H. C. KORFHAGE.

CLOCK SYNCHRONIZING SYSTEM.

APPLICATION FILED NOV. 22, 1906.

970,241. **Patented Sept. 13, 1910.**

3 SHEETS—SHEET 1.

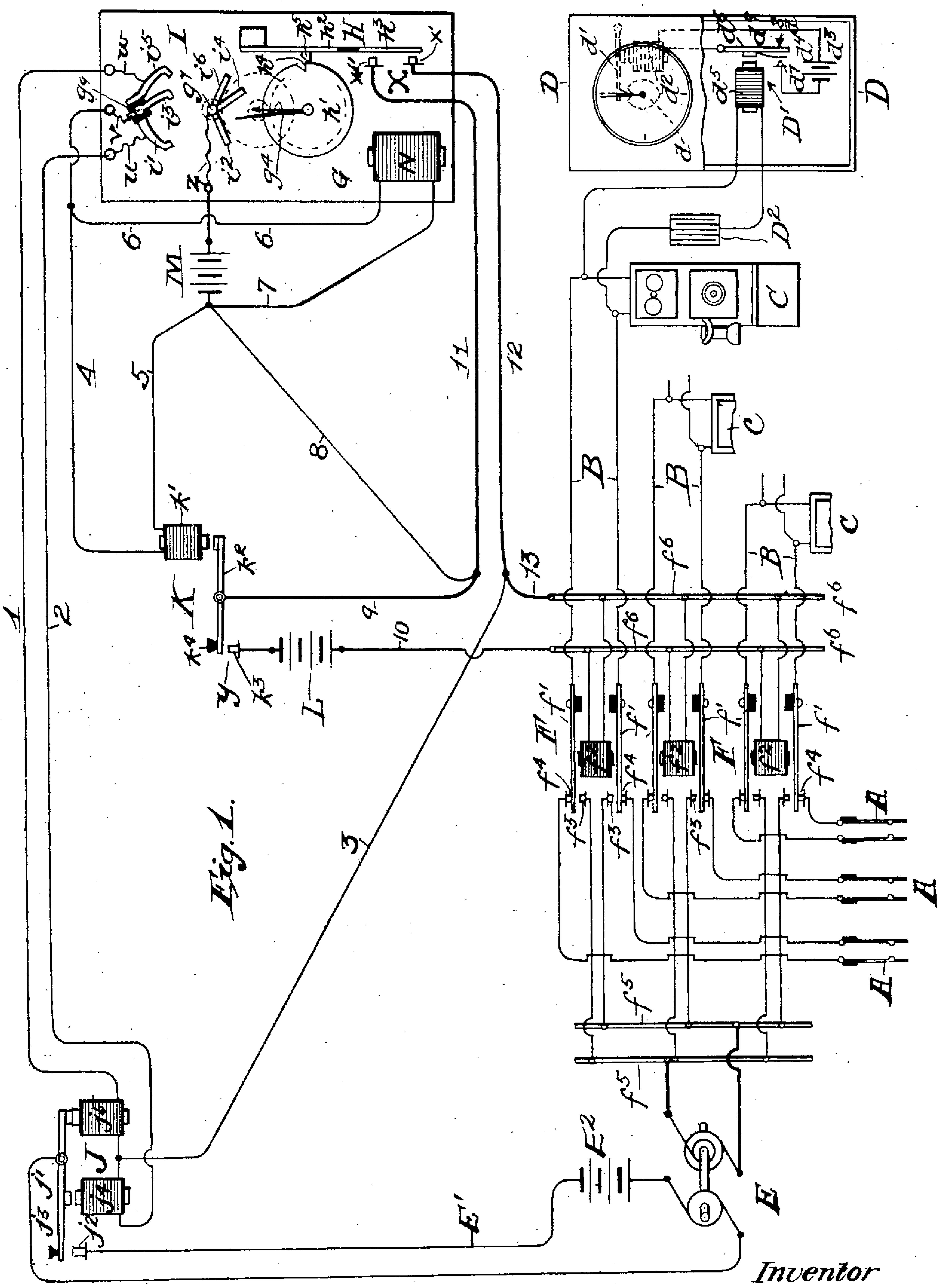

Fig. 1.

Witnesses

A. H. Nelson

M. Simon

Inventor

Herman C. Korfhage

by

Att'y

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3 SHEETS—SHEET 2.

