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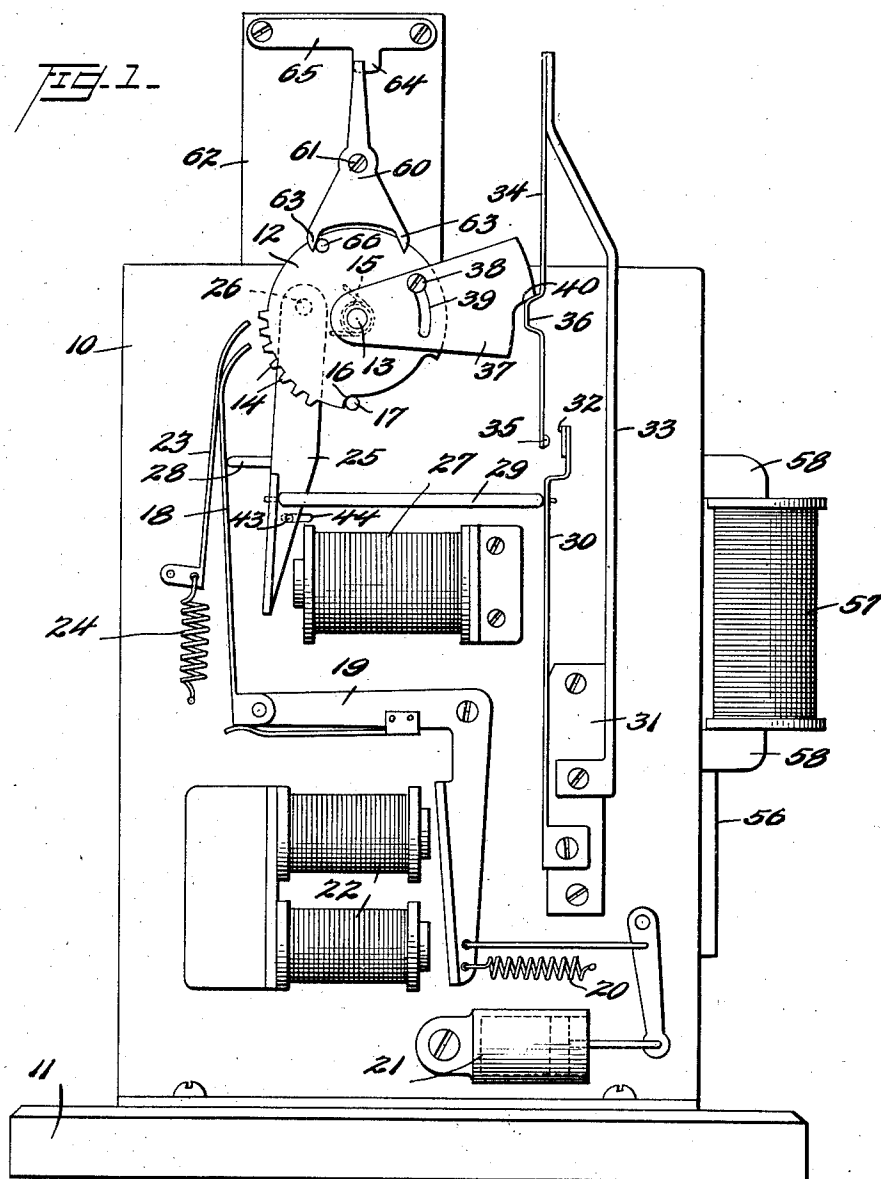
R. M. WOOD

