April 28, 1936. S. KEILIEN 2,039,084

ELECTRIC CLOCK APPARATUS

Original Filed Feb. 19, 1929 2 Sheets-Sheet 1

Fig. 2

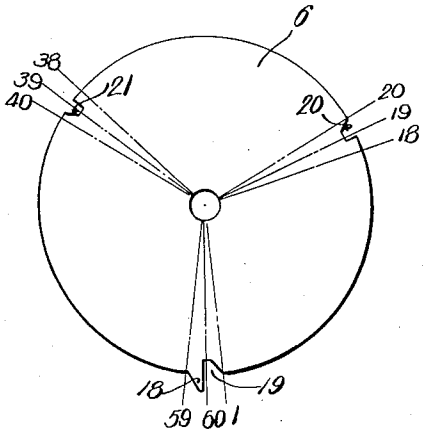


Fig. 1

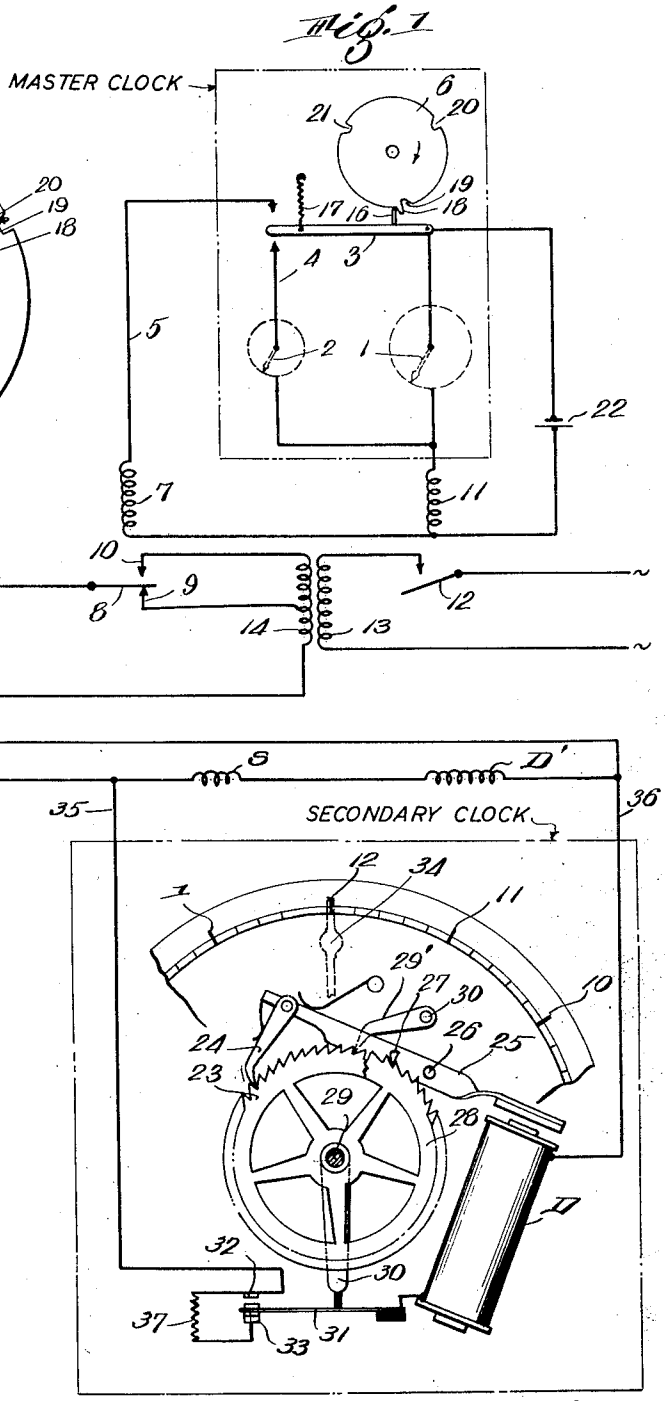


Fig. 3

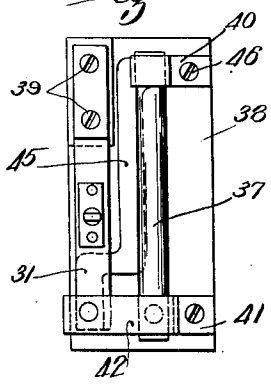
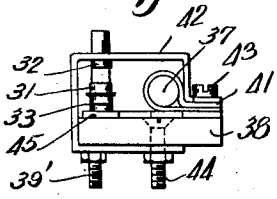


Fig. 4



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Fig. 5

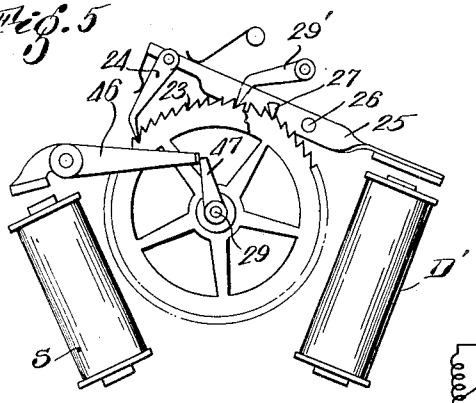


Fig. 6

Fig. 8

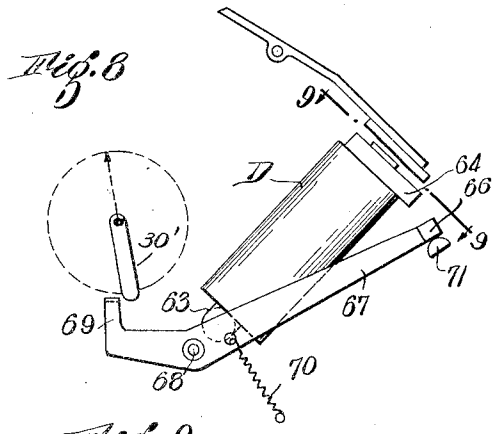


Fig. 7

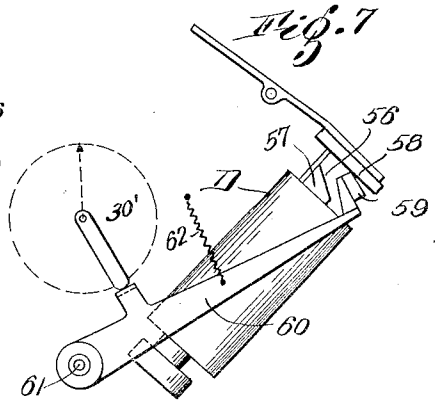
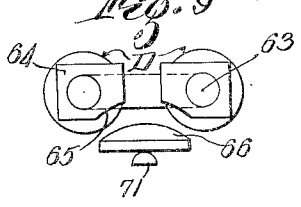


Fig. 9



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Patented Apr. 28, 1936 2,039,084

UNITED STATES PATENT OFFICE

2,039,084

ELECTRIC CLOCK APPARATUS

Saul Kellien, Springfield, Mass., assignor to The Standard Electric Time Company, Springfield, Mass., a corporation of Connecticut

Application February 19, 1929, Serial No. 341,176
Renewed March 7, 1934

5 Claims. (Cl. 58—24)

This invention relates to electric clock systems in which impulses are transmitted from a master clock or other control apparatus to secondary clocks having electromagnets or other means for advancing the hands in response to the impulses, and particularly to systems in which the secondary hands are advanced in direct response to the impulses rather than indirectly through a rewinder which stores energy derived from the impulses for driving the hands continuously.

