(No Model.) 3 Sheets—Sheet 1.

M. HUTIN & M. LEBLANC.

MULTIPLE TELEPHONY.

No. 522,564. Patented July 3, 1894.

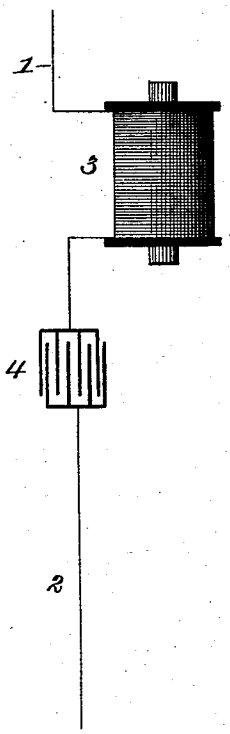

Fig. 1.

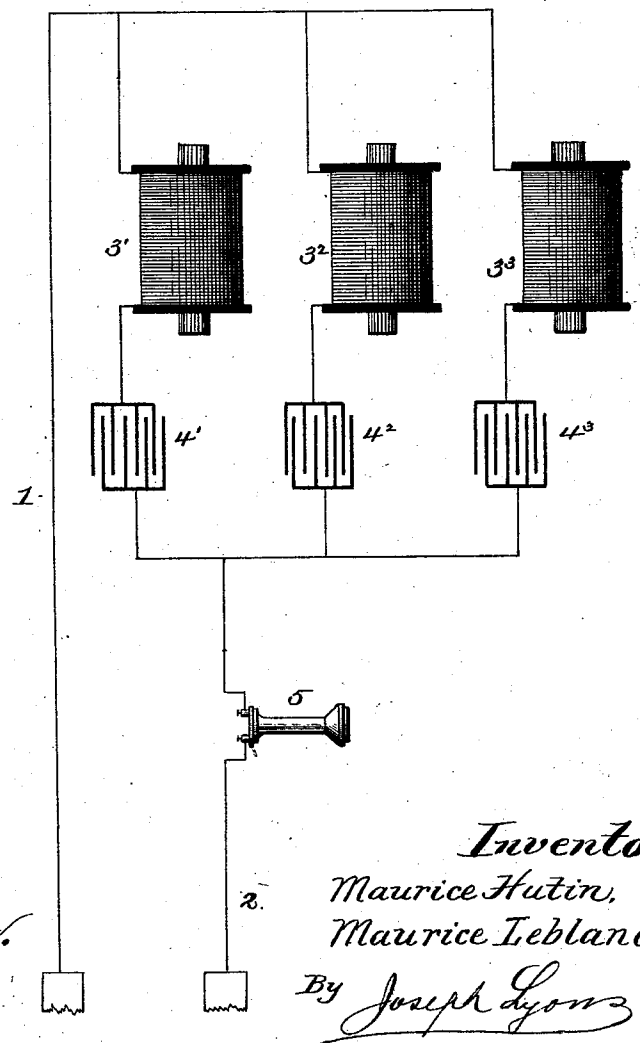

Fig. 2.

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(No Model.) 3 Sheets—Sheet 2.

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MULTIPLE TELEPHONY.

No. 522,564. Patented July 3, 1894.

