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ELECTRIC CLOCK AND SYSTEM

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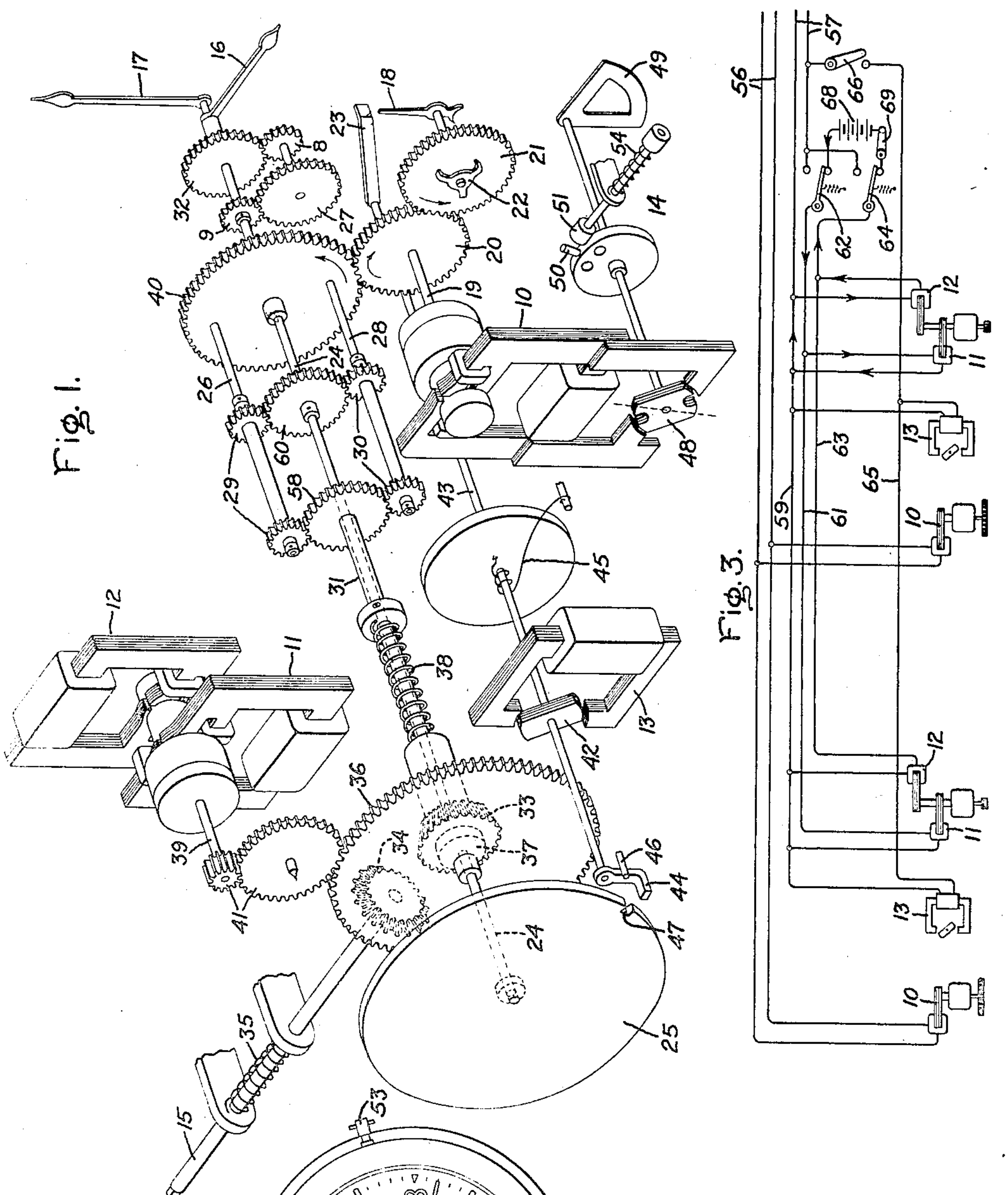

