R. H. MANSON.

TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED MAY 29, 1907.

900,676.

Patented Oct. 6, 1908.

5 SHEETS—SHEET 1.

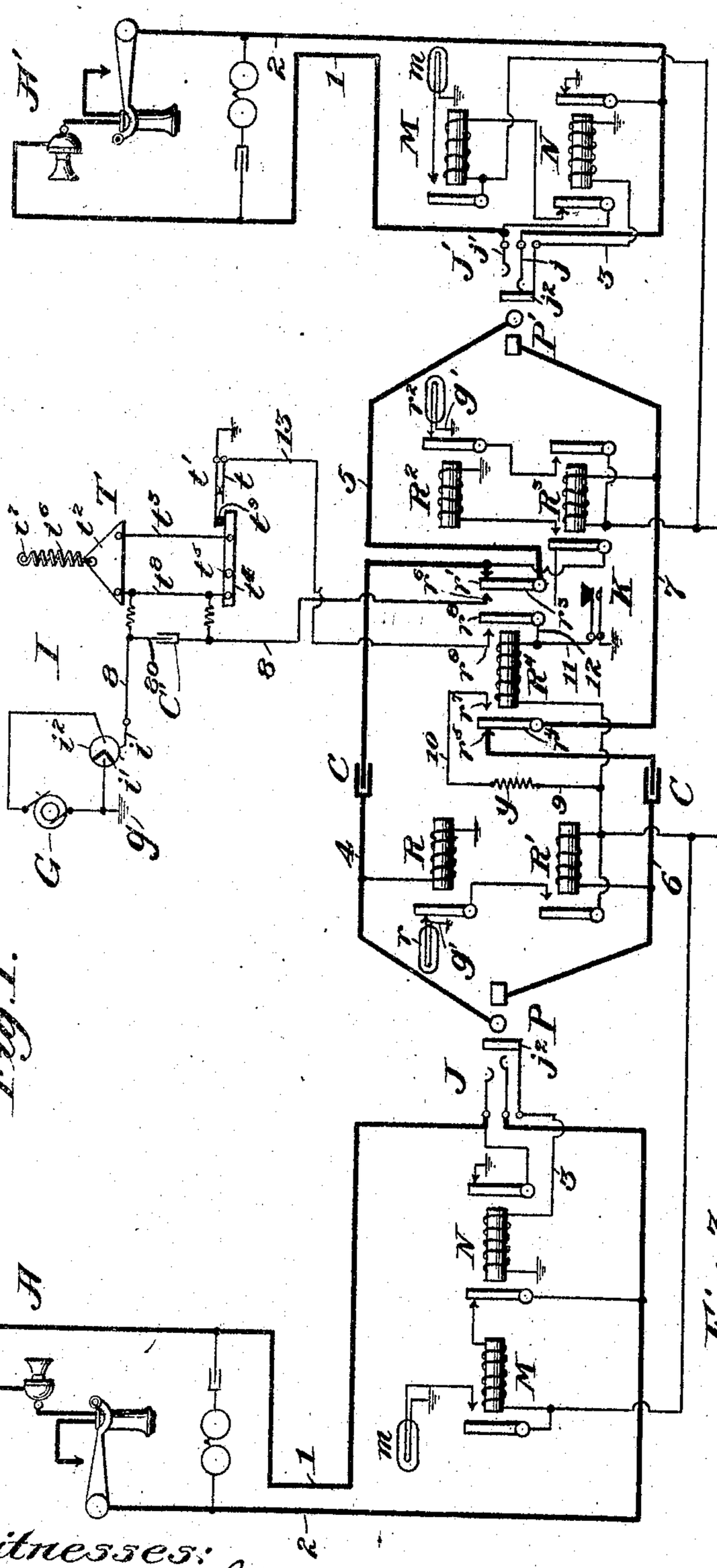

Fig. 1.

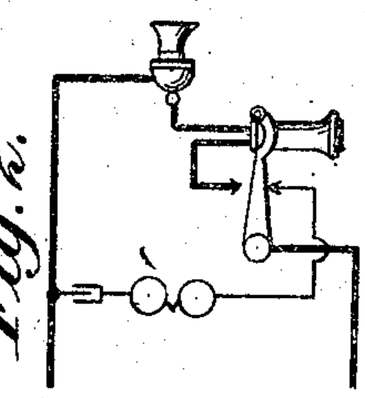

Fig. 2.

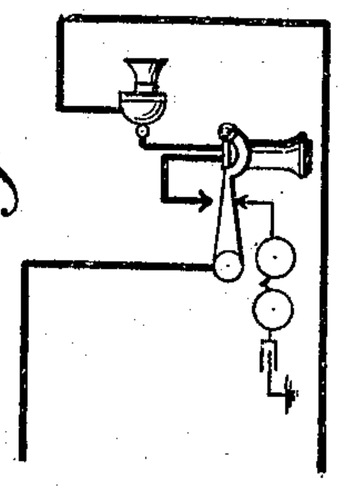

Fig. 3.

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Inventor:

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Atty.

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5 SHEETS—SHEET 2.

