

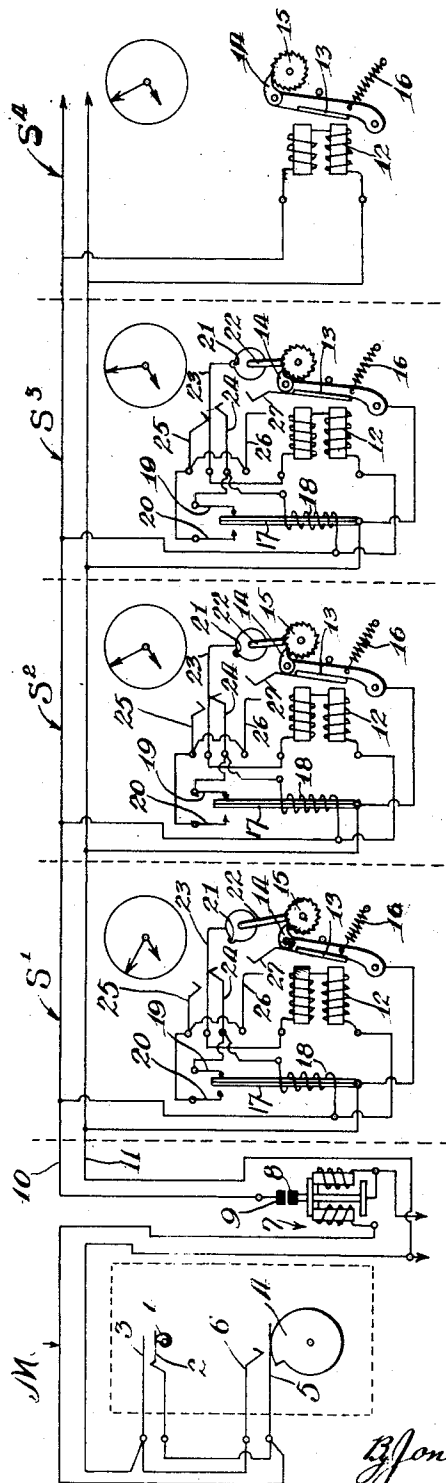
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TIME CONTROLLED SYSTEM

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TIME-CONTROLLED SYSTEM

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The present invention relates in general to corrective time-controlled systems and more particularly to a synchronizing arrangement for a system of this type in which secondary apparatus, such as clocks, recorders and time stamps, are operated or controlled by impulses transmitted from a primary or master clock. The main object of the invention is to provide improved means for periodically synchronizing the secondary apparatus with the master clock.

In the known minute impulse corrective systems, slow secondary apparatus is rapidly advanced by fast accelerating impulses transmitted periodically, such as once an hour, by the master clock. Other systems use a mechanical synchronizing arrangement in which the hands of secondary clocks are mechanically moved to the correct time in response to a special impulse from the master clock. The later scheme, however, is practical only with secondary clock systems and cannot readily be employed where type wheels of recorders or time stamps are to be synchronized.

The fast impulses used to advance rapidly slow secondary apparatus in systems of the first-mentioned type are usually initiated by contacts on the escapement or verge of the master clock or by pendulum contacts. It is well known that to secure accuracy in a master clock, the load on the same must be reduced as much as possible. Seconds contacts must necessarily be operated at the weakest part of the clock movement and therefore interfere most with the timekeeping qualities of the clock. The effect of minute or hourly contacts is greatly minimized by the intermediate gear reduction.

In view of the foregoing, one of the most important features of the present invention is the elimination of the fast contacts in the master clock, thereby greatly increasing its accuracy and improving its timekeeping qualities.

According to another feature of the invention, the rapid accelerating impulses heretofore transmitted by the master clock to advance slow secondary apparatus are generated within the secondary apparatus itself in response to a synchronizing signal from the master clock.

The foregoing features of the invention permit the use of a master clock with only two contacts, the regular minute impulse contacts and an hourly synchronizing impulse contact, which is a further desirable feature of the invention.

Another feature of the invention resides in the manner in which each secondary apparatus is stopped each time it reaches a predetermined

chronological position and is permitted to advance only at the termination of the synchronizing signal.

According to another feature of the invention, both corrective and non-corrective secondary apparatus may be operated from the same control circuit from the master clock. This is possible since no fast impulses are transmitted over the circuit. The synchronizing signal is received by the non-corrective apparatus as a regular minute impulse.