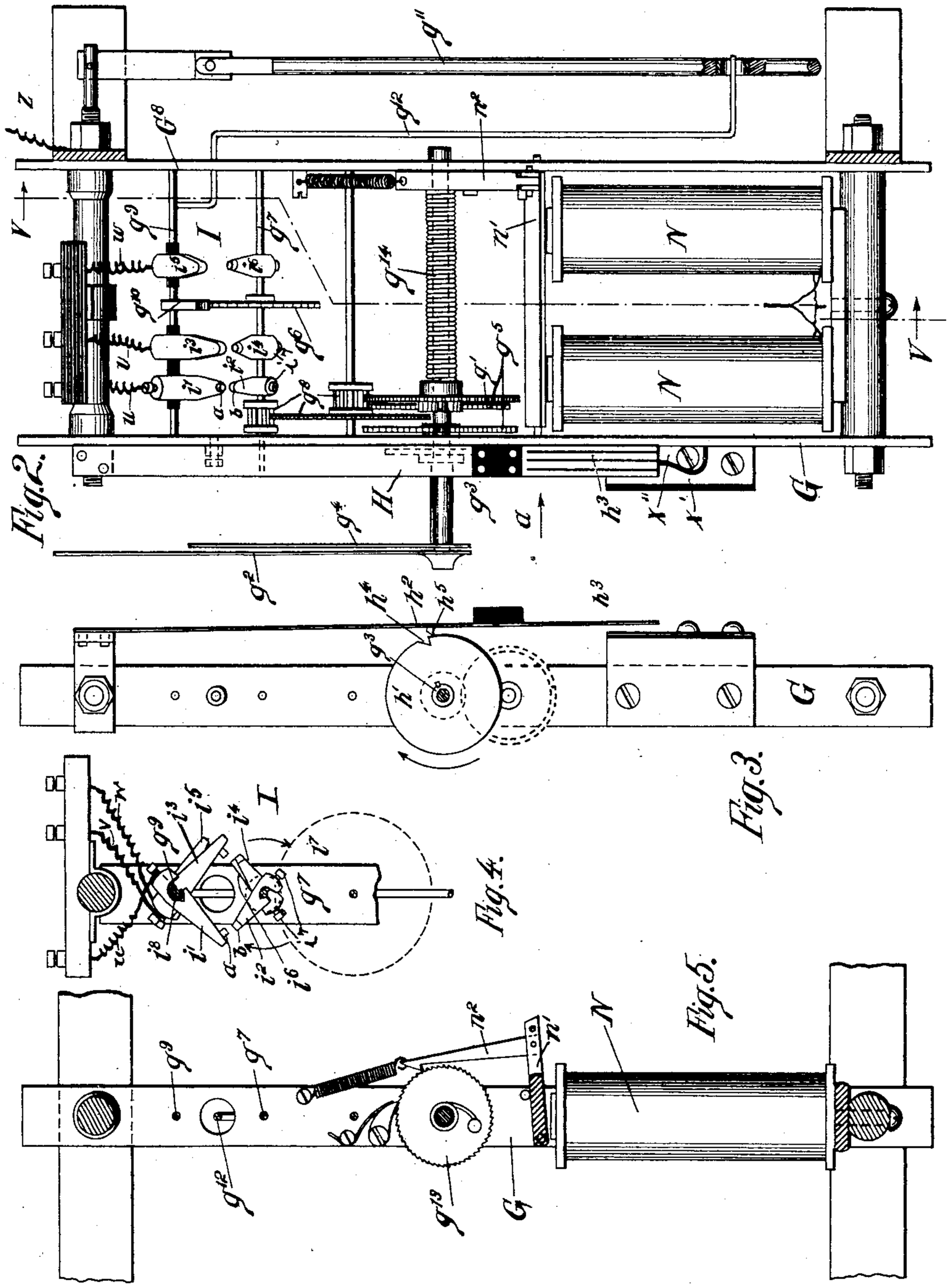

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Witnesses

J. A. Nelson

M. Simon

Inventor

Herman C. Korfhage

by Church Gilbert Stanley

Atty

H. C. KORFHAGE.

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3 SHEETS—SHEET 3.