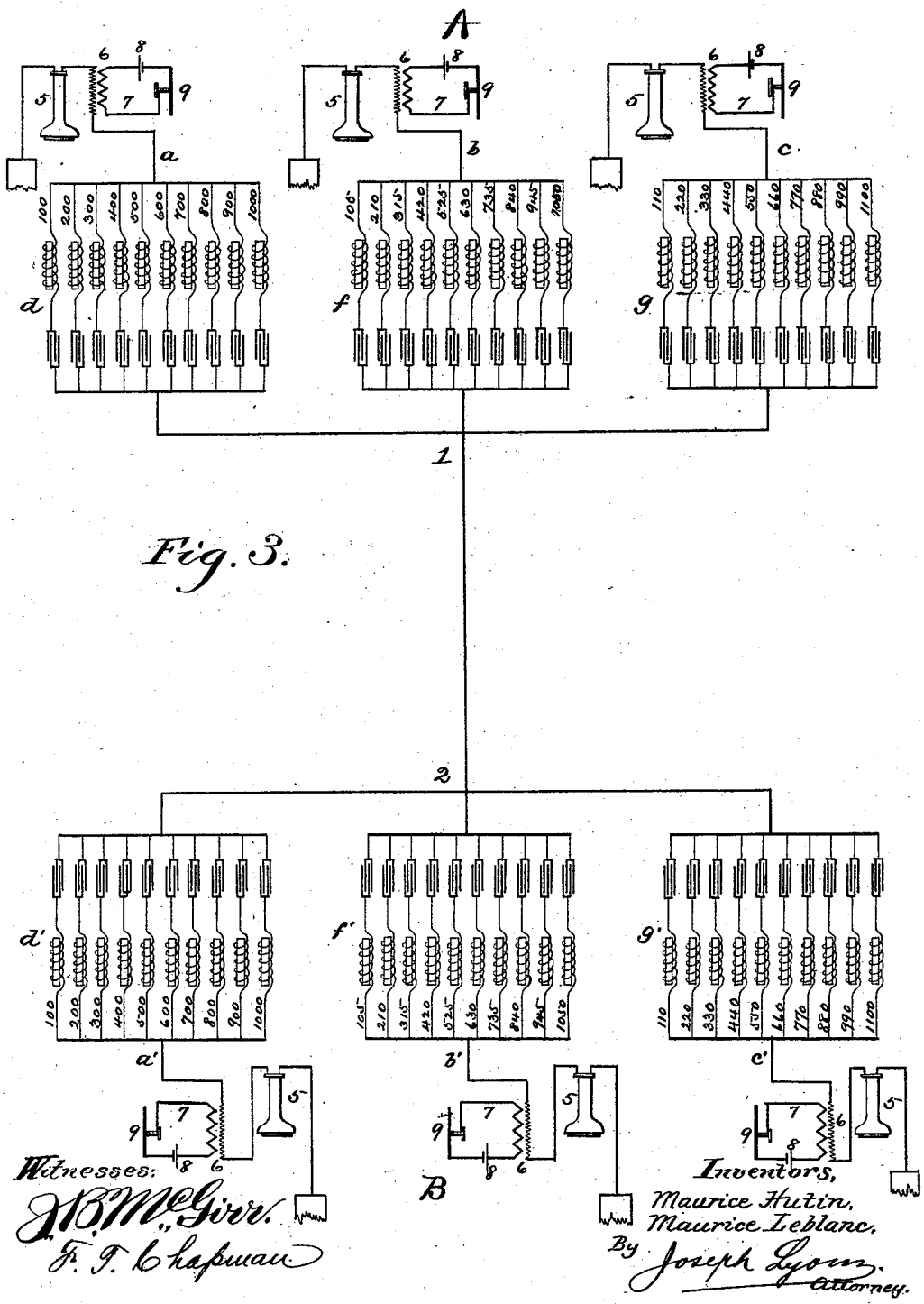

Fig. 3.

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MULTIPLE TELEPHONY.

