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SYNCHRONIZING CLOCK SYSTEM

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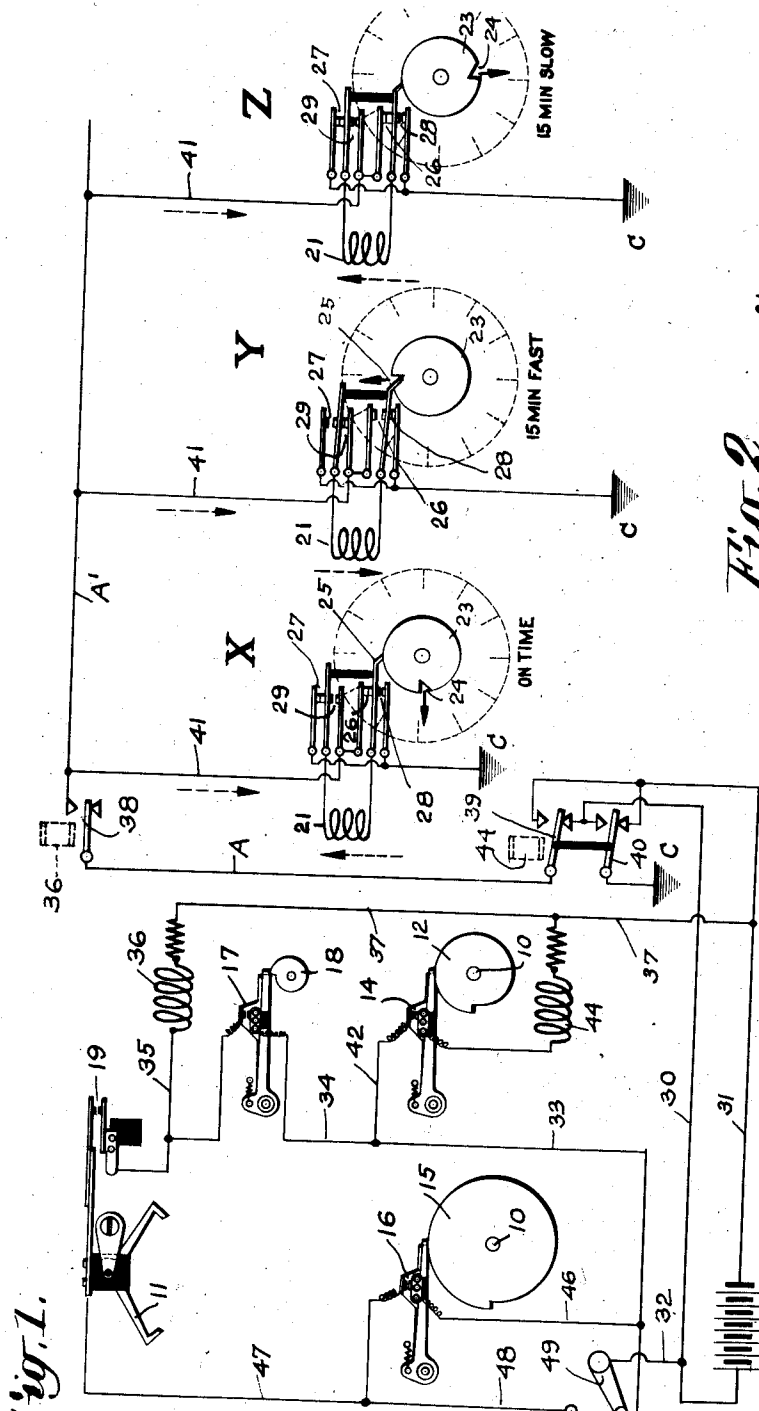
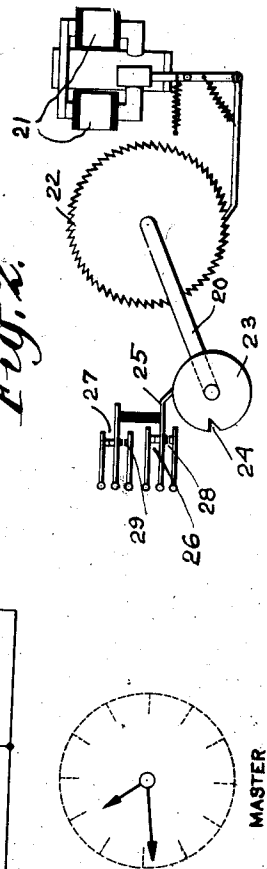


Fig. 2.



