Oct. 26, 1943. L. C. MENARD ET AL 2,332,827

ELECTRIC CONTROL APPARATUS

Filed Aug. 20, 1938 4 Sheets-Sheet 1

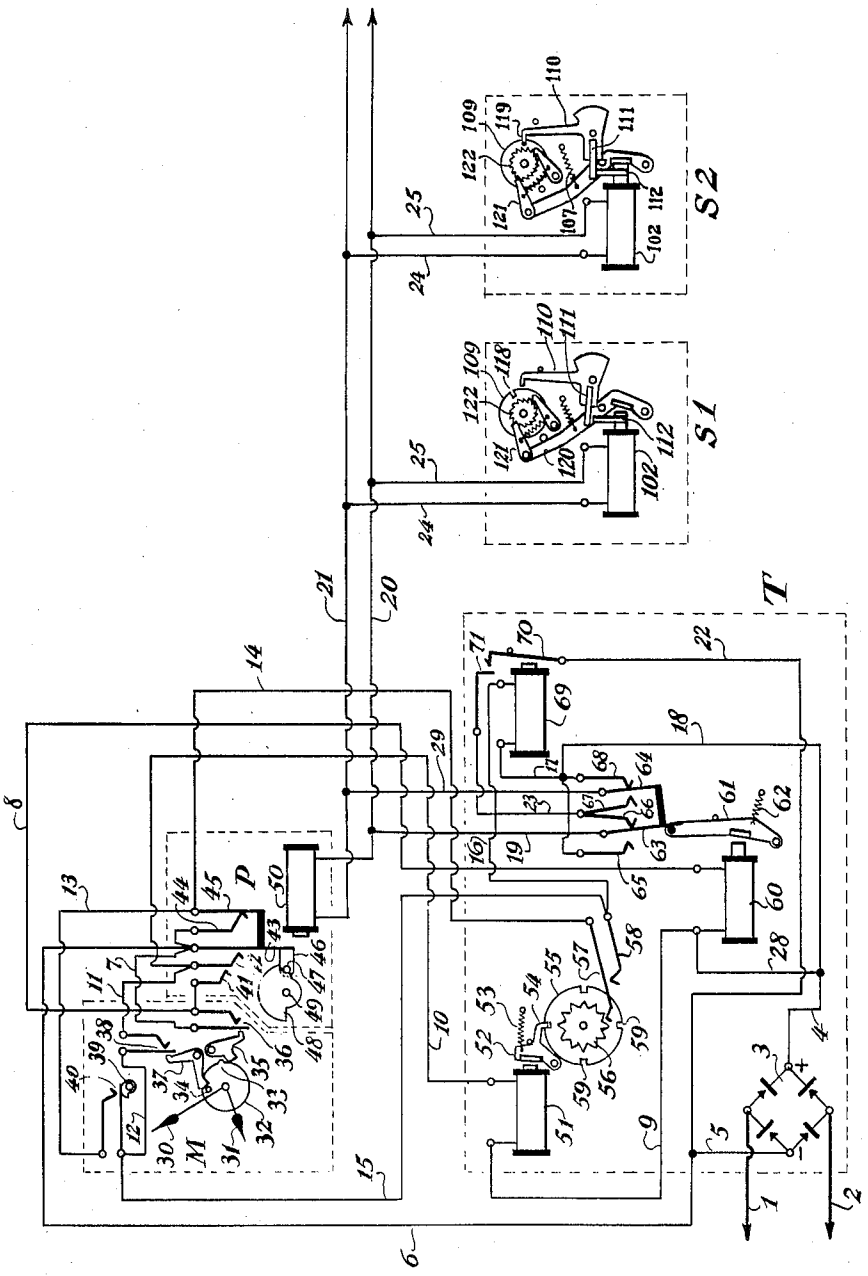


FIG. 1

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ELECTRIC CONTROL APPARATUS

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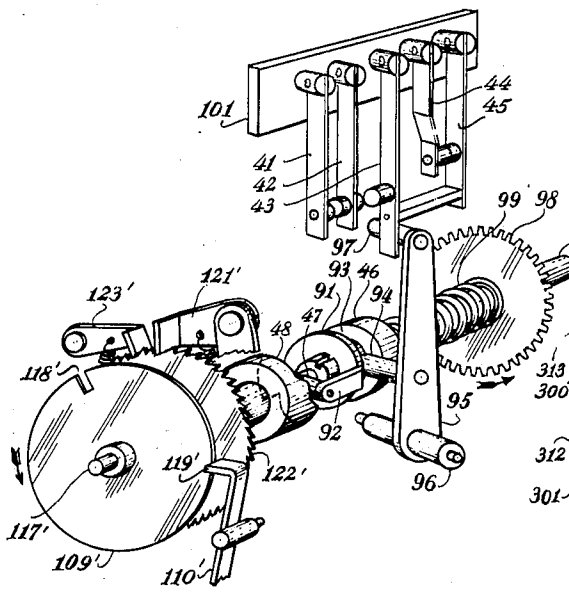


