May 27, 1930. J. W. BRYCE 1,760,631

SELF REGULATING CLOCK SYSTEM

Filed March 4, 1927 2 Sheets-Sheet 1

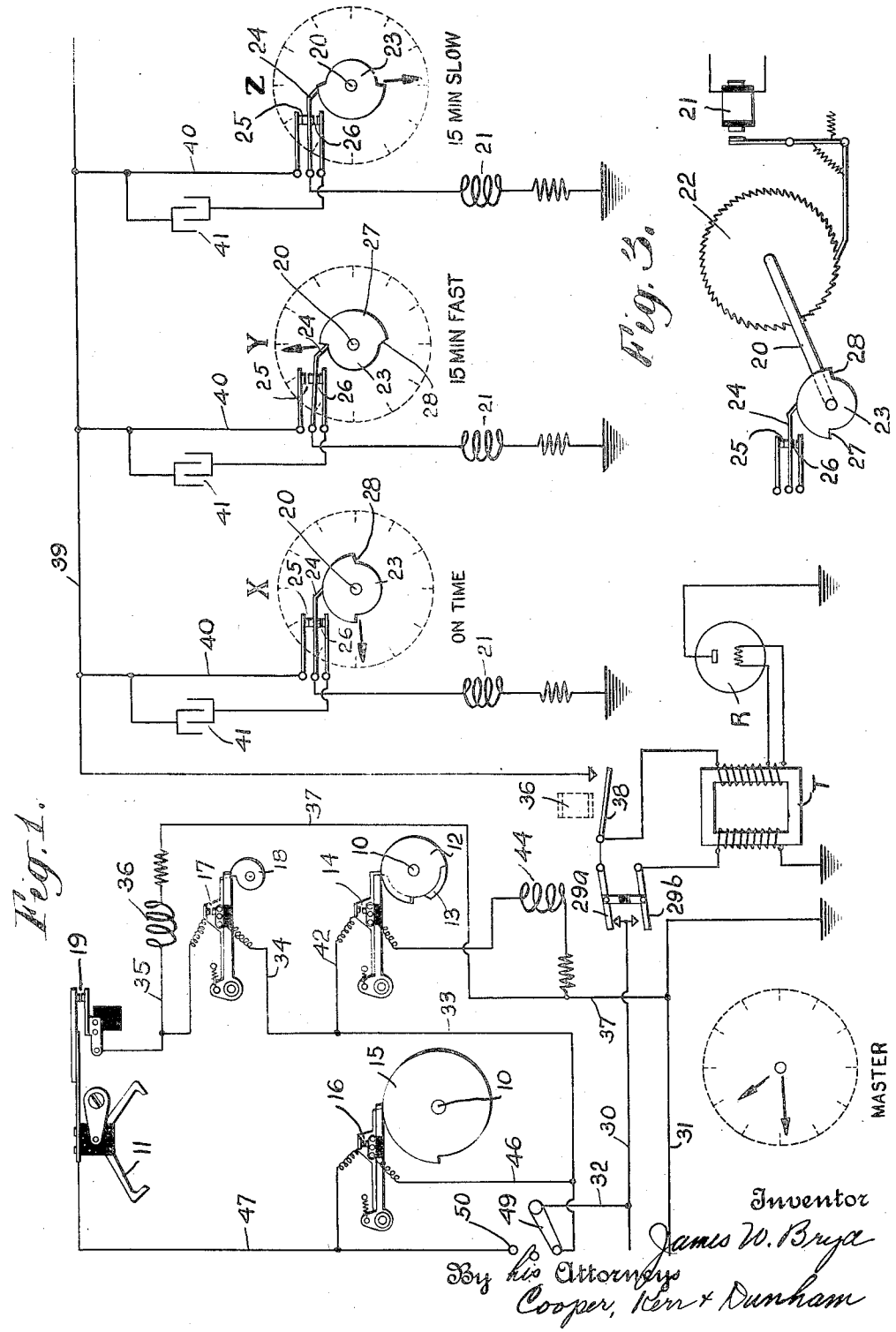


Fig. 1.

Fig. 2.