The above and other novel features of the invention not specifically mentioned will best be understood from a perusal of the following specification when read in connection with the accompanying drawing, comprising one figure only, which shows, by means of the usual schematic diagram, a time-controlled system embodying the features of the present invention.

Referring to the drawing in detail, the construction shown comprises master apparatus M, corrective secondary apparatus S', S² and S³, the normal advance and correction of which is controlled by the master apparatus, and a non-corrective secondary apparatus S⁴, the advance of which is controlled by the master apparatus.

The master apparatus shown comprises cam means 1, on the minute arbor, for periodically closing a circuit through contacts 2 and 3 (ordinarily once per minute) for a relatively short time (for example, one second) for controlling the normal advance of both corrective and non-corrective secondary apparatus, cam means 4, on the hour shaft, for periodically closing the circuit through contacts 5 and 6 (ordinarily once per hour) for a relatively long time (for example, ninety seconds) for effecting correction of the corrective secondary apparatus, and a relay 7 controlled by both of said circuit closing means, for controlling the contacts 8 and 9, which control the circuit 10, 11, between the master apparatus and the secondary apparatuses.

The long-closed period may, for example, be from 58 minutes and 15 seconds after the hour until 59 minutes and 45 seconds after the hour. This long-closing period will thus include one and one only of the short-closing periods. The effect of this is that the relay will be closed at intervals of one minute up to and through the fifty-eighth minute by master apparatus time; that it will be held closed for 90 seconds from 58 minutes and 15 seconds after the hour until 59 minutes and 45 seconds after the hour, and that it will thereafter be again closed for a short period at the end of the sixtieth minute.

The non-corrective secondary apparatus S⁴ may be of any usual or suitable type comprising an electromagnet 12 controlled by the relay circuit 10, 11, the armature 13 of which carries a pawl 14 which operates a ratchet wheel 15 on the secondary apparatus. Each time the electromagnet 12 is energized, it attracts the armature, withdrawing the pawl to cause it to engage a new tooth of the ratchet wheel. When the electromagnet 12 is de-energized, the spring 16 effects the withdrawal of the armature to advance the ratchet wheel 15 of the secondary apparatus.

Each of the corrective secondary apparatus S¹, S², and S³ comprises elements 12, 13, 14, 15 and 16, similar to those of the non-corrective secondary apparatus and, in addition, means for temporarily suspending the operation of any secondary apparatus which may be fast (after the fifty-eighth minute period of the particular secondary apparatus), and means operative during the long-closed period of the relay circuit for rapidly advancing any secondary apparatus which may be slow.

The rapid advance of slow secondary apparatus during the long-closed period of the relay circuit is effected by means of a delayed-action heat-responsive element 17 which is caused to oscillate slowly back and forth during the long-closed period by the action of an electrical heating element 18 which is alternately heated and allowed to cool off as a result of the action of the heat-responsive element 17 itself.

The delayed-action heat-responsive element 17 may be a bi-metallic element carrying contacts 19 for engagement and disengagement with respect to the contacts 20, respectively, and having its flexing movement so designed that the short-time closing periods of the relay circuit will have no effect on the heat-responsive element but so that the long-time closing period of the relay circuit will cause a repeated periodic movement back and forth of the heat-responsive element 17 to successively make and break contact with respect to the contacts 19 and 20 repeatedly during the entire long-closed period. This periodic oscillation of the heat-responsive element 17 is effected by the automatic opening and closing of the circuit for the heating coil 18. This automatic opening and closing is effected by the action of the heat-responsive element itself. As it flexes to the left under the influence of the heating coil 18, it breaks the circuit for this heating coil by moving away from the contact 19. The heating action of the heating element 18, however, will continue to affect the heat-responsive element 17 to a sufficient extent to bring it into engagement with the contact 20, the effect of which will be explained hereinafter. Soon, however, the heating coil 18 begins to cool off, resulting in a cooling off in the heat-responsive element 17 and a flexing to the right to re-establish the circuit for the heating coil when the heat-responsive element 17 engages the contact 19. This periodic oscillation of the heat-responsive element and the periodic making and breaking of contact with respect to the contacts 19 and 20 continues during the entire long-closed period of the relay circuit.