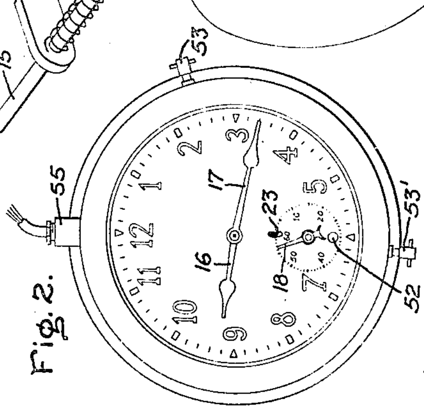

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ELECTRIC CLOCK AND SYSTEM

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11 Claims. (Cl. 58—34)

My invention relates to electric clock installations which are particularly suitable for use on ocean-going ships, such as naval vessels although not limited to such use. In an installation of this character, it is important that all the clocks of the system shall read exactly alike and be capable of being quickly and accurately reset from a central control point. These and other objects are accomplished in accordance with my invention preferably through the utilization of synchronous clock-setting motors in combination with special control features therefor.

The features of my invention which are believed to be novel and patentable will be pointed out in the claims appended hereto. For a better understanding of my invention, reference will be made in the following description to the accompanying drawing, Fig. 1 of which represents an exploded view of the principal parts of a clock embodying my invention; Fig. 2 is a face view of such a clock; and Fig. 3 represents a clock system and control circuits using the type of clock represented in Fig. 1.

The clock mechanism represented in Fig. 1 includes, in addition to the synchronous motor 10 for normally operating the clock hands, two additional synchronous motors 11 and 12, one for quickly setting the clock hands ahead and one for quickly setting the clock hands backward. An electromagnetic stop device 13 is also provided for stopping the clock hands in certain definite positions for use when it is desirable to assure that all clocks of the system indicate the same. The synchronous motor 10 for normally driving the clock is preferably provided with an electromagnetic signal device 14 for indicating failures of power. Provision is made at 15 for manually setting the clock hands with a special key. Suitable gear drives and the necessary clutches are provided between the different motors and clock hands as will presently be explained in detail. The entire clock mechanism is preferably placed in a watertight clock casing which may be sealed or locked to prevent unauthorized access thereto.

Referring now to the detail construction of the clock of Fig. 1, I will first explain the drive from the normal operating motor 10 to the clock hands. The hour and minute hands are designated by reference characters 16 and 17, and the second hand by 18. As viewed from the back in Fig. 1, these hands will all rotate counterclockwise. The terminal shaft 19 of the motor 10 will be assumed to rotate at one revolution per minute and drives a gear 20 in the direction indicated. Gear 20 meshes with a similar gear 21 connected to the second hand shaft through a friction clutch 22. This clutch slips only when the second hand is held stationary by the stop catch indicated at 23. Gear 20 also drives a larger gear 40 which, in the example given, will have twice as many teeth as gear 20 and will, therefore, rotate at one-half revolution per minute. Gear 40 rotates freely on the minute hand shaft 24 of the clock which extends through the entire mechanism represented from the minute hand 17 to the stop catch disc 25 at the rear of the clock. Secured to and extending from the face of gear 40 are two shafts 26 and 28. These shafts are equally distant from and on opposite sides of the central minute hand shaft 24. Rotatively mounted on shafts 26 and 28 are similar pinions 29 and 30. Ordinarily the two pinions shown on the same shaft will constitute a single pinion but, in the illustration, the parts are spread apart for better illustration. In any event, if two pinions 29 or 30 are used on the same shaft 26 or 28, they will be secured together on the same hub so as to rotate together about shafts 26 or 28. These pinions mesh with gears 58 and 60 which reference characters also designate, in the example given, the numbers of teeth in these two gears.