Objects of the invention are to provide a system in which any one of the secondary clocks, if too fast or too slow, is corrected at predetermined intervals, as for example at the end of each hourly cycle, automatically and without interference with the normal operation of other secondary clocks in the system, which requires only a single circuit (two wires or one wire and ground) between the control apparatus and the secondary clocks while permitting the use of a multiple circuit if desired, which is simple and economical in construction and reliable and durable in use, and which is generally superior to prior systems of this character.

In one aspect the invention is characterized by control apparatus for transmitting impulses of different characteristics (such as high and low voltage impulses or alternating current and direct current impulses or impulses which differ both in magnitude and also in kind of current) and at different time intervals (such as once per hour and once per minute respectively) together with secondary clocks normally driven by one kind of impulses and periodically synchronized by the other kind of impulses. While slow secondaries may be advanced to synchronism in various ways, preferably a series of fast impulses are transmitted thereto during the period between the synchronizing or starting impulse and the next preceding normal or driving impulse, thereby to bring any of the secondaries which may be slow into position to be started in synchronism with all the other secondaries when the starting impulse (of high voltage or alternating current or otherwise different) is transmitted.

By making the periods of time between the starting impulse and the first and last normal driving impulses substantially equal to the periods between succeeding normal impulses, the starting impulses and the driving impulses (other than said fast impulses) together constitute a series of regular impulses transmitted at constant predetermined time intervals throughout recurrent cycles (every minute throughout hourly cycles, e. g.) the starting impulse involving merely a change in the character (magnitude or kind of current) of impulse and constituting an altered driving impulse of the aforesaid regular series.

The secondary clocks are characterized by an electromagnet or other means for advancing the hands in response to the driving impulses (minute impulses in the aforesaid example) until the hands reach predetermined positions (with the minute hands in the 60-minute positions, e. g.) together with means for then rendering the aforesaid means ineffective further to advance the hands until a starting impulse (of different voltage or different kind of current) is received. If a secondary be slow the aforesaid fast impulses also function as driving impulses just before the starting impulse initiates a new cycle or conditions the secondary clocks for a new cycle. The aforesaid means for rendering the secondary magnet ineffective preferably comprises means for increasing the reluctance of the magnetic circuit or the impedance of the electric circuit. For example, when using high voltage starting impulses a resistance may be connected in circuit with the electromagnet so that the relatively low voltage driving impulses do not energize the magnet sufficiently to actuate the hands when the resistance is included in circuit. A switch controlled by the secondary movement may be employed to short-circuit the impedance or otherwise conduct current to the magnet independently of the impedance at all times other than those when the magnet is intended to be responsive only to the starting impulses.

For the purpose of illustrating the genus of the invention typical concrete embodiments are shown in the accompanying drawings in which

Fig. 1 is a diagram of one system;

Fig. 2 is an elevational view of the timer of the master clock;

Fig. 3 is a plan view of a switch assembly at the secondary clock;

Fig. 4 is an end elevation of the switch assembly;

Fig. 5 is an elevational view of a secondary clock movement differing somewhat from that shown in Fig. 1;

Fig. 6 is a diagram of a modified system;

Fig. 7 is an elevation of a modified secondary magnet;

Fig. 8 is a similar view of a further modification; and

Fig. 9 is a section on line 9—9 of Fig. 8.

The particular embodiment of the invention shown in Fig. 1 comprises a master clock having a circuit closer 1 which closes circuit at regular

intervals such as once per minute, another circuit closer 2 which closes circuit at more frequent intervals such as once per second, a circuit controller 3 normally standing in the neutral position shown in Fig. 1 and closing either circuit 4 or circuit 5 when moved to its lower or upper positions respectively, a timer 6 for controlling the circuit closer 3 and turning at a constant speed, preferably one revolution per hour, an electromagnet 7 for controlling switch 8, the switch normally engaging contact 9 and being lifted into engagement with contact 10 when the magnet 7 is energized, an electromagnet 11 controlled by the switches 1 and 2 for closing the switch 12 when energized, and a transformer having a primary 13 connected to a source of alternating current through switch 12 and a secondary 14 connected to a rectifier 15 through switch 8, the rectifier 15 being connected across the entire secondary when the switch 8 is in upper position and being connected across only a part of the secondary when the switch is in the lower position.