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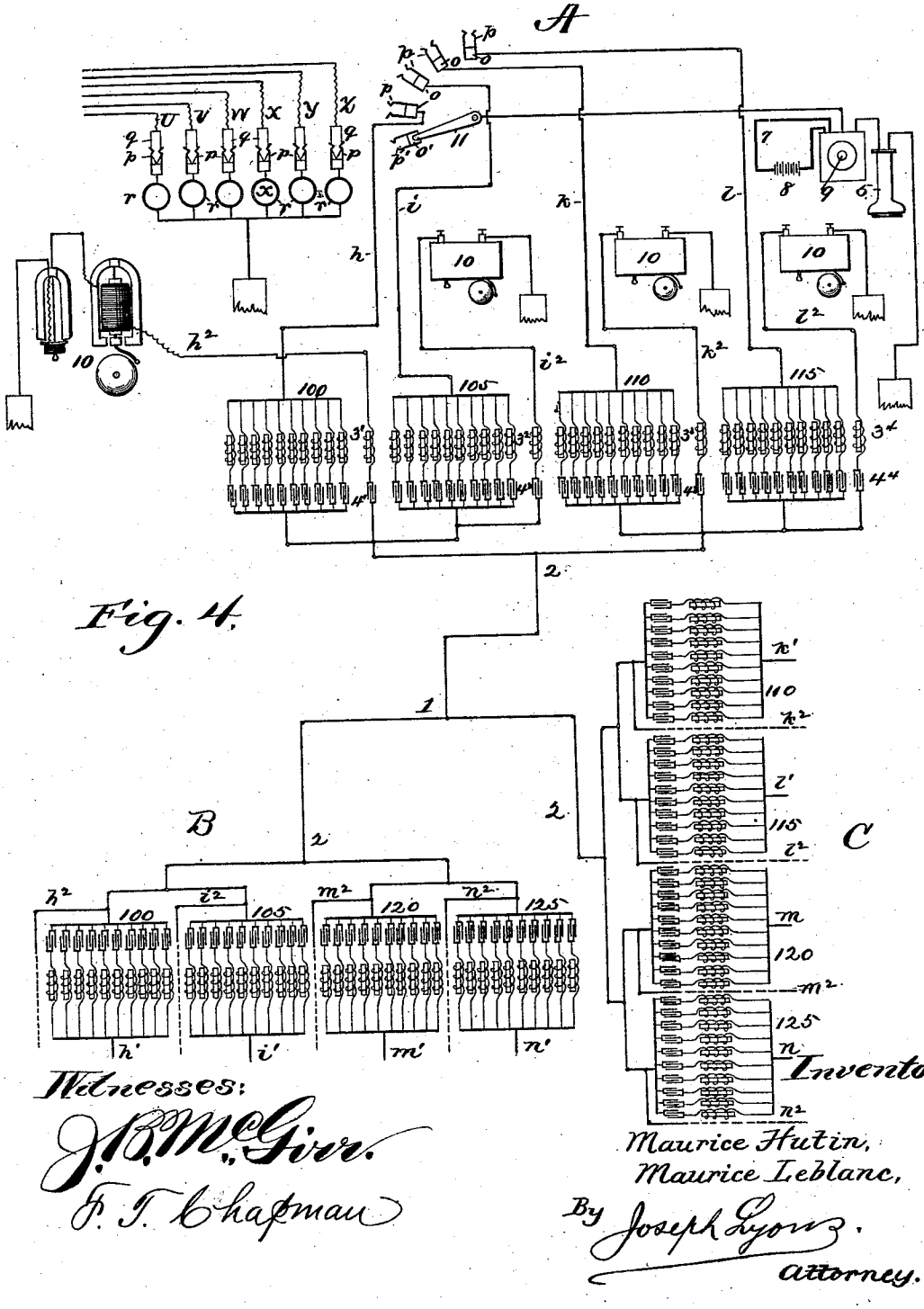

Fig. 4.

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UNITED STATES PATENT OFFICE.

MAURICE HUTIN AND MAURICE LEBLANC, OF PARIS, FRANCE.

MULTIPLE TELEPHONY.

SPECIFICATION forming part of Letters Patent No. 522,564, dated July 3, 1894.

Application filed June 1, 1894. Serial No. 513,188. (No model.) Patented in France December 13, 1893, No. 234,785; in England April 6, 1894, No. 6,888, and in Belgium April 10, 1894, No. 109,416.

To all whom it may concern:

Be it known that we, MAURICE HUTIN and MAURICE LEBLANC, citizens of the Republic of France, and residents of Paris, Department of the Seine, Republic of France, have invented certain new and useful Improvements in Multiple Telephony, of which the following is a specification, and for which we have obtained patents in France, No. 234,785, dated December 13, 1893; in Belgium, No. 109,416, dated April 10, 1894, and in England, No. 6,888, dated April 6, 1894.

Our invention has reference to improvements in the art of telephony, its object being to transmit between two or more central stations connected by a single line or net-work of connected lines, telephonic messages simultaneously in all directions without interference with each other. By an extension or amplification of our system we are also enabled to establish simultaneous telephonic intercommunication between the subscribers whose lines terminate at the different central stations.