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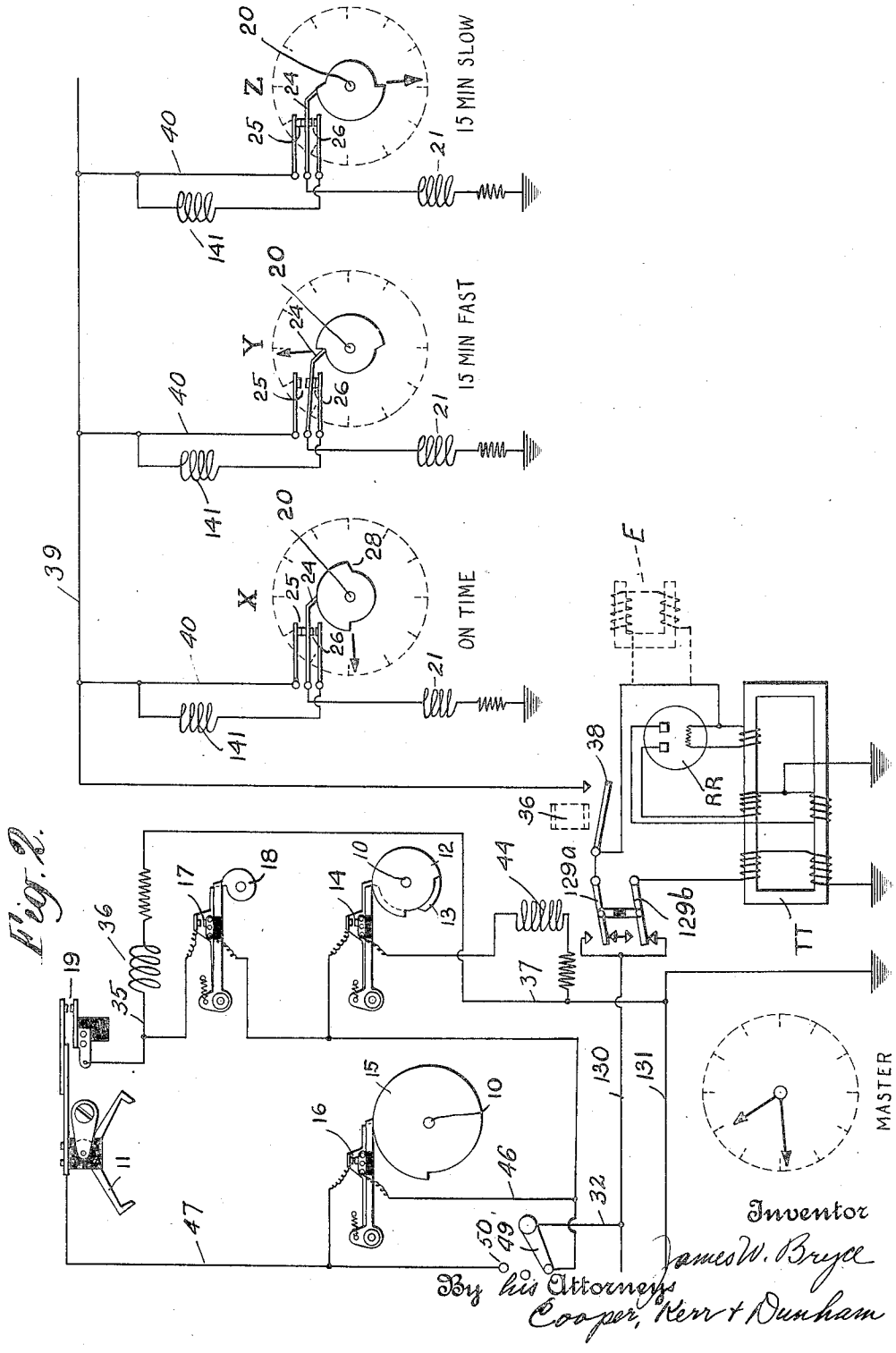


Fig. 2.

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Patented May 27, 1930

1,760,631

UNITED STATES PATENT OFFICE

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SELF-REGULATING CLOCK SYSTEM

Application filed March 4, 1927. Serial No. 172,909.

This invention relates to a system and method of actuating and regulating secondary clocks.

Among the objects of the invention is to enable one or more secondary clocks of a system of secondary clocks to be actuated and regulated by the use of current impulses of different electrical character initiated during successive periods of time, the character of the current impulses during one period being identified as of alternating current and the character of the current impulses during another period being identified as of rectified or direct current.

Further and other objects will appear in the specification and will be illustrated in the drawings, in which:

Fig. 1 is one wiring diagram by which secondary clocks may be actuated and regulated in the practice of the present invention.

Fig. 2 illustrates another wiring diagram by which secondary clocks may be actuated and regulated in accordance with the principles of the present invention and in which the periods of current distribution are reversed in respect to the arrangements for current distribution illustrated in Fig. 1.

Fig. 3 is a view of the actuating mechanism of the secondary clocks.