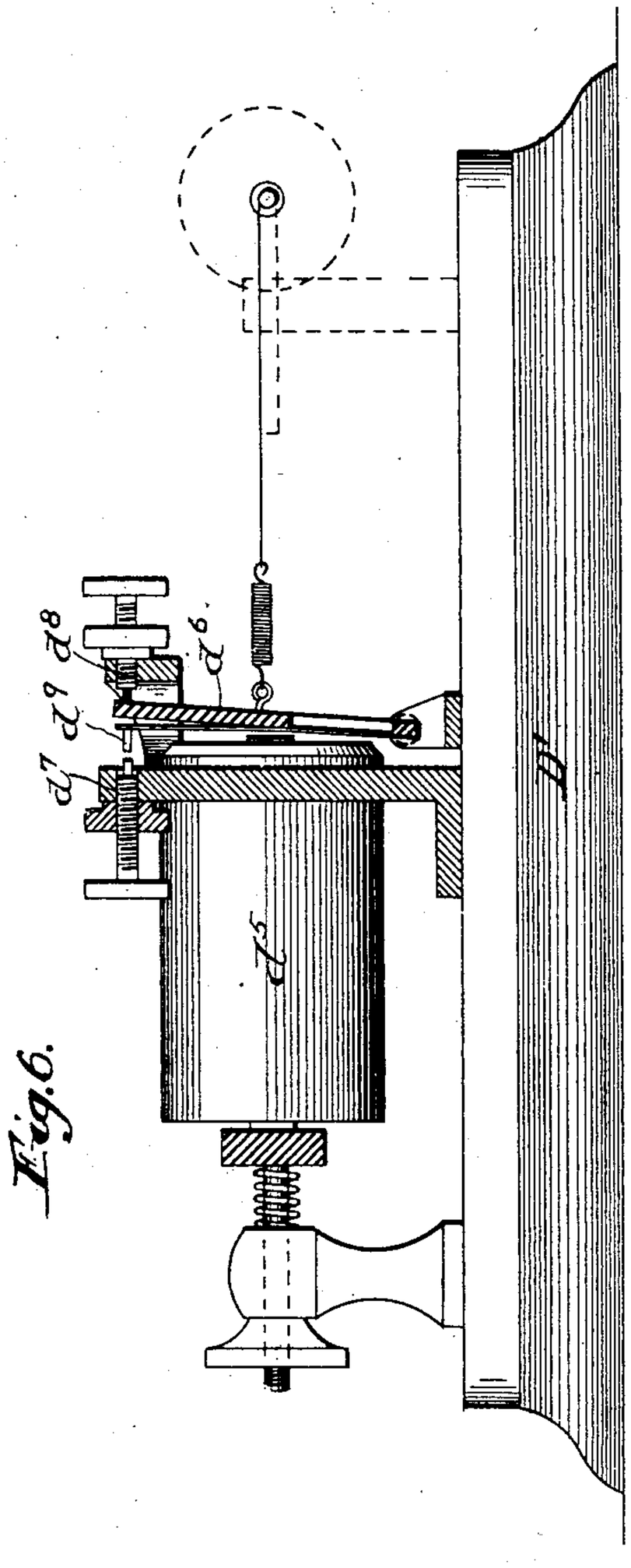

Fig. 6.

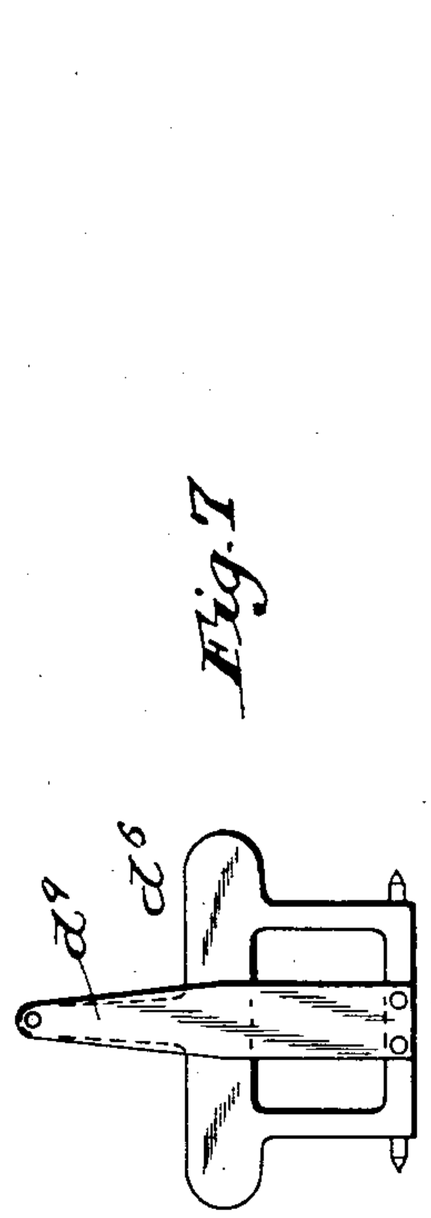

Fig. 7

Witnesses
A. W. Nelson
M. Simon

Inventor
Herman C. Korfhage
by Clark Wilson Hawley
Atty.

UNITED STATES PATENT OFFICE.

HERMAN C. KORFHAGE, OF NEW ALBANY, INDIANA.

CLOCK-SYNCHRONIZING SYSTEM.

970,241. Specification of Letters Patent. **Patented Sept. 13, 1910.**

Application filed November 22, 1906. Serial No. 344,620.

To all whom it may concern:

Be it known that I, HERMAN C. KORFHAGE, a citizen of the United States, and a resident of New Albany, in the county of Floyd and State of Indiana, have invented a certain new, useful, and Improved Clock-Synchronizing System, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to means for electrically synchronizing clocks, that is to say, for synchronizing a large number of clocks at different points simultaneously.

In cities and outlying districts it has been the practice to employ clocks equipped with electric synchronizers and winders, these clocks being synchronized and wound by electric impulses sent over special lines through the agency of a master clock at a central point or station. These systems, though demonstrating the desirability of synchronized electric clock systems, have not gone into very extensive use because of the cost of installing and maintaining them.

The primary object of my invention is to provide a clock synchronizing system which may be installed at low cost and operated at a fraction of the expense that attaches to the operation of present day systems. To this end, in carrying out my invention, I utilize the circuits of telephone exchanges and the like, simply connecting a synchronizable clock to the line of each subscriber who desires time service, and providing means for periodically operating all the clocks that are connected with the system.

The particular object of my invention is to provide a system for synchronizing clocks, and more especially clocks located in buildings or houses provided with telephones, without the erection of any extra line wires. In other words, the object of my invention is to utilize telephone, telegraph, or other existing lines for transmitting the clock-synchronizing currents.

A further particular object of my invention is to utilize telephone lines as clock-synchronizing circuits without interrupting the telephone service, and without causing the telephone call-bells to be sounded.

The further object of the invention is to install such subscribers' clocks upon the telephone or telegraph wires, in such a manner that the clocks shall not be operated by the electric currents normally employed on said telephone or telegraph lines or wires.