The periphery of the timer 6 engages the switch arm 3 through a lug 16 which is held against the timer by spring 17. The periphery is provided with a cam projection 18 which depresses the switch arm 3 into contact with the terminal of circuit 4 for a brief interval during each revolution of the timer, as for example from fifty-nine minutes and ten seconds to fifty-nine minutes and forty seconds. Immediately following the projection 18 is a depression 19 into which the lug 16 is moved by spring 17 as soon as the projection passes, preferably just before the master clock reaches the sixty-minute position, thereby to close circuit 5 while the minute circuit closer 1 sends the sixtieth minute impulse. The timer 6 may also be provided with any number of depressions 20 and 21 to permit the circuit closer 3 to close the circuit 5, through electromagnet 7 and source 22, at intervals intermediate the sixty-minute positions, for example while the circuit closer 1 sends the nineteenth and thirty-ninth minute impulses.

The angular positions of the projection 18 and the depressions 19, 20 and 21 are indicated in Fig. 2 where the numerals at the ends of the radial lines indicate the times when the respective points of the circumference of the timer intersected by the radial lines pass the lug 16 on arm 3.

The secondary clock movement diagrammatically illustrated in Fig. 1 comprises an electromagnet D for driving the ratchet wheel 23 through a pawl 24 on arm 25 pivoted at 26. Arm 25 carries a stop 27 for engagement with a second ratchet wheel 28 fast to shaft 29 upon which the ratchet wheel 23 is fastened to prevent overthrow by pawl 24, a pawl 29' pivoted at 30 and engaging with ratchet wheel 23 preventing retrograde movement of the ratchet wheels. Fast to shaft 29 is an arm 30 for engagement with an insulating lug on a switch spring 31 normally engaging contact 32 and moved by arm 30 into engagement with contact 33 when the secondary clock reaches a predetermined position (e. g. the sixty-minute position as indicated by the minute hand 34 in Fig. 1). The electromagnet D is connected across the rectifier 15 through conductors 35 and 36, switch 31 and contact 32, except when the clock movement is in the position shown in the Fig. 1, at which time the resistance 37 is included in the circuit.

A suitable switch assembly for use in the secondary clock is shown in Figs. 3 and 4 where the parts 31, 32, 33, 37 are designated as in Fig. 1. The switch spring 31 is mounted on a base plate 38, which is preferably of insulation material, by screws 39 one of which may constitute a binding post for connection to the electromagnet, as shown at 39' in Fig. 4. The resistance 37 is mounted on the base plate 38 by means of two metallic clips 40 and 41. The contact 32 is carried on a strap 42 which is held at one end by the screw 43 which anchors the clip 41 to the base plate 38 and at the other end by means of a screw 44, the head of which is countersunk in the plate 38 and the lower end of which constitutes a binding post for connecting the line conductor 35. The contact 33 is carried on an angular strip 45 which is secured under the clip 40 by means of screw 46. Thus when the switch spring 31 is in upper position current flows from conductor 35 through the binding post 44, thence through strip 42 to contact 32 and thence through the switch spring to the electromagnet. When the spring 31 is depressed into the position shown in Figs. 1 and 4, current flows from conductor 35 through binding post 44, strip 42, clip 41, resistance 37, clip 40, conductor 45, contact point 33 and thence through the switch 31 to the electromagnet.