Master clock

The master clock may be of any standard design. Referring to Figs. 1 and 2, it includes the usual time train adapted to drive the minute-hand arbor 10, which makes one revolution per hour. The usual escapement mechanism 11 is provided. Fixed to the minute-hand arbor 10 is a pair of cams 12, 13 which are shaped and positioned so as to control a pair of contacts 14. The arrangement of parts is such that the contacts 14 are closed during the synchronizing period and are opened at other times.

In the present disclosure the synchronizing period commences just after the minute-hand of the master clock is forty-four minutes past the hour and it terminates just prior to the sixtieth minute.

Also fixed to the minute-hand arbor 10 is a cam 15 which is adapted to control the opening and closing of contacts 16. These contacts are arranged to close just after the fifty-ninth minute and open prior to the sixtieth minute. Contacts 16 should open just before contacts 14 open at the end of the synchronizing period.

In addition, the master clock is provided with minute impulse contacts 17 which are controlled from a minute cam 18.

For advancing or stepping forward the secondary clocks, there is provided clock actuating contacts 19, one of which is attached to the escapement mechanism 11. These contacts will close at every movement of the escapement mechanism.

Secondary clock

The secondary clock illustrated in Fig. 3 is of conventional form and it includes a minute-hand arbor 20 which makes one revolution per hour. This arbor is advanced by means of an impulse magnet 21 which acts through a ratchet-wheel 22 to advance the minute-hand arbor 20, step-by-step, as the magnet 21 receives successive electrical impulses from the master clock. Each minute-hand arbor 20 carries a synchronizing cam 23. Cooperating with this cam 23 is a contact device including a blade 24 adapted to close contacts 25 when the high portion of the cam is under the blade 24 and to close contacts 26 when the blade 24 is on the low portion of the cam. The cam 23 is so timed that when the minute-hand of the secondary clock is opposite the fifty-ninth minute the blade 24 has just fallen off the high point 27 of the cam, thereby breaking the 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 about twenty-nine minutes after the hour, contacts 25 are closed and contacts 26 are opened. For reasons which will be self-evident from the subsequent description the point of rise 28 upon the cam may be positioned anywhere on the periphery of the cam prior to forty-four minutes past the hour and exclusive of the synchronizing period.

Normal operation

A full explanation of a manner in which the method may be practiced will be described with particular reference to Fig. 1.

Referring to the wiring diagram illustrated in Fig. 1, current is supplied to the bus-lines 30, 31 from a source of alternating current not shown.

The first operation to be described will be the normal impulse operation for actuating the secondary clocks. For charity, it will be assumed that all of the secondary clocks are in position somewhere between the hour reading and forty-four minutes after the hour reading.

The circuits of the master clock are illustrated as being across the bus-lines 30, 31 and current is taken over wires 32, 33 and 34 through minute contacts 17, wire 35, master relay coil 36, wire 37, and back to the bus-line 31. Due to the opening and closing of contacts 17, current impulses energize the master relay coil 36 once every minute, attracting relay armature 38 and causing the current to flow from bus-line 30 through switch 29^a, armature 38, feed-line 39, through contact 25 or contact 26, blade 24 to the electro-magnet 21 of each secondary clock and back through the ground return to bus-line 31. Thus, each minute the secondary clocks are advanced step-by-step with the master clock.

The alternating current flowing from bus-lines 30, 31 enables the secondary clocks to be operated without interruption no matter which of contacts 25, 26 is closed. When contact 25 is closed, current is taken from feed-line 39 through branch-line 40, and when contact 26 is closed current is taken from feed-line 39 through a condenser, 41. Whichever branch-line the current flows over, the electro-magnets 21 will be activated.

Synchronization

The synchronizing period starts just after the forty-fourth minute when contacts 14 are timed to close. This action causes alternating current to flow through wires 32, 33, 42 and contacts 14, now closed, synchronizing relay coil 44 and back to bus-line 31. The energization of synchronizing relay coil 44 attracts the armature of switch 29^b thereby throwing the primary coil of transformer T in circuit with bus-lines 30, 31. This position of switch 29^b is maintained until just prior to the sixtieth minute by reason of the energization of coil 44 during the synchronizing period. During this period the secondary clocks which are on time or slow are advanced step-by-step, on each minute, by the minute impulses delivered over feed-line 39 and branch-lines 40 of each secondary clock.