FIG. 2

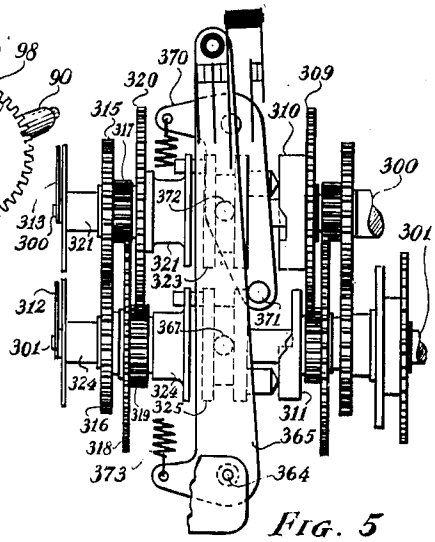


FIG. 5

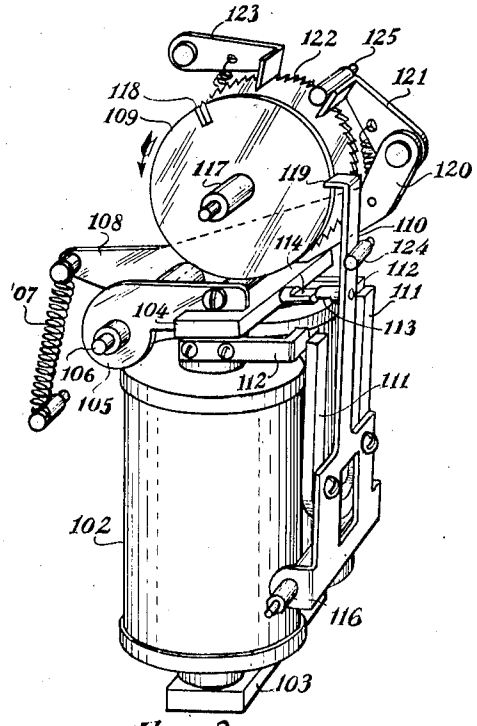


FIG. 3

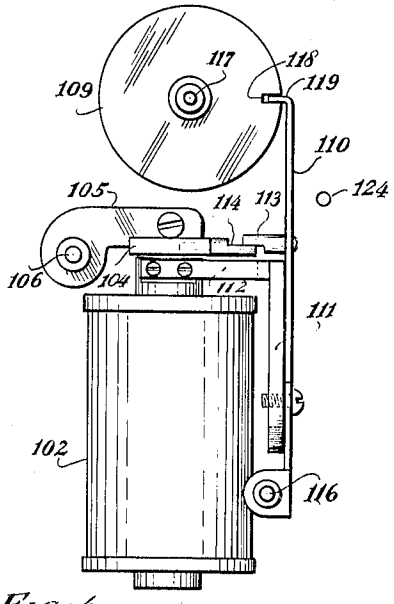


FIG. 4

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ELECTRIC CONTROL APPARATUS

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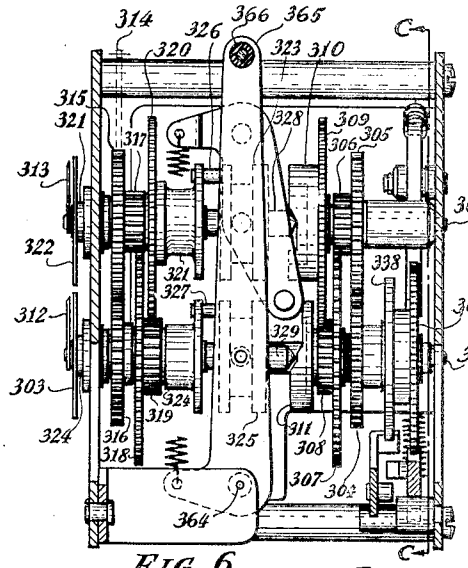


