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SYNCHRONIZING CLOCK SYSTEM

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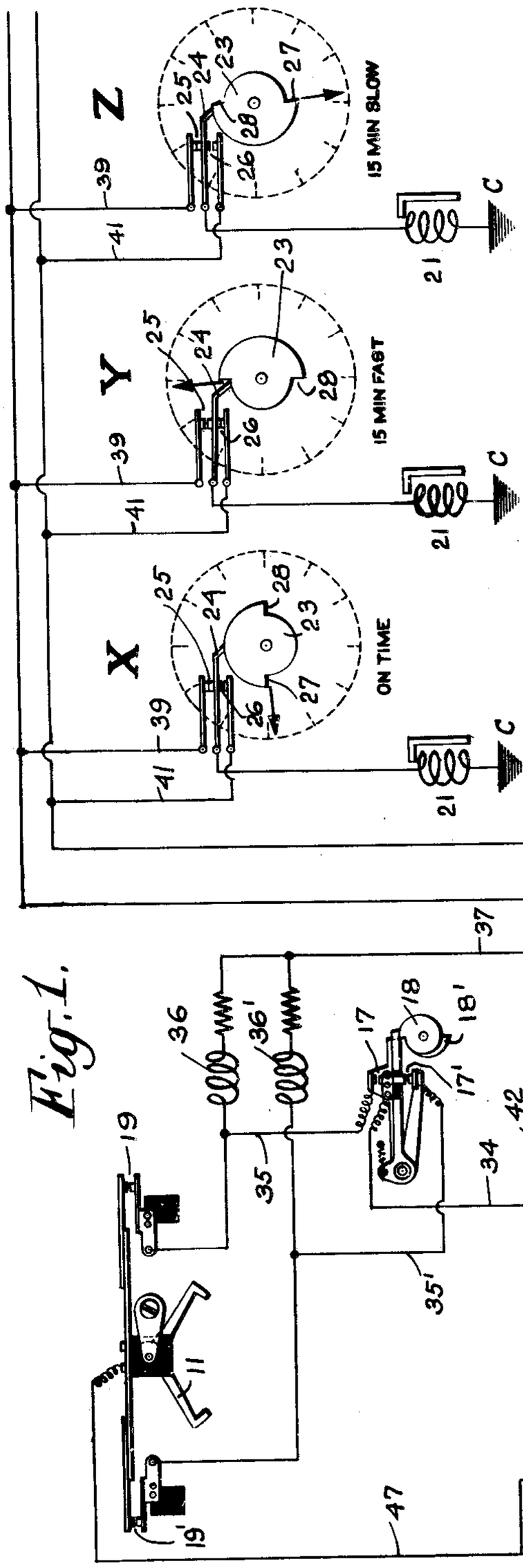

Fig. 1.