The alternating current set up in the secondary coil of the transformer T causes the cathode of the electron tube rectifier R to be heated. The electron flow to the anode, thereby created, causes the impulses of current flowing through the rectifier R and feed-line 39 to be rectified. Any type of electron tube rectifier may be used for the purpose of rectifying the current. The successive closing and opening operations of contacts 17 causes electro-magnet 36 to close the feed-line 39 at succeeding periods and the rectified current impulses flowing over armature 38 and feed-line 39 will flow through branch-line 40, contacts 25 and electro-magnet 21 (clocks X and Z.)

The secondary clocks that are fast will have stopped at the fifty-ninth minute position (clock Y) for in these clocks contacts 25 will have opened and condenser 41 will have been thrown into the circuit upon the closing of contacts 26. Obviously, there will be no flow of rectified current through the condenser and hence no current will be available for activating electro-magnet 21.

It is obvious that between the sixtieth and forty-fourth minutes, as indicated by the master clock, when the alternating current is flowing over feed-line 39 to the secondary clocks, all of the secondary clocks will be operated step-by-step, whichever of contacts 25 and 26 are closed. However, 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 impulses and acceleration impulses hereinafter described. Thus those secondary clocks having contacts 26 closed at any time during the synchronizing period will stop because the rectified current will not be able to pass through the condenser 41.

In the wiring diagram of Fig. 1, three secondary clocks are shown marked respectively X, Y and Z. Clock X is on time with its minute-hand in agreement with the master clock. Clock Y is fifteen minutes fast and clock Z is fifteen minutes slow. Synchronizing cam 23 of clock X is at about the center of its high position, thus maintaining contacts 25 closed. Cam 23 of the Y, or fast, clock has reached such a position that blade 24 has dropped from the high portion of the cam. Contacts 26 are closed and contacts 25 are open. Cam 23 of the Z or slow clock is illustrated as maintaining contacts 25 closed and contacts 26 open. As determined by the master clock, the synchronizing period is about to begin and clock Y will remain stationary until the end of that period for the only current impulses flowing over the feed-line 39 are prevented from activating electro-magnet 21 because contacts 25 are open and condenser 41 is in circuit. Clocks X and Z on the other hand, are in such positions that contacts 25 are closed and they therefore are in condition to receive minute impulses during the synchro-

nizing period. Clocks X and Z continue to step along in the usual manner, receiving the normal impulses every minute until close to the end of the synchronizing period. Just when clock X has advanced to the fifty-ninth minute position, contacts 25 will be opened and contacts 26 will be closed and this clock will continue to operate by reason of the alternating current impulses which start to flow at the sixtieth minute.

Just after the fifty-ninth minute, as indicated by the master clock, cam 15 reaches a position to close contacts 16. Current may now flow as follows: bus-line 30, wire 32, switch-blade 49, wire 46, contacts 16, wire 47, contacts 19, wire 35, master relay coil 36, wire 37 and bus-line 31. Contacts 19 close in comparatively rapid succession. For example, once every two seconds, and energize coil 36 a plurality of times, thereby causing armature 38 to be actuated a like number of times during the period of closure of contacts 16. The rapid opening and closing of armature 38 causes a succession of fast or acceleration impulses to be sent out over feed-line 39. It is clear that clock X, which is on time, will have opened contacts 25 just after the fifty-ninth minute impulse and before contact 16 closes, thereby preventing the fast acceleration impulses from affecting it. Clock Z, on the other hand will have its parts in such positions that contacts 25 are closed so that the fast or acceleration impulses are received by it. These fast acceleration impulses cause the secondary clock to be stepped forward and accelerated to advance the synchronizing cam and clock hands at a fast rate until they reach a position which causes the cam to open contacts 25. It has now been disclosed how all of the clocks (X, Y and Z) are brought into synchronism with the master clock at a time just preceding the sixtieth minute impulse. When contacts 16 open, contacts 19 cannot send further impulses. Shortly after contacts 16 open and just before the sixtieth minute impulse, contacts 14 will open, thus de-energizing synchronizing relay coil 44, releasing the armature of switch 29^a, 29^b and allowing the switch to connect the feed-line 39 so as to receive alternating current from bus-lines 30, 31. This connection simultaneously discontinues the activation of the primary coil of transformer T and the electron tube rectifier R is cut out of operation.

On the sixtieth minute contacts 17 will close and the closing of these contacts at this time and at subsequent times will cause current impulses of alternating current to be transmitted over the feed-line 39. The current impulses now flowing over feed-line 39 will cause each of the secondary clocks to be stepped ahead, step-by-step, in synchronism with the master clock.