The means for suspending operation of any fast secondary apparatus, which is governed by the chronological condition of the secondary apparatus itself, is controlled by a cam 21 on the shaft 22 of the secondary apparatus which, at the end of the fifty-eighth minute by secondary apparatus time, lifts the contact member 23 away

from the contact member 24, thus breaking the normal circuit of the electromagnet 12 but not, however, breaking the normal circuit of the electrical heating element 18.

In order to place the secondary apparatus again in condition to be advanced when the normal short-time circuit-closing periods are resumed, it is necessary that some means be provided for moving the secondary apparatus off from the "dead spot" in which it is placed when the contact 23 is lifted. For this purpose, means are provided whereby an auxiliary circuit is established which will cause a one-step action of the electromagnetic actuator to move the secondary apparatus off the "dead spot" at the end of the long-closing period. This auxiliary circuit means must also be so designed as to prevent the rapid impulses generated within the secondary apparatus itself by the action of the electric heating coil 18 from causing advance movement of the secondary apparatus. To accomplish these results, the auxiliary circuit, prepared when the contact is moved, comprises a contact 25 engaged by the lifted contact 23, the aforementioned contact 20 engageable by the delayed-action heat-responsive device 17, and a locking contact 26 for engagement with a contact 27 on the armature 13 of the electromagnet 12 whereby when the electromagnetic is energized, its armature will be held in attracted position until the termination of the long-closed period of the relay circuit.

When the cam 21 has lifted the contact 23 into engagement with the contact 25, the next engagement of the heat-responsive element 17 with the contact 20 will cause the energization of the electromagnet 12 and the attraction of its armature 13 and the holding of the armature in attracted position until the termination of the long-closed period of the relay circuit.

Having described the design and operation of the corrective apparatus in a general way, I will now summarize in detail the operation in the three possible conditions of the secondary apparatus, exemplified in S¹, S² and S³.

Contacts 2 and 3 of the master clock M are closed for a period of about one second, once each minute, by a cam 1 on the minute arbor of the clock in the well known manner. The closing of these contacts completes an obvious circuit from the current source to the relay 7. Relay 7 operates and closes its contacts 8 and 9, thereby completing a circuit from one side of the current source, through contacts 8 and 9, operating magnet 12 of the secondary apparatus S¹, cam contact springs 23 and 24, and contact 19 of the thermostatic contactor 17 to the other side of the current source. A parallel circuit extends through the heating coil 18 of the thermostatic contactor. Similar circuits are completed through the other secondary apparatuses S² and S³. The operating magnets 12 of the secondary apparatuses are momentarily energized by each impulse over the above circuits and, upon releasing, advance the secondary apparatuses one step. The contact 26 of the secondary apparatus S¹ is engaged by the contact 27 each time the magnet operates but this produces no effect at this time. The normal impulses are not of sufficient duration to heat the coil 18 of the thermostatic contactor sufficiently to cause the metal strip to be deflected.

When a secondary apparatus such as S³ becomes fast and reaches position 58, the disc cam 21 operates the contact spring 23, opening contact 24 and closing contact 25. This opens the

circuit of the operating magnet, the impulses thereafter passing only through the heat coil 18 of the thermostatic contactor.

Shortly after the master clock has passed position 58, contacts 5 and 6 are closed by the cam 4 which may be located on the hour shaft in known manner. The cam is designed to maintain contacts 5 and 6 closed for a relatively long time, for example, one and one-half minutes, from 58 minutes and 15 seconds to 59 minutes and 45 seconds. Since contacts 5 and 6 are in multiple with contacts 2 and 3, this cancels the regular minute impulse which would normally be sent out when the master clock reached position 59.

The sustained impulse or synchronizing signal sent out by the master clock in the above manner controls the secondary apparatus in a manner dependent upon their chronological position. Considering, first, the slow secondary apparatus S¹, the magnet 12 will be operated in the circuit previously traced. Heat coil 18 will receive current long enough so that the bimetallic strip 17 is deflected, opening contact 19 and closing contact 20. The opening of contact 19 opens the circuit of the magnet 12, allowing it to release and advance the secondary apparatus one step. Contact 19 also opens the circuit of the heat coil 18, allowing the strip 17 to cool and again close contact 19. This again completes the circuit of the operating magnet and the heat coil, and the operation is repeated. In this manner, rapid accelerating impulses are generated within the slow secondary apparatus and such apparatus is rapidly advanced during the synchronizing period.