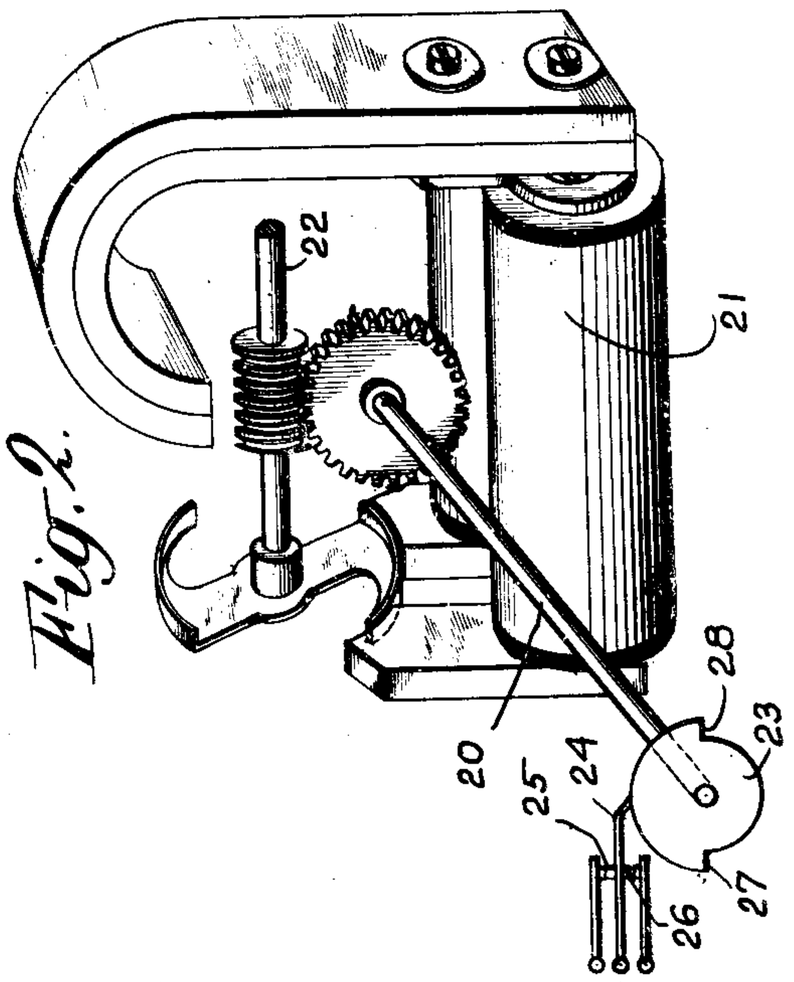

Fig. 2.

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UNITED STATES PATENT OFFICE

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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 to utilize for these purposes alternate impulses of opposite polarity which are initiated and controlled by the master clock from a source of direct current.

Another object resides in the production of a master clock which will control the sending out of alternate impulses of opposite polarity and thereby cause the actuation of secondary clocks by the resulting effect of the alternate impulses of opposite polarity on the driving mechanism of the secondary clocks.

Another object resides in producing a synchronized clock system in which the secondary clocks are noiseless in their operation and require a minimum of current for their operation.

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

In the drawings:

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 shaft are a pair of cams 12, 13, which cams are shaped and positioned to control a pair of contacts 14. Preferably the arrangement of parts is such that the contacts 14 are closed for the synchronizing period and opened at other times. It will be obvious, however, that by a proper rearrangement of the associated parts of the system these cam contacts could operate in a reverse manner opening in the synchronizing period and closing at other times.

In the present and preferred embodiment I provide for a synchronizing period commencing just after the minute hand of the master clock is forty-four minutes after the hour and terminating just prior to the sixtieth minute, for reasons which will hereinafter appear.

Also fixed to the minute 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 just after the fifty-ninth minute position and open at approximately fifty-nine and a half. For a proper functioning of the apparatus the contacts 16 should open just before contacts 14 open at the end of the synchronizing period.

The master clock is provided with impulse contacts 17 which are controlled in the usual way from a two minute cam 18 or otherwise as is the custom in clocks of this sort. In addition, cam 18 has a rise 18′ which is in the path of the contact arm of the upper contact of contacts 17 and which will cause this arm to be raised every second minute. This arm carries another contact point and when it is raised on every second minute, contacts, hereinafter designated as 17′, will be closed.

For advancing or stepping forward the secondaries there are provided two pairs of quick acting contacts 19 and 19′ which are preferably operated by their attachment to the verge mechanism 11. Each pair of contacts will close once 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 this system is shown in Fig. 2, but any electro-magnetic device which is capable of utilizing alternate impulses of opposite polarity to obtain mechanical movement may be used. The minute hand arbor 20 must make one revolution in one hour and the driving ratio existing between arbor 20 and its driving shaft 22 must be such as to produce this rate of revolution. Force is exerted to rotate shaft 22 through magnet 21 which comprises two coils and a permanent magnet. The two coils normally are energized once every minute by electrical impulses that will establish opposite polarity alternately in the coils by the control of the source of electrical energy by the master-clock as will be hereinafter pointed out. Carried by the minute hand arbor 20 on each secondary clock there is provided a synchronizing cam 23. Cooperating with this cam is a contact device of any desired form here shown as including a blade 24 adapted to close contacts 25 when the raised portion of the cam is under the blade 24 and to close contacts 26 when the blade 24 is on the low portions of the cam. The cam 23 is so timed that when the minute hand of the block is opposite the fifty-ninth minute the blade 24 has just fallen off the high point 27 of the cam 23 breaking contact 25 and making contact 26. The cam rise 28 in the present embodiment of the invention is disposed substantially 180° around the cam from the drop-off point 27 so that at twenty-nine minutes after the hour or slightly thereafter contacts 25 are closed and contacts 26 will be opened. The parts are so arranged that at no time except momentarily during the shifting of blade 24 are both contacts 25 and 26 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. Either of main lines 30 and 31 is connected with the secondary clocks at all times. For simplicity in the present description, the return circuit of the secondary clocks will be grounded and this ground circuit is designated as C.

