



## UNITED STATES PATENT OFFICE

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## SELF-REGULATING CONTROL SYSTEM

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This invention relates to synchronized clock systems and more particularly to self-regulatory systems of the above type.

This invention is an improvement over the system shown in the patent to Bryce, No. 1,687,491 issued October 16, 1928, and relates specifically to a synchronizing clock system in which a plurality of secondary clocks are to be operated in accordance with a primary or master clock by minute impulses transmitted by the master clock. The impulses are automatically transmitted over a plurality of connected wires commonly called A and B wires to which the secondary clocks are connected selectively in accordance with contacts controlled by the position of the secondary clocks themselves. Whenever impulses are being transmitted over both wires the secondary clocks will be stepped ahead one unit, commonly one minute, each time an impulse is received, irrespective of the position of the controlling contacts. During a certain interval called the synchronizing period one of the main wires such as the B wire is disconnected from the master clock and impulses are transmitted over the remaining wire or A wire only. Under such conditions the secondary clocks which are connected to the A wire are stepped ahead in accordance with the minute impulses from the master clock while the secondary clocks connected to the B wire remain stationary.

The selective contacts in the secondary clocks are controlled by cams in accordance with the time indication of the secondaries to disconnect the clock from the A wire and connect it with the B wire when the clock reaches a given position which is commonly chosen as the 59 minute position. If the master clock is designed to open the B wire during the last fifteen minutes of each hour, should any secondary clock be fast, its contacts would be operated as soon as the clock indicated the 59th minute to connect the clock with the B wire. The B wire being then

opened by the master clock no impulses are received and the clock remains stationary until the master clock itself reaches the even hour period when impulses are again transmitted over both wires and both clocks stepped ahead in synchronism.

In order to synchronize a clock which is running slow mechanism is associated with the master clock which will impress a series of rapid impulses upon the A wire during the last minute of the hour. Any secondary clock which is slow will then be stepped ahead in accordance with the rapid impulses until the selective contacts are actuated to disconnect the clock from the A wire.

In systems of this type should the relay associated with the master clock for disconnecting the B wire during the synchronizing period fail to operate for any reason such as an open winding or due to sticking of the armature, the rapid impulses would be transmitted over both wires and all clocks would be stepped ahead in accordance with these impulses irrespective of their position relative to the master clock.

It is therefore an object of this invention to provide means for preventing secondary clocks from being stepped ahead during the synchronizing period through failure of any associated apparatus.

Another object is to prevent secondary clocks from being stepped ahead during the synchronizing period by reason of failure of the relay designed to disconnect one of the synchronizing lines.

A further object is to provide means for impressing rapid impulses upon a series of secondary clocks during a synchronizing period which is independent of the main actuating means.

A still further object is to provide an automatically regulating synchronized clock system of improved and novel construction and design as hereinafter set forth and more fully described.

The above objects and others which will be apparent as the nature of the invention is disclosed are accomplished in accordance with the present invention by providing an independent means for impressing rapid impulses upon the synchronizing line during the preselected period. This means comprises a relay operable in response to the two-second contacts on the master clock which is so connected in the circuit that it only impresses impulses upon one line after the other line has been disconnected. By the arrangement of circuits hereinafter more fully described should both lines be connected during the synchronizing period due to failure of any of the operating mechanism the rapid impulses from the two contacts will not be impressed upon the mains.

Although the novel features which are believed to be characteristic of this invention will be pointed out with particularity in the claims appended hereto, the invention itself, as to its objects, advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawing forming a part thereof in which:

The figure is a diagrammatic representation of a self-regulating control for synchronized clocks constructed in accordance with this invention.

Referring to the figures more in detail a plurality of secondary clocks 1, 2 and 3 are shown in various time relations to a master clock 4. Clock 1 is shown as on time, that is indicating the time corresponding to that shown by the master clock. Clock 2 is illustrated as fifteen minutes fast and clock 3 as fifteen minutes slow. These clocks are each operated in response to minute impulses energizing coils 5 which are connected to the usual stepping mechanism whereby the clocks are stepped ahead one minute as the coils 5 are energized. Cams 6, operatively associated with the secondary clocks and adapted to turn in accordance with the minute indications thereon, are designed to actuate contacts 10 and 11 by means of which coils 5 are connected selectively to either of a pair of transmission wires, A, B. Cam 6 is designed to open contact 10 connecting coils 5 with line A and close contact 11 which will connect coils 5 with line B between the 59th and 60th minute indications of the clock.

Minute impulses are impressed upon lines A and B from master clock 4 by means of contacts 12 which are operated by a cam connected to the master clock and designed to close once per minute. Contacts 12 complete a circuit from source 13 through relay coil 14 and resistance 15 each time they are closed. Contacts 16 are closed by the armature of relay 14 in response to each energization thereof. A circuit is then completed from source

13 through contacts 16 to line A and through back contact 17 of relay 18 to line B and thence through contacts 10 or 11 through coils 5 and back through line 19 to source 13. By means of the circuit previously traced coils 5 are energized once per minute by contacts 12 on the master clock 4 and serve to step secondary clocks 1, 2 and 3 ahead one minute each time master clock 4 has advanced a minute.