When the secondary apparatus S¹ has reached position 58 under control of the self-generated impulses, the cam 21 operates spring 23 to break its contact with spring 24 and to make contact with spring 25. Magnet 12 is now energized through contact 20 of the thermostatic contactor and is held energized through its own armature spring contact 26 and contact springs 25 and 23. The thermostatic contactor 17 continues its intermittent operation but without effect since the operating magnet 12 is now held energized over its locking circuit.

Since the secondary apparatus S² was on time or in synchronism with the master clock, its cam 21 opened contact 24 and closed contact 25 when it moved into position 58. Also, secondary apparatus S³ was fast and has, therefore, been previously stopped in the manner heretofore pointed out. When the long impulse or synchronizing signal is received by S² and S³, the thermostatic contactors 17 respond and complete circuits for the operating magnets 12 in a manner similar to that just explained for S¹. These magnets are then held energized in locking circuits completed over their armature spring contacts 26 and 27. Thereafter, the intermittent operation of the thermostatic contactors is without effect.

In the non-corrective secondary apparatus S⁴, the magnet 12 is energized by the long impulse and this long impulse takes the place of the regular impulse S⁴ would have received in position 59 of the master clock.

All the secondary apparatuses are now in position 58 and the magnets thereof are held energized by the synchronizing signal. In the assumed case, the long impulse terminates when the master clock reaches 59 minutes and 45 seconds. When the line circuit is opened by relay 7, the operating magnets 12 of all the secondary

apparatuses are deenergized and advance the apparatuses one step into position 59. When the master clock reaches position 60, a regular impulse is sent out by contacts 2 and 3 (contacts 5 and 6 now being open) and the secondary apparatuses are all advanced to position 60 and into synchronism with the master clock.

It is to be understood that the closing of contacts 5 and 6 and the sending of the synchronizing signal may occur at any time during the hour cycle and the length of the signal may be varied, the time of 58 minutes and 15 seconds to 59 minutes and 45 seconds having been chosen merely for the purpose of illustration. Allowing five seconds for a complete cycle of operation for the thermostatic contactors, this assumed synchronizing period would take care of secondary apparatus which was as much as eighteen minutes slow.

Other modifications and embodiments of the invention will be apparent to those skilled in the art and may be made without departing from the spirit and scope of the invention.

Having thus described the invention, what is claimed as new and is desired to secure by Letters Patent is:

1. In a secondary apparatus for use in a corrective time-controlled system, an impulse magnet for effecting all advancing movements of said apparatus, means controlled by the chronological condition of said apparatus for opening the circuit of said magnet, and means including a delayed response device responsive only to a prolonged impulse for completing an auxiliary circuit for said magnet.

2. In a secondary apparatus for use in a corrective time-controlled system, means for advancing said apparatus step by step responsive to current impulses, circuit-controlling means for suspending advance of said apparatus in a predetermined position in case it is too fast, and means including a device responsive only to a current impulse of prolonged duration, for again permitting continued normal advance of said apparatus at the termination of said prolonged impulse.

3. In a secondary apparatus for use in a corrective time-controlled system, an impulse magnet for effecting all advancing movements of said apparatus responsive to received impulses, means for suspending advance of said apparatus in a predetermined position in case it is too fast, and means in said apparatus responsive to a received impulse of prolonged duration for automatically controlling said impulse magnet to rapidly advance said apparatus in case it is too slow.

4. In a secondary apparatus for use in a corrective time-controlled system, an impulse magnet for effecting all advancing movements of said apparatus under control of impulses received thereby, and circuit-controlling means responsive to an impulse of prolonged duration for holding said magnet energized in case said apparatus is on time and for intermittently energizing said magnet to rapidly advance said apparatus in case said apparatus is slow.

5. In a secondary apparatus for use in a corrective time-controlled system, an impulse magnet for controlling the step-by-step advance of said apparatus, and means within said secondary apparatus responsive to a received synchronizing impulse for generating rapid accelerating impulses to effect rapid advance of said apparatus

by said impulse magnet in case said apparatus is slow.

6. In a secondary apparatus for use in a corrective time-controlled system, operating means for said apparatus, a normal operating circuit over which said operating means is controlled by impulses of short duration to effect normal advance of said apparatus, means controlled by the chronological condition of said apparatus for opening said operating circuit and for preparing an auxiliary control circuit for said operating means, and means including a delayed response device responsive only to a prolonged impulse for completing said auxiliary control circuit.