Normal operation

The first operation to be described will be the normal minute impulse operation for controlling the secondary clocks. For clarity it will be assumed that all of the clocks at this moment are at a position somewhere between the hour reading and forty-four minutes later.

The circuits of the master clock always remain across the main lines 30, 31, and current is taken from the source over wires 32, 33 and 34, through contacts 17, (17′), wire 35, (35′), master relay coil 36, (36′), wire 37, and back to main line 31. Contacts 17 are controlled by cam 18 so as to close once every two minutes on the odd minute, and contacts 17′ are controlled by cam 18′ so as to close once every two minutes on the even minute thereby causing the energization of relay 36 and relay 36′ which respectively attract relay armatures 38 and 38′ alternately every minute.

This alternate and periodic actuation of armatures 38 and 38′ respectively causes the direction of the flow of current in the secondary clocks circuit to be reversed alternately for each successive minute impulse. When contacts 17 close, armature 38 will be raised and the accompanying impulse will travel from main line 30 through armature 38, line A, branch 39 contacts 25, blade 24, or if contacts 25 happen to be open, through armature 40, line B, branch 41, contacts 26 thence to the coils of magnet 21 of each secondary clock and thence back to main line 31 through the ground C, and armature 38′. When contacts 17′ close on the next ensuing minute, armature 38′ will be raised and the accompanying impulse will travel from main line 30 through armature 38′ ground C, the coils of magnet 21 of each secondary clock, blade 24, contact 25 branch 39, line A, or if contact 25 happens to be open, through contacts 26, branch 41, line B, armature 40, thence to armature 38 to main line 31 connected to the negative terminal of the source.

The impulses alternately flowing in opposite directions cause the actuation of each secondary clock and advances it as the master clock continues to indicate the proper time and send out the successive impulses in the manner just described.

Synchronization

The synchronizing period starts just after the forty-fourth minute when contacts 14 are timed to close. This causes current to flow from main line 30, through wires 32, 33, 42 and contacts 14 now closed, synchronizing relay coil 44 and back to main line 31. The energiaztion of synchronizing relay coil 44 attracts the armature of switch 40 thereby cutting out the secondary clock circuit B. This position of switch 40 is maintained until just

prior to the sixtieth minute by reason of the continued energization of coil 44. During this period the secondary clocks which are on time or slow are advanced by the operation of electro-magnets 21 caused by the minute impulses of opposite polarity that are being sent out alternately by the master clock over line A, branch 39 contact 25 electro-magnet 21 and ground C. The secondary clocks that were fast will have stopped at the hour position, for, in these clocks, contacts 25 will have opened with the result that no current can reach the secondary clocks since line A is cut out of circuit by the opening of contacts 25 and line B is already out of circuit as a consequence of the opening of armature switch 40 by coil 44 that occurred just after the forty-fourth minute. Hence, during the synchronizing period starting just after the forty-fourth minute only the secondary clocks having contacts 25 closed will be actuated by the minute and acceleration impulse hereinafter to be described.

In the diagram three secondary clocks are shown marked respectively X, Y and Z. Clock X is assumed to be on time with its minute hand in agreement with the master clock. Clock Y is assumed to be fifteen minutes fast and clock Z fifteen minutes slow. Synchronizing cam 23 of clock X is about the center of its high portion thus closing contacts 25. Cam 23 of the Y or fast clock has reached such position that blade 24 has dropped off step 27 closing contacts 26 and opening contacts 25. Cam 23 of the Z or slow clock has just passed the rise and has reclosed contacts 25 and has opened contacts 26.

For the reasons previously explained, during the period of synchronization, clock Y will remain stationary until the end of the synchronizing period. Clocks X and Z, on the other hand, are in such position that contacts 25 are closed and they therefore are in condition to receive minute impulses during the synchronizing period. The clocks X and Z then step along in the usual way, receiving the normal impulses every minute until the end of the synchronizing period of reached.