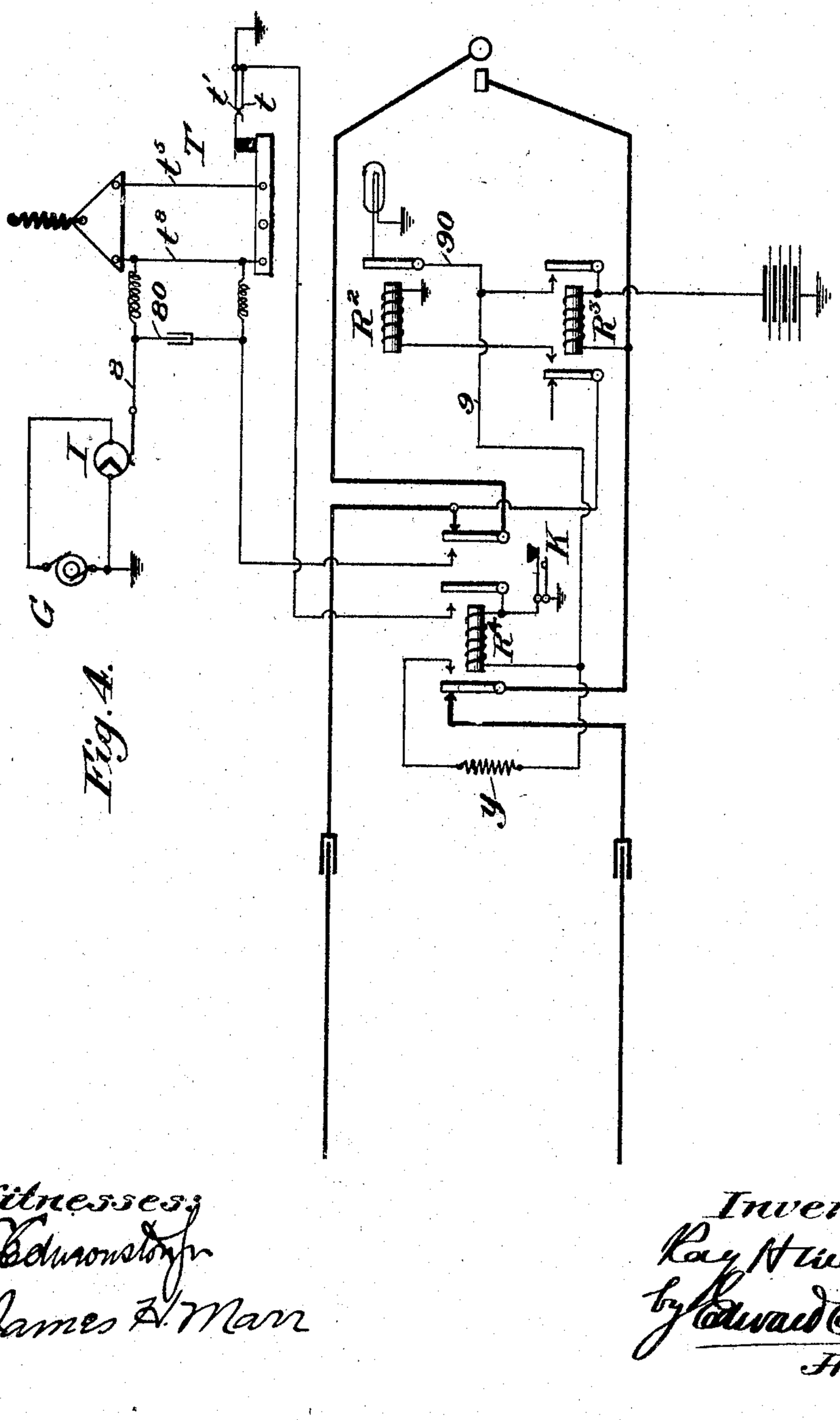

Fig. 4.

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5 SHEETS—SHEET 3.

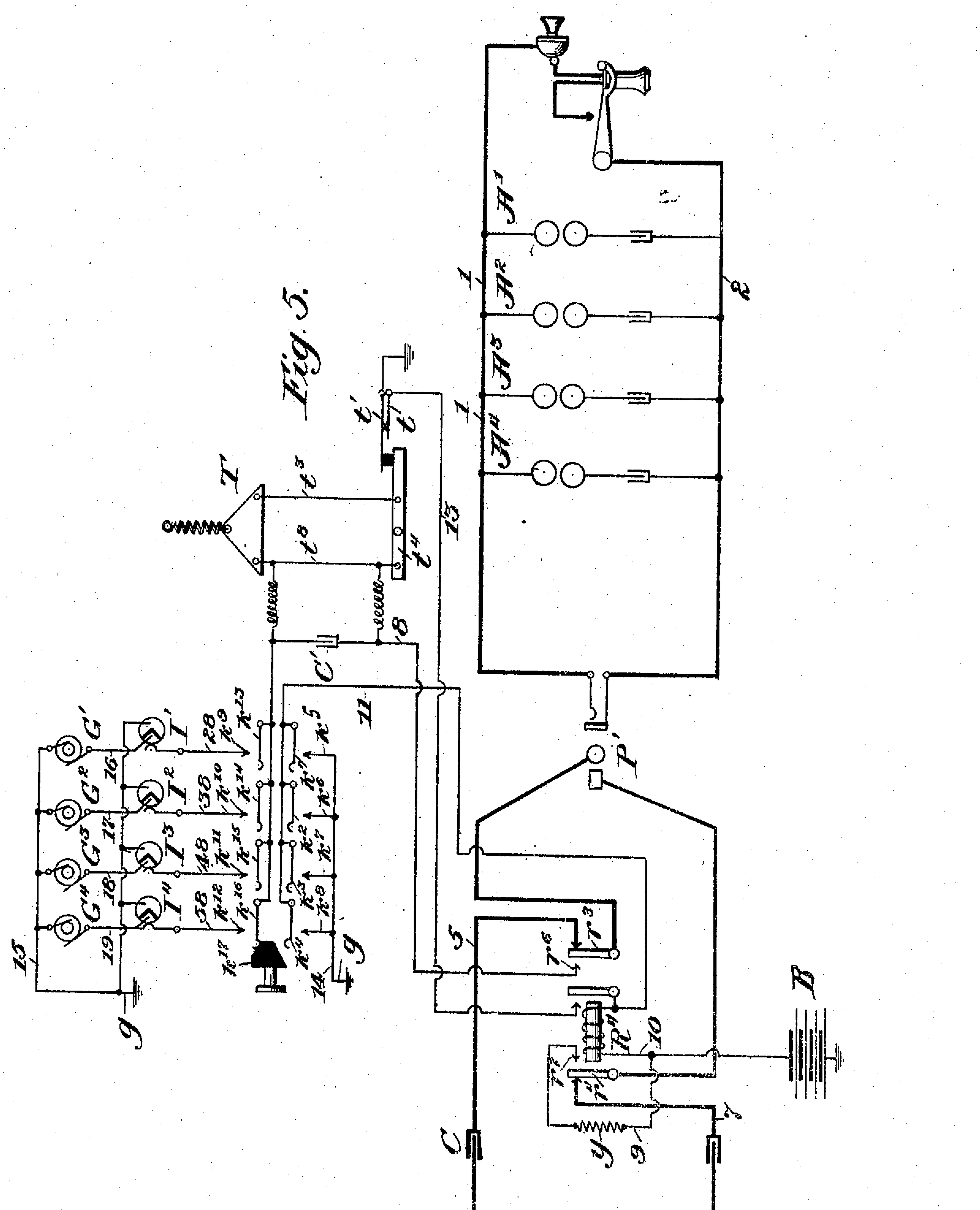

Fig. 5.