FIG. 6

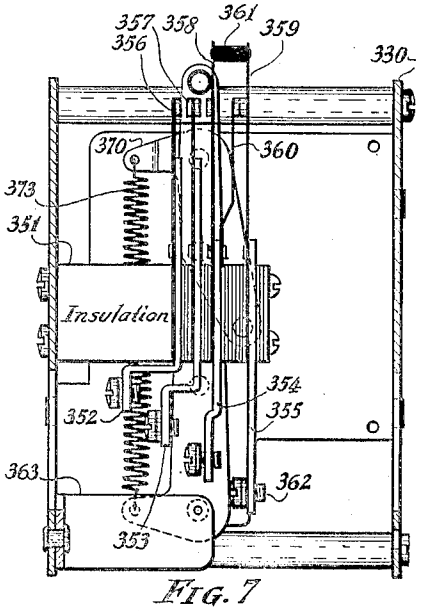


FIG. 7

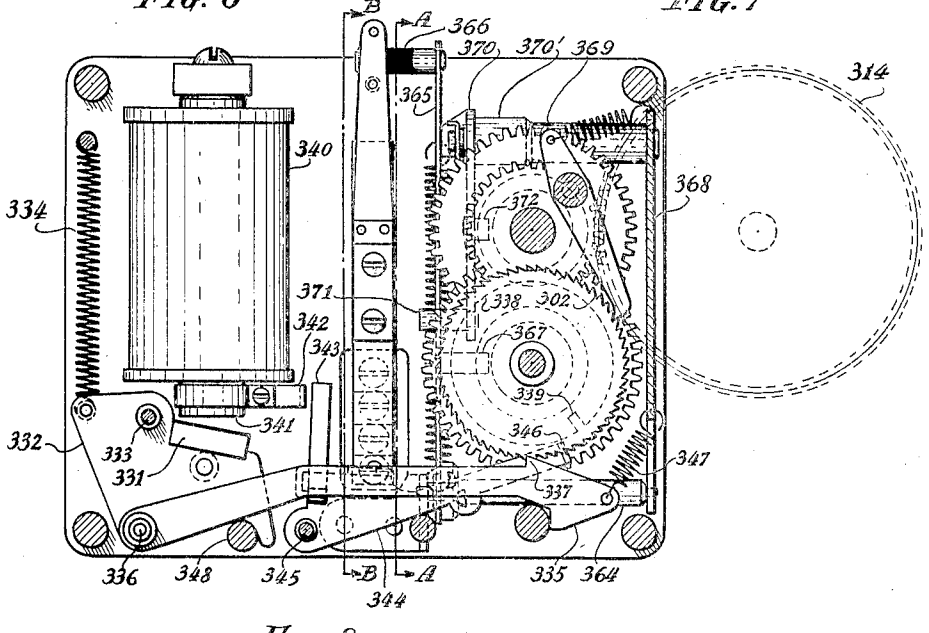


FIG. 8

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ELECTRIC CONTROL APPARATUS

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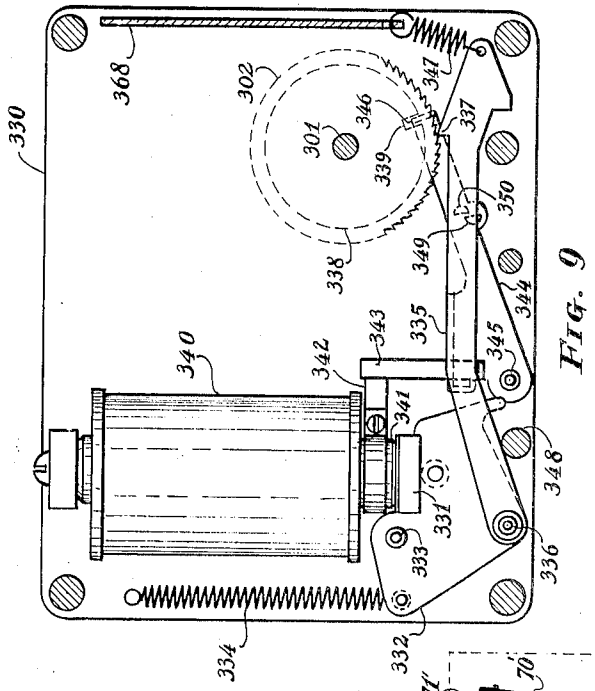


FIG. 9

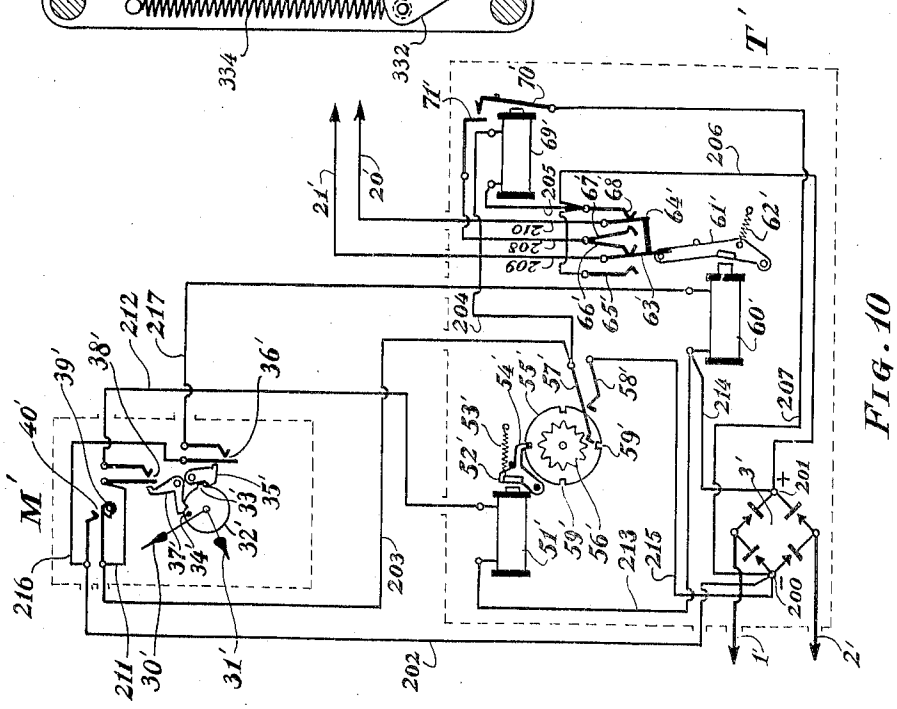


FIG. 10

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Patented Oct. 26, 1943 2,332,827

UNITED STATES PATENT OFFICE

2,332,827

ELECTRIC CONTROL APPARATUS

Louis C. Menard and Charles V. Seibert, Louisville, Ky., assignors, by mesne assignments, to General Time Instruments Corporation, New York, N. Y., a corporation of Delaware

Application August 20, 1938, Serial No. 225,876

14 Claims. (Cl. 58—24)

This invention relates to electric control apparatus and in particular to a system wherein one or more secondary units may be motivated and controlled remotely by a master unit. Such a system may be applied in a secondary corrective clock system, and the particular embodiment herein disclosed will relate to such application.

In such systems, the secondary clocks are generally provided with electromagnets which, upon receipt of impulses regularly transmitted by the master clock, advance the clock train step by step. Means are generally provided to correct each secondary clock with respect to the master clock at longer intervals, such as once each hour, as contrasted with the clock advancing impulses which may occur at intervals of one minute. If the setting of the master clock is changed, according to the usual practice, the secondaries will not correct themselves immediately, but must wait until the expiration of the hour or corrective interval. Furthermore, the change of setting of the master clock may not be more than a fraction of an hour to effect automatic correction at the expiration of the hour interval.

