12 will operate to register the call. When relay 70 releases, a locking circuit is provided for relay 52 from battery through the winding of this relay, its own contacts, contacts of relay 70, contacts of relay 52 to the ground over the sleeve connection at the selector 4. Relay 70, in releasing, opens the circuit for relay 72, which releases and removes the battery from lead 73 to release the register 12. Relay 70 also releases any other relay, 51, 49 or 50, that may be operated and the identification circuit is thereby restored to normal and, the sender 10 having in the meantime been dismissed, the connection between the calling subscriber and the called subscriber is now cleared for talking.

What is claimed is:

1. In a telephone system, a party line terminating at one end in a plurality of party line subscriber stations, and at the other end in a central office, a source of alternating current at

said central office, means responsive to the removal of the receiver at any one of said stations for connecting said source to the line, means responsive to the flow of current from said source for producing in said line second or third harmonics of the fundamental frequency of said current that are individually distinctive in regard to their energy levels for each station, and means at the central office responsive to said harmonics for identifying the calling party.

2. In a telephone system, a party line terminating at one end in a plurality of party line subscriber stations, and at the other end in a central office, a source of alternating current at said central office, elements at each substation having non-linear resistance voltage characteristics, means responsive to the removal of the receiver from the switchhook at any one of said stations for connecting said source to said line, said elements being so adjusted and arranged at the stations that when current from said source is applied to said line, the energy level of said source is adjusted and applied to said elements to produce harmonics in said line of the fundamental frequency of the currents from said source that are individually distinctive for each calling subscriber's station, and means at said central office responsive to said harmonics for identifying a calling party.

3. In a telephone system, a party line terminating at one end in a plurality of party line telephone stations and at the other end in a central office, a source of alternating current at said central office, an element of non-linear resistance characteristic connected across the line conductors at one of said stations and in addition a rectifier connected in series with said two elements and a reactance connected in shunt of said two elements and the rectifier at another of said stations, the elements of said first-mentioned station being adjusted to produce in said line harmonics of the third order and the elements at said second-mentioned stations being adjusted to produce in said line harmonics of the second order when currents from said source are applied to said line, means responsive to the removal of the receiver from the switchhook at any one of said stations for connecting said source to said line so as to produce corresponding harmonics individually distinctive in regard to their energy levels for each calling station, and means at said central office responsive to the harmonics in said line produced at a calling station for identifying it.

4. In a telephone system, a party line terminating at one end in a plurality of party line subscriber stations and at the other end at a central office, a source of alternating current at the central office, an element of non-linear resistance characteristics connected across the line conductors at some stations and in addition a copper-oxide rectifier connected in series with said non-linear element and a reactance connected in shunt to said non-linear element and the rectifier at other stations, the elements at certain of said first-mentioned stations being responsive to alternating current from said source at a certain energy level to produce harmonics of the third order of a corresponding energy level and the elements at certain other of said first-mentioned stations being responsive to alternating current from said source at a certain different energy level to produce harmonics of the third order of a corresponding energy level and said elements at certain of said last-mentioned stations being responsive to alternating currents from said source at certain energy levels to produce harmonics of the second order of a corresponding energy level, said elements at said certain other of said second-mentioned stations being responsive to alternating current from said source at a certain different energy level to produce harmonics of the second order at a corresponding energy level, means responsive to the removal of the receiver from the switchhook at any one of said stations for connecting said source to the line and adjusting the energy level thereof so that the elements at the calling station will produce a corresponding distinctive harmonic in said line and means at the central office responsive to said harmonic for identifying the calling station.

5. In a telephone system, a party line terminating at one end in a plurality of party line subscriber stations, and at the other end at a central office, a source of alternating current at the central office, an element of non-linear resistance characteristics connected across the line conductors at some stations and in addition a rectifier connected in series with said element and a reactance connected in shunt to said element and the rectifier at other stations, said elements at certain of said first-mentioned stations being responsive to alternating current from said source at a certain energy level to produce harmonics of the third order of a corresponding energy level and the elements at certain other of said first-mentioned stations being responsive to alternating current from said source at a certain different energy level to produce harmonics of the third order of a corresponding energy level and the elements at certain of said last-mentioned stations being responsive to alternating currents from said source at certain energy levels to produce harmonics of the second order of a corresponding energy level, and the elements at certain other of said second-mentioned stations being responsive to alternating current from said source at a certain different energy level to produce harmonics of the second order at a corresponding energy level, means at the central office responsive to the removal of the receiver from the switchhook at a calling station for connecting said source to said line at a certain lower energy level of the applied voltage for testing whether the elements at the calling station are adjusted to produce harmonics of a corresponding lower energy level or whether the elements require the application of voltage at the central office from said source at a higher energy level for producing harmonics at the corresponding higher energy level, means operative in case the elements producing the desired harmonics at the lower level for identifying the calling party and operative in case the elements at the calling station do not produce the desired harmonics for raising the energy level of the applied voltage and for identifying the calling party in this latter case.

6. In a telephone system, a party line terminating at one end in a plurality of party line subscriber stations and at the other end in a central office, a source of alternating current at said central office, means responsive to the removal of the receiver from the switchhook at any one of said stations for applying to said line voltage waves of the fundamental frequency as produced by said source and of varying energy levels depending on the station calling, and for producing in said line second or third harmonics

of the fundamental frequency of an energy level corresponding to the energy value of the voltage as applied by the source, said harmonics being of individually distinctive character for each station calling, and means operative in response to said introduced harmonics for identifying the calling party.

7. In a telephone system, a party line terminating at one end in a plurality of party line subscriber stations, and at the other end in a central office, a source of alternating current at said central office, means responsive to the removal of the receiver at any one of said stations for connecting said source to the line, means responsive to the flow of current from said source for producing in said line, second or third harmonics of the fundamental frequency of said current that are individually distinctive with regard to the energy level for each station and means at the central office for identifying the calling party solely dependent for its operation on the character of the particular harmonics produced and the energy level thereof.

8. In a telephone system, a party line, terminating at one end in four party line subscriber stations and at the other end in a central office, a source of alternating current at said central office, means responsive to the removal of the receiver at any one of said stations for connecting said source to the line, means responsive to the flow of current from said source for producing in said line second harmonics of the fundamental frequency of said current if either of two of said stations is calling and responsive to the flow of current from said source for producing in said line third harmonics of the fundamental frequency of said current if either of the two other stations is calling with the energy of either harmonic being of a lower level if a certain one of the stations in each pair is calling than if either of the other stations of said pairs is calling, and means at the central office responsive to either of said harmonics and to the low or high energy levels thereof to identify the calling station.

ALEXIS A. LUNDSTROM.