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5 SHEETS—SHEET 4.

Fig. 6.

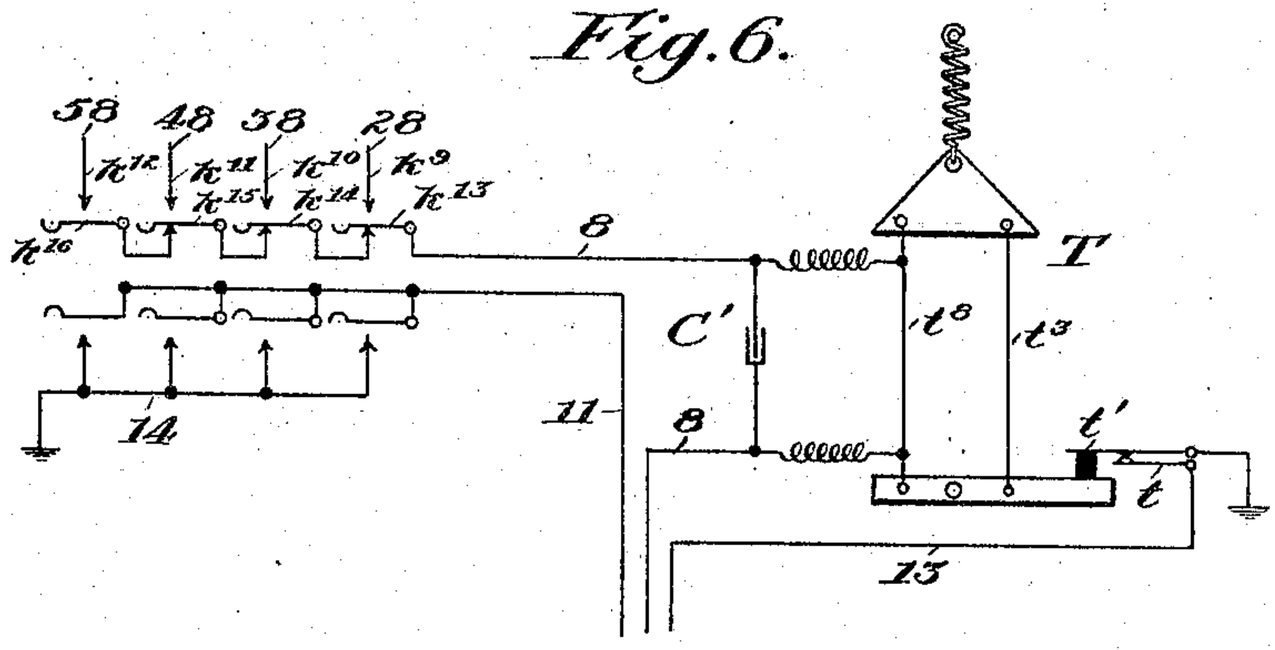


Fig. 7.