An object of this invention is to provide an improved time control apparatus.

A further object is to provide an improved secondary corrective clock system.

A further object is to provide an improved polarized magnet.

A further object is to provide an improved secondary driving mechanism which has incorporated within it no contacts or contact mechanism of any sort.

Another object is to provide a secondary clock system wherein the secondary clocks will respond immediately to any change in the setting of the master clock.

Still another object is to provide an electric clock system wherein the master clock may be set ahead any desired interval and wherein the secondary clocks will be automatically advanced a corresponding interval.

A still further object is to provide an improved secondary clock mechanism which is of inexpensive construction and of positive and efficient operation.

Other objects, features and advantages will be apparent as the description proceeds. Reference is hereby made to the accompanying drawings which form a part of this specification, and in which:

Figure 1 is a circuit diagram of a secondary corrective clock system embodying my invention.

Figure 2 is a perspective view of the pilot.

Figure 3 is a perspective view of the secondary driving mechanism.

Figure 4 is an elevation of the secondary driving mechanism in locked position.

Figure 5 is an elevation of a modified form of pilot in slow position, only a portion thereof being shown.

Figure 6 is a sectional elevation of the modified form of pilot in normal position, the section being taken along line A—A of Figure 8.

Figure 7 is a sectional elevation taken along line B—B of Figure 8, certain elements which are shown in Figure 6 being omitted for the purpose of clarity.

Figure 8 is a sectional elevation along line C—C of Figure 6.

Figure 9 is a sectional elevation similar to Figure 8 but showing only the pilot secondary driving mechanism in locked position.

Figure 10 is a circuit diagram of a simplified system wherein the pilot is not employed.

Referring now to Figure 1, M represents the master clock, S_1 and S_2 the secondary clocks, P the pilot and T the impulse transmitter, each of the above being an assembly of elements to be more fully described hereinafter.

Reference numerals **1** and **2** represent suitable A. C. power lines between which is connected a rectifier **3** from which positive and negative lines **4** and **5**, respectively, lead. Supplied with current from conductors **4** and **5** are a plurality of secondary clocks, S_1, S_2, etc., relays **51**, **60** and **69**, and pilot secondary **50**.

The secondaries are connected to the impulse transmitter T by conductors **20** and **21** over which four different types of impulses are transmitted, namely; minute impulses, rapid impulses, reverse polarity minute impulses and reverse polarity rapid impulses. Upon receipt of each impulse, with one exception, each secondary will be advanced one minute; consequently during transmission of the minute impulses, each secondary will advance with the master clock. At the fifty-ninth minute position of each secondary, however, means are provided to render the secondary inoperative until the master clock reaches the even hour position, at which time a distinctive type of impulse, in this embodiment a reverse polarity minute impulse, is transmitted which causes all secondaries to be released and to be advanced to the even hour position. Thus, all secondaries which are fast will become locked in the fifty-ninth minute position ahead of the others, and will remain locked until the other secondaries have also become locked in the fifty-

ninth minute position, after which all are released and simultaneously advanced to the sixtieth minute position.

Between the fifty-ninth and sixtieth minutes, when the on time and fast secondaries are locked, a series of rapid impulses are transmitted by the master clock, which enables any secondary which happens to be slow, to advance step by step rapidly until that secondary becomes locked in the fifty-ninth minute position along with those secondaries which were previously ahead of it.

The secondary clocks comprise the usual clock train which is adapted to be advanced step by step each minute by the driving mechanism shown in Figure 3. The electromagnet 102 is suitably mounted on the secondary clock and has a core 103 adapted to co-operate with which is armature 104. The armature is mounted on one or more arms 105 which are rigidly affixed to shaft 106. This shaft may be suitably journaled in the frame plates of the secondary clock. The armature is biased to the retracted position by spring 107, one end of which may be affixed to the frame of the clock, and the other end of which is affixed to lever 108 also rigidly mounted on shaft 106. A secondary armature 110 is affixed to shaft 116, also journaled in the frame plates to which armature is clamped or otherwise suitably affixed a permanent magnet 111. Secondary pole pieces 112, of suitable magnetic material, are mounted on the magnet core 103 and are adapted to attract to it or repel, depending upon the polarity thereof, the permanent magnet 111 and the secondary armature 110. It will be noted that pole pieces 112 shunt only a small portion of the magnetic flux into the secondary armature and permit the use of a comparatively small permanent magnet.