The invention is based upon the following facts and considerations: Over a line having a given coefficient of self induction and a given static capacity, alternating currents of only a certain definite frequency can be passed without suffering undue diminution of volume, while currents of all other frequencies are weakened to such extent that they are practically of no value. It is, therefore, possible to so adjust the coefficient of self induction and the static capacity of a line that only alternating currents of a desired frequency can be passed over the same for practical purposes.

Another fact upon which this invention is based is the following: The sounds which compose articulate speech are generally looked upon, each as the combination of a number of simple musical tones, one of which, namely—the one which has the lowest pitch, is called the fundamental tone, while the others of higher pitch are known as the upper harmonics, or overtones. The quality of the sound or composite tone depends upon the numbers of the overtones and upon the relative intensities of the same with reference to each other and to the fundamental tone. Each sound or composite tone which is found in articulate speech can, therefore, be resolved into a number of components which have a harmonic relation to each other; the pitch of the fundamental tone is, in that case, the pitch of the sound. Now we have found that, just as in mechanics any force can be resolved into any number of components, so also can a composite tone, or, as it may properly be called, a resultant sound, be resolved into a great number of harmonic components, each being a simple musical tone, and the fundamental of these tones being of much lower pitch than that of the resultant composite tone. This resolution of the resultant tone into a great number of simple upper harmonics of a very low pitch fundamental, is a purely mathematical process, which perhaps cannot be perfectly realized experimentally. When these components are again combined by the inverse mathematical process, the original resultant tone is again obtained. Now we have found that if in the process of recombination of these components a number of them are omitted, the resultant thus obtained does not greatly differ from the true resultant which is obtained when all the components are utilized in the synthesis. From this it follows that articulate speech can be reproduced in a manner to be recognized by reproducing a considerable number but not all of its simple components, and the correctness of this conclusion we have verified by the apparatus which is used in the realization of our invention. The effect of our process upon the ear is about the same as the effect upon the eye when a faintly colored glass is interposed between the same and a colored picture; the details and the relative color values of the picture are still recognized, although of course slightly differentiated. Similarly, by reproducing some but not all of the simple sound components, the quality of the resultant sound is still recognized, although somewhat differentiated.

The manner in which we utilize these principles for multiple telephony will more fully appear from the following detailed description with reference to the accompanying drawings, in which—

Figure 1 is a representation, mainly in dia-

gram of an electric resonator; Fig. 2, a diagram, showing the combination of several electric resonators, constituting an electric current selector. Fig. 3, is a diagram of a system of multiple telephony between two stations, and Fig. 4 is a diagram of a complete system of multiple telephony between the subscribers of three distinct central stations.

Like letters and numerals of reference indicate like parts.

Referring now to Fig. 1, there are shown, included in a line 1, 2, a reaction coil 3, and a condenser 4, and for the sake of simplicity it is assumed that the coefficient of self induction and the static capacity of the line wire are so small as to be practically of no value; therefore, the self induction of the coil is, for all practical purposes, that of the line as whole and the capacity of the condenser is also that of the line as a whole.

We have shown in other pending applications that if a great number of sources of alternating currents of different frequencies are simultaneously connected with a line having a given self induction and a given capacity, only currents having a certain frequency will pass over the line with sufficient volume to actuate a translating device in the circuit, while all other currents will be so weak as to have no practical value. Since there is a definite relation between the coefficient of self induction of a line and its static capacity, on one hand, and the frequency of an alternating current that may be passed with effective intensity over the same on the other hand, it is clear that by proper selection of reaction coils and condensers, a line may be so equipped that it will carry, effectively, currents of one definite frequency, and no other. A circuit thus equipped, therefore, behaves toward alternating currents in about the same manner as a Helmholtz resonator toward sound vibrations, and on account of this analogy we have called such circuits "electric current resonators," or "electric resonators," simply. These terms are also applied to the combined reaction coil and condenser, not including the line in which they are placed, and we speak accordingly of an electric resonator for the frequency 1,000 or 2,000, or for any other number.