1,723,964

CLOCK SYNCHRONIZING MECHANISM

Filed May 29, 1925

3 Sheets-Sheet 1



Inventor

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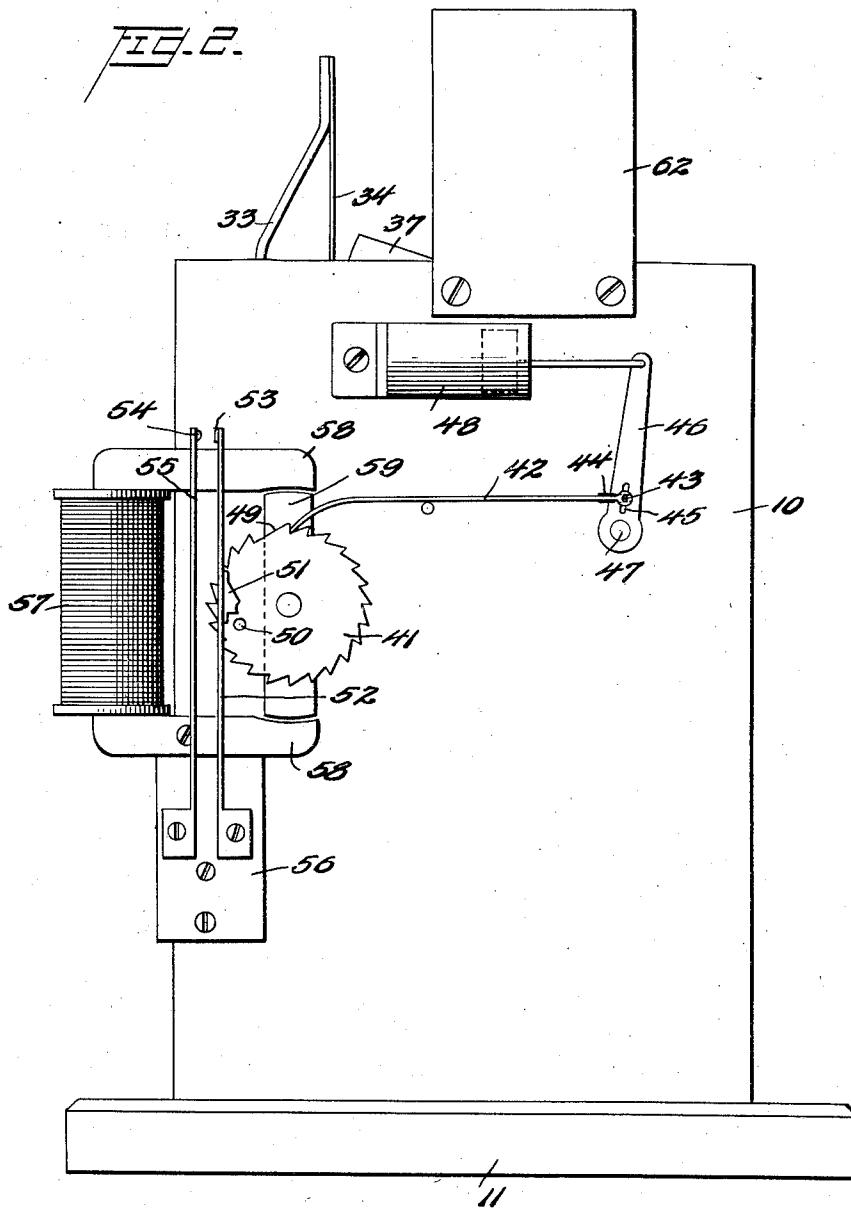
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3 Sheets-Sheet 2