The operation of the system illustrated in Figs. 1, 2, 3 and 4 is as follows: With the switch 3 normally standing in neutral position at the master clock the minute circuit closer 1 energizes electromagnet 11 once per minute, thereby closing switch 12 at minute intervals to send minute impulses to the secondary clock, the switch 8 standing in the lowermost position so that these impulses are of comparatively low voltage (for example six volts). With switch 31 at the secondary clock in upper position these impulses are transmitted to the electromagnet D to advance the secondary hands through a one-minute interval at each impulse. Between the fifty-nine and sixty-minute positions of the master clock the switch 3 is depressed to connect the seconds impulse circuit-closer 2 in circuit with the electromagnet 11, thereby to send impulses once per second to the secondary clock during a part of this minute, for example from fifty-nine minutes and ten seconds to fifty-nine minutes and forty seconds, thereby rapidly to advance to the sixty-minute position any one or more of the secondary clocks which may be slow.

In this connection it is noted that in this and the following illustrations the secondary clocks are intended to advance from their fifty-nine minute positions to their sixty-minute positions when the master clock reaches its fifty-nine minute position (and likewise at every other minute position) so that the secondary clocks, if running normally, are never behind the master clock; although it will of course be understood that the secondaries might be adjusted to advance to each new position only when the master clock has reached that position.

When the secondary clocks have reached the sixty-minute position, the resistance 37 at each secondary is included in circuit as illustrated at the bottom of Fig. 1, this resistance being sufficient to render the low-voltage impulses ineffective to actuate the electromagnet D. In the case of those secondary clocks which are on time the resistance 37 will be included in circuit on the fifty-ninth impulse of the minute circuit closer 1.

In the case of those secondary clocks which are too fast the resistance 37 will be included in circuit before the master clock has depressed the switch 3, so that all succeeding impulses by either the minute switch 1 or the seconds impulse switch 2 will be ineffective to actuate the electromagnets D until the sixty-minute impulse is transmitted. Those secondary clocks which are too slow will be advanced to the sixty-minute position by the seconds impulse switch 2 as above described.

With the hands of all of the secondary clocks in the sixty-minute position, when the timer 6 reaches the sixty-minute position the lug 16 on the switch 3 moves into the recess 19, thereby closing the circuit of electromagnet 7 to lift switch 8 into engagement with contact 10 whereupon the entire secondary 14 is connected to the rectifier 15. Thus when the minute hand 1 energized the electromagnet 11 to close switch 12 at the end of the sixtieth minute, an impulse of higher voltage (for example 12 volts) is transmitted to the secondary clocks, the electromagnets D of which are adjusted to respond to these higher voltage impulses through the resistance 37. Thus the hands of the secondary clocks are started on a new hourly cycle by this high voltage impulse, and after the hands have moved to the one-minute position the switches 31 are permitted to spring upwardly into engagement with contacts 32, thereby rendering the electromagnets D responsive to the normal impulses of lower voltage. After the high voltage impulse is transmitted by the master clock the lug 16 rides out of the recess 19, thereby restoring the switch 3 to neutral position and permitting the switch 8 to move back against contact 9. The normal low voltage impulses may then be transmitted continually for fifty-nine minutes; or, as illustrated in Figs. 1 and 2, high voltage impulses may be transmitted at the nineteen and thirty-nine minute positions of the master clock by providing the additional recess 20 and 21, so that any secondary clock which failed to respond to the sixty-minute impulse of high voltage (or which failed to receive the impulse due to current interruption or other cause) need not wait a full hour for another starting impulse. Normally the secondary clocks will of course respond to the nineteenth and thirty-ninth minute impulses of high voltage as they do to the low voltage impulses.

Instead of providing the secondary clocks with a single magnet D and switch 31 they may be provided with two magnets D' and S as shown in Figs. 1 and 5, the magnet D' functioning in the same way as magnet D and the magnet S serving to stop the clock movement in the sixty-minute position by providing its armature with a stop 46 in the path of arm 47 fast to the shaft 29'. By connecting the two magnets S and D' in series as shown in Fig. 1 and adjusting the winding of magnet S so that it will respond only to high voltage impulses, the clock movements will remain in the sixty-minute position until a high voltage impulse causes electromagnets S to move the stops 46 out of the paths of the arms 47, the same high voltage impulse which energized magnets S also energizing magnets D' to advance the clock movements one step so that the arms 47 will pass the stops 46 before the latter drop back.