During the synchronizing period, which is herein assumed to be between the 45th and 59th minute of every hour, cam contacts 22, which are operated in response to cams 23 carried by the master clock 4, are designed to close and complete a circuit from the source 13 through relay 18. This relay being energized attracts its armature opening contacts 17 and closing contacts 24. The circuit to the B wire is then broken and henceforth operation of contacts 16 in response to minute relay 14 will serve to send impulses over the A wire only. Whenever a secondary clock reaches the 59th minute contact 10 is broken by cam 6 associated with the secondary clock and stepping magnet 5 is disconnected from line A. Consequently, these clocks will not pass the 59th minute until the master clock has passed the 59th minute and contact 22 has again opened releasing relay 18 and closing contact 17.

In order to step ahead any secondary clocks which may register slow the master clock cam contacts 28 operated in response to cam 29 are designed to close for a certain period of time such as thirty seconds during the 59th minute. When contacts 28 are closing a circuit is completed through contacts 22 now closed, contacts 28 through two-second contacts 30 and relay 31, back to source 13. Relay 31 being energized attracts its cooperating armature and closes contacts 32. A circuit is then completed from source 13 through contacts 32, contacts 24 of relay 18, line 33 to the A wire. A series of two-second impulses will then be impressed upon the A wire in response to impulses of two second contacts 30 which will step ahead any secondary clocks connected to that line. Contacts 22 are designed to open just before the 60th minute releasing relays 18 and 31 thereby restoring the system to its original condition whereby both the A and the B wires are energized upon the next energization of relay 14 which will occur at the 60th minute.

Should relay 18 fail to be energized for any reason, the fast impulses produced by reason of energization of relay 31 will not be impressed upon either the A or B lines inasmuch as contact 24 will be open. There is therefore no possibility of the secondary clocks being stepped ahead beyond their predetermined position due to a circuit failure in the system. Should relay 18 fail to operate entirely, the system would operate as a non-

self-regulatory synchronized clock circuit which would mean that the clocks would not be forced any further out of step than they were at the time of failure. As previously mentioned with the type of system heretofore employed upon failure of the selective relay to operate the clocks would all be advanced in accordance with their rapid impulses which would be objectionable. This condition is avoided by the present invention.

Although this invention has been shown as applied to the above described system it is not to be limited thereto but only in accordance with the scope of the invention as defined by the following claims.

I claim:

1. A self-synchronizing clock system comprising a master clock and one or more secondary clocks, a pair of transmission lines normally connecting each of said secondary clocks to said master clock through a common circuit and means for intermittently disconnecting one of said lines from said common circuit and thereafter connecting the other line to said master clock through an independent circuit.

2. A self-synchronizing clock system comprising a master clock and one or more secondary clocks, a pair of transmission lines normally connecting each of said secondary clocks to said master clock through a common circuit and interlocking switch mechanism for intermittently disconnecting one of said lines from said common circuit and thereafter connecting the other line to said master clock through an independent circuit only in the event of the prior disconnection of the first named line from the common circuit.

3. A self-synchronizing clock system comprising a master clock and one or more secondary clocks, a pair of transmission lines normally connecting each of said secondary clocks to said master clock through a common circuit, means for intermittently sequentially disconnecting one of said lines from said master clock and thereafter establishing a connection between the other line and the master clock through an additional independent circuit while maintaining its connection through the common circuit.

4. A self-synchronizing clock system comprising a master clock and one or more secondary clocks, a pair of transmission lines normally connecting each of said secondary clocks to said master clock through a common circuit and interlocking switch mechanism for intermittently disconnecting one of said lines from said common circuit and thereafter connecting the other line to the master clock through an independent circuit, while maintaining its connection through the common circuit only, in the event of the prior disconnection of the other line from the common circuit.

5. A self-synchronizing clock system comprising a master clock and one or more secondary clocks, said master clock comprising periodically operating means for continuously initiating a series of periodic impulses and intermittently operating means for initiating a series of more rapid impulses during a selected recurring period, a pair of transmission lines and means controlled by each secondary clock for selectively connecting it to one or the other of said lines in accordance with predetermined time indications, one of said transmission lines being permanently connected to said periodically operating means and the other being removably connected thereto and means for disconnecting the last named transmission line from said periodically operating means and thereafter connecting the other line to said intermittently operating means prior to each recurring operative period thereof.

6. A self-synchronizing clock system comprising a master clock and one or more secondary clocks; said master clock comprising periodically operating means for continuously initiating a series of periodic impulses and intermittently operating means for initiating a series of more rapid impulses during a selected recurring period, a pair of transmission lines and means controlled by each secondary clock for selectively connecting it to one or the other of said lines in accordance with predetermined time indications, said transmission lines being normally connected to said periodically operating means and means for disconnecting one of them therefrom prior to each period of operation of said intermittently operating means and subsequently connecting the other to said last named means.