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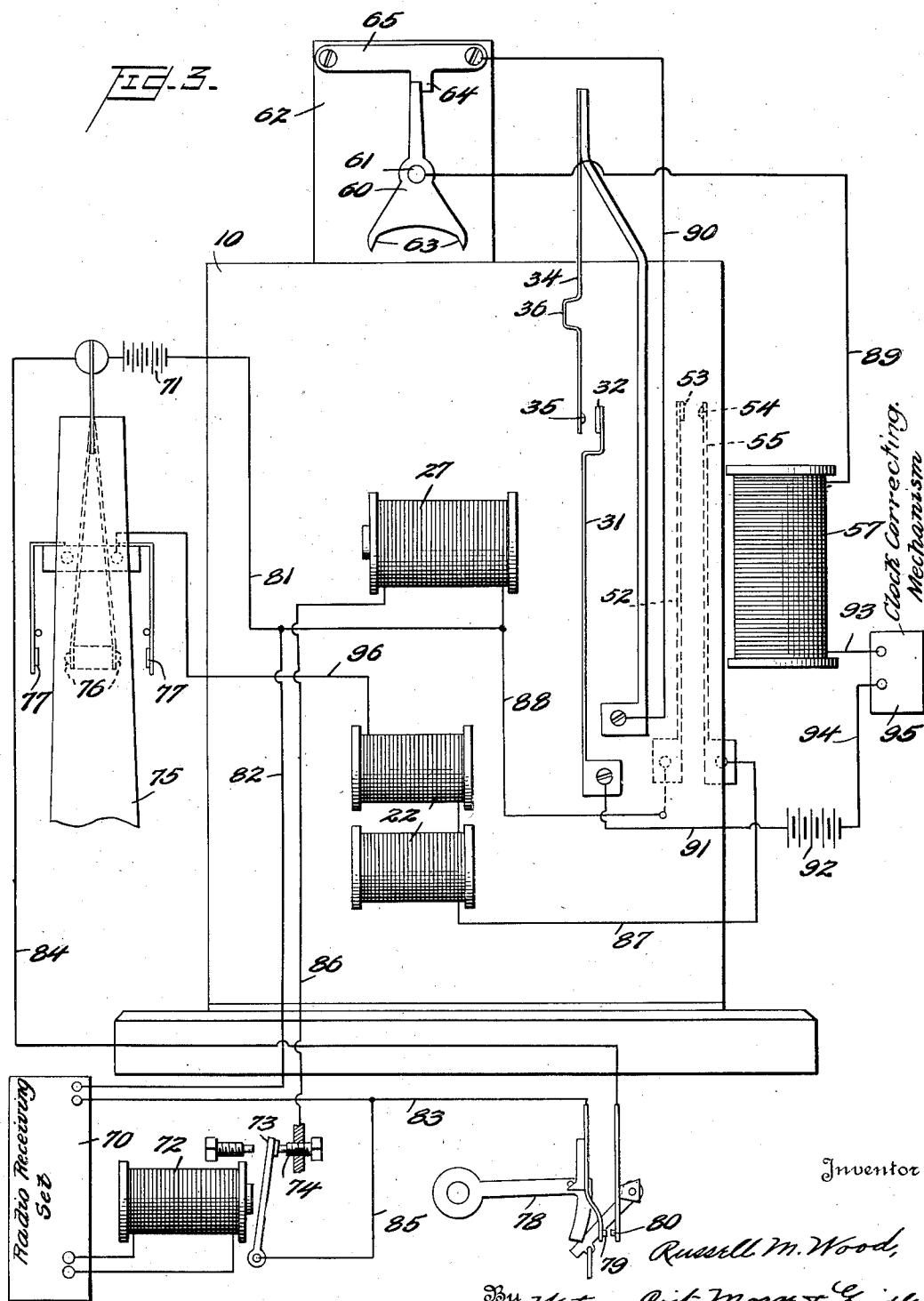
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CLOCK SYNCHRONIZING MECHANISM

Filed May 29, 1925

3 Sheets-Sheet 3



Patented Aug. 6, 1929.

1,723,964

UNITED STATES PATENT OFFICE.

RUSSELL M. WOOD, OF PLAINFIELD, NEW JERSEY, ASSIGNOR TO RADIO ELECTRIC CLOCK CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

CLOCK-SYNCHRONIZING MECHANISM.

Application filed May 29, 1925. Serial No. 33,820.

The present invention relates to clock synchronizing mechanism, and relates more particularly to apparatus of this character adapted to be utilized in correcting master or other clocks by Hertzian waves transmitted thru space from a central station at which a standard time piece is located.

The present invention comprises an improvement over the invention disclosed in the application of T. S. Casner, Serial No. 748,271, filed Nov. 6, 1924, and is adapted to be used in connection with a synchronizing system such as therein disclosed. The application referred to discloses a system in which radio time signals, such as those sent out from the United States Government station at Arlington, Virginia, are utilized to correct a master clock. The apparatus includes a radio receiving set which is adapted to be sharply tuned to the time signals to be received, a relay connected to this receiving set so that it is operated upon receipt of each signal impulse, a master clock having make and break contacts which are closed periodically by the clock mechanism, a clock controlled time switch which is adapted to be closed shortly before the time signals are due to be transmitted to put the entire system in operative condition, clock correcting mechanism which is adapted to set the hands of the clock when current is passed thru the same, and an electromagnetic switching device connected to the relay and the pendulum contacts and adapted to select the proper signal from the groups of impulses sent out so as to close the circuit of the clock correcting mechanism at the proper instant.

The primary aim of this invention is to provide an additional safeguard for this electromagnetic switching device which will prevent the clock correcting circuit from being closed at the wrong instant. More specifically, in the Casner application above referred to, an accidental break in the signals equalling or exceeding the correct length of one of the silent periods of the code of time signals, would cause the clock to be set erroneously by the next succeeding signal. This invention has for its purpose to provide a means whereby the clock correcting circuit may be closed only by a signal following a silent period of exactly the correct duration, and which therefore greatly diminishes the possibility of error.