A further object of the invention is to provide an electro-magnetic circuit closer for the subscribers' clocks, that shall be responsive to a weak alternating current of high frequency, and which shall be adapted to firmly close and maintain the local clock circuit throughout the time the electro-magnet of the clock is energized by said current.

A further and particular object of my invention is to improve the construction and operation of master clocks for clock synchronizing systems.

My invention consists generally in a system which is characterized by a plurality of circuits each containing two translating devices, as for example a telephone set constituting the primary device and a clock in secondary relation, in combination with means for interconnecting said circuits to permit the interchange of signals or conversations, as between telephones, and means for periodically actuating the secondary translating devices upon all said circuits.

My invention further consists in a clock synchronizing system wherein each clock is provided with or controlled by an electro-magnet which is connected to the telephone subscriber's existing line wires or circuits and wherein an electrical generator and means for intermittently connecting the latter to the circuits are located at a central office.

My invention further consists in the combination of a central station apparatus comprising an alternating current high frequency generator, and an automatic switch for momentarily connecting said generator to the subscriber's lines and simultaneously disconnecting the switchboard circuits from said lines to exclude the synchronizing current therefrom.

My invention further consists in the combination of the above recited instrumentalities, with a novel subscriber's clock relay or electro-magnetic circuit closer peculiarly adapted to the high frequency alternating current which I prefer to use.

My invention further consists in the combination of a subscriber's circuit, with means for connecting a source of electrical energy to both sides of said circuit, a subscriber's

clock relay which is also connected to both sides of said circuit and a device in said circuit for shielding said relay from the normal telephone currents while permitting passage of the synchronizing currents.

My invention further and particularly consists in a synchronizing circuit-closing device of novel and improved construction; and it further consists in a master clock provided with a preliminary circuit closer and with final circuit closing devices.

My invention also consists in an electromagnetic device which is so constructed as to firmly close a local circuit when energized by an alternating current of high frequency and maintain the closure until cessation of the current.

My invention consists further in various details of construction and in combinations of parts, all as hereinafter described, and particularly pointed out in the claims.

My invention will be more readily understood by reference to the accompanying drawings, which form a part of this specification and in which—

Figure 1 is a diagrammatic representation of the preferred embodiment of my invention as applied to a telephone system; Fig. 2 is a side elevation of a master clock of novel construction embraced in my invention; Fig. 3 is an elevation of the preliminary circuit-closing device, viewed in the direction of arrow "*a*"; Fig. 4 is an elevation of the rotary circuit-closers, which are parts of the master clock (also viewed in the direction of arrows "*a*"); Fig. 5 is a section on line V—V of Fig. 2, disclosing the master clock-winding device; Fig. 6 is a sectional elevation of a subscriber's local circuit closer or relay which is so constructed as to be operable by a high frequency alternating current; and Fig. 7 is a detail view of the inner side of the relay armature or vibrator, detached.

My clock synchronizing system is capable of embodiment with or in connection with electrical distribution systems of various kinds; but the specific purpose of the drawings herein is to illustrate the invention as applied to or connected with a telephone exchange system.

The invention as herein illustrated may be defined as including the circuits of a telephone exchange, together with the central station and the subscribers' apparatus, also a plurality of synchronizable or electrically operable time pieces in electric connection with the subscribers' circuits and located at the subscribers' stations.

The arrangement is such that the subscribers' lines or circuits are utilized at certain times during the day for the purpose of operating the clocks thereon, and at such times I prefer to sever the connections between the subscribers' stations and the central station or switchboard. Whether or no the lines of the subscribers who are supplied with clocks shall be actually severed from the switchboard depends upon the character of the electric current utilized in setting the clocks, and also upon whether or no the clock-operating circuits are grounded.

While I prefer to avoid supplementary electrification of the telephone system at clock-synchronizing moments, it will be obvious that the telephone circuits may remain intact, provided the particular telephone apparatus in use is of such character that it will not be injured by the energy used in operating the time pieces.

A thorough understanding of my invention will be facilitated by a brief description of the system in the preferred form, which is shown in the drawings.

A telephone system is represented by the switchboard spring jacks A—A, the subscribers' circuits B—B, and the subscribers' telephone instruments or sets C—C.

D represents a subscriber's clock. This is either a mechanical clock arranged for synchronization electrically, or may be an electrically driven synchronizable instrument. The electro-magnetic circuit closer of the subscriber's clock is connected with the telephone circuit B, being preferably arranged in parallel with the telephone set C. As better explained hereinafter, the ringing and talking currents, used upon the telephone circuit, do not affect the subscriber's clock.

I employ a distinct source of energy wherefrom to operate the subscribers' clocks. The word operate, as herein used, is intended to define that operation of the subscriber's clock or clocks which results in synchronizing the same with a master clock hereinafter described. The source and kind of energy which I prefer to employ is a motor driven generator and the high frequency current derived therefrom. In the drawings, E represents the motor-generator referred to.

F—F represent certain electro-magnetic instruments which I employ for momentarily connecting the motor-generator with the subscribers' circuits, *i. e.*, with such circuits as are supplied with clocks.