A pin 113 is mounted on secondary armature 110 and is adapted to latch the corresponding projection 114 extending from armature 104 when the armature is in the operated position, thereby preventing the retraction of armature 104 by the spring 107. A shaft 117 is suitably journaled in the frame plates and on the shaft is rigidly mounted a disk 109, having a slot 118 therein, and a ratchet wheel 122. A projection 119 extends inwardly from the upper end of secondary armature 110 and is adapted to ride on the periphery of disk 109 as the shaft 117 is rotated and upon attraction of said armature by pole pieces 112 the projection 119 will slip into slot 118 as it is rotated into registry with the projection, thereby locking armature 104 and preventing further rotation of the shaft 117. This locking is timed so as to take place at the fifty-ninth minute position of the secondary.

An arm 120 extends from lever 108 and a pawl 121 is pivoted at the end thereof, the pawl being adapted to engage ratchet wheel 122 and rotate it in a counterclockwise direction as the spring 107 moves the lever 108. A fixed pawl 123 is mounted on the frame of the clockwork and is adapted to engage ratchet 122 and prevent backward movement thereof when the lever 108 and arm 120 are moved in opposition to the spring by the attraction of electromagnet 102 for the armature 104. A suitable stop 124 is provided to limit the motion of secondary armature 110 away from pole pieces 112, and a stop 125 is provided to engage the pawl 121 and prevent the movement thereof by the spring more than one notch at a time. It will be seen that upon energization of electromagnet 102 the armature 104 will be attracted to it tensioning the spring 107 so that the ratchet 122 will be rotated one notch in a counterclockwise direction as soon as the magnet is de-energized. Simultaneously therewith the permanent magnet 111 and the armature 110 are attracted to the pole pieces 112 provided that the energizing current is of normal polarity. However, the disk 109, which engages projection 119, prevents the movement of secondary armature 110 at all times except when the slot 118 is in registry with projection 119, which would correspond to the fifty-ninth minute position of the secondary. At the fifty-ninth minute position the secondary armature 110, upon attraction, is free to move to a position where pin 113 engages projection 114 and locks the armature 104 in closed position. There it will remain as shown in Figure 4 due to the attraction of the permanent magnet 111 for the pole pieces 112 until such time as an impulse of reverse polarity, which is transmitted on the sixtieth minute position of the master clock, repels the permanent magnet, throwing projection 119 out of the slot 118 and disengaging armature 104, thereby permitting spring 107 to advance the pawl 121 and ratchet 122 to the sixtieth minute position upon deenergization of magnet 102.

It will be noted with respect to the locking of the secondary clock in the fifty-ninth minute position that, in the embodiment herein shown, it is the action of the spring 107 which advances the ratchet; consequently, the disc is not advanced to the fifty-ninth minute position until after the magnet 102 has been de-energized subsequently to the fifty-ninth impulse. Therefore, it is the next succeeding impulse, or one of the rapid impulses, which attracts secondary armature 110 to its operated position which it is adapted to latch armature 104 in its attracted position. The complete action of armature 110 is delayed by the abutting of pin 113 against the end of projection 114 until armature 104 has been attracted to the operated position, after which the pin 113 is permitted to slide over the upper surface of projection 114 and lock armature 104 in the operated position. Furthermore, as the actual movement of secondary armature 110 is effected in either direction when armature 104 is in the operated position, and as a small clearance is provided between the projection and the pin when the armature 104 is in the operated position, the secondary armature is enabled to move into or out of locking position by the application of a comparatively small force. This construction permits the use of a small permanent magnet.

Between positive and negative lines 4 and 5 are connected in parallel with each other releasing relay 51, polarity reversing relay 60, impulsing relay 69, and the several secondaries. The several circuits are established by contacts closed by the master clock, by the pilot, and by the relays in parallel circuits to produce one of the four types of impulses which go out over the secondary lines to operate the secondary clocks.