Further objects and advantages of my invention will be apparent from the following description, taken in conjunction with the accompanying drawings, which form a part of this specification, and in which;

Figure 1 is a front elevation of an electromagnetic switching device embodying the present invention;

Figure 2 is a rear elevation of the same; and

Figure 3 is a diagrammatic view showing the electrical connections of the invention in relation to the other parts of the synchronizing system.

Referring more particularly to the drawings, in which like reference characters denote like parts throughout the several views thereof, 10 denotes a vertical support or panel which is secured to a suitable base 11. A toothed wheel 12 is rotatably mounted on a stud 13 secured to the face of the panel 10 near the top thereof. The wheel 12 in the present instance is provided with six effective teeth 14 arranged along a portion of its periphery. A biasing means such as a spring 15 tends to keep the wheel constantly in the position shown in Figure 1 with a shoulder 16 on the wheel contacting with a stop pin 17 mounted on the panel.

Means are provided to impart a step by step movement to the wheel, and comprise a pawl 18 pivoted at its lower end to one arm of a right angled armature 19 pivoted at its apex to the panel 10. The armature 19 is adapted to be moved about its pivot against the action of a spring 20 and a dash pot 21 by a pair of electromagnets 22 and is normally held retracted from the poles of the electromagnets 22 by the spring 20. A dog 23 is urged to engage the teeth of wheel 12 by means of a spring 24 and is adapted to hold the wheel in advanced position.

An armature 25 is pivoted at 26 to the vertical panel 10 and is adapted to be operated by an electromagnet 27. The armature 25 is provided with a projection or knob 28 which engages the pawl 18 and holds it and the dog 23 out of engagement with the teeth 14 when the electromagnet 27 is de-energized, as shown in Figure 1. An insulating rod 29 connects the armature 25 with a leaf spring blade 30 which is secured to an insulating block 31 mounted on the

panel 10, and which holds the armature 25 in the retracted position shown in Figure 1. As indicated on the drawing, the rod 29 may be supported by having reduced ends thereof engaging respectively apertures in spring blade 30 and armature 25. The free end of the spring 30 is provided with a contact 32. A supporting bar 33 is also secured to the insulating block 31 and has suspended therefrom a spring blade 34 which carries at its free end a contact 35 which is adapted to cooperate with the contact 32 on the spring 30. The spring 34 is provided with a bend or hump 36, the purpose of which will appear hereafter.

An arm or sector 37 of insulating material is also rotatably mounted on the shaft 13 independently of the wheel 12, and is connected to the wheel 12 by means of a pin 38 on the wheel which passes thru an arcuate slot 39 in the sector. Sector 37 is formed with a shoulder 40 adapted to engage the bowed portion or hump 36 of spring blade 34. The circumferential length of slot 39 is such that the wheel 12 can be rotated from its initial position thru an angle subtended by four teeth without affecting sector 37. On further rotation of wheel 12, however, as when it has been advanced five teeth, pin 38 contacts with the lower end of the slot 39 so that the wheel 12 and the sector 37 move together, the shoulder 40 of the sector pressing spring 34 to the right from the position shown in Figure 1. When the spring 34 has been thus pressed to the right the contact 35 will engage the contact 32 on spring 30 when the magnet 27 is deenergized so that the spring 30 is in the position shown in Figure 1. The contacts 32 and 35 will not engage until each has been moved towards the other. It is obvious, of course, that instead of using a single switch having two movable terminals, two switches connected in series might be employed, each switch having one movable terminal cooperating with a stationary terminal.

As will be seen in Figure 2, a ratchet wheel 41 is rotatably mounted on the rear of panel 10 and is adapted to be operated by a pawl 42. This pawl is operatively connected to the armature 25, the connection chosen consisting in a pin 43 fixed to the armature and projecting thru a slot 44 in the panel and having its projecting end pivoted to pawl 42. Pin 43 also passes thru a vertical slot 45 in an arm 46 pivoted at 47 and having its free end connected to the piston of a dash pot 48.