Gear 60 is secured to the minute hand shaft 24 and gear 58 is secured to a hollow shaft 31 rotatively mounted on shaft 24. These two epicyclic gear arrangements form a differential. In normal operation gear 58, constituting one member of the differential, is held stationary and, since gear 60 has two more teeth than gear 58 and the pinion shafts 26 and 28 are rotated with gear 40 at one-half revolution per minute, gear 60 and the minute hand shaft 24 will be driven counterclockwise at 1/60 revolution per minute which is the correct rate and direction for the minute hand. The hour hand 16 is driven 1/720 revolution per minute from the minute hand shaft 24 through the usual back-gearing arrangement consisting of gears 9, 27, 8 and 32. The above constitutes the normal clock-driving arrangement.

Gear 58, which is normally stationary, is rotated when it is desired to set the minute and hour hands ahead or back. The hollow shaft 31 on which gear 58 is secured may be turned in either direction manually or by the synchronous motors 11 and 12. For manual setting, a bevel gear 33, which is splined on hollow shaft 31, is engaged by a second bevel gear 34 secured on the key shaft 15. The key shaft 15 and gear 34 are normally withheld from driving relation with bevel gear 33 by a spring 35 but may be pressed inward to driving engagement in the manual setting operation. The key shaft 15 will extend to a point adjacent the side wall of the casing of the clock where it may be engaged by a suitable key from the outside by some authorized person.

In Fig. 2, the plug 53 represents a closure opposite the end of key shaft 15, which plug, when removed, allows a key to be inserted to move shaft 15 endwise to driving position and also to be turned for manually setting the hour and minute hands of the clock.

For automatic setting of the clock hands, the gear 36 is provided, which gear is connected in driving relation with the hollow shaft 31 by a friction clutch, part of which is represented in dotted lines at 37. 37 represents a friction washer which is pressed against the side of gear 36 by the spring 38 acting through the hub of gear 33 which is splined to hollow shaft 31. Gear 36 is in driving relation with the common terminal shaft 39 of the two synchronous motors 11 and 12 through gear 41. Since these motors are normally stationary, the gear connection normally holds gear 36 and gear 58 stationary. The friction clutch at 37 slips to allow rotation of gear 58 during a manual setting operation and also serves an additional purpose, which will be explained hereinafter.

Synchronous motors 11 and 12 are designed to operate in opposite directions. Their rotors are mounted on the same shaft. Synchronous motor 12, when energized alone, drives the terminal shaft 39 in one direction and synchronous motor 11, when energized alone, drives the terminal shaft 39 in the opposite direction. To illustrate practicable values, it may be assumed that the normal speed of terminal shaft 39 is thirty revolutions per minute and that the gear relation is such as to normally drive gear 58 at 3⅓ revolutions per minute during an automatic clock-setting operation. It will be observed that by reason of the differential connection either manual or automatic clock setting may be accomplished while the normal clock-driving motor 10 is in operation. During automatic clock-setting operations, the forward setting of the clock hands will then be slightly faster than a backward setting because, in setting the hands forward, the forward rotation due to the normal driving motor 10 is added and, in setting the hands backward, this normal movement is subtracted from the movements imparted to the clock hands from the synchronous resetting motors. For the gear relations and speeds previously given, the minute hand of the clock will be set ahead at the rate of one revolution in 18.6 seconds and set back at the rate of one revolution in 19.1 seconds by the synchronous resetting motors when the normal clock motor 10 is in operation. If the normal clock motor is stopped during an automatic setting operation, the forward and backward setting rates will be exactly the same. In either case, it will be evident that the clock hands exclusive of the second hand may be quickly set ahead or back without interfering with or being interfered with the normal operating parts of the clock drive whether the latter be in operation or otherwise. It will also be observed that the normal clock driving motor 10 might be a spring motor controlled by an escapement without changing the clock setting features.