Synchronization of the clocks is brought about by first setting the motor generator into operation and then actuating the instruments F at exactly the right moment to move the hands of the clocks to proper position. The operation is substantially instantaneous and the connection between the motor generator and the subscribers' clocks endures for a second only.

G represents the master clock, this is preferably an automatic electrically wound chronometer and aside from indicating the passage of time at the telephone exchange or station, its offices are to control the motor

generator and the instruments or circuit closers F. The master clock is equipped with circuit closing devices of two kinds. First, a preliminary circuit closer H, which prepares the various circuits for use; and, second, a multiple precision circuit closer I, whereby the circuits made ready by the device H are utilized to bring about the momentary energization of the subscribers' circuits and clocks at the instant that the master clock indicates the hour.

In operating or controlling the motor-generator the master clock works through the agency or medium of an instrument J, located in the motor circuit of said generator and in controlling the instruments F, the master clock works through the medium of an instrument K, which is located in a circuit which contains a source of energy and is connected with the electro-magnets of all said instruments F.

The sequence of operations is as follows: During the normal operation of the telephone system, the spring jacks are connected with respective subscribers' circuits in the usual manner and there is no connection whatever between the subscribers' circuits and the master clock or associated instruments. Therefore, the subscribers' circuits may be freely interconnected as required for the exchange of signals and for conversation between subscribers. During this period each subscriber's clock operates under its own motive force. Discrepancies in the operation thereof require correction. The corrective office is performed by the synchronizing devices of the individual clocks under the control of the master clock at the central station. The circuit which includes or is connected with the circuit closing devices F is normally open at two points and the circuits which include the instruments J and K are each likewise open at two points. As the time for synchronizing the subscribers' clock approaches, the preliminary circuit closer H of the master clock prepares the several circuits by closing each at one point. Thereafter the master clock operating through the precision circuit closer I, causes the operation of the instrument J, and thereby closes the energized circuit of the motor generator E, setting the latter into operation. At the next instant the precision device, I, closes the circuit of the instrument K, which operates to close the energized circuit including the instruments F. The latter instantly connect the generator E with all of the time subscribers' circuits, causing the synchronization of the subscribers' clocks. An instant later the precision circuit closer opens the circuit of K and reverses the instrument J, causing first (through K) the reconnection of the subscribers' circuits to the switch-board and second, (through J) the opening of the energized circuit of the motor generator, stopping the latter. As will be better explained hereinafter the instrument K closes the circuits of the instruments F—F at an exact predetermined instant, usually at the end of each twelve hour period, hence the subscribers' clocks are reset or synchronized at noon and at midnight, or at other hours if desired.

It is obvious that instruments of various forms may be employed in carrying out my invention and I desire it to be understood that my invention is not limited to the specific apparatus herein shown.

Referring again to the drawings for details of construction, it will be noted that the arbor of the minute hand (also similar arbor on second hand not shown in drawings) of the subscriber's clock bears the heart cam d for coöperation with the striking pawl d'. When the latter is pressed upon the cam, the cams and the minute and seconds hands will be rotated to restore the hands to the point 12 on the dial. The striker d' is actuated by an electro-magnet d^2, arranged in a local circuit d^3, containing battery d^4 and a circuit closer D^1. The electro-magnet d^5, of this circuit closer is connected with the subscriber's circuit B.

A condenser D^2 is inserted in one branch of the clock circuit. This condenser permits the passage of the high frequency current used in synchronizing the clock, but prevents passage of talking currents, used on the subscriber's circuit. (The ringing current not being of sufficient voltage to operate circuit closer D^1.)

The armature lever d^6 of the instrument D^1 is connected with one side of the circuit d^3, and is adapted to engage the contact d^7, which is the opposite terminal of the battery d^4. When the local circuit is closed between d^6 and d^7, the synchronizer will be operated.

The instrument D^1 is best shown in Fig. 6. The electro-magnet d^5 is arranged in a suitable frame. The parts d^6 and d^7 are shown in proper relations insulated from one another. d^8 is a dead point or stop. The electro-magnet d^5 is energized by the high frequency current from the motor generator E, and the alternations of said current are such that a plurality of contacts between d^6 and d^7 would occur if these parts were permitted to engage directly. As it is desirable that the local circuit d^3 of the clock shall be closed but once, I employ a light spring contact d^9 on the inner side of the armature lever d^6. The coil d^5 being energized the lever will be drawn up sufficiently to force d^9 against contact d^7, and although the lever d^6 will fluctuate slightly, the spring contact will remain in firm engagement with contact d^7, throughout the time that the coil d^5 is energized.

Each instrument F comprises two arma-

ture levers preferably in the form of flat springs f^1, an electro-magnet f^2 and four contacts f^3—f^3 and f^4—f^4. The pairs of contacts f^4—f^4 of the several instruments F are connected with respective spring jacks A, and the springs f' are normally in engagement with said contacts f^4. All of the contacts f^3 are connected with the generator E through the medium of bus bars f^5—f^5. The terminals of the subscribers' circuits are connected with respective contact springs f^1, hence when these are closed upon the contacts f^3, direct connections are made between the subscribers' circuits and the high frequency current generator E. The terminals of the electro-magnets f^2 are connected with the master clock bus bars f^6—f^6 and are energized from a battery or other source of energy L, arranged in a circuit which is normally open at points X and Y, *i. e.* at instruments H and K.