Ratchet wheel 41 has one or more of its teeth omitted at 49, so that after it has been stepped around to the point where this mutilated part is under pawl 42, further operation of the latter effects no rotation of the wheel. When this point is reached a pin 50 on wheel 41 rests in a notch on the peak

of a cam 51 secured to the back of a spring blade 52 provided with a contact 53 at its free end, and by thus flexing the blade to the left from the position shown in Figure 2, presses this contact into engagement with a similar contact 54 secured to a second spring blade 55. The spring blades 52 and 55 are each mounted at their lower ends on an insulating block 56. An electromagnet 57 has its pole pieces 58 projecting respectively above and below wheel 41 so as to cooperate with an armature 59 secured in any suitable way to the wheel 41. Wheel 41 in armature 59 may be mounted so as to be frictionally held against retrograde movement. When the wheel 41 has been rotated to the point where pawl 42 is over the mutilated part of the wheel and pin 50 rests on the peak of cam 51, the parts will remain in such positions until magnet 57 is energized, whereupon armature 59 will be drawn to the vertical position shown in Figure 2, thereby rotating wheel 41 sufficiently to bring the next ratchet tooth thereof into engagement with pawl 42 and to cause pin 50 to clear cam 51, allowing contacts 53 and 54 to separate. Pawl 42 is then effective to step the ratchet wheel around when operated until the mutilated part 49 again comes under the pawl. The wheel 41 may be provided with any suitable number of teeth, the number adopted in the present instance being 22.

The parts so far disclosed are shown in the application referred to above and I now come to a description of the present invention. Referring to Figure 1, a switch arm 60 is pivoted to a stud 61 secured to an insulating block 62 fastened near the top of the panel 10. The arm 60 has at its lower end two prongs 63, the angle between the inside edges of these prongs being equal to that subtended by five teeth on the wheel 12. The upper end of the arm 60 is adapted to make contact with a projecting contact 64 extending from a flat contact piece 65 secured to the block 62. A pin 66 is secured to the wheel 12 in such position as to be in contact with the left hand prong 63 when the parts are in the position shown in Figure 1.

The wiring of the apparatus is shown in Figure 3 in diagrammatic form. A radio receiving set of any suitable construction is indicated at 70 and a battery for energizing the set at 71. Battery 71 is also utilized for operating electromagnets 22 and 27. The receiving set should be sharply tuned to the frequency of the time signal waves. An audio frequency relay of any suitable construction is illustrated diagrammatically at 72. When the set is rendered operative relay 72 will be energized upon the reception of each signal impulse and will be deenergized at all other times. A pair of contacts 73, 74 are operated by the relay

in such manner that circuit between them will be opened when the relay is energized by the reception of a signal impulse. 75 denotes the pendulum of a suitable master clock which carries a pair of movable contacts 76 adapted to engage with a pair of stationary contacts 77 so as to close the circuit between these contacts once each second.

78 represents a clock controlled switch, the details of construction of which may be found in the application referred to above. This switch is operated by the clock in such manner that the contacts 79 and 80 thereof will be closed at approximately five minutes to noon each day. Suitable mechanism is provided for opening these contacts immediately following correction of the clock by the clock correcting mechanism, or, failing this, the contacts 79 and 80 will be opened by the clock itself at approximately one-half minute after noon.

Normally the radio receiving set 70 is inoperative and is rendered operative only during the time that the contacts 79 and 80 are closed, at which time battery 71 is connected to the receiving set by a circuit including conductors 81, 82, 83, contacts 79 and 80 and conductor 84 back to the battery. For convenience of description I will call this circuit the "receiving-set-energizing circuit."

The circuit of electromagnet 27 may be traced as follows: conductor 81 from one side of the magnet to one side of the battery, conductor 84 from the other side of the battery to switch 78, conductors 83 and 85 to contact 73 of relay 72, and from contact 74 of the relay to the other side of electromagnet 27 by conductor 86. Since this circuit is opened upon the reception of each time signal, it may be called the "time-signal-responsive circuit".

The circuit of electromagnets 22 includes conductor 87 to contact 54, thence to contact 53, conductors 88 and 81 to battery 71, the other side of battery 71 to pendulum contacts 76 and 77, and conductor 96 from contacts 77 back to electromagnets 22. As this circuit is controlled by the clock so as to be closed and opened at one second intervals after the preliminary closure of contacts 53 and 54, it may be called the "clock-controlled circuit".

Finally, the circuit of electromagnet 57 includes conductor 89 to switch arm 60, contact 64, conductor 90, contacts 35 and 32, conductor 91 and battery 92. The other side of electromagnet 57 and battery 92 are to be connected by conductors 93 and 94 respectively to the terminals of the clock correcting mechanism 95. A suitable mechanism for this purpose is shown in the Casner application referred to above. Since the armature 59 resets the premature-operation-preventing switch 53, 54, this circuit

may be called the "clock-correcting and switch-resetting circuit".