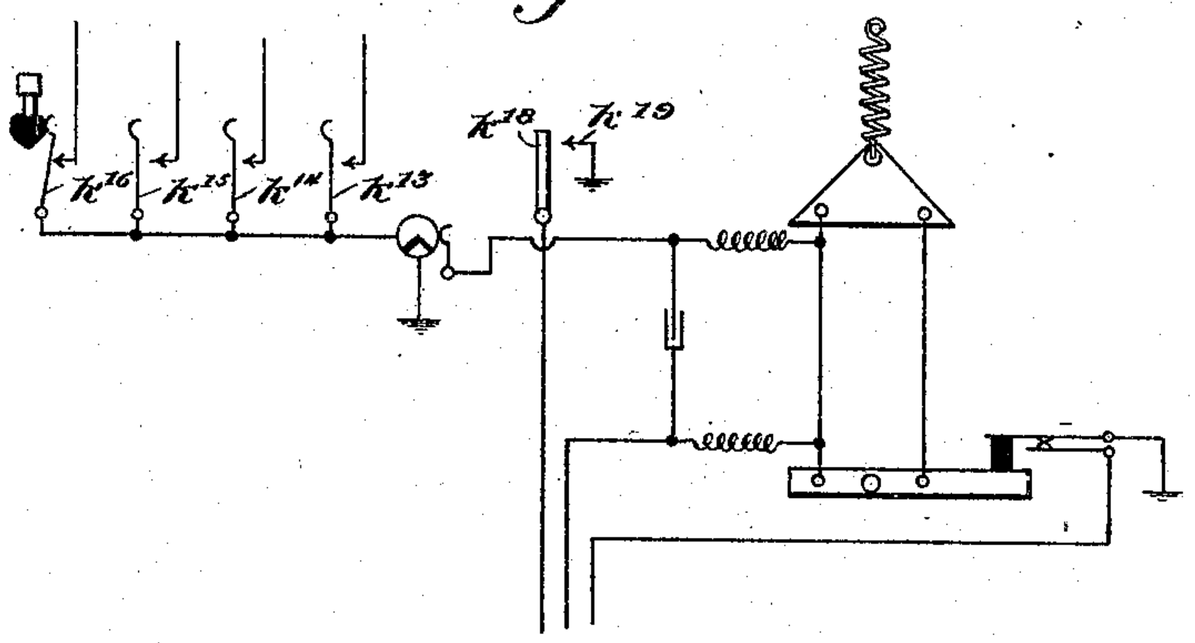
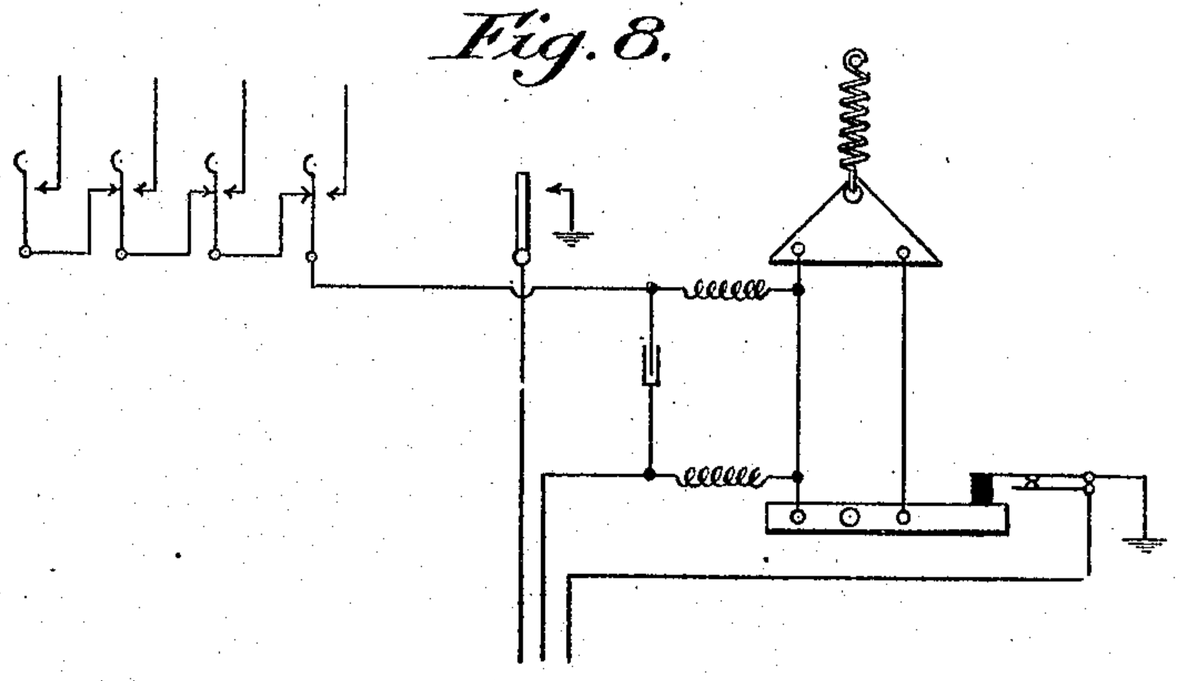


Fig. 8.



Witnesses:
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TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED MAY 29, 1907.

900,676.

Patented Oct. 6, 1908.