Fig. 6 illustrates a modified application of the invention in which corresponding parts are correspondingly numbered, this modification comprising a three-wire circuit instead of a two-wire circuit between the control apparatus and the secondary clocks. The three conductors between the control apparatus and the secondary clocks are indicated at 48, 49 and 50. An additional switch 51 is connected to the switch 8 so as to contact with contacts 52 and 53 when switch 8 contacts with 9 and 10 respectively. Thus the minute and second impulses of normal voltage are transmitted over conductor 49 and the high voltage impulse is transmitted over conductor 48. The driving magnet D at each secondary clock is connected to conductor 49 through a switch 54 and to conductor 48 through a resistance 55. As in Fig. 1 the arm 30 of each secondary clock is positioned to open the switch 54 when the clock is in the sixty-minute position. Thus the normal voltage impulses are transmitted to magnet D through the switches 54 until the hands reach the sixty-minute position whereupon the switches 54 are opened so that the electromagnets D are unresponsive to impulses transmitted over conductor 49 until the clock movements have been advanced one step beyond the sixty-minute position. This one step is effected by a high voltage impulse transmitted over conductor 48 through resistances 55 when the master clock reaches the sixty-minute position, the resistances 55 serving to prevent the electromagnet at any one secondary clock responding to an impulse transmitted over conductor 49 and thence through the switch at another secondary clock.

In Fig. 6 the left-hand, middle and right-hand secondaries illustrate the condition when the clocks are fast, on time and slow respectively. Referring to the middle secondary, which is on time as indicated by the corresponding relations of the switch arm 30 at the secondary and the timer 6 at the master clock, the clock hands will continue to be advanced by impulses received through switch 54 until the hands reach the sixty minute position whereupon the clock will continue to advance, without more than the normal minute pause, in response to the high voltage impulse transmitted over conductor 48. Referring to the left-hand secondary, which is too fast as indicated by the fact that the arm 30 is ahead of the arm 30 of the middle clock, when the hands reach the sixty-minute position they remain in that position until the master clock reaches the sixty-minute position to transmit a high voltage impulse over conductor 48, whereupon this secondary will continue to advance in synchronism with the other secondaries. Referring to the right-hand secondary which is too slow, after the fast and on time secondaries have reached the sixty-minute position and during the minute preceding the high voltage impulse, fast impulses are transmitted by the circuit closer 2 over conductor 49 to bring the slow secondary to the sixty-minute position ready to be started in synchronism with the remaining clocks of the system.

Fig. 7 illustrates a further modification in which the secondary driving magnet B is rendered unresponsive to the normal impulses, not by connecting a resistance in series therewith as in Fig. 1 but by altering its magnetic circuit. In this modification the gap 56 between the core 57 of the magnet and the armature 58 is normally bridged by a pole piece 59 mounted on arm 60 to swing about pivot 61 out of the gap to the position shown in the figure. The arm 60 is swung to this position by an arm 30' of the sec-

ondary movement corresponding to arm 30 in Figs. 1 and 6, arm 60 being restored to normal position by spring 62. With the arm 60 in normal position substantially to fill the gap 56 with the pole piece 59, the magnet D responds to the normal impulses of low voltage; but when the pole piece 59 is moved out of the gap 56 to the position shown in Fig. 7 and the secondary reaches the sixty-minute position, the magnet D is responsive only to a high voltage impulse.