The time signals transmitted from the Arlington station begin at five minutes before noon and are sent out in a series of impulses of very short duration, called for convenience "dots," one every second, omitting the thirtieth second of each minute, up to and including the fifty-fifth second of the fifty-sixth, fifty-seventh, fifty-eighth and fifty-ninth minute, and a like series of dots up to and including the fiftieth second of the sixtieth minute, there being a single long impulse sent out beginning exactly at noon. That is to say, for five minutes just preceding noon, short signal impulses are being sent out at one second intervals, omitting the thirtieth second of each minute, except during the five seconds at the end of the fifty-sixth, fifty-seventh, fifty-eighth and fifty-ninth minutes, and except during the ten seconds preceding noon. The apparatus according to the present invention is adapted to set the clock at the end of any one of these four five-second silent periods.

The operation of the system will now be described, starting with the normal positions of the various parts shown in the accompanying drawings. Since the clock does not ordinarily vary more than a few seconds from the correct time, it may be assumed that the switch 78 will be closed at or within a few seconds of five minutes before noon. When the switch 78 closes, battery 71 is connected to the radio receiving set thru the "receiving-set-energizing circuit," thereby rendering the set operative, and magnet 27 is also connected to the battery 71 thru the "time-signal-responsive circuit." Magnet 27 will accordingly be energized, attracting its armature 25 and permitting pawl 18 and dog 23 to come into engagement with ratchet wheel 12 and also rotating ratchet wheel 41 thru an angle of one tooth. Now upon the reception of the first dot subsequent to the closure of switch 78, relay 72 will be energized, thereby opening the circuit of magnet 27. The armature 25 will thereupon be retracted by spring 30, throwing pawl 18 and dog 23 out of engagement with the wheel 12 and retracting pawl 42 into position to engage the next tooth of ratchet wheel 41. Upon cessation of the dot the circuit of magnet 27 will be again closed, permitting pawl 18 and dog 23 to engage the wheel 12 and advancing ratchet wheel 41 another tooth. Thus wheel 41 will be stepped around one tooth per second during the initial part of the signal reception, or until the mutilated part 49 of the wheel has been brought under the pawl 42. As the wheel 41 has 22 teeth, this number of operating impulses of pawl 42 is required to step wheel 41 from its initial position to the position where pin 50 is seated on the peak of cam

51 and closes contacts 53, 54. Since pawl 42 is given an operating impulse upon the reception of each dot, it follows that contacts 53, 54 will be closed approximately on the twenty-second second of the fifty-sixth minute of the hour preceding noon. If the clock is fast, so that the switch 78 is closed prior to the beginning of the time signals, contacts 53, 54 will be closed exactly on this
 10 twenty-second second. If the clock is slow, so that switch 78 is closed subsequent to the beginning of the time signals, contacts 53, 54 will be closed a corresponding interval after this twenty-second second. Within rather
 15 wide limits the exact time of closure of contacts 53, 54 is immaterial.

The closing of contacts 53, 54 closes one of the gaps in the "clock-controlled circuit," the other gap in this circuit being at the pendulum contacts 76, 77. It will be evident
 20 that the electromagnets 22 will be energized and deenergized once each second by the closing of the pendulum contacts 76, 77 after the contacts 53, 54 are closed as above described. Upon each energization of magnets
 25 22, pawl 18 will be raised, but unless magnet 27 is simultaneously energized the pawl will be held away from the teeth of wheel 12 by the knob 28 on armature 25. If the signal
 30 impulses are synchronous with the energizations of magnets 22, so that magnet 27 is deenergized when magnets 22 are energized, pawl 18 will be held away from wheel 12 and the latter will remain unaffected as long
 35 as the signals come once per second. If the signal impulses are not synchronous with the energizations of magnets 22, magnets 22 and 27 may be simultaneously energized, in which event pawl 18 will step wheel 12 thru
 40 an angle of one tooth but the wheel will be immediately returned to its initial position upon reception of the next signal impulse and consequent deenergization of magnet 27. It therefore follows that under no circum-
 45 stances can the wheel 12 be operated thru an angle exceeding that subtended by one tooth so long as the signal impulses come in once per second.