In the practice of our invention a number of electric resonators, each for a different frequency, are combined together to form a group for joint operation; this is shown conventionally in Fig. 2.

In the line 1, 2, are inserted the three resonators composed respectively of the reaction coils and condensers $3'$, $4'$, 3^2 4^2, 3^3 4^3, constructed for the frequencies, say of 100, 200, 300, respectively. Supposing now, that the line is connected simultaneously with a great number of sources of alternating currents, each having a different frequency, such for instance as 50, 80, 100, 150, 200, 260, 300, 340, &c. It is clear from what has been said, that of all these currents, only those having the frequencies 100, 200 and 300, will pass with effective intensity over the line as follows: currents of frequency 100, through the resonator $3'$, $4'$; currents of frequency 200, through the resonator 3^2, 4^2, and currents of frequency 300, through the resonator 3^3 4^3.

All other currents will be practically excluded, and a translating device 5, in the main circuit will be acted upon simultaneously by the currents having the frequencies 100, 200 and 300, and by no other currents. If the translating device 5 is a telephone, as shown, it will emit a sound composed of three simple musical tones.

A group of electric resonators, connected in multiple arc, as shown in Fig. 2, or in any other suitable manner, for joined operation, we call an electric current selector, or current selector or selector, simply; it may be composed of any number of resonators and by preference for practical work, all the resonators composing a current selector will be united in one structure, as shown and described in other pending applications.

A simple system of multiple telephony, in accordance with the principles hereinbefore set forth, is represented in Fig. 3.

Two telephone stations A, B, are connected by a single main line 1, 2, which at each station splits into a number of grounded branches; in the present instance we show three such branches, a, b, c and a', b', c', respectively, and in these branches are included the electric current selectors d, f, g and d', f', g', the secondary coils of inductoriums or transformers 6, and the telephones 5. In place of the ground connections a common return wire may be used.

Each current selector is composed of a number of electric resonators, and in the present instance we have shown ten resonators for each selector. The resonators are illustrated by the conventional representations of reaction coils and condensers and each resonator is marked with the number designating the frequency of alternating current for which it is constructed.

In the example here shown, the selectors d and d' are composed of resonators for the frequencies 100, 200, 300—1,000; the selectors f and f' are composed of resonators for the frequencies 105, 210,—1,050, and the selectors g and g' are composed of resonators for the frequencies 110, 220,—1,100. Each selector thus has a wide range of current frequencies, corresponding to a low fundamental tone and its nine upper octaves, since each alternation of current produces a complete vibration of the diaphragm in a telephone. The fundamental frequency of each selector should be considerably lower than the number of vibrations corresponding to the deepest vocal sound that can be produced in speaking or singing, and if it should be found that the fundamentals 100, 105, 110 are too high, much lower fundamentals, such as 50, 55, 60, may be chosen, and the resonators of the selectors

are then graduated accordingly. With this understanding it will be assumed, for the purposes of this specification, that the tone, corresponding to one hundred and ten vibrations per second is deeper than any vocal sound that can be produced. Consequently, the vocal sounds that can be produced may be resolved into a great number of components which are upper harmonics of such low fundamental tones as correspond to one hundred, one hundred and five, or one hundred and ten vibrations per second. If instead of recombining all of these components, only the fundamental tone and its nine upper harmonics are recombined, the resultant sound will slightly differ from the original sound, but will have such near resemblance to the same that its main characteristics will be about the same. If, for instance, the original sound, was the vowel sound "Ah," the resultant of the combination of the ten tones represented by any one of the selectors, would still be the vowel "Ah," but with a peculiarity of characteristic somewhat different from the original sound and dependent upon the particular ten tones of which it is composed. The three combinations represented by the three selectors in this case, would therefore result in three slightly different Ahs, but each of them would be recognized as an Ah.

The primary coil of each inductorium 6, is included in a local circuit 7, in which there is also a battery 8, and a microphone 9.

The operation of this system will now be readily understood.