5 SHEETS—SHEET 5.

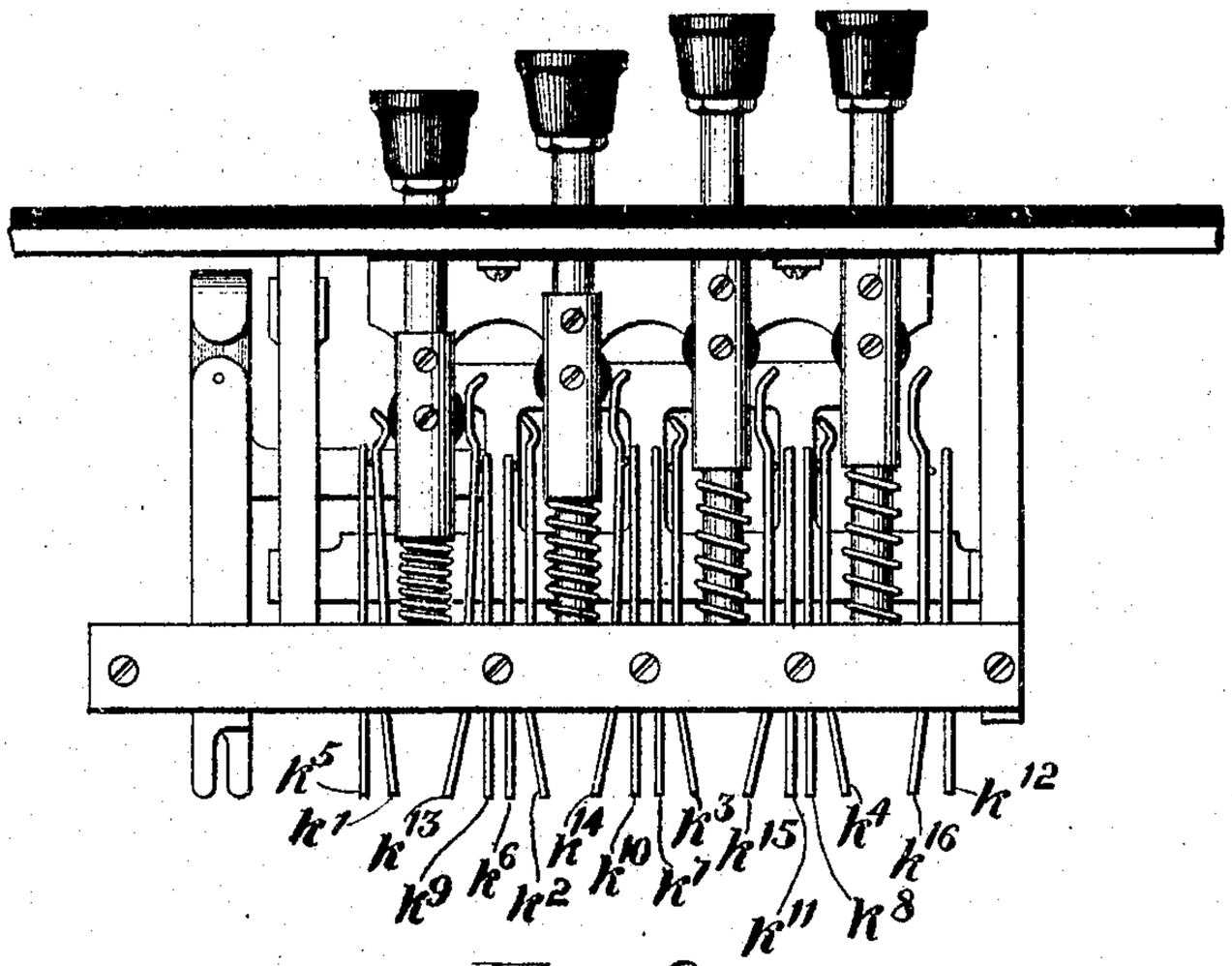

Fig. 9

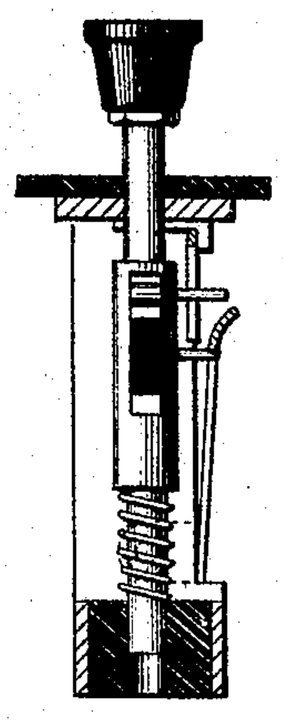

Fig. 10.

Witnesses
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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

No. 900,676. Specification of Letters Patent. Patented Oct. 6, 1908.

Original application filed February 1, 1907, Serial No. 355,208. Divided and this application filed May 29, 1907. Serial No. 376,425.

To all whom it may concern:

Be it known that I, RAY H. MANSON, a citizen of the United States, residing at Elyria, in the county of Lorain and State of Ohio, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a specification, reference being had therein to the accompanying drawing.

My invention relates to telephone exchange systems, and has for its object the production of a ringing circuit for such systems which shall be automatically controlled by the joint act of the operator and the called subscriber, the former connecting the ringing generator to the called line, and the subscriber disconnecting when he answers the call. In this circuit I employ a thermal type of relay for cutting off the ringing current and commutators for interrupting the flow of generator current so as to give intermittent ringing. These interrupter commutators are so arranged as to provide a ground or shunt path in place of the generator when ringing so that the release relay will be operated as soon as the telephone receiver is removed from the switch hook at the called station.

In designing the present circuit I have found it necessary, in order to use a thermal or hot wire relay, to provide a shunt path for line current around the same, to equalize the effects of the alternating ringing current and the direct battery current, so that the thermal relay will operate the same when either current is passing through its wire. For this purpose I preferably employ a condenser, and I have found that such a condenser will act automatically as an equalizer for the different frequencies employed in harmonic party line signaling so as to produce a uniform operation of the thermal relay regardless of the character of the current.

The present application is directed particularly to the feature of equalizing current flow at different frequencies, and is a division of my prior application filed February 1, 1907, Serial Number 355,208.

My invention is illustrated in the accompanying drawings in which

Figure 1 is a diagram of a central office cord circuit and two subscribers' lines adapted to be connected thereby. Figs. 2 and 3 are diagrams of modified substation circuits. Fig. 4 is a diagram of a modified cord circuit. Fig. 5 is a diagram similar to Fig. 1, showing the calling end of a cord circuit with a multi-generator equipment and connections for harmonic ringing, and a subscriber's party line having harmonic ringers. Fig. 6 is a diagram showing a cut-off type of key having a special arrangement to prevent two keys from being depressed at once and thereby connecting current of two frequencies to the ringing circuit. Fig. 7 is a diagram showing a selective key having a master contact for setting the ringing relay. The contacts on this key are in parallel. Fig. 8 is a diagram of a modification of the same key showing cut-off contacts to prevent crossing of two frequencies. Fig. 9 is a side view of a key adapted for use in the circuit shown. Fig. 10 is an end view of said key.

Referring to the drawings, and particularly to Fig. 1, A and A′ are two subscribers' stations each equipped with the apparatus usually employed in common battery systems. As the line and other connections and apparatus of these two sub-stations are identical, one description will suffice for both. The line wires 1—2 from station A′ pass to the central office, where they terminate upon a jack J′ and at the contacts of a cut-off relay N, through which they are normally connected to the line relay M and the main battery B on one side, and to the ground on the other. Relay M controls the line signal lamp *m*. The relay N has its windings connected on one side to the ground and on the other side through a wire 3 to the test thimble or ring j^2 of the jack J′. Of course in the case of a multiple board the springs *j* and *j*′ and the thimble j^2 will all be duplicated and connected in multiple to the wires 1—2—3.

For the purpose of interconnecting the lines, I provide the usual plugs P and P′ connected by the cord circuits 4—5 and 6—7. The cord circuit is provided with supervisory relays R—R′ and R^2—R^3, controlling the supervisory lamps *r*—r^2. The main battery B is bridged across each end of the cord between the tip and sleeve relays, in the usual manner, these relays therefore serving as impedance or choking coils in the battery supply circuit.

For purposes of listening in, and of testing lines to ascertain if they are busy, I provide the usual operator's telephone set, with a suitable key for connecting it across the cord conductors 4—6, and test contacts controlled by the relay R^3. For the purpose of ringing the wanted subscriber, I provide the ringing relay R^4, adapted to be set by a key K, so as to open the cord at the contacts r', r^3, r^4 and r^5, and connect the plug P′ through the contacts r^3, r^4 to the generator wire 8 and the return wire 9. This generator wire extends from the contact i of the commutator or interrupter I to the thermal relay T, and thence to the contact r^6 of the ringing relay R^4. The return wire 9 on the other hand extends from the contact r^7 of the ringing relay through the non-inductive resistance y to the main battery B and through the ground at g' to the point g constituting the common connection of the battery B and the generator G to the commutator segments i' and i^2. The commutator is constantly driven while ringing, and may be maintained constantly in motion, preferably by the same motor which drives the charging and ringing machines. The driving means is immaterial to the present invention, however, and may be anything desirable or available in a particular case.