The instrument K, used for closing the circuit at point Y, comprises a magnet k', an armature lever k^2, a contact k^3 and a stop k^4. When the magnet k' is energized the lever k^2, is closed upon contact k^3 placing the battery in circuit with the bus bars f^6 and the magnets f^2; but this action causes the operation of the instruments F only when the circuit has been previously closed at X.

M is a battery or other source of energy, wherefrom the circuit closers K and J are energized, also the master clock winding magnet N.

The instrument J comprises a double armature lever j^1, a contact j^2, a stop j^3, and two electro-magnets j^4 and j^5. When the electro-magnet j^4 is energized, as hereinafter explained, the lever j^1 is closed upon contact j^2. The instrument is so constructed that when closed upon contact j^2, the armature lever will remain in contact therewith until positively removed. Removal is brought about by deënergizing the coil j^4 and energizing magnet j^5. The armature lever j^1 and the contact j^2 are the terminals of the motor circuit E′ which contains a battery or other source of energy E^2. Obviously the closing of the circuit at instrument J sets the motor generator into operation and the opening of said circuit stops the generator.

The construction of the master clock is best shown in Figs. 2, 3, 4, and 5. g^1 is the center wheel mounted upon the center shaft, which carries the minute hand g^2. g^3 is the staff of the hour hand, g^4, and is driven from the center wheel g^1 by a train of gears g^5. g^6 is the escapement wheel mounted on a shaft g^7, driven from the center wheel g^1 by a train of gears g^8. g^9 represents the rocking pallet shaft which carries the escapement or pallets g^{10}, actuated from the pendulum rod g^{11}, through the medium of the pendulum arm g^{12}.

As thus far described the clock is of ordinary construction.

For winding the clock I employ an electro-magnet N fixed upon the frame G, and having an armature lever n', which is provided with a pawl n^2 engaged with a ratchet wheel g^{13}, loosely mounted on the shaft of the minute hand. A spring g^{14} is connected to the ratchet wheel g^{13}, and to the center wheel g^1, or the minute hand shaft. The operation of the electro-magnet N places the spring g^{14} under tension and through the medium of the latter furnishes the force necessary to operate the clock. The arrangement is such that the clock winding magnet N is included in or connected with the circuit of the electromagnet k' and is operated once a minute.

The preliminary circuit closer H comprises a cam wheel h' fixed upon the hour hand staff g^3;—a co-acting spring or arm h^2 having an insulated end or bridge h^3; and, two contacts x' and x'' insulated from one another upon the frame of the clock. When the cam notch h^4 of the wheel h' arrives before the lug h^5 on the spring h^2, the latter sinks into the notch and the bridge piece h^3 is permitted to rest upon the contacts x'—x'' for approximately a minute, during which time the circuits which terminate at the contacts x'—x'' are closed at other points, to operate the devices therein. Such closing of the circuits by the master clock is brought about by the precision circuit closer I; a device of simple construction, but most reliable in operation. This device comprises three pairs of contacting members i' and i^2, i^3 and i^4, i^5 and i^6. These are small arms having properly positioned platinum points, *a*, *b*. The arms i^2, i^4, i^6 are fixed upon the metal shaft g^7 by small set screws i^7;—while the arms i', i^3, and i^5, likewise secured upon the pallet shaft g^9, are insulated therefrom by bushings i^8. The rocking of the shaft g^9 oscillates the contact arms i'—i^3—i^5, and the rotation of the shaft g^7 carries the co-acting arms i^2, i^4, i^6 around in time to meet them, *i. e.*, respective opposed contacts i', i^3, i^5. An electrical connection *z* made to the frame of the clock serves as the connection for the rotative contacts i^2—i^4—i^6. Separate connections *u*, *v*, and *w* are provided for the contacts i'—i^3—i^5. These connections, being flexible, and balanced as to tension, do not oppose the action of the pallet shaft and pendulum.

Lines 3 and 12 connect both magnets j^4, j^5 of the instrument J with the preliminary circuit closer contact x'. Separate lines 1 and 2 extend from magnets j^4 and j^5 to the precision contact connections *w* and *u* respectively. The opposed precision contacts

are connected with the opposed preliminary circuit closer contact x'' by the lines z, 8, and 11, the battery M being interposed in the line. One terminal of the magnet k' is connected to the precision contact i^3 through v and line 4; and its other terminal is connected with the opposed precision contact through line 5, the battery M, and the connection z. The clock winding magnet N is placed across the circuit 4—5 by the lines 6—7, connected thereto, and said circuit being open at the precision device the magnet N will only be operated when the precision contacts i^3 and i^4 engage, *i. e.*, at the instant that the instrument K is operated. A line 10 extending from the bus-bars f^6 to the contact k^3 includes battery L, and the circuit is completed through the armature lever k^2, the line 9, and lines 11, 12, and 13. It will be noted that the lines 11 and 12, like the contacts x' and x'' are common to the circuit 9—10, the circuit 1, 3, 8, z, and the circuit 2, 3, 8, z. Though the line 8 is connected with the battery at the same point as the lines 5 and 7, the circuits 4, 5, and 6, 7, are not dependent upon lines 11—12, or the preliminary circuit closer.