To set all of the clocks of a system so that their indications are identical, the magnet latch device 13 is provided and it may be used alone or in combination with the clock-setting motors, depending upon the results desired. The magnet latch consists of a field magnet having an energizing coil and provided with an air gap in which is located an armature 42. The armature is secured to a rotatable shaft 43 which carries a latch 44 adjacent a latch disc 25 on the minute hand shaft 24, and also a latch 23 which extends through a small opening in the clock face (see Fig. 2) adjacent the 60 minute position of the second hand 18. Means such as a spring 45 is provided to bias the shaft 43 to the rotary position shown where the latches 44 and 23 are withdrawn from their latching positions and where the armature 42 is in a position to be rotated when its field of its magnet is energized. A stop indicated at 46 limits the movement of the shaft in the deenergized position. When the magnet 13 is energized, its armature 42 rotates to a minimum reluctance position in the air gap and brings latch 44 into engagement with the edge of disc 25. Disc 25 is provided with a notch 47 which preferably is opposite latch 44 when the minute hand is opposite the 12 o'clock position. Thus when this magnetic latch device is energized, the minute hand will be stopped in the 12 o'clock position the next time it arrives at such a position. When the magnetic latch is energized the catch 23 also moves into the path of the second hand 18 and stops the same as the second hand reaches the 60 second position.

At first sight, it would appear that, when the minute hand shaft is stopped by the latch 44 entering notch 47, the normal driving motor 10 would be stopped from further rotation and that, consequently, the second hand 18 might not reach the 60 second position. Such is not the case as neither of these pointer stopping operations block the operation of motor 10 or its drive to the pointer which is last to stop. When the minute hand shaft is stopped by latch 44, gear 40 rotates gear 58 and gear 60 stands still, this being permitted by reason of differential connection and the slipping of the clutch 37 between hollow shaft 31 and gear 36. When the second hand is stopped, friction clutch 22 slips.

It will also be evident that the hour hand may be quickly set to the 12 o'clock position when the latch magnet is energized by either of the synchronous setting motors 11 or 12 or by the manual setting device. Following a hand stopping operation the latch magnet 13 is deenergized, spring 45 withdraws the latches from their stopping positions and the pointers immediately start and move normally. The utility of these features will be clearer when the system of Fig. 3 is explained.

The clock may also be provided with the electromagnetic signal device 14 to indicate interruptions in the source of supply to motor 10 when the latter is an electric motor. This device consists of a small magnetic armature 48 located in the air gap of a magnet which derives its flux from the field of motor 10. The armature 48 is secured to a shaft which is biased for limited rotation in a clockwise direction by a weight 49. This rotary movement is limited by stops 50 and 51. The shape of the armature 48 is such that, when the field is energized, the armature has two positions of minimum reluctance, one position being as represented. The other position of minimum reluctance is where the armature is turned counterclockwise slightly from the position shown to cause the pole pieces indicated on the dotted line axis to align with the stationary pole pieces of the magnet. The sector 49 has two differently colored portions, such as red and white, which colors alternately appear in an opening 52 in the clock face (see Fig. 2) when the armature 48 is turned from one position of minimum reluctance to its other position of minimum reluctance. The stop 51 may be pushed inward by hand by inserting a suitable tool through an opening in the side wall of the clock casing to move the signal and armature from the position shown to its other position above mentioned. The opening in the clock casing for this purpose is normally closed by a water-tight plug indicated at 53' in Fig. 2. The stop 51 when released returns to the position shown by reason of the spring 54.

The operation of this device is as follows: When the motor 10 is energized, armature 48 is initially manually positioned so that the dotted line axis of the armature aligns with the field pole pieces and the sector 49 is raised somewhat from the position shown. So long as the motor remains energized, the signal will be held in this position by the field flux and the white color of the sector 49 will appear in the opening 52 in the clock dial. If now the source of supply to motor 10 fails, the signal shaft will rotate by gravity into approximately the position shown, bringing the red color on sector 49 in the clock face opening 52. Even though the source of supply is restored, the signal will remain in this position because this is also a position of minimum reluctance of its armature 48. The signal will thus indicate that there has been a failure in the source of supply and that the clock probably needs resetting before its time indication can be relied upon. When the clock is corrected, the signal should be manually reset to its original position.

The circuit connections to the clock are preferably carried through a water-tight conduit in the clock casing such as is represented at 55, Fig. 2.