The ringing relay R^4 has its windings connected on one side to the main battery B. On the other side they are connected through wire 11 to the key K and when that is closed to ground, and so to the battery; and also through wire 12 to a self-locking device consisting of the contacts r^8—r^9, the latter connected through wire 13 to a contact t in the thermal relay T and thence through its normally closed mate t' to ground. Whenever the key K is depressed for a moment, the relay R^4 becomes energized and upon pulling up its armatures locks itself on the following locking circuit, B, R^4, 12, r^8, r^9, 13, t, t' and ground. This circuit, however is controlled by the thermal relay, and the said thermal relay is controlled by the wanted subscriber, having one of its wires included in series with the ringing wire 8, so that when the subscriber answers the relay will become energized to open its contacts t—t', breaking the locking circuit, and thereby deënergizing the ringing relay R^4, cutting off the ringing current and restoring the continuity of the cord circuit. The thermal relay is constructed and arranged in the following manner; a tension yoke t^2 has attached to it but insulated from it the ends of two wires t^3 and t^8. The other ends of these wires are attached to points on a pivoted lever t^4, these points lying on opposite sides of the pivot t^5 of the lever. The two wires are maintained under tension by means of the spring t^6 attached at one end to the yoke t^2 and at the other to a fixed support t^7. The lever t^4 carries upon it a stud of insulation t^9, by which it can lift the contact spring t' from its anvil t. Normally the spring rests on the anvil, and the wires t^3 and t^8 are maintained under uniform tension, so as to keep the lever t^4 in a neutral position. In order to multiply the movement of this lever, I may make it of any length desired.

I have stated that the wire 8 is connected in series with the relay wire t^8. Generator current passing through the wire 8 must pass therefore through the relay wire also, but the carrying capacity of the wire, and the amount of current which will pass through the line wires and the ringer of the wanted subscriber are so adjusted that such an amount of current will not heat the relay wire sufficiently to destroy the balance of the relay. Of all atmospheric effects the relay obviously remains balanced, because both wires t^3 and t^8 are exposed to the same changes.

In order to equalize the effects of the battery and generator currents on the thermal relay, I provide a capacity C′ in a shunt branch 80 around the wire t^8. This capacity constitutes an important feature of my invention, a condenser being employed which will shunt enough of the alternating current from the wire t^8 to prevent the latter being unduly heated. Since I intend that the thermal relay shall be operated both by the battery current and by the ringing current, and since the voltage and consequently the relative amount of current flow through the same resistances is different for the ringing current and for the battery current, it is necessary to provide some means for equalizing the effects of these currents on the thermal relay, and I find the condenser or capacity effects this very well.

The operation of my invention as thus far described will now be understood. Assuming that subscriber A has called for connection with subscriber A′, and that the operator has inserted the plug P into the answering jack J, has tested the jack J′ of the wanted line and has inserted the plug P′ therein, it remains for her to apply ringing current to the line 1—2 of subscriber A′. This she does by depressing the key K for a moment whereby the following circuit is closed: B, R^4, 11, K, and ground. Current in this circuit energizes relay R^4, which pulls up its armatures, opens the cord conductors 5—7 and connects the tip of the plug P′ to the commutator I through the following path: tip, to contact, r^3, r^6, 8, t^8, C′ in parallel, 8 to contact i. The relay also connects the sleeve of the plug through the following path: sleeve, r^4, r^7, y, 9, B and ground. The commutator I is supposed to be rotating whereby its two segments i', i^2 come into

connection alternately with the spring *i*. The segment i^2 is shown as the larger of the two, the period of ringing thereby being made longer than the period of rest; but this may be varied in any manner desired. The segment i^2 is connected to the generator G, and the segment *i'* is connected direct to the point *g*, whence both branches are connected through the ground to the battery B. The complete ringing circuit while generator is on is as follows: G, i^2, *i*, 8, t^8 and C' in parallel, 8, r^6, r^3, tip, *j'*, 1, A', 2, *j*, sleeve, r^4, r^7, *y*, 9, B, ground, *g* and back to generator. When the segment *i'* comes around to the spring *i*, the circuit is the same, except that the generator is cut out and the connection is completed from point *g* direct to the spring *i*. This leaves the battery B alone in the circuit. The relay R^4 when pulling up also locked itself over the following circuit: B, R^4, 12, r^9, 13, *t*, *t'* and ground back to battery.

Figs. 2 and 3 show different arrangements of the apparatus at the subscriber's station. It is to be observed that I am not confined to any particular one of these arrangements, so long as the required basic feature is presented, which is that with the line in a condition of disuse, a path of relatively high resistance or low conductivity is closed for the generator or battery current upon the line; but when the subscriber takes down his receiver for use, a path of relatively low resistance is closed. In Fig. 1 I have shown the subscriber's ringer permanently bridged across the line with a condenser interposed, the resistance of the ringer, either ohmic or inductive, or the capacity of the condenser, or both, being so adjusted that the amount of alternating current which will pass in ringing is insufficient to heat the wire t^8 of the thermic relay T to operate the latter. The condenser prevents the passage of direct current. When the subscriber's telephone is in use, a parallel path of relatively low resistance is closed through his talking set, which permits sufficient current, either alternating or direct, to pass over the line, to heat the wire t^8 so that its expansion will unbalance the relay T, tilting the lever t^4 upon its pivot t^5 so as lift the spring *t'* off the anvil *t*, to open the locking wire 13 thereby depriving the relay R^4 of its ground, and permitting it to retract so as to disconnect the wires 8 and 9 and reconnect the tip and sleeve of the plug P' to the cord conductors 5 and 7 respectively.