The impulses are put on the secondary lines 20, 21 by impulsing relay 69 the energization of which closes contacts 70, 71, thereby establishing the circuit through the secondary lines and the secondary clocks. Energization of polarity reversing relay 60 will attract the armature 61, which closes contacts 63, 65, and 64, 67 reversing the polarity of the current in the secondary lines. The armature 61 is biased by spring 62 to the retracted position wherein contacts 63, 66 and

64, 68 are closed to supply current to the secondary lines of normal polarity.

Energization of relay 51 will attract armature 52 in opposition to spring 53, withdrawing tooth 54 from the slot 59 in disc 55, permitting the same to rotate. The disc may be driven by a spring motor not shown and have associated with it suitable means, such as a ratchet wheel 56 to rapidly open and close contacts 57, 58 a definite number of times, after which tooth 54 slips into an adjacent slot, stopping rotation of the ratchet and leaving the contacts open. These contacts 57, 58 are spring biased in the open position as are all contacts hereinafter described, unless otherwise noted. It is evident that instead of a spring motor and ratchet wheel 56, any other suitable means may be used to rapidly close contacts 57, 58, or otherwise to generate the rapid impulses upon energization of relay 51.

In addition to the above contacts operated by the relays, certain contacts are operated by the master clock M, others by the pilot P.

The master clock may be of usual construction, and have associated therewith a cam 39 adapted to close minute contacts 40 once every minute. A second cam 32 is also associated with the clockwork in such a manner as to make one revolution per hour. Mounted on cam 32 are a finger 33 and a pin 34, the finger being adapted to trip lever 35 to close contacts 36 a few seconds before and to hold them closed through the sixtieth minutes impulse of the master clock, and pin 34 being adapted to trip bell crank 37 to close contacts 38 a few seconds before the fifty-ninth minute position of the master clock, and to hold them closed through the fifty-ninth minute impulse of the master clock.

Mounted on the pilot are contact members 41 and 42 which are adapted to close the circuit between members 42 and 43 and members 41 and 43 when member 43 is moved to the left. Member 45 is mechanically connected with member 43 by means of an insulating strip so that when the latter is moved to the right, the circuit between members 44 and 45 is opened. At all other times members 44 and 45 are in contact with each other. The position of member 43 is determined by cam rider 46 carrying a roller 47 which bears on a cam 48 which has an intermediate surface on which the rider normally rests between a high surface and a low surface. The construction of the pilot will be described in detail below; it will suffice to say here that when the master clock is set ahead of the secondaries the cam rotates so that the rider rests on the low surface, closing contacts 41, 42 and 43, and when the master clock is set back, the cam rotates so that the rider rests on the high surface, opening contacts 44 and 45.

For instance, when the pilot is in its normal position, contacts 44 and 45 are closed so that the operation of relay 69 is controlled either by the closing of minute contacts 40 which establishes a circuit from negative line 5 through conductor 6, contacts 44, 45, conductor 13, contacts 40, conductors 15 and 16, relay 69, and conductors 17 and 18 to positive line 4; or, by the closing of rapid contacts 57, 58, which are shunted around the minute contacts through conductor 14, contacts 57, 58 to conductor 16. Operation of relay 69 closes contacts 70, 71 which will transmit to the secondaries, from negative line 5 through conductor 22, contacts 70, 71, conductor 23, contacts 66, 63, conductors 19, 20, and 25 to S_1, S_2, etc., and back through conductors 24, 21, 29, contacts 64, 68, conductor 18 to positive line 4, either minute impulses or rapid impulses depending upon which of the contacts 40 or 57, 58 are closed.

The successive opening and closing of rapid contacts 57, 58 is effected by suitable means rendered operative by the energization of relay 51, which in this embodiment is energized by the closing of contacts 38 at or shortly before the fifty-ninth minute position of the master clock, thereby establishing a circuit from negative line 5 through conductor 6, contacts 44, 45, conductor 13, contacts 40, conductor 12, contacts 38, conductors 11 and 10, relay 51, conductors 9 and 28 to positive line 4.