In Fig. 3, I have represented a clock system and control circuits for use with clocks of the character shown in Fig. 1. The electrical devices of two such clocks are indicated in Fig. 3 by the same reference characters as were used for the corresponding devices in Fig. 1. The normal driving motors 10 of the clocks will be connected to a suitable source of alternating current supply 56, the frequency of which is accurately regulated so as to distribute time. The synchronous clock-setting motors 11 and 12 will be connected to suitable control circuits leading to a control point and a suitable source of alternating current supply. This source is indicated at 57. It may be the same as source 56 but it is unnecessary that its frequency be regulated for time accuracy. The source of supply for the magnetic clutch devices 13 may be either direct or alternating current. As represented, I use the source 57 for this purpose. One side 59 of source 57 goes directly to one terminal of all of the clock-setting motors, and to one terminal of all of the magnetic latch clock-stopping devices. The other terminals of all of the clock-setting motors 11, which are used for forward setting of the different clocks, are connected to a common control line 61 and a switch 62 in order that they may be simultaneously connected to and disconnected from the other side of the supply source 57. These motors are thus controlled as a group. Likewise, the remaining terminals of all of the clock-setting motors 12, which are used for a backward setting of the different clocks, are connected to a common control line 63 and a switch 64 so as to be started, stopped, and controlled as a group. The magnetic latch or clock-stopping devices are all connected by wire 65 and control switch 66 into a third control group. These control switches will ordinarily all be located at one control point and, if more than one control point is desired, a duplicate set of control switches connected in parallel with the set shown can be used at such other control point.

While I have shown a system embodying only two clocks, it is to be understood that ordinarily, where such a system is used, a much larger number of clocks will be included in the system and be subject to the group control outlined above.

It will be observed that the control switches 62 and 64 are biased against back contacts by springs and that these back contacts may be connected to a source of direct current represented by a battery 68. This direct current source may be utilized for quickly bringing the synchronous clock-setting motors to a stop following a clock-setting operation. It will be observed that with the auxiliary switch 69 leading to the battery 68 closed and the control switches 62 and 64 in the positions shown, a direct current will circulate through all of the field windings of the various clock setting motors. This is indicated by the arrow heads in the connections associated with the setting motors for the clock nearest the control point. The rotors for the motors 11 and 12 are mounted on the same shaft and both turn when either motor is operated. Consequently, a very effective magnetic braking action occurs when direct current is circulated through the field windings of these motors following a clock-setting operation which quickly brings the motors to a stop and prevents the scattering which might otherwise occur due to possible different coasting periods of different motors. Thus, to set the clocks ahead, the switch 69 is closed and switch 62 pressed upward. This energizes motor group 11 with alternating current from source 57 with motor group 12 deenergized. The motors are self-starting and of a type that start and reach synchronous speed almost instantaneously. Obviously, there is no scattering of these motors when operating synchronously. When the clocks are set ahead the desired amount, switch 62 is released, motor group 11 is deenergized and both motor groups 11 and 12 are almost instantaneously energized by direct current and stop almost instantaneously.

To set the clocks back, switch 64 is closed upward. This opens the direct current circuit and energizes motor group 12 from source 57. When the clocks are set the desired amount, switch 64 is released and both motor groups are energized with direct current as before to exert a powerful magnetic braking action on both groups of motors 11 and 12.

The switch 66 is used whenever it is desired to set all the clocks to a specified hour indication or to bring all the clocks to given indication to assure that they are all alike previous to a clock-setting operation.

The following examples are given in order to make clear the more important uses of the resetting control. Assume (1) that all the clocks are in synchronism and register 3:07. If it is desired to set all of the clocks to 5:00, switch 62 is closed until the clocks have been set ahead beyond 4:00 and then the stop magnet switch 66 is closed. Close switch 62 again and all of the clocks will be set ahead to 5:00 where they will all be stopped by the catches 44 and 23. The switch 66 should be closed for at least 60 seconds after the minute hands have stopped in order to give all of the second hands time to reach the 60 second stopping point.