If a sound within the range of human organs of speech is uttered against the microphone 9 controlling the local branch a at station A, there will be generated in the secondary coil of the inductorium 6, only ten sets of alternating currents, namely—such as have the frequencies 100, 200—1,000, since no other alternating currents can pass the selector d; these currents cannot pass any of the other selectors at station A, and can only pass through selector d', at station B. Consequently these currents with all their variations of intensity will pass through no other telephone receiver at station B, except the receiver in the local branch a', and an adequate although not perfect reproduction of the sound uttered against the diaphragm of the microphone at station A, will be heard at the receiver in the local branch a', at station B, and in no other receiver; the home receiver at station A, being of course excepted. Thus, while the local branches a, a', converse with each other, the local branches b, b', and the local branches c, c', may also converse with each other, each without interference with the others.

It will be understood that any number of local branches may be formed at each station, so that any number of independent conversations may be carried on over a single main line. A system of this kind is especially adapted for long distance telephony, when the two stations A and B, are equipped with a great number of branches of the kind described. The system represented in Fig. 3, has the inconvenience that persons in one city, say in Albany, have to repair to the long distance multiple telephone station A in order to call up station B at Buffalo, and the person with whom they desire to converse must be called to and must go to station B. By an amplification of our system this inconvenience is avoided, as will appear from the consideration of the system shown in Fig. 4. We here show three central stations, A, B, C, which may be widely separated and which are connected by a single branched main line 1, 2, 2. The central stations are all equipped alike, and we have therefore, for the sake of simplicity shown the complete outfit of only one of these central stations, viz: of central station A.

At each central station the main line divides into any number of telephone branches, h, i, k, l,—m, n, &c.; in this instance we have shown four telephone branches at each station, and an equal number of signaling branches, h^2, i^2, k^2, l^2,—m^2, n^2, &c. Each telephone branch terminates in a contact switch block o, to which is also connected the spring clasp p, of jack-knife switch. In each telephone branch is included an electric current selector composed of ten electric resonators; these selectors are marked in the drawings each with the number of frequency of its fundamental resonator; thus we have the selectors 100, 105, 110, 115 and 120,—it being assumed in this instance that any sound producible by the organs of speech has a higher pitch than that corresponding to one hundred and twenty vibrations per second.

Each signaling branch is grounded at the central station and has included in its circuit a signaling apparatus 10, of any kind capable of generating a certain definite number of alternating currents per second, and no other number; the well known reed signaling apparatus of Abdank-Abakanowicz will serve this purpose, and such is indicated in the drawings; in each of these circuits is also an electric resonator, $3'$, $4'$, 3^2, 4^2, &c., adjusted to the frequency of the signal generator. The frequencies of the signaling apparatus in the branches marked with like letters are the same, but are different from the frequencies of the resonators composing any of the selectors of the system, so that if the reed of the signal apparatus in, for instance, branch h^2, at central station A, is set into vibration, the currents generated will only pass through the branch h^2, at station B, and through no other branch.

The contact blocks o are arranged in an arc over which sweeps the switch lever 11, connected with the station telephone outfit 7, 8, 9, 5, which is of any ordinary or improved kind.

Each central station is connected with any number of subscribers U, V, W, X, Y, Z,

whose lines terminate at the central station in jack-knife switches p, q, and annunciators r, of any kind, the drop plates of which are marked with the subscriber's designation, either a number or letter, as usual; all these incoming subscribers' lines have a common ground, as shown.

In addition to the series of contact blocks o, o,— and spring clasps p, p,— at which the branches h, i, k, &c., terminate, there are also a contact block o', and spring clasp p', and the switch lever 11, is normally upon this contact o'.