It will now be obvious that the first group of circuits will be called into action only once during the rotation of the hour hand of the clock, whereas the circuits which include the electro-magnets k' and N are utilized once each minute, that being the time required for one revolution of the shaft g^7, which bears the rotating contacts i^2, i^4, and i^6.

The operation of the remaining elements of my invention having been already described it only remains to fully explain the operation of the master clock.

The escapement wheel and pallet operate in the ordinary manner and at the moment that the contact i^2 arrives in radial alinement with the contact i', the latter rocks down upon it, thereby closing, at this point, the circuit of the electro-magnet j^4. The complete closure occurs only at times when the bridge h^3 is in engagement with the contacts x'—x'';—at other time, the circuit remaining open at x'—x'', the engagement of the contacts i^2—i' does not occasion the operation of the instrument J. But assuming that the circuit is closed at both points, the instrument J will then close the circuit E′ and start the motor-generator. At the next instant the contact i^4 will aline with and be engaged by the rocking contact i^3, thereby closing the circuit of the clock winding magnet N and the circuit of the instrument K. Closure of the latter through lines v, 4, 5, the battery M, and z, energizes the instrument K and causes it to close the circuit 9—10, through battery L. The closure at Y, occurring at a moment when the circuit is closed at X, all of the instruments F will be operated, the current flowing thence from the battery L and returning through the bus-bar and the lines 13, 12, 11, and 9. Closure of the circuit 4, 5, through contacts i^3—i^4, at other times, serves only to keep bright the contacts of instrument K, and to energize the clock winding magnet N. At the moment that the circuits are simultaneously closed at contacts i^4, i^3, and at points, X, and, Y, a moment co-incident with the indication of noon or midnight by the master clock, the energization of instruments F causes the contacts or springs f' thereof to engage the motor generator contacts f^3, whereupon current is thrown upon the subscribers' lines to operate the subscribers' clocks as hereinbefore described. At the next instant the parting of the contacts i^4—i^3 causes the deënergization of the instrument K, and the breaking of the circuit of the instruments of F at Y, restoring the subscribers' lines to the switch board and cutting off the generator. Following this the contacts i^6 and i^5 engage, whereupon the reversing magnet j^5 of instrument J is energized to break the circuit E′ of the motor generator. Thereafter the recurring engagement of contacts i^4—i^3 causes the regular operation of instruments K and N, but the sequence of operations above described, resulting in synchronization of the subscribers' clocks, does not again occur until the cam wheel h' of the preliminary circuit closer again presents its notch to the bridge lever and permits the bridge to close upon contacts x'—x''.

I prefer that all the circuits of my system shall be complete metallic circuits, but it is obvious that my invention may be carried out with single or grounded circuits. Likewise the various sources of energy herein described may be consolidated, or made fewer in number. For these and other apparent reasons, I do not confine my invention to the specific system or apparatus herein described.

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

1. The improvements herein described, comprising a telephone exchange and a plurality of subscribers' circuits and instruments, normally adapted for interconnection through said exchange, in combination with subscribers' electrically synchronizable clocks, connected with respective subscribers' circuits a normally quiet rotary generator for energizing said circuits to synchronize the subscribers' clocks, and electromagnetic means for periodically disconnecting each subscribers' circuits from said exchange and master clock mechanism for starting said generator and at a given instant energizing

said electromagnetic means, substantially as described.

2. The improvements herein described, comprising a telephone exchange, in combination with a plurality of subscribers' circuits adapted for inter-connection through said exchange, a source of alternating current energy normally connected with said circuits, subscribers' telephone instruments, subscribers' clocks connected with said circuit, a condenser interposed in the line of each said clocks, a rotary generator for energizing said circuits and operating said clocks and means at said exchange for periodically connecting said rotary generator with the circuits which are provided with clocks, for synchronizing the latter, substantially as described.

3. The improvements herein described, comprising a telephone exchange, in combination with a plurality of subscribers' circuits, each provided with a synchronizable clock and containing a subscribers' telephone set, condensing means D^2 in each said circuit preventing the operation of the clock therein by the energy commonly employed upon said circuits, an alternating current generator, a master clock and means interposed in each said circuit and controlled by said master clock adapted to connect said generator with said circuits at a given instant to synchronize the clocks therein, substantially as described.

4. The improvements herein described, comprising a telephone exchange, in combination with a plurality of subscribers' circuits adapted for inter-connection thereto, subscribers' instruments in said circuits, synchronizable clocks connected with said circuits, a normally quiet rotary generator, electromagnetic switches interposed in said circuits, each normally connecting one of the same with said exchange, but adapted to connect it with said generator, a master clock causing the operation of said switches and means controlled or actuated by said master clock for starting and stopping said generator before and after the operation of said switches, substantially as described.

5. The improvements herein described, comprising a telephone exchange, subscribers' circuits, telephone instruments and synchronizable clocks, in combination with an electrical generator, instruments interposed in said circuits normally connecting the same with said exchange, but adapted to connect them with said generator, a master clock, a preliminary circuit closer operable thereby and adapted to prepare said instruments for operation and a precision circuit closer also actuated by said clock for finally closing the circuits of said instruments and operating to start and stop said generator, substantially as described.