The arrangement shown in Fig. 2 is the same as that in Fig. 1, except that the ringer and condenser at the subscriber's station are not permanently bridged but are disconnected when the telephone set is connected. The arrangement shown in Fig. 3 is similar in principle, but has the ringer in a ground tap from the tip side of the line with a suitable resistance interposed between it and ground, this ground tap with the ringer and resistance being disconnected from the line when the telephone comes into use. With any of these arrangements it is sufficiently obvious that after the operator has depressed the key K and so energized the relay R^4, the latter will remain locked until the subscriber answers, when the thermic relay T will release the relay R^4 and stop the ringing.

In Fig. 4 I have shown a modified arrangement of the cord circuit, in which the wire 9 instead of being connected directly to the main battery B, is connected to a wire 90 controlled by the relay R^3, and receiving current from battery only when the said relay is energized. This arrangement has the advantage of leaving the signaling portions of the circuit free from battery connections except when the calling plug is inserted in the spring jack. It should be noted that I leave the battery connected through the resistance *y* to the sleeve of the plug and thence through the thimble j^2 of the jack to the cut-off relay N during the ringing, the purpose of this being to maintain the cut-off relay constantly energized. This circuit may be traced as follows: B, 9, *y*, 10, r^7, sleeve of P', j^2, N and ground. Also from P' through *j* to line and back to *j'*, thence when ringing by way of r^3, wire 8, t^8 and commutator segment to ground, either direct or through the generator. It should also be noted that the battery current assists the generator current to operate the thermic relay when the subscriber answers, flowing out over the sleeve side of the line and back on the tip side and so through the wire 8 and through the generator to ground. The relay R^4 will be disconnected at the instant the subscriber answers, no matter what the position of the commutator I happens to be.

Fig. 5 shows my present invention applied to a harmonic ringing system, in which I find an equalizing device such as the condenser C' to be eminently desirable, if not necessary, in order to secure a uniform action of ringing current at different frequencies upon the thermic relay. The arrangement and connections of the cord circuit and its bridging relays are preferably the same in this case as those shown in Figs. 1 and 4, but as they are immaterial to the particular features important in harmonic ringing, they are not shown in Fig. 5. The plug P' and the cord conductors 5 and 7, with the ringing relay R^4, its armatures, the battery wire 9, the relay wire 10, the resistance *y*, the thermic relay T, and the connecting wires 8 and 13 are all the same as in the foregoing description. In the present case, however, the wire 11 instead of passing to a single key K, passes to a set of contact springs *k'*, k^2, k^3

and k^4 in parallel, these springs having anvils k^5, k^6, k^7 and k^8, respectively, all connected in parallel through wire 14 to ground. Instead of a single generator G, there are four generators G,′ G², G³ and G⁴ all connected on one side through the wire 15 to ground, and on the other side connected through the branch wires 16, 17, 18 and 19 to the commutators I′, I², I³ and I⁴, respectively. From the contacts of these several commutators the wires 28, 38, 48 and 58 pass to the anvils k^9, k^{10}, k^{11} and k^{12} of a set of selective ringing buttons whose springs k^{13}, k^{14}, k^{15} and k^{16}, are connected in parallel to the wire 8. In Figs. 9 and 10 I have shown such a set of buttons. Each unit key in this set has a cam roller connected to a push button stem so that when the button is depressed, the pair of springs k', k^{13}, etc., with which it is associated, are spread apart against their anvils and are so maintained as long as the button is held down. Each button stem is provided with a mechanical lock and all the buttons are interlocking, the arrangement being such that when pressure is applied to one button, any other buttons which may have been down previously are at once released, and when pressure is removed from the button in use, it retracts through a portion of its path of movement so as to open the ground spring k', k^2, but still maintains the generator springs closed. A convenient form of locking mechanism for such a set of keys comprises the common latch shown extending along the side of the button stems, each stem having a pin or pair of pins to engage said latch, these pins being so set that when any key is locked it is held with its generator contacts closed, and its ground contacts open.

A form of cam and actuating button for an individual pair of springs is indicated in Fig. 5 in connection with the springs k^4 and k^{16}, being marked k^{17}. It will be understood that this is merely diagrammatic, but that if individual springs k', k^2, k^3 and k^4 are employed, there should be one of these double cams for each pair.

It will be observed that in Fig. 5 I show a subscriber's line 1—2 extending to four substations A′, A², A³ and A⁴, the last three of which are indicated by the ringer bridges only. The ringers at these four stations are tuned so that each will respond to a predetermined frequency of ringing current only. The four generators G′, G², G³ and G⁴, or the equivalent pole changers or frequency changers, are arranged so as to supply current at corresponding frequencies.

Assuming that it is desired to ring a particular party, as the party at substation A′, on the line 1—2, the operation is as follows: The line having been tested and found idle, the plug P′ is inserted and the selective button associated with the springs k', k^{13}, is pushed all the way down so as to force both its springs against the anvils k and k^9 respectively. The branch wire 28 leading from the commutator I′ is thereby connected to the generator wire 8, and at the same time the ringing relay circuit is closed as follows: B, 9, 10, R⁴, 11, k', k, 14, ground and back to battery. The ringing relay thereupon pulls up its armatures and closes the circuit of the generator G′ to line as follows: G⁴, 16, I′, 28, k^9, k^{13}, 8, t^8 and C′ in parallel, 8, r^6, r^3, to tip of plug P′, line wire 1, all the substations, line wire 21, sleeve of plug P′, r^4, r^7, y, battery B, ground and wire 15 back to generator. The ringers at substations A² A³, and A⁴ do not respond to current from generator G′, but the ringer at substation A′ is effectively actuated, and continues to be so actuated at intervals until the subscriber answers or until the plug P′ is withdrawn from his jack. In the latter case, and assuming the cord circuit of Fig. 4 to be in use, the relay R⁴ is disconnected from the battery, and releases its armatures. In the former case, the rush of current due to the lowering of the resistance at the subscriber's station, heats up the wire t^8 of the thermic relay T and the latter breaks the locking circuit 13 at the spring t' as in the previous cases. It should be noted that as soon as the ringing key is set, and pressure is removed therefrom, the spring k' lifts from the contact k so that the wire 11 is open, and the relay R⁴ is thereafter dependent upon its locking circuit 13.