The operation of the system is as follows: Suppose, subscriber X, connected with central station A, desires to communicate with a subscriber connected with central station C. All subscribers' stations are supposed to be equipped with the ordinary telephonic outfit; subscriber X will, therefore, send a call to his central station, and thereby drop his annunciator plate, as indicated. The attendant at the central station A, then draws the jack q of subscriber X, from its spring clasp and inserts it into the spring clasp o', thereby establishing telephonic communication with the calling subscriber, who now names the subscriber of station C, with whom he desires to speak. The attendant then operates any one of the reed calls that have their duplicates at station C, viz., either the call in branch k^2 or in branch l^2. Station C, now returns the call and both central station operators turn their switch lever 11, upon one of the contacts o, which is the terminal either of the branch of selector 110 or of the branch of the selector 115, according whether one or the other of the two branches is at the time unoccupied. In this manner the two central stations are put in speaking connection, and station C is informed of the name or number of his subscriber with whom subscriber X of central station A desires to speak. Station C now calls up the subscriber who is wanted, and both central station operators return their switch lever 11, to the contact o', and insert the plugs of subscriber X and of the subscriber who had been called, respectively, into the spring clasps at which the branches containing the selectors 110 or 115 terminate. The two subscribers are now in speaking connection, and from what has been said before it will be clear that their conversation cannot be heard by any other subscriber or even by the central stations of the system. There being two selector branches at station A, which are identical with two selector branches at station C, it is clear that two subscribers at one station may be simultaneously in speaking connection with two subscribers at the other station, and it will now be readily understood that by increasing the number of selector branches at each station, any number of subscribers at the different central stations may simultaneously converse with a like number of subscribers at the other central stations, without interference.

When the conversation between two subscribers has terminated, the central stations are notified of it, or are called "off," in any suitable manner, and restore the original condition of the apparatus.

The arrangement for calling "off," forms no part of our present invention and no particular provision for this purpose is indicated in the drawings. It will, however, be noticed, that if each central station operator, after having placed the switch lever upon the contact o for communicating with the other central station, allows that lever to remain there while the conversation between the subscribers takes place, each central station may receive the "off" signal at any time, through the branch connected with that lever.

In actual practice we prefer a different provision for calling "off;" but this will be made the subject of another application.

Having now fully described our invention, we claim and desire to secure by Letters Patent—

1. The improvement in the art of telephony, which consists in transmitting vocal or other sounds by generating electrical undulations similar in form to the sound waves, and selecting therefrom and charging a line with components of these electrical undulations, substantially as described.

2. The improvement in the art of telephony, which consists in transmitting vocal or other sounds by generating electrical undulations similar in form to the sound waves, and selecting therefrom and charging a line with components of these electrical undulations which have frequencies related to each other as the harmonics of sound, substantially as described.

3. The improvement in the art of telephony, which consists in transmitting vocal sounds by generating electrical undulations similar in form to the vocal sound waves, and selecting therefrom and charging a line with components of these electrical undulations, one of said components having a lower frequency than the vibrations corresponding to the deepest sound producible by the organs of speech, and the others having frequencies corresponding to the upper harmonics of the first, substantially as described.

4. The method of reproducing a number of telephonic messages simultaneously impressed upon a line, each as a group of alternating currents, which consists in separating at the receiving end the groups of currents representing the different messages and converting them separately into sound vibrations, substantially as described.

5. The method of transmitting a number of telephonic messages simultaneously over a single line or net-work of connected lines and reproducing the same at a distance by generating for each message electrical undulations similar in form to the sound waves, and selecting therefrom and charging the line with components of these electrical undula-

tions, and separating at the receiving end the groups of components representing the different messages, and converting them separately into sound waves, substantially as described.

6. An electric current selector for a single translating device, composed of a group of electric resonators, each consisting of a closed branch of a common line and each having a predetermined but different static capacity and coefficient of self induction from the others, substantially as described.

7. An electric current selector for a single translating device, composed of a group of electric resonators, each consisting of a closed branch of a common line and each including a reaction coil and condenser in series, and all related so as to adapt the different branches to current frequencies having harmonic relation to each other, substantially as described.

8. As an element of a system of multiple telephony, the combination of a current selector composed of a harmonic series of electric resonators, all in closed multiple arc branches of a common line, with telephonic apparatus in series with the current selector, substantially as described.

9. A system of multiple telephony, comprising a line or net-work of connected lines terminating at two or more stations in a number of speaking branches, a current selector for a special fundamental frequency in each branch, composed of a harmonic group of electric resonators, each of the different selectors at each station being identical with one selector at one other station, and telephonic apparatus for transmitting and receiving through either or all branches, substantially as described.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

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MAURICE LEBLANC.

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