6. The improvements herein described, comprising a telephone exchange, subscribers' circuits, subscribers' telephone instruments and subscribers' synchronizable clocks, in combination with a motor generator, the power circuit thereof, a circuit closer arranged in said power circuit, instruments interposed in the said subscribers' circuits normally connecting the same with said exchange, but adapted to connect them with said generator, a master clock, a preliminary circuit closer actuated thereby for preparing said circuits, said closer and said instruments for operation, a precision circuit closer also actuated by said master clock for closing the circuit of said instruments and other precision circuit closers for operating the circuit closer in said power circuit before and after the operation of the first mentioned precision circuit closer, substantially as described.

7. The herein described improvements, comprising a circuit containing a primary translating device and normally energized with direct current energy, in combination with a synchronizable clock connected with said circuit, means for periodically impressing an alternating current upon said circuit to operate said clock and means interposed in said circuit preventing the simultaneous employment of direct and alternating currents upon said circuits, substantially as described.

8. The herein described improvements, comprising a telephone circuit containing a telephone and a synchronizable clock connected therewith, in combination with a condenser interposed between said circuit and clock, and means for non-simultaneously energizing said circuit with currents which do and do not energize said telephone, substantially as described.

9. The herein described improvements, comprising a line containing a primary translating device operated by normal currents; a secondary translating device connected to said line; a source of high frequency alternating current for actuating the secondary translating device; a condenser in circuit with the secondary device; and means for periodically impressing said alternating current upon the line, substantially as described.

10. The herein described improvements, comprising a plurality of circuits containing a telephone set, in combination with means for normally energizing said circuits, a clock electrically connected in circuit with each said circuit; a normally idle secondary-current generator adapted to produce a current of higher tension than the normal current; means for periodically impressing the secondary current upon said circuits for actuating said clocks, and means for starting and stopping said generator before and after the actuation of the clocks, substantially as described.

11. The herein described improvements, comprising a circuit containing a telephone, and a clock connected thereto, in combination with a secondary current generator, an electro-magnetic switch for momentarily connecting the generator to the circuit; and automatic means for starting and stopping the generator before and after the operation of said switch, substantially as described.

12. The herein described improvements, comprising a circuit containing a primary translating device; and a secondary translating device connected thereto; in combination with a motor generator, an electro-magnetic switch for momentarily connecting the generator to the circuit; a relay for operating said switch, a precision circuit closer for periodically operating said relay and automatic means for starting and stopping said motor generator before and after the action of said switch, substantially as described.

13. The herein described improvements, comprising a plurality of circuits each containing a primary translating device and a secondary translating device; in combination with means for interconnecting said circuits; a motor generator, electro-magnetic switches for periodically connecting said generator to said circuits for actuating the secondary translating devices; automatic means for starting and stopping said motor generator before and after the action of said switches; and a master mechanism for controlling the action of said switches and of said starting and stopping means, substantially as described.

14. The herein described improvements, comprising telephone circuits to be energized, in combination with a motor generator, a motor generator starting circuit, a motor generator stopping circuit, corresponding electro-magnets, in combination with a master clock comprising a preliminary circuit closing device in said magnet circuits and final precision circuit closers for closing the starting and stopping circuits in the order named, substantially as described.

15. The herein described improvements comprising, in combination, a motor generator starting circuit, a motor generator stopping circuit, and a relay circuit; a master clock having a preliminary circuit closing device and final circuit closers for closing the starting, the relay, and the stopping circuits in the order here named, and clock escapement mechanism for controlling the operation of said final circuit closers.

16. The herein described improvements, comprising a circuit containing a primary translating device, in combination with a secondary translating device relay connected to said circuit; a secondary alternating current generator for supplying the secondary translating device actuating current, said generator being normally disconnected from said circuit and non-operative; said relay being provided with a resilient circuit closing member, for the purpose described.

17. The herein described improvements, comprising a circuit containing a primary translating device, in combination with a generator and switch for normally energizing said circuit and primary device, a secondary translating device, a circuit connecting the same with the first mentioned circuit, a relay therein, an alternating current generator, said relay being adapted to be energized by current from said generator and said primary translating device being uninfluenced thereby, electro-magnetic means for coupling said alternating current generator with the first mentioned circuit and simultaneously disconnecting the first mentioned generator and a master clock governing the operation of said electro-magnetic means and said alternating current generator, as and for the purpose specified.

18. The improvements herein described, comprising a plurality of telephone circuits and their terminals, in combination with telephone instruments in said circuits, switches interposed in said circuits and normally connecting respective telephone instruments with respective circuit terminals, a source of energy, means for simultaneously actuating all said switches to connect said source with said telephone circuits and disconnect the latter from their terminals, operatively interposed means for making ready and cutting out said source in advance of and after the operation of said switches, synchronizable clocks electrically connected with respective circuits, a master clock and precision circuit closers actuated thereby and governing said source and said switches, substantially as described.

In testimony whereof, I have hereunto set my hand, this 19th day of November, 1906, in the presence of two subscribing witnesses.

HERMAN C. KORFHAGE.

Witnesses:

NELLIE M. KEANEY,

LOUIS C. MENARD.