In Fig. 6 I have shown the thermic relay T, the wires 8, 11 and 13 leading to this relay and the keys, the ends of branches 28, 38, 48 and 58 and the key springs with their anvils, the latter being arranged in series instead of in parallel, the object of this arrangement being to prevent the connection of more than one generator to the generator wire 8 at the same time. When any generator spring is moved so as to make contact with its anvil, it is simultaneously disconnected from the following springs, so that if two keys should be simultaneously pressed down, only the lowest one in order would connect its generator to the wire 8.

In Fig. 7 I have shown the four springs k', k^2, k^3 and k^4 replaced by a single master contact k^{18}, which is closed on its anvil k^{19} whenever any of its individual generator springs k^{13}, k^{14}, k^{15} and k^{16} is closed and the button thereof depressed to the fullest extent. The master contacts k^{18} and k^{19} are open at all other times. A type of key which may be employed in this circuit or any of the other circuits herein described with but slight modification, is shown in Fig. 8 with the series arrangement of Fig. 6. Unless some mechanical means is provided to prevent the depression of two buttons at the same time, by simultaneous pressure, a cut-off scheme

of this kind must be employed if it be desired to prevent crossing of two frequencies. The ringing circuit being entirely automatic, if the operator should push down two keys at once, two frequencies of ringing current would go to line until one of the subscribers answered.

The condenser C′ in shunt with the wire t^8 of the thermic relay is shown in all of the figures, constituting an essential feature of my invention. Its importance will appear from this, that the thermic relay, and in fact any relay to operate satisfactorily in automatic ringing, must be provided with some means to equalize the effect thereon of current at different frequencies. A uniform current flow must be maintained, and by means of this condenser shunt is maintained in the wire t^8. The condenser exhibits a lower resistance to the higher frequency currents and by properly determining the capacity in advance, the efficiency of the shunt is made to vary approximately with the frequency. Thus, the same effect is produced in the thermic relay with a high frequency current as with a low frequency. In some standard harmonic systems, the frequencies employed range from 16 to 66 cycles and the voltages are graded from 50 for the 16 cycle current to 150 to 175 for the higher frequencies. If no shunt path were provided around the wire t^8 of the thermic relay, it would be impossible to adjust the same so as to allow the locking contact t, t' to remain closed with high frequency current flowing to line and with the telephone receiver on the hook. The condenser action in equalizing the effect of current at different frequencies is thus the same as in equalizing the alternating and direct current effects, both these effects being combined in harmonic ringing.

While I have described my invention herein as applied through the agency of certain specific forms of apparatus, it is to be understood that these can be varied widely at will. I do not wish to limit myself to any particular type of key, any particular type of cord or line circuit, or any particular arrangement of automatic or other ringing. The resources of the art are varied and numerous and the field of choice in designing is a broad one.

I contemplate applying my invention to systems and apparatus of various types and all such non-essential changes as are required to make it conform to any given system I desire to have included within the scope of my claims. In its broadest aspect the feature of the condenser branch C′ is a ringing shunt or an equalizer, and I am fully aware that other devices may be employed instead of a condenser for a similar purpose. It is to be understood, therefore, that in claiming an equalizer or balancing means, I intend to include any means for producing a uniform current and a uniform action in the controlling device T.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a telephone exchange system, subscribers' line circuits, a cord circuit for interconnecting them, a plurality of ringing generators adapted to supply current of different frequencies, means for selectively connecting the same through the cord circuit to the line of a wanted subscriber, non-inductive controlling means responsive to the act of the called subscriber to disconnect the same, and an equalizer for said controlling means, whereby it will be equally affected by current at different frequencies, substantially as described.

2. In a harmonic signaling system, means for supplying a plurality of currents at different frequencies, means for connecting the same to a wanted subscriber's line, and controlling means therefor, with an equalizing shunt for said controlling means, substantially as described.

3. In a telephone exchange system, harmonic signaling means comprising a plurality of current sources, a switching device for connecting the same selectively to a wanted subscriber's line, and a non-inductive controlling device for said switching device together with an equalizing shunt for the controlling device, substantially as described.

4. In a telephone exchange system, harmonic signaling means comprising a plurality of devices supplying current at different frequencies, a plurality of selective keys, a generator wire common to said keys, a ringing relay controlling the generator wire, a non-inductive device controlling the ringing relay, and an equalizing shunt for the non-inductive device, substantially as described.

5. In a telephone exchange system, harmonic signaling means comprising a plurality of sources supplying current at different frequencies, a source of direct current, a plurality of commutators, a generator wire common to all the commutators and having branches thereto, a ringing relay controlling the generator wire, a thermal relay connected to the generator wire and controlling the ringing relay, and a capacity shunt for said thermal relay, adapted to equalize the effect thereon of currents at different frequencies, substantially as described.

6. In a harmonic signaling system for telephone exchanges, a plurality of sources of current at different frequencies, a plurality of selective keys therefor, a master key adapted to be momentarily actuated in the actuation of any selective key, a ringing relay arranged to be energized by said master key, a self-locking circuit for said ring-

ing relay, and a thermal relay controlling said locking circuit, substantially as described.

7. In a harmonic signaling system for telephone exchanges, a plurality of sources of current at different frequencies, a plurality of selective keys therefor, a master key adapted to be momentarily actuated in the actuation of any selective key, a ringing relay arranged to be energized by said master key, a self-locking circuit for said ringing relay, and a thermal relay controlling said locking circuit, together with an equalizing shunt for said thermal relay, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

RAY H. MANSON.

Witnesses:
A. J. ROBERTS.
W. O. STRONG.