During the five-second silent period just
 50 preceding the beginning of the fifty-seventh minute, relay 72 is deenergized, closing the "time-signal-responsive circuit" and energizing magnet 27 during the whole of this period. Hence pawl 18 and dog 23 will be
 55 in their operative positions with respect to wheel 12 for five seconds, permitting magnets 22 to step wheel 12 thru an angle of five teeth. At the fourth step pin 38 reaches the bottom of slot 39, and on the fifth step
 60 sector 37 is moved downwardly, its shoulder 40 pressing spring blade 34 to the right. Now upon reception of the impulse at the end of the sixtieth second, or the beginning of the fifty-seventh minute, relay 72 will be
 65 energized, opening the "time-signal-respon-

sive circuit" thru magnet 27. This will permit spring blade 30 to move to the left, and contact 32 will engage contact 35, thereby closing the "clock-correcting-and-switch-resetting circuit" thru magnet 57 and
 70 the clock correcting mechanism connected to conductors 93 and 94. The second hand of the clock will thereby be set in a vertical or zero position, if it is not already in that position, as described in the Casner appli-
 75 cation referred to above. The contacts 79, 80 will be simultaneously opened as fully set forth in Patent 1,575,096 to Casner, thereby disconnecting battery 71 and putting the apparatus in an inoperative condition
 80 until five minutes preceding noon of the next day. When the magnet 27 is deenergized upon the reception of the impulse at the beginning of the fifty-seventh minute, as described, pawl 18 and dog 23 are re-
 85 moved from engagement with wheel 12, permitting spring 15 to rotate the wheel to its initial position with its shoulder 16 engaging stop pin 17. In returning to this position, pin 38 on the wheel engages the upper
 90 end of slot 39 in sector 37 and moves the sector upwardly to its normal position, permitting spring blade 34 to move away from blade 30, thus opening the "clock-correcting-and-switch-resetting circuit" contacts 32, 35.
 95 The clock correcting mechanism is accordingly deenergized and drops to the position it normally occupies, thereby releasing the second hand of the clock. It will be observed that the deenergization of magnet 27
 100 effects both the closing and the opening of the circuit thru the clock correcting mechanism, so that the latter is energized only an instant, thereby offering no appreciable interference with the operation of the sec-
 105 ond hand. The parts are so constructed that the switch blade 30 is brought into engagement with blade 34 before dog 23 is removed from engagement with the teeth of wheel 12, thus permitting the clock correcting mechanism to be energized long
 110 enough to overcome its electrical inertia and the mechanical inertia of the parts operated thereby. The energization of magnet 57 when the "clock-correcting-and-switch-
 115 resetting circuit" is closed, as described, will turn armature 59 to its vertical position, thereby rotating ratchet wheel 41 thru a sufficient angle to cause the opening of con-
 120 tacts 53, 54 and the engagement of pawl 42 with a ratchet tooth. Thus battery 71 is disconnected and all the various parts of the apparatus are returned to their normal positions automatically upon completion of the setting operation.
 125

It will be noted that the operation of wheel 41 thru a predetermined number of steps must be performed before magnets 22 can be energized to step around wheel 12 and effect the setting of the clock. The
 130

purpose of thus making the operation of wheel 41 a condition precedent to the setting of the clock is to insure that the time signals are actually being received and that the apparatus is properly responsive, and hence that the clock will not be set prematurely and inaccurately. It is possible that due to the fact that the clock is fast, relay 72 would not attract its armature until five seconds or more had elapsed after the closing of switch 78. In such an event, if the circuit of magnets 22 were controlled solely by the pendulum contacts 76, 77, magnets 22 would step wheel 12 around five steps before relay 72 had responded to a time signal, and the clock would be wrongly set on the first response of relay 72. With the circuit of magnets 22 controlled by contacts 53, 54, an inaccurate setting from such cause cannot occur, as these contacts are closed only after the reception of a predetermined number of time signals.

It may happen that during the five-second silent period preceding the beginning of the fifty-seventh minute, relay 72 will be energized by the response of the receiving set to a stray signal or static. If this should happen, magnet 27 would be deenergized and its armature would throw pawl 18 and dog 23 out of engagement with wheel 12, which would then return to its initial position, preventing setting of the clock at the end of this silent period. But in the absence of interference the clock would be set at the end of the next silent period or at the beginning of the fifty-eighth minute. That is to say, the clock may be set at the end of any one of the four five-second silent periods preceding noon, so that if interference occurs in the first silent period, the clock setting will take place at the end of the first succeeding silent period during which no interference occurs. In the improbable event that there is interference during all the silent periods, failure to set the clock will, of course, occur, and the apparatus will remain in the operative condition until approximately one-half minute after noon, when the switch 78 will be opened by the operation of the clock.