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SYNCHRONIZING CLOCK SYSTEM

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This invention relates to systems for actuating secondary clocks by a master clock and to the accomplishment of maintaining all of the clocks in the system in synchronism with the master clock.

The present invention is directed to actuation and synchronization of secondary clocks under the control of a master clock by the agency of electrical energy, and has for its object the utilization of uni-directional impulses by secondary clock actuating mechanisms for actuating the secondary clocks, which impulses are initiated and controlled by the master clock from a source of direct current.

Another object resides in providing means for controlling the reversal of the current through the polarized electro-magnet of a secondary clock when it is desired to render the particular secondary clock immobile.

Another object resides in producing a synchronizing clock system which necessitates the use of a minimum number of wires and is otherwise simplified by the existence of a relatively few number of parts in the secondary clocks.

Further and other objects of the present invention will be pointed out hereinafter in the accompanying specification and claims and shown in the drawing which by way of illustration shows a preferred embodiment of the invention.

In the drawing:

Fig. 1 is a view showing the pertinent parts and wiring of a master clock in cooperative relation to the wiring diagram of a complete system.

Fig. 2 is a view of a minute hand arbor driving means such as may be used for driving secondary clocks used in the system.

Master clock

The master clock in its general details may be of any desired form. For example, it may be that shown in United States Patent No. 1,390,018. Referring to Fig. 1, the master clock includes the usual time train adapted to drive the minute arbor 10 which makes one revolution per hour. The usual verge mechanism 11 is provided. Fixed to the

minute-hand arbor is a cam 12 with a single drop-off shoulder causing contacts 14 to be closed during the interval between the successive releases of the two levers carrying said contacts.

Also fixed to the minute-hand arbor 10 is a cam 15 which is adapted to control the opening and closing of contacts 16. In the preferred embodiment, contacts 16 are arranged to close for a short period just after the fifty-ninth minute and then open just before contacts 14 are closed. Contacts 14 are designed to close immediately after contacts 16 open and before the sixtieth minute impulse and then remain closed for the sixtieth minute impulse after which they will immediately open.

The master clock is provided with minute impulse contacts 17 which are controlled from a minute cam 18 or otherwise as is the custom in clocks of this sort.

For accelerating the advance or forward movement of the secondaries there are provided quick acting contacts 19 which are preferably operated by the verge mechanism 11. These contacts 19 will close at every swing of the pendulum if a pendulum movement is employed.

Secondary clock

The secondary clock driving mechanism which is adapted for use in the present system is shown in Fig. 2, but any electro-magnetic device which is responsive to the effects of uni-directional flow of current and which is capable of causing translatory movement of a ratchet may be used. Each secondary clock includes a minute-hand arbor 20 which makes one revolution per hour. This arbor is rotated by means of a polarized electro-magnet 21 which is actuated by uni-directional impulses only and will act on each uni-directional impulse to advance the ratchet-wheel 22 and arbor 20 step-by-step.

Carried by the minute-hand arbor 20 on each secondary clock there is provided a notched disk 23 having a notch 24 so positioned as to allow switch blade 25 to drop just as the hands of the particular secondary clock indicate fifty-nine minutes past the

hour. When the switch blade is in its high position only contacts 26 and 27 will be closed and when the switch blade is in its low position, only contacts 28 and 29 will be closed and contacts 26 and 27 will be open. The parts are so arranged that at no time except momentarily during the shifting of blade 25 are both sets of contacts open.

Referring to the circuit diagram, current is supplied to the system from main line 30, which is connected to the positive terminal of a battery or other source of direct current. Main line 31 is connected to the negative terminal of the same source of direct current. A reversing switch 39, 40 is provided for changing the direction of flow of current in the secondary clocks circuit with a change of position of the switch. For simplicity of description, the return circuit of the secondary clocks will be grounded and this ground circuit is designated as C.