7. In a secondary apparatus for use in a corrective time-controlled system, means for normally advancing said apparatus step by step under the control of received impulses of short duration, means for periodically rendering said first means inoperative, and means including circuit-controlling means responsive only to an impulse of prolonged duration for again permitting advance of said apparatus by said first means at the termination of said prolonged impulse.

8. In a secondary apparatus for use in a corrective time-controlled system, means for normally advancing said apparatus under the control of received impulses of short duration, means for periodically rendering said first means inoperative, and means responsive only to an impulse of prolonged duration for automatically controlling said first means to rapidly advance said apparatus in case it is slow and for rendering said second means ineffective to perform its function of rendering said first means inoperative.

9. In a corrective time-controlled system wherein secondary apparatus is normally operated by impulses transmitted from a master apparatus, means in the secondary apparatus responsive to the impulses for advancing said secondary apparatus step-by-step, and means in said secondary apparatus responsive to a synchronizing signal from said master apparatus for generating rapid accelerating impulses, said accelerating impulses controlling said first means to bring said secondary apparatus into synchronism in case it is lagging behind said master apparatus.

10. In a corrective time-controlled system wherein secondary apparatus is normally operated by impulses of short duration transmitted from a master apparatus, means in said master apparatus for periodically transmitting a synchronizing impulse of prolonged duration to said secondary apparatus, means in each secondary apparatus for periodically suspending operation of said apparatus in a predetermined position, and means in each secondary apparatus responsive only to said synchronizing impulse for causing the rapid operation of said secondary apparatus to said predetermined position in case its operation has not been suspended and for re-initiating the operation of said secondary apparatus at the termination of said synchronizing impulse.

11. In a time-controlled system comprising master apparatus, corrective secondary apparatus and non-corrective secondary apparatus, means in said master apparatus for transmitting normal operating impulses and for periodically transmitting a distinctive synchronizing impulse to said secondary apparatuses, means in each secondary apparatus responsive to said normal impulses for advancing the associated apparatus

step-by-step, and means in each corrective secondary apparatus responsive to said synchronizing impulse for causing rapid step-by-step advance of the associated apparatus in case it is slow, said synchronizing impulse causing said non-corrective secondary apparatus to advance one normal step.

12. In a time-controlled system comprising master apparatus, corrective secondary apparatus and non-corrective secondary apparatus, means in said master apparatus for transmitting normal operating impulses and for periodically transmitting a distinctive synchronizing impulse to said secondary apparatuses, means in said non-corrective secondary apparatus responsive both to normal impulses and to said synchronizing impulse for advancing said apparatus step by step, and means in said corrective secondary apparatus responsive to said normal impulses for advancing said apparatus step by step and responsive to said synchronizing impulse for bringing said apparatus into synchronism with said master apparatus in case it is either slow or fast.

13. In a step-by-step, impulse operated secondary apparatus for use in a corrective time-controlled system, means for preventing advance of said apparatus in a predetermined position when fast, and means including a delayed response device responsive only to an impulse of abnormal duration and a circuit-controlling device controlled thereby for rendering said first means ineffective to prevent advance of said apparatus.

14. In a time-controlled system in which step-by-step secondary apparatus is controlled over an operating circuit by impulses transmitted from a master apparatus, means for periodically synchronizing said secondary apparatus with said master apparatus, said means including a delayed response device responsive only to an impulse of abnormal duration transmitted over said operating circuit and a circuit-controlling device in said operating circuit controlled by said delayed response device.

15. In a secondary apparatus for use in a corrective time-controlled system, an impulse magnet for effecting all advancing movements of said apparatus, means controlled by the chronological condition of said apparatus for opening the circuit of said magnet, and means including a delayed response device for completing an auxiliary circuit for said magnet, said delayed response device comprising an electric heating element and a heat-responsive element controlled by said heating element.

16. A corrective time-controlled system comprising master apparatus and corrective secondary time-controlled apparatus, said master apparatus comprising means for periodically closing a circuit for a relatively short time for controlling the normal advance of the secondary apparatus and means for periodically closing said circuit for a relatively long time for effecting correction of the secondary apparatus, said corrective secondary apparatus comprising electromagnetic means included in said circuit for controlling the advance movement of said secondary apparatus, and corrective means for effecting rapid opening and closing of said circuit responsive to said long-time circuit-closing means but non-responsive to said short-time circuit-closing means.