Just after the fifty-ninth minute, as indicated by the master clock, the cam 15 reaches a position to close the contacts 16. Current may flow from main line 30 over wire 32, wire 46, contacts 16, wire 47, contacts 19, (19′) to wire 35, (35′) and master relay coil 36, (36′) wire 37, and back to main line 31. The contacts 19, (19′) close in comparatively rapid succession and energize coil 36, (36′) a plurality of times which attracts armature 38, (38′) a plurality of times thereby sending a succession of fast or acceleration impulses over wire A at the rate of one every second. It will be understood that on clock X which is on time, contacts 25 will have opened just after the fifty-ninth impulse and before contacts 16 were closed, thereby preventing the fast step-up impulses from effecting it. Clock Z, on the other hand, will have the parts in such position that contacts 25 are closed so that the fast impulses are received by it which causes the clock to be stepped forward or accelerated to advance the synchronizing cam until it reaches a position to open contacts 25. All of the clocks X, Y and Z are now in synchronism with the master clock. After contacts 19, (19′) have sent the selected number of fast impulses, contacts 16 will open thus rendering contacts 19, (19′) ineffective to send further impulses. Shortly after contacts 16 open and just before the sixtieth minute impulse, contacts 14 will open thus de-energizing the synchronizing relay coil 44, releasing the armature of switch 40 and allowing the switch to throw line B of the secondary clock circuit across main lines 30, 31.

On the sixtieth minute, contacts 17, (17′) will close and thereafter send the usual minute impulses to the secondary clocks. Inasmuch as contacts 26 on all of the clocks X, Y and Z are now closed they will be all stepped along in synchronism as the master clock controls the periodic closing of armature 38, (38′).

This would be the usual operation of a system, but if a secondary clock should be interfered with by accident or otherwise so that it would be behind time a greater number of minutes than there are acceleration impulses furnished by the master clock, it would still be late at the hour impulse and contacts 25 would not have opened. This clock would still continue to operate, however. On the next hour this delinquent clock would be brought into synchronism with the others, as already described. The timing of the various cams in the system disclosed herein has been found satisfactory to maintain all clocks in synchronism and it is only under unusual circumstances that any secondary clock would be so slow as not to be on time on each sixtieth minute.

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 to 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 as shown in Fig. 1 which will now be described. Referring to the diagram a wire 48 is provided terminating in a switch point as shown. A switch member 49 is disposed in line 32 and for the usual running position is closed in the position shown. To

retard the secondary clocks the switch 49 is displaced to the open or off position breaking line 32 and also being out of contact with the switch point on wire 48. 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, (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 (19′) closing every second it will take one minute 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 system will function to bring the clocks 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.

While in the present embodiment I have elected a synchronizing period of fifteen minutes, it will be understood that this period is given merely for purposes of illustration and that this period may be greater or less as desired. In conventional clock systems of the present day this period has been found to be ample for all practical purposes.

In the present system it will be apparent that the master clock sends out impulses which alternate in polarity, some of these impulses being minute impulses for the purpose of operating the secondary clocks so that their hands will advance at the same rate as those of the master clock, and other of said impulses being sent out at the rate of one per second for the purpose of advancing the hands of any tardy secondary clock at a rapid rate; the distribution of the impulses over two lines or over only one of these two lines being subject to the control of the master clock.

The actuation and synchronization of a secondary clock are effected by an electro-magnetic device which utilizes alternate impulses of opposite polarity and converts this form of energy into rotary mechanical movement. Each clock determines whether its electro-magnetic device shall receive fast impulses, or whether it shall not receive any impulses for a time, depending upon whether it indicates a time slower or faster than the master clock sending out the impulses.

What I claim is:

1. In a synchronizing clock system, the combination comprising a master clock, secondary clock circuits, a source of direct current, means controlled by said master clock for alternately reversing the connections of said circuits with said source and causing impulses of current of the same duration and of opposite polarity to flow in said circuits, secondary clocks, means in each of said secondary clocks for advancing the hands upon each impulse received from said secondary clock circuits, means associated with said master clock for suppressing the sending out of impulses over one of said circuits for definite periods of time during which secondary clocks may be regularly driven from another of said circuits, and means in said secondary clock or clocks for connecting said clocks to the one of said circuits on which no impulses are being sent out at a predetermined time in their operation.

2. In a synchronizing clock system, the combination comprising a master clock, secondary clock circuits, a source of direct current, means for alternately reversing the connections of said circuits with said source and for causing current impulses of equal duration to flow in said circuits when said connections are reversed, means for suppressing the flow of current in one of said circuits for a predetermined period of time during which secondary clocks may be regularly driven from another of said circuits, secondary clocks, means in said circuits adapted to be responsive to succeeding current impulses of opposite polarity for advancing the hands of said secondary clocks, and means controlled by the chronologic condition of each of said secondary clocks to determine whether or not said impulses will be effective.