Synchronization

Synchronization of a number of secondary clocks is achieved in the following manner: Current is obtained from main lines 30 and 31 and the clocks are continually actuated during their normal operation by minute impulses through polarized magnets 21. Current from main line 30 flows through wires 32, 33 and 34, through contacts 17, wire 35 master relay coil 36, wire 37, and back to main line 31. This current is intermittent due to the periodic closing of contacts 17 by cam 18 on the minute arbor of the master clock and therefore armature switch 38 will be closed once every minute for a short interval. This will allow an intermittent current in the form of minute impulses to flow from main line 30, through upper blade 39, of reversing switch 39, 40, through line A armature switch 38, distributing line A', branch 41, contacts 26, "up" through polarized relay 21, contacts 27 and back through the ground C, through switch blade 40, to main line 31, thus causing polarized magnets 21 to keep all of the secondary clocks in step with the master clock.

All of the secondary clocks of the system will be actuated in this manner. If any one of the clocks is fast the polarized magnet will be rendered non-responsive to these minute impulses which are being delivered to it over branch lines 41, for when the particular secondary clock reaches its fifty-ninth minute reading switch blade 25 will drop into the notch on disk 23 and contacts 26, 27 will be opened. However, contacts 28, 29 will close and impulses will continue to flow through contacts 29, "down" through polarized magnet 21, as indicated by clock Y, and back through the ground to the source. When contacts 28 and 29 were closed, the direction of current in the coils of the polarized relay will have changed, and since this new direction ("down") is opposite to that which is

effectual to operate the secondary clocks, the particular secondary that has reached the fifty-ninth minute indicator ahead of the proper time will stop for its polarized magnet is non-responsive to the impulses now being delivered to it.

Should any of the secondary clocks be slow they must be stepped ahead at a rapid rate in order that they be on time on the hour. This is accomplished by causing rapid actuation of polarized magnets 21 just before each hour reading of the hands of the master clock. Cam 15 closes contacts 16 preferably after the fifty-ninth minute and allows current to flow from main line 30, through switch 49, wire 46, contacts 16, wire 47, contacts 19, wire 35, master relay coil 36, wire 37 and to main line 31. Contacts 19 close once every two seconds and cause the intermittent current set up to energize master relay coil 36 at the same rate. This results in closing armature switch 38 at the same rate. Current will flow in the secondary clock circuit, as in the normal advance of the secondary clocks, from main line 30, through switch blade 39, line A, armature switch 38, distributor line A', branch 41 of the tardy secondary clock, contacts 26, "up" through polarized magnet 21, contacts 27 and back through the ground C, through switch blade 40, to main line 31, thus producing rapid advance of the particular tardy secondary clock or clocks.

In my preferred embodiment, this period of acceleration of the tardy clocks occurs on the tenth second after the fifty-ninth minute and lasts for about thirty seconds, thus allowing for a positive correction of fifteen impulses each hour. This period may be lengthened if desired, but it must terminate prior to the closing of contacts 14 by cam 12 which is timed to close these contacts for a period of approximately twenty seconds starting at about ten seconds before the hour.

Contacts 14 are timed to be closed during the sixtieth minute impulse so that a steady flow of current will flow from main line 30, to wires 32, 33 and 42 relay coil 44, wire 37 to main line 31. This condition causes reversing switch 39, 40 to be held in a raised position so as to reverse the direction of flow in line A. Now, when the sixtieth minute impulse is sent out by the closing of contacts 17, current will flow from main line 30, through switch blade 40, ground C, contacts 28 "up" through polarized magnet 21, contacts 29, wire 41, line A', armature switch 38, line A, switch blade 39 to main line 31. The direction of the flow of current being that ("up") to which the polarized magnet is responsive, all of the secondary clocks will step off together and will indicate the hour. At the hour indication switch blade 25 will be in its raised position

and contacts 26 and 27 will be closed. Before the next ensuing impulse is initiated, contacts 14 at the master clock will have opened thereby permitting the reversing switch 39, 40 to drop and assume its normal position. The next ensuing impulse and all following ones up to the time when contacts 14 are again closed will flow from main line 30 through switch blade 39, line A, armature switch 38, line A', branches 41, contacts 26, "up" through polarized magnets 21, contacts 27, switch blade 40 and ground C to main line 31. The successive minute impulses will cause the secondary clocks to be advanced step-by-step and the operation of the system above described will be repeated every hour.

It will be apparent from the foregoing that the period of coincidence of all of the clocks in the system described in this embodiment of my invention occurs after the fifty-ninth minute and may last until ten seconds past the sixtieth minute, allowing for an advance of slow secondary clocks of as much as fifteen minutes and a retardation of fast secondary clocks of a maximum amount of a little less than fifty-nine minutes. It is manifestly obvious that the corrections may be relatively varied according to the timing of the various cams.