Assume (2) that the clocks are out of synchronism, that one registers 3:07 and another 3:25, and it is desired to set all to 8:15. Press the set-ahead switch 62 to close until the slowest clock registers within 60 minutes of 8:00. Then, close the stop switch 66 and again close the set-ahead switch 62 until all clocks have reached and been stopped at 8:00. The clocks are now in synchronism. Now close the magnetic braking switch 69, if it is not already closed, open the locking switch 66, and again close the set-ahead switch 62 until the clocks register 8:15.

It will be apparent that, with the arrangement described, there will be no noticeable scattering of the minute hands in the final setting operation above described after they have been synchronized at the 8:00 position. Also the second hands will be in synchronism as they all start off together when the lock switch 66 is opened and this synchronous relation of the second hands is not interfered with by the operation of the clock-setting motors 11 and 12.

The second hand may be set to any exact second during a sixty-second interval by energizing the magnetic stop device to stop the second hand and then deenergizing the magnetic stop circuit at the proper instant during such interval.

Suppose the clocks are two minutes and thirty seconds fast and it is desired to correct the same. This may be accomplished by first closing switch 69 to assure magnetic braking and quick stopping of the resetting motor and then close switch 64 upward momentarily until the minute hands are corrected. Switch 69 should then be reopened to prevent waste of energy. Then close switch 66 to energize the magnetic stop devices and stop the second hands for thirty seconds. The clocks are now correct as it will be evident that the stopping of the second hand does not stop the minute hands unless the latter happen to be at the exact 12:00 o'clock position. The order of correcting the minute and second hands just mentioned might be reversed with the same results.

When a clock is out of synchronism by more than an hour, the hour hand needs attention, and it is necessary to set it ahead or back to within the 60 minute automatic clock setting range with the other clocks by hand, after which it can be exactly synchronized and set with the other clocks automatically from the control station.

The clock apparatus and system above described is particularly useful on ocean-going vessels where it is necessary to reset the clocks ahead and back frequently. It is particularly useful for the clocks on naval vessels and large aircrafts where it is essential that clocks at different points on a vessel and on the different vessels of a fleet be synchronized for gun fire and navigation control, etc.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. An electric clock comprising clock hands, a clock motor, a drive train between said motor and clock hands through which the clock hands are normally driven at a time-keeping rate, said drive including a differential, one portion of which is normally stationary, and a pair of clock-setting motors connected to drive the normally stationary part of said differential in opposite directions for setting the clock hands ahead or back at a rate appreciably faster than the time-keeping rate and without interfering with the normal operation of said first mentioned motor.

2. A clock comprising hour, minute, and second hands, a clock motor connected to normally drive said hands at the time-keeping rates indicated, a differential, the drive to the hour and minute hands being through said differential, one part of which is normally held stationary, a pair of normally idle synchronous motors for driving the stationary part of said differential in opposite directions for rapidly setting the hour and minute hands ahead or back while the first mentioned motor is driving said second hand at its normal rate, and electrically controlled means for stopping the minute and second hands in predetermined positions upon their arrival at such positions without stopping said first mentioned motor.

3. An electric clock comprising hour, minute, and second hands, a clock motor for normally driving said hands at the rates indicated, a differential included in the drive to the hour and minute hands, one part of which is normally held stationary, a slip friction clutch, a pair of normally idle clock-setting motors connected to the normally stationary part of said differential through said slip friction clutch for rapidly setting the minute and hour hands forward or backward, another slip friction clutch between the first mentioned motor and second hand, and means for stopping the minute and second hands in predetermined positions as they arrive at such positions without stopping said first mentioned motor.

4. An electric clock comprising hour, and minute hands, a clock motor for normally driving said hands at the rates indicated, a differential, said drive being through said differential, one part of which is normally held stationary, normally disengaged manual means for rotating the normally stationary part of said differential for setting the clock hands, a pair of normally inactive synchronous motors for rotating the normally stationary part of said differential for automatically setting the clock hands in either direction, and a slip friction clutch between said last mentioned motors and the normally stationary part of said differential.