The modification shown in Figs. 8 and 9 is similar to that shown in Fig. 7 except in that the magnetic circuit of the driving magnet B is short circuited instead of being lengthened when the secondary hands reach the sixty-minute position. In Figs. 8 and 9 the driving magnet B is of the horse-shoe type having two windings and a U-shape core 63. Mounted on the ends of the core 63 are pole pieces 64 shaped at 65 to receive a bridge piece 66 mounted on an arm 67 pivoted at 68 and having a projection 69 in the path of the arm 30' of the secondary clock. The arm 67 is normally held in the position shown in Figs. 8 and 9 by a spring 70 with the bridge piece 66 bearing against a fixed stop 71; and when the secondary clock reaches the sixty-minute position the arm 30' engages projection 69 to swing the bridge piece 66 into engagement with the surfaces 65 or at least into close proximity to these surfaces. The bridge piece 66 thus short circuits the magnetic circuit of the driving magnet B so that the magnet is unresponsive to normal impulses of comparatively low voltage and only responsive to the higher voltage impulse when the master clock reaches its sixty-minute position. Manifestly the modification of Figs. 7, 8 and 9 may be used in either of the systems illustrated in Figs. 1 and 6. It will also be evident that many other modifications of the secondary clocks, the master clock and also the circuit connections may be devised to carry out the present invention in its various aspects.

From the foregoing it will be evident that this invention affords a remarkably simple and reliable clock system. For example the secondary clocks may be fully controlled with a single-circuit magnet (or magnets as disclosed in my copending application filed on even date herewith) in contra-distinction to magnets having a plurality of windings and requiring multiple circuits such as differentially wound magnets heretofore used. Moreover, the secondaries may be synchronized by a momentary starting impulse, preferably lasting only a small fraction of a minute, whereas prior systems have required the application of current for as long as fifteen minutes.

While the impulse of high voltage of different kind is herein referred to as a starting impulse inasmuch as it initiates a new cycle, it may of course be regarded as the last impulse of each cycle, especially when the secondary clocks are adjusted to move from their fifty-nine-minute positions to their sixty-minute positions in response to the sixty-minute impulse instead of the fifty-nine-minute impulse of the master clock.

My Patent 1,884,723, granted October 25, 1932, and the patent to Harter 1,892,699, granted January 3, 1933, claim subject-matter related to this invention.

I claim:

1. An electric clock for use in a system in which the clock is advanced in direct response to impulses transmitted from a control station, having means effective only in one position of the minute hand for limiting the advance of the hands beyond predetermined positions and means effective only in response to impulses of different character for rendering said means inoperative, said last means being responsive in the same sense to impulses of both polarities.

2. A secondary clock system of the impulse type comprising a clock train, means including an electromagnetic winding for moving the clock train in recurrent cycles in response to impulses, means for terminating further advance of the clock train at a predetermined point in each cycle if the clock is fast, means including a second electromagnetic winding in the secondary clock for effecting further advance of the clock train in response to different impulses, said last means being unresponsive to said first impulses but responsive to impulses in both directions therethrough.

3. A secondary clock system of the impulse type comprising a clock train, means including an electromagnetic winding for moving the clock train in recurrent cycles in response to impulses, means for terminating further advance of the clock train at a predetermined point in each cycle if the clock is fast, means including a second electro-magnetic winding in the secondary clock for causing further advance of the clock train, said means being responsive only to impulses of increased magnitude to cause a fast clock train to advance beyond said predetermined point.

4. An electric clock for use in a system in which the clock is advanced in direct response to impulses transmitted from a control station, having means effective only in one position of the minute hand for limiting the advance of the hands beyond predetermined positions and means effective only in response to impulses of different character for rendering said means inoperative, said last means being responsive in the same sense to direct current impulses in either direction.

5. A secondary clock system of the impulse type comprising a clock train, means including an electro-magnetic winding for moving the clock train in recurrent cycles in response to impulses, means for terminating further advance of the clock train at a predetermined point in each cycle if the clock is fast, means including a secondary electro-magnetic winding in the secondary clock for effecting further advance of the clock in response to different impulses, said last means being unresponsive to said first impulses but responsive to direct current impulses in both directions therethrough.

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