3. In a synchronizing clock system, the combination comprising a master clock, means for controlling the distribution of electrical energy over two circuits so as to cause intermittent flow of current in the form of impulses of equal duration over both of said circuits, means to alternately reverse the direction of flow of current in said circuits, means to suppress the sending of impulses over one of said circuits for a predetermined period, a secondary clock, means in said circuits responsive to each successive impulse of current delivered by either of said circuits regularly to advance the hands of said secondary clock, and means controlled by said secondary clock for determining whether or not said impulses will be effective to advance said secondary clock.

4. In a synchroninzing clock system, the combination comprising a master clock, one or more secondary clocks, circuits for controlling the operations of said secondary clocks, a source of current, branch circuits

in said master clock, means in said master clock for alternately energizing said branch circuits, one at a time with current impulses of equal duration, a relay in each of said branch circuits for alternately connecting said first named circuits with said source of current, an electro-magnetic means adapted to be energized by any of said first named circuits for advancing said secondary clocks, and means at said secondary clocks for determining which of said first named circuits will be connected so as to be effective for energizing said electromagnetic means for regularly advancing a secondary clock.

5. In a synchronizing clock system, the combination comprising a master clock, one or more secondary clocks, circuits for controlling the operations of said secondary clocks, a source of current, branch circuits in said master clock, means in said master clock for alternately energizing said branch circuits, a relay in each of said branch circuits adapted to cooperate in alternately reversing the connections of said first named circuits with said source of current, and an electro-magnetic means in said first named circuits whereby said secondary clocks are progressively advanced at each successive impulse, and means controlled by each secondary clock for connecting said electro-magnetic means to any one of said first named circuits.

6. In a synchronizing clock system, the combination comprising a master clock, one or more secondary clocks, circuits for controlling the operations of said secondary clocks, a source of current, branch circuits in said master clock, means in said master clock for alternately energizing said branch circuits at predetermined intervals, other means in said master clock for alternately energizing said branch circuits at a relatively faster rate, a relay in each of said branch circuits for reversing the connections of said first named circuits with said source of current upon the energization of said relays by either of said means, and electro-magnetic devices across said first named circuits whereby each secondary clock is advanced at a rate corresponding to the rate of change of said connections.

7. In a synchronizing clock system, the combination comprising a master clock, one or more secondary clocks, circuits for controlling the operations of said secondary clocks, a source of current, branch circuits in said master clock, means in said master clock for alternately energizing said branch circuits at predetermined intervals, other means in said master clock for alternately energizing said branch circuits at a relatively faster rate, a relay in each of said branch circuits for reversing the connections of said first named circuits with said source of current upon the energization of said relays by either of said means, means controlled by said master clock for permitting only one of said first named circuits to be connected to said source of current when said faster rate of change of connections is being enacted, electro-magnetic devices across said first named circuits whereby each secondary clock is advanced at a rate corresponding to the rate of change of said connections, and means controlled by each secondary clock for determining whether or not said fast impulses created by said fast rate of change of connection will be effective to drive the particular secondary clock.

8. In a synchronizing clock system in combination with a master clock and one or more secondary clocks connected in circuits receiving impulses from the master clock, means controlled by the master clock for sending out normal impulses and faster than normal impulses, means for reversing the direction of flow of successive impulses, an electro-magnetic device for actuating said secondary clock regardless of the direction of flow of current, and means controlled by the chronologic condition of said secondary clock to determine whether or not said electro-magnetic device shall receive faster than normal impulses and no normal impulses for a time.

9. A synchronizing clock system including a master clock, a secondary clock, a plurality of circuits connecting said secondary and master clocks, means controlled by the master clock for sending normal impulses over certain of said circuits and for sending fast impulses over certain of the same circuits during certain time periods and for omitting the sending of all impulses over certain circuits during certain other periods, said means causing each successive impulse to be of opposite polarity, and means in the secondary clock for connecting the clock at a certain time with the circuit receiving no impulses if the clock is fast, said means having provision for maintaining the clock connected with the circuit receiving fast impulses if the clock is slow, said means likewise having provisions for switching said secondary clock to the circuit receiving no impulses when the said clock is brought into time with the master clock.

In testimony whereof I hereto affix my signature.

JAMES W. BRYCE.