As has been stated above, the angle between the inside edges of the prongs 63 of arm 60 is equal to the angle subtended by five teeth on the wheel 12. It will thus be seen that no movement of the arm 60 will take place during a silent period of only five seconds. If the signals should, however, be accidentally interrupted for any reason, the sixth step of the wheel 12 will cause the pin 66 on the wheel, which is touching the right hand prong 63 at the end of the five seconds of silence, to rock the arm 60 so that the upper end of the arm is moved out of engagement with the contact 64. The "clock-correcting-and-switch-resetting circuit" will

thereby be opened, preventing the next signal received from setting the clock erroneously, as would otherwise be the case. Without this additional safeguard, any accidental interruption of the signals, causing a silent period exceeding five seconds in duration, would result in the clock being set erroneously by the next impulse received. This additional safeguard renders it impossible to use the final ten-second silent period for setting the clock, as may be done with the original Casner construction, but this is not a serious loss as it is exceedingly improbable that the clock will fail to be set during one of the four preceding five-second silent periods. In compensation, my improvement makes it impossible for the clock to be set except by a silent period of exactly five seconds duration, and thereby greatly reduces the possibility of an erroneous setting of the clock.

It is to be understood that although the present invention has been specifically described in connection with a code of time signals transmitted by radio, it is by no means limited thereto. The invention may be applied to the selection of a desired signal from a code of signals however transmitted, and may be utilized either to set a clock or to give any other indication of the instant of receipt of said signal.

It will be apparent to one skilled in the art that various changes or modifications might be made in my invention without affecting the spirit thereof, and I desire to be limited, therefore, only by the prior art and the scope of the appended claims.

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

1. In a system for setting a clock in response to a code of time signals, switching mechanism for controlling an electric circuit through a clock correcting mechanism, comprising in combination, means tending to close said circuit upon receipt of each signal, means tending to close said circuit after a silent period of certain definite duration, and means for opening said circuit after a silent period exceeding said certain definite duration, whereby said clock correcting mechanism may be actuated only by a silent period of said certain definite length immediately followed by a signal.

2. In a system for setting a clock in response to a code of time signals, means for controlling an electric circuit through a clock correcting mechanism, comprising in combination, a switch in said circuit consisting of two normally separated movable terminals, means for moving one terminal towards the other upon receipt of each signal and for moving it away upon the cessation thereof, means for moving the other terminal towards the first terminal after a

silent period of certain definite duration, said terminals being adapted to contact only when each has been moved towards the other, a second switch in said circuit consisting of two normally engaged contacts, and means for opening said second switch after a silent period exceeding said certain definite duration, whereby both of said switches may be closed and said clock correcting mechanism actuated only by a silent period of said certain definite length immediately followed by a signal.

3. In a system for setting a clock in response to a code of time signals, means for controlling an electric circuit through a clock correcting mechanism, comprising in combination, a switch in said circuit consisting of two normally separated movable terminals, means for moving one terminal towards the other upon receipt of each signal and for moving it away upon the cessation thereof, clock controlled step-by-step mechanism adapted to move the other terminal towards the first terminal when moved a predetermined number of steps from an initial position, said terminals being adapted to contact only when each has been moved towards the other, means to return the step-by-step mechanism to its initial position upon receipt of each signal, a second normally closed switch in said circuit, and means for opening said switch when said step-by-step mechanism has moved more than said predetermined number of steps necessary to move said second terminal.

4. In a system for setting a clock in response to a code of time signals consisting of a plurality of series of impulses sepa-

rated by silent periods, in combination, clock controlled step-by-step mechanism, impulse responsive means for returning said mechanism to initial position upon reception of each impulse, whereby said mechanism will operate through a certain phase only during one of said silent periods, electromagnetic clock setting means having a circuit controlled jointly by said mechanism and said means and closed only when an impulse is received at the completion by said mechanism of said phase of movement, and means controlled by said mechanism for opening said circuit whenever the movement of said mechanism exceeds said phase.

5. In a system for setting a clock in response to a code of time signals consisting of a plurality of series of impulses separated by silent periods, in combination, clock controlled mechanism adapted to operate through a certain phase from an initial position, impulse responsive means for returning said mechanism to initial position upon reception of each impulse, whereby said mechanism will complete said phase of movement only during one of said silent periods, means for setting the clock controlled jointly by said mechanism and said means and actuated only when an impulse is received at the completion of said phase of movement by said mechanism, and means controlled by said mechanism for rendering said clock setting means inoperative whenever the movement of said mechanism exceeds said phase.

In testimony whereof I hereunto affix my signature.

RUSSELL M. WOOD.