It will be understood that if in any case it is required to correct the time of the entire system, as for example, when the master clock is running fast or slow and this correction is to be within the range permitted by the synchronizing period it is only necessary to reset the hands of the master clock of the desired extent. The secondaries will then set themselves within the next hour. If the amount is in excess of the synchronizing period for which the system is designed, for example, when a daylight saving correction is required, a manual control is brought into operation which will now be described. Referring to the diagram, a wire 48 is provided terminating in a switch point as shown. To retard the secondary clocks the switch 49 is displaced to the open or off position. This switch is maintained open for the desired retarding period. If it is desired to advance the clock, the switch 49 is thrown to connect with the switch point or wire 48. The effect of connecting switch 49 with wire 48 is to cause the fast set-up contacts 19 to come into action and rapidly advance the various secondary clocks. The switch 49 will be held closed until the secondary clocks advance to the desired extent. For example, to advance all of the clocks one hour with contacts 19 closing every two seconds it will take two minutes to bring about the proper advance of the secondaries.

It will be understood that it is not essential to hold switch 49 closed for the exact period inasmuch as the synchronizing sys-

tem will function to bring the clock in time with the master clock whether the said secondary clocks are fast or slow with respect to the master clock. It is only necessary that they be brought within the range of the synchronizing period.

The above is equally true with regard to retarding operations it being only necessary to open switch 49 for approximately the desired retarding period.

In Fig. 1, three secondary clocks are illustrated showing their time relation to the master clock. As before stated, between the fifty-ninth and sixtieth impulses all secondary clocks behind time will be urged ahead by the rapid series of accelerating impulses, but since clock X is on time it will not be affected for when it reaches the fifty-ninth minute contacts 26 and 27 will open and the direction of the current through the polarized magnet will be in the non-responsive ("down") direction. Clock Y, which is fast, will have reached this condition sooner and will have stopped for the same reason. Clock Z, however, will still have contacts 26 and 27 closed and it will receive the fast impulses and be rapidly advanced thereby until contacts 26 and 27 open and switch blade 25 will have fallen. With each of these clocks thus brought into synchronism, the sixtieth impulse will be effective to start all of them off together for reversing switches 39, 40 will have caused the current to flow in the direction ("up") of responsiveness of the polarized magnets.

So as to make the operation of the system easily understood, I have referred to the direction of the current to which the polarized magnets are responsive as being "up", and to the opposite direction as being "down", but aside from indicating the opposite directions of flow of current in the polarized magnet these words are of no consequence. The arrows used on the diagram indicate the direction of flow under the conditions existing only. It is obvious that main lines 30 and 31 could be attached to negative and positive terminals of the battery respectively and that the system would properly function for the polarized magnets depend for their operation upon their uni-directional character.

Certain features of the present invention are broadly claimed in my copending application, Serial No. 24,322, filed April 20, 1925.

What I claim is:

1. In a synchronizing clock system, in combination with a master clock and a secondary clock, a single secondary clock circuit, means for controlling the distribution of electrical energy over said single circuit so as to cause intermittent flow of current in the form of impulses, electro-magnetic means in said single circuit for causing the actuation of said secondary clock, and means controlled by said secondary clock for reversing the di-

rection of flow of current through said electro-magnetic means whereby said impulses are ineffectual to actuate said electro-magnetic means.

2. In a synchronizing clock system, in combination with a master clock and a secondary clock, a single secondary clock circuit, means for controlling the distribution of electrical energy over said single circuit so as to cause intermittent flow of current in the form of impulses, a polarized magnet in said circuit for causing the actuation of said secondary clock, and a pole changer controlled by said secondary clock for automatically reversing the polarity of said magnet at a predetermined time.

3. In synchronizing clock system, in combination with a master clock and one or more secondary clocks, a distributing circuit, means controlled by said master clock for sending impulses over said circuit, a polarized magnet in said circuit for actuating a secondary clock, a pole changer controlled by said secondary clock for reversing the direction of flow of current in said polarized-magnet, and a pole changer controlled by said master clock for reversing the direction of flow of current in said circuit.