7. A self-synchronizing clock system comprising a master clock and one or more secondary clocks, said master clock comprising periodically operating means for continuously initiating a series of periodic impulses and intermittently operating means for initiating a series of more rapid impulses during a selected recurring period, a pair of transmission lines and means controlled by each secondary clock for selectively connecting it to one or the other of said lines in accordance with predetermined time indications, one of said transmission lines being connected to said periodically operating means and interlocking switch mechanism for normally connecting the other transmission line to said periodically operating means and disconnecting it therefrom prior to each period of operation of the intermittently operating means and thereafter connecting the first line to the last named means only if the other has previously been disconnected from said periodically operating means.

8. A self-synchronizing clock system comprising a master clock and one or more sec-

ondary clocks, a pair of transmission lines for connecting said secondary clocks to said master clock, a common master clock circuit to which one of said lines is connected and a relay operated by the master clock having front and back contacts one of which is connected to the other line and the other of which is connected to an independent master clock circuit and an armature for said relay electrically connected to said common master clock circuit whereby simultaneous connection of said first named line to the common and independent master clock circuits while the other line is connected to the common circuit is prevented.

9. A self-synchronizing clock system comprising a master clock and one or more secondary clocks, a pair of transmission lines and means for selectively connecting each secondary clock to one of them, means controlled by the master clock for initiating a series of periodic impulses and means controlled by the master clock for intermittently initiating a series of more rapid impulses, separate relays for impressing the two series of impulses to said transmission lines and a third relay for disconnecting one of said lines from each of the other relays during the operation of the means for initiating rapid impulses.

10. A self-synchronizing clock system comprising a master clock and one or more secondary clocks, a pair of transmission lines and means for selectively connecting each secondary clock to one of them, means controlled by said master clock for continuously initiating a series of periodic impulses and means controlled by said master clock for intermittently initiating series of more rapid impulses during predetermined recurring periods, a common relay for impressing the periodic impulses to both of said lines, a second relay for impressing the more rapid impulses on one of said lines and a third relay for sequentially disconnecting one of lines from the common relay and thereafter connecting the other line to the second relay prior to each recurring period.

11. A self-synchronizing clock system comprising a master clock and one or more secondary clocks, a first and a second transmission line and means for selectively connecting each of said secondary clocks to one of said lines, means controlled by the master clock for continuously initiating a series of periodic impulses, means controlled by the master clock for intermittently initiating series of more rapid impulses during predetermined recurring periods, a common source of energy for the impulses, a net work connecting said lines to said source comprising a first relay having one contact connected to said source and a coacting contact connected to said first line, a second relay having one contact connected to said source and a

coacting contact and a third relay having an armature and front and back contacts and having one contact connected to the coacting contact of said second relay and the other contact connected to the second line and its armature connected to the first line, and controlling means for said third relay operated by the master clock for shifting its armature prior to each recurring rapid impulse period to disconnect the second line from the first and connect the first line to the source for both periodic and rapid impulses.

12. A self-synchronizing clock system comprising a master clock and one or more secondary clocks, a pair of transmission lines and means for selectively connecting each secondary clock to one or the other of said lines according to time indications by the secondaries, means controlled by the master clock for initiating a continuous series of periodic impulses and independent means controlled by the master clock for intermittently initiating a recurring series of more rapid impulses, means for permanently connecting one of said lines to the source of periodic impulses and common means for selectively connecting the said line to the source of intermittent impulses and disconnecting the other line from the source of periodic impulses or disconnecting the said line from the source of intermittent impulses and connecting the other line to the source of periodic impulses.

13. A self-synchronizing clock system comprising a master clock and one or more secondary clocks, a pair of transmission lines and means for selectively connecting each secondary clock with one or the other of said lines according to time indications by the secondaries, a first circuit with means controlled by the master clock for initiating a continuous series of periodic impulses therein, a second circuit with means controlled by the master clock for intermittently initiating a recurring series of more rapid impulses therein, one of said transmission lines being permanently connected to the first circuit and interlocking switching mechanism for connecting said line to the second circuit and disconnecting the other line from the first circuit prior to each series of rapid impulses and connecting the other line to the first circuit after each series of rapid impulses.

14. A self-synchronizing clock system comprising a master clock and one or more secondary clocks, a pair of transmission lines and means for selectively connecting each secondary clock with one or the other of said lines according to time indications by the secondaries, a first circuit with means controlled by the master clock for initiating a continuous series of periodic impulses therein, a second circuit with means controlled by the master clock for intermittently initiating a recurring series of more rapid impulses therein, one of said transmission lines being

permanently connected to the first circuit  
and a relay energized under control of the  
master clock during the occurrence of the  
rapid impulses and having a front contact  
5 connected to the second circuit, an armature  
contact connected to the one transmission line  
and a back contact connected to the other  
transmission line.

10 In testimony whereof I hereto affix my  
signature.

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