5. An electric clock including minute and second hands, a synchronous motor, separate driving connections between said motor and hands for normally driving said hands at the rates indicated, a normally inactive latch mechanism that may be actuated for stopping said hands in a predetermined time-indicating position when said hands arrive at such position, and slip friction clutches associated with the driving connections between said synchronous motor and hands whereby, during a hand-stopping operation, the hand which is last to arrive at the stopping position continues to be driven by said motor after the other hand has been stopped.

6. An electric clock including a minute hand and a second hand, a synchronous motor, separate driving connections between said synchronous motor and hands for normally driving said hands at the rates indicated, an electromagnetic latch mechanism which when energized causes the minute hand to be stopped in a predetermined position upon its arrival thereat, said mechanism also including means for stopping the second hand in a predetermined position upon its arrival at such position, and slip friction means associated with the drive for the minute hand which permits said motor to continue to drive the sec-

ond hand to stopping position after the minute hand has been stopped.

7. In a device having a rotary indicating hand, a pair of self-starting synchronous motors connected in driving relation with said hand, one motor when energized alone driving the hand in one direction and the other motor when energized alone driving the hand in the opposite direction, a source of alternating current, control circuits for separately energizing said motors from said source, a direct current source and means for connecting said motors in series to said direct current source for quickly stopping the same following a hand-setting operation.

8. In a device having a rotary indicating hand, a pair of self-starting synchronous motors connected in driving relation with said hand, one motor when energized alone driving the hand in one direction and the other motor when energized alone driving the hand in the opposite direction, a source of alternating current, a control circuit including a switch having a position for energizing one of said motors from said source, a control circuit including a switch having a position for energizing the other motor from said source, and a direct current source, said switches having other positions for connecting said direct current source in series relation with said motors.

9. In a clock system including a plurality of clocks, means for synchronously setting the minute and hour hands of the clocks comprising, in each clock, a pair of normally idle self-starting synchronous motors having their rotors connected on a common shaft and respectively connected to drive the clock hands in opposite directions at an appreciably higher rate than normal, an alternating current source, a control circuit for connecting only one of the motors of each pair in a group to said source for setting all the clocks in one direction, a control circuit for connecting only the other motors of each pair in a group to said source for setting all the clocks in the opposite direction, and means for simultaneously energizing both groups of motors over said control circuits for magnetic braking purposes to quickly stop the same immediately following a clock-setting operation in either direction.

10. In a clock system having a plurality of clocks, means for synchronously setting the minute and hour hands thereof comprising, in each clock, a pair of normally idle self-starting synchronous motors having their rotors mounted on a common shaft and connected to drive the clock hands at an appreciably higher rate than normal without otherwise interfering with the normal operation of said clock, one motor of each pair being connected to drive the clock hands clockwise and the other motor of each pair being connected to drive the clock hands counterclockwise, a source of alternating current supply, a control circuit for energizing only the clockwise setting motors of all the clocks in a group from said source, a control circuit for energizing only the counterclockwise setting motors in a group from said source, a direct current source and means for simultaneously energizing the motors of both groups over said control circuits to quickly stop the same immediately following a clock-setting operation in either direction.

11. A clock system including a plurality of clocks each provided with hour, minute and second hands and normally active means for synchronously driving the clock hands at the rates indicated, means for quickly setting the hands of all said clocks to any desired indication in case their time indications are different by not more than an hour comprising, in each clock, normally inactive synchronous motor means connected to drive the minute and hour hands in either direction at a rate appreciably faster than normal without otherwise interfering with the normally active clock driving means, also, in each clock, a normally inactive electromagnetic stop device which when energized stops the minute hand and the second hand at predetermined minute and second indications which are similar in the different clocks, when said hands arrive at said indications without otherwise interfering with the normally active means for driving said hands, a source of alternating current supply, control circuits including switches, selective as to the direction of clock setting, for connecting the synchronous motor clock-setting means of all of said clocks to said source, and a control circuit including a switch for energizing the electromagnetic stop devices of all clocks.

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