4. In a synchronizing clock system, in combination with a master clock and one or more secondary clocks, a single distributing circuit, means controlled by said master clock for sending out impulses over said circuit, a polarized magnet in said circuit for actuating a secondary clock, means controlled by said secondary clock to reverse the direction of flow of current in said magnet so as to render said secondary clock immobile, and a pole changer controlled by said master clock to reverse the flow of current in said polarized magnet whereby said polarized magnet is permitted to advance said clock, said second named means causing the reversal of current flow in said magnet.

5. In a synchronizing clock system in combination with a master clock and one or more secondary clocks, a secondary clock circuit, means controlled by said master clock for sending out impulses over said circuit to each of said secondary clocks, a polarized magnet in each secondary clock subject to be actuated by uni-directional impulses only, means controlled by a secondary clock for reversing the polarity of said magnet to stop the advance of said clock by said magnet, and means to cause the direction of said current to be reversed to permit again the actuation of said secondary clock at a predetermined time, said second named means acting to concomitantly change the polarity of said magnet and said third named means causing reversal of said current in said circuit whereby uni-directional impulses are permitted to be delivered to actuate said secondary clock.

6. A synchronizing clock system, with a

master clock and one or more secondary clocks connected in circuits receiving impulses from the master clock, means controlled by said master clock for sending out normal impulses and faster than normal impulses, in combination with means controlled by said master clock for reversing the direction of flow of one of said normal impulses, a polarized magnet for actuating said secondary clock, and a means controlled by said secondary clock for permitting all of said normal impulses to be effective to activate said polarized magnet if said secondary clock is on time or slow and to effect or suppress activation of said polarized magnet by said faster than normal impulses.

7. A synchronizing clock system with a master clock sending out over a circuit to a secondary clock normal and fast impulses, in combination, means at the master clock for sending out over the circuit at the termination of the sending of fast impulses, a single impulse in reverse direction, means at the secondary clock including a polarized magnet for controlling the clock, and a circuit controller for alternating the direction of flow of current therethrough, said circuit controller being controlled by the chronological condition of the clock for effecting or suppressing operative energization of the actuating magnet by the normal and fast impulses.

8. In combination, a secondary clock having a polarized actuating impulse magnet, and secondary clock-controlled means for controlling the polarity of current supplied to said magnet.

9. In combination, in a secondary clock of the impulse type, a polarized actuating impulse magnet for driving the clock, and secondary clock controlled means for periodically reversing the direction of flow of impulses to said magnet for the purpose described.

10. A secondary clock adapted to be advanced by normal impulses for ordinary running, by fast impulses when slow, and to be stopped when it has arrived at a definite time to be afterwards restarted, said clock comprising a polarized actuating impulse magnet and means controlled by said magnet itself for reversing the flow of current therethrough when the secondary clock reaches said definite time position whereby the receipt of further impulses thereby whether rapid or normal is ineffective to effect operative energization of the magnet and whereby receipt of a normal operation impulse is necessary for again operatively energizing the magnet to advance the clock.

11. A synchronized clock system including a master clock and a secondary clock, means in the master clock for sending unidirectional normal and fast impulses, means in the secondary clock for actuating the clock by the impulses received from the master clock,

means in the secondary clock including a switching device controlled by the chronological condition of the secondary clock for arresting the advance of the secondary clock upon its arrival at a predetermined point in its cycle, and means in the master clock for sending out a single impulse of opposite polarity for rendering ineffective the arresting means and for again and by said current impulse stepping off the secondary clock after its action has been suspended.

12. A secondary clock for use in a synchronized clock system of the impulse type wherein each secondary impulse clock is advanced by regularly recurring impulses and accelerated if slow by more rapidly recurring current impulses and wherein each secondary comprises electrical circuit controlling means for cutting it off from operation as it reaches a certain chronological condition and including in combination therewith a polarized magnet, and means in the secondary brought into operation upon the receipt of a reverse current impulse in the secondary for re-establishing operative conditions of the secondary.

13. A secondary clock of the impulse type and comprising a common impulse magnet which serves the dual purpose of advancing the clock for normal step by step operations and for also more rapidly advancing the clock by rapid impulse operations and including in combination therewith, a single pair of circuit terminals by which controlling impulses can enter and leave the clock over a common single line circuit and means intermediate said terminals for periodically suspending operation of the clock, and other means intermediate said terminals and arranged to be operatively effective upon the receipt of a reverse current impulse for re-initiating the advance of the clock after such suspension of operation.