The system of wiring just described will cause the secondary clocks to be operated and synchronized automatically. If it should be desirable to cause the clocks to be advanced at a rapid rate, a switch blade 49 is provided for this purpose. By changing the position of the switch blade 49 so as to bridge over wire 32 and contact 50 a series of rapid impulses may be sent to all the secondary clocks in the system. On the other hand, if it should be desired to stop the secondary clocks, the switch blade 49 could be used to open the master clock controlling circuits.

In the system illustrated in Fig. 1, it is apparent that the master clock sends out impulses of alternating current over a main circuit for a definite period of time, and then automatically sends out over the same circuit for another definite period of time impulses of rectified current. The period of rectified current has been described as being the synchronizing period.

The actuation and synchronization of the secondary clocks are dependent upon whether or not the current impulses sent out by the master clock are effective to actuate a secondary clock. The secondary clock determines by its own chronologic condition whether or not the electrical impulses flowing over the feed-line will be utilized for actuating and synchronizing purposes.

Wiring diagram of Fig. 2

The wiring diagram illustrated in Fig. 2 is intended to disclose the manner by which the method may be practiced with the relation of the periods of current flow reversed with respect to each other, that is to say, the wiring is so arranged that the alternating current will flow instead of rectified current during the synchronizing period.

For this purpose, the condenser 41 of Fig. 1 has been replaced by reactance 141 in Fig. 2. In Fig. 2 the normal position of switch 129^b is such that the primary coil of the transformer TT is activated during the period immediately succeeding the hour. This period exists from the hour to the forty-fourth minute and, following the forty-fourth minute when the electro-magnet 44 is energized, the switch 129^b will be raised thereby discontinuing the activation of the primary coil of the transformer TT and throwing the feed-line 39 in circuit with the alternating current bus-lines 130, 131. The electro-magnet 44 will remain energized as has already been set forth during the synchronizing period commencing just after the forty-fourth minute and concluding just prior to the sixtieth minute. During this period, the alternating current flowing over the feed-line 39 will actuate those clocks which are either on time or slow because of the fact that in these clocks contacts 25 are closed. However, in those clocks which are fast, clock Y, contacts 25 will be open and contacts 26 will be closed. Those fast clocks will not be operated because the

constants of the circuit due to the reactance 141 will cause the current strength to be cut down so low as to be ineffective to cause activation of the electro-magnet 21 of the secondary clock. Hence when contacts 26 are closed, the particular secondary clock will not be operated until rectified current flows on the sixtieth minute impulse. As has been pointed out hereinbefore, just prior to the sixtieth minute the electro-magnet 44 will be deenergized and the primary coil of the transformer TT will be activated by the alternating current of bus-lines 130 and 131. This condition sets up current flow of opposite polarity in the electron tube rectifier RR and the cold anode plates of the electron tube rectifier will be alternately oppositely poled. This electron tube rectifier may be of any desirable construction and it is illustrated by way of an example only. The type of electron tube rectifier illustrated will cause a full wave rectification of the alternating current and the wave may be smoothened by the use of a reactance E, if desired.

It is apparent that the system is one by which secondary clocks may be operated from a single main circuit by current impulses continuously distributed from sources of alternating current and of rectified or direct current during alternate periods of time.

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

I claim:

1. The method of actuating and regulating one or more secondary clocks by the use of alternating and direct current impulses comprising sending over a main line alternating current impulses and direct current impulses during alternate periods of time; connecting a secondary clock to the main line so as to be driven by either current impulses of alternating current or by current impulses of direct current during the aforesaid periods; and causing one or more of the said current impulses of one of said periods to be ineffectual upon a secondary clock when a secondary clock is fast or causing the secondary clock to continue to be affected by said current impulses during the same period when the secondary clock is slow.

2. The method of actuating and regulating one or more secondary clocks by the use of current impulses of different electrical character comprising delivering to a secondary clock current impulses of alternating current and of direct current in recurring alternate periods of definite duration; operating a secondary clock by said current impulses delivered during the successive periods; and rendering certain of the said current impulses of one character ineffective to continue the operation of a secondary clock when it is fast.

3. The method of actuating and regulating one or more secondary clocks by the use of current impulses of different character comprising initiating successive current impulses over a main circuit; controlling the character of said impulses during successive periods of definite duration so that the current impulses will be of alternating current during one period and of direct current during another period; operating a secondary clock by the said current impulses; during one of the periods, rendering certain of the said current impulses ineffective to operate a secondary clock if it be fast or continuing to operate a secondary clock if it be on time or slow; and then proceeding with the continued operation of the secondary clock at the beginning of the next succeeding period of time.

In testimony whereof I hereto affix my signature.

JAMES W. BRYCE.