17. A corrective time-controlled system comprising master apparatus and corrective secondary time-controlled apparatus connected by a control circuit, said master apparatus compris-

ing means for periodically closing said circuit for a relatively short time for controlling the normal advance of the secondary apparatus and means for periodically closing said circuit for a relatively long time for effecting correction of the secondary apparatus, said secondary apparatus comprising electromagnetic means for controlling the advance movement of said secondary apparatus, a normal circuit and an auxiliary circuit for said electromagnetic means, corrective means for effecting rapid opening and closing of said normal circuit responsive to said long-time circuit-closing means but non-responsive to said short-time circuit-closing means, and means controlled by the chronological condition of said secondary apparatus for periodically opening said normal circuit of said electromagnetic means to prevent further movement of said secondary apparatus.

18. A corrective time-controlled system comprising master apparatus and corrective secondary time-controlled apparatus connected by a control circuit, said master apparatus comprising means for periodically closing said control circuit for a relatively short time for controlling the normal advance of the secondary apparatus and means for periodically closing said control circuit for a relatively long time for effecting correction of the secondary apparatus, said secondary apparatus comprising electromagnetic means for controlling the advance movement of said secondary apparatus, a normal circuit and an auxiliary circuit for said electromagnetic means, corrective means for effecting rapid opening and closing of said normal circuit responsive to said long-time circuit-closing means but non-responsive to said short-time circuit-closing means, means controlled by the chronological condition of said secondary apparatus for periodically opening said normal circuit to prevent further movement of said secondary apparatus, and means including said auxiliary circuit for permitting continued normal advance of said secondary apparatus after its advancing movement has been prevented.

19. A corrective time-controlled system comprising master apparatus and corrective secondary time-controlled apparatus connected by a control circuit, said master apparatus comprising means for periodically closing said control circuit for a relatively short time for controlling the normal advance of the secondary apparatus and means for periodically closing said control circuit for a relatively long time for effecting correction of the secondary apparatus, said secondary apparatus comprising electromagnetic means for controlling the advance movement of said secondary apparatus, a normal circuit for said electromagnetic means, corrective means for effecting rapid opening and closing of said normal circuit responsive to said long-time circuit-closing means but non-responsive to said short-time circuit-closing means, means controlled by the chronological condition of said secondary apparatus for periodical-

ly opening said normal circuit to prevent further movement of said secondary apparatus, and means for permitting continued normal advance of said secondary apparatus after its advancing movement has been prevented, including an auxiliary circuit for causing energization of said electromagnetic means controlled by the chronological condition of said secondary apparatus and by said rapid circuit-opening and closing means.

20. A corrective time-controlled system comprising master apparatus and corrective secondary time-controlled apparatus connected by a control circuit, said master apparatus comprising means for periodically closing said control circuit for a relatively short time for controlling the normal advance of the secondary apparatus, and means for periodically closing said control circuit for a relatively long time for effecting correction of the secondary apparatus, said corrective secondary apparatus comprising electromagnetic means for controlling the advance movement of said secondary apparatus, a normal circuit for said electromagnetic means, means for effecting rapid opening and closing of said normal circuit responsive to said long-time circuit-closing means but non-responsive to said short-time circuit-closing means, means controlled by the chronological condition of said secondary apparatus for periodically opening said normal circuit to prevent further movement of said secondary apparatus, and means for permitting continued normal advance of said secondary apparatus after its advancing movement has been prevented comprising an auxiliary circuit for causing energization of said electromagnetic means and a stick circuit for said electromagnetic means for holding said electromagnetic means energized during said long-time circuit-closing period.

21. In a secondary apparatus for use in a corrective time controlled system, an impulse magnet responsive to received impulses of short duration for normally advancing said apparatus step-by-step, and means responsive to a received impulse of longer duration for controlling said impulse magnet to effect correction of said apparatus irrespective of its fast or slow condition.

22. In a corrective time controlled system, master apparatus and secondary apparatus connected by a control circuit, means in said master apparatus for regularly and periodically closing said circuit for a relatively short time, means in said master apparatus for regularly and periodically closing said circuit for a relatively long time, means in said secondary apparatus responsive to the closures of said circuit by said first means for effecting its normal operation, and means in said secondary apparatus for effecting correction thereof if said secondary apparatus is slow responsive to the closure of said circuit by said second means.

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