14. A secondary clock comprising clock mechanism and a common impulse magnet which constitutes the sole means for normally stepping ahead the clock and for also accelerating it if slow, in combination with polarized magnet means and circuit controllers at each clock, each said circuit controller being controlled by the chronological condition of its own clock, said controller cooperating to permit operative action of the impulse magnet if the clock is in such chronological condition that impulses should be received by the common magnet and also cooperating to suspend effective operation if the clock is in such chronological condition that its operation should be suspended, and said controller and polarized magnet cooperating upon the receipt of a current impulse of reverse polarity for stepping off each secondary clock mechanism by the impulse magnet after such suspension.

15. In a secondary clock of the type wherein a single impulse magnet during a certain

chronological period receives more than sufficient impulses to advance it to indicate the time which has actually accrued during such period, and in which cyclically operated means automatically suspend advance of the clock when it reaches a predetermined time position, in combination with a polarized magnet means a circuit controlling means cooperating therewith for restoring impulse advance of the secondary after such suspension and by and upon receipt of a current impulse of reverse polarity by said polarized magnet means.

16. A secondary clock comprising an impulse magnet, and means in said clock for so directing current to the magnet that such magnet operates upon the receipt of each impulse by the clock until a certain chronological condition is attained thereby, means for thereupon suspending impulse advance of the clock by altering the circuit connections to the impulse magnet, and means brought into operation when operation of the clock is thus suspended by the aforesaid means and including devices effective upon receipt of an initial current impulse of reverse polarity for rendering ineffective said suspending means and for re-initiating advance of said clock under the action of the impulse magnet.

17. A secondary clock including an impulse magnet in which clock mechanism is stepped ahead by said magnet to a determined time position, a circuit controller controlled by the clock mechanism and arranged to suspend impulse advance of the clock when it reaches a certain time period, said controller providing for the transmission to the clock of additional impulses to bring it up to time if the clock is slow, and means controlled by the receipt of a single initial impulse of reverse polarity for stepping off said clock when its action has been so suspended.

18. A secondary clock comprising in combination, time-indicating means, an impulse magnet and means for causing said magnet to advance the indicating means upon receipt of current by the secondary clock, circuit reversing means operated by the electromagnet for suspending actuation of the indicating means when the latter attains a predetermined position, and means operative upon receipt of current by the secondary clock of reverse polarity with respect to the first mentioned current for energizing the impulse magnet to cause advancement of the indicating means.

19. In combination, a secondary clock including time-indicating means and an impulse magnet, means for causing said impulse magnet to move said time-indicating means to a predetermined position whether it is ahead of or behind actual time, circuit controlling means in the secondary operative only when the time-indicating means has reached said predetermined position for sus-

pending operation of the indicating means by said impulse magnet, and means operative by reversal of current supplied to the secondary clock for causing said impulse magnet to
5 advance the indicating means from said predetermined position.

20. In combination, a secondary clock; master-clock-controlled means for supplying in succession to said secondary clock, normal
10 current impulses, rapid current impulses, and a current impulse of reverse polarity with respect to the preceding normal and rapid impulses; said secondary clock including time-indicating means, an impulse mag-
15 net for advancing the indicating means to a predetermined position by receipt of said normal impulses or said normal and rapid impulses, circuit controlling means in the secondary clock for suspending operation of the
20 indicating means by said impulse magnet when it has reached said predetermined position, and means for causing advancement of the indicating means from said predetermined position by said impulse magnet upon
25 initiation of said impulse of reverse polarity.

21. In a clock system, a master clock, a secondary clock, means controlled by the master clock to periodically accelerate the secondary when it lags behind the master, means to
30 retard the secondary when it leads the master clock, and means controlled by the master clock, including a permanent magnet, and circuit switching means in the secondary to release the secondary when both clocks are in
35 the same phase.

22. In a secondary clock, a minute shaft, operating means including an electro-magnet having coils through which the actuating current normally flows in a given direction,
40 circuit controlling means in the secondary tending when operated to periodically stop the clock, and means operable on a reversal of the current in the coils of the electro-magnet for rendering said stop means ineffective.
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In testimony whereof I hereto affix my signature.

JAMES W. BRYCE.

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