The polarity of the impulses transmitted can be reversed by the closing of contacts 36, which in the present construction is effected a few seconds before the sixtieth minute position of the master clock, thereby establishing a circuit from negative line 5 through conductors 6 and 7, contacts 36, conductor 8, relay 60, conductor 28 to positive line 4 to energize relay 60 and to close contacts 64, 67 and 63, 65 after opening contacts 64, 68 and 63, 66, thereby reversing the polarity.

Thus the minute impulses, rapid impulses and reverse polarity minute impulses are transmitted which advance the secondaries and cause them to correct themselves individually with respect to the master clock.

If, however, it is desired to set the master clock back a few minutes to the correct time, the resulting rotation of the pilot cam, to be described hereinafter, will open contacts 44, 45, preventing any impulses from being transmitted and rendering the secondaries inoperative until the master clock catches up therewith.

If, on the other hand, it is desired to set the master clock ahead to the correct time, or if a current interruption has occurred, upon resumption of which the master clock is ahead of the secondaries, the pilot cam will be rotated to close contacts 41, 42 and 43, the contacts 44, 45 remaining closed. The closing of contacts 42, 43 will energize relay 51 by establishing the circuit from negative line 5 through conductor 6, contacts 43, 42, and on through conductor 10 to relay 51, conductors 9 and 28 to line 4, thereby causing rapid impulses to be transmitted to the secondaries as above described in connection with the closing of contacts 38. The closing of contacts 41, 43, being in parallel with contacts 36, will energize relay 60 as above described by establishing the circuit from negative line 5 through conductor 6, contacts 43, 42, 41, conductor 8 to the relay 60, and back to the positive line 4 through conductor 28, causing the impulses transmitted to be of the reverse polarity rapid impulse type. These impulses enable the secondaries to step up rapidly the number of minutes the master clock was advanced, and in the event the latter was advanced through the fifty-ninth minute position, or that the current interruption occurred through the fifty-ninth minute, the reversed polarity of the impulses will prevent the secondaries from locking in the fifty-ninth minute position.

The pilot P comprises a secondary clock driving unit, the upper portion only of which is shown in Figure 2. The shaft 117' is journaled in a suitable frame structure, not shown, and is adapted to be rotated step by step every minute by the action of pawl 121' on ratchet 122' substantially as described above in connection with shaft 117 of Figure 3. A slotted disc 109' is also pro-

vided having a slot 118' in the fifty-ninth minute position with which is adapted to co-operate projection 119' of secondary armature 110' so that shaft 117' may be corrected at the same time the secondaries are and may be substantially in synchronism therewith.

A cylindrical cam 48 is fixedly mounted at one end of shaft 117' adapted to co-operate with which is a cam rider 46 freely mounted on shaft 90, the cam rider comprising a collar 91 having a projection 92 at the end of which is carried roller 47 for contacting the cam surface. A member 95 is fastened on shaft 96, journaled in a suitable frame, and has a projection 94 which is adapted to ride in a groove 93 formed in collar 91 and to cause angular displacement of pivoted member 95 as relative rotation of shafts 117' and 90 causes axial displacement of cam rider 46. It will be noted that although cam rider 46 is keyed to shaft 90 for rotation therewith, it is adapted to slide axially thereon, the coil spring 99 bearing against the end of the rider to urge roller 47 into contact with the surface of cam 48. A 47 into contact with the surface of cam 48. A is driven by the clock train of the master clock to rotate the shaft and cam rider 46, at the rate of one revolution per hour.

Regarding the operation of the pilot, it will be seen that the cam 48 is intermittently driven by a secondary clock driving mechanism in the same direction and at the same average speed as cam rider 46, which is driven by the master clock. As long as the master clock and the secondary of the pilot are in time with one another, the cam rider will ride on the intermediate portion of the cam surface, and hold lever 95 in the position shown in Figure 2, wherein projection 97 engages spring biased contact 43 to hold contacts 44 and 45 closed. This position permits normal operation of all secondaries, whereby they are advanced every minute by the minute impulses, and any scattering among them is corrected every hour between the fifty-ninth and sixtieth minute positions of the master clock.

If, however, the master clock is set ahead of the secondary of the pilot, relative rotation in a counterclockwise direction as viewed in Figure 2 of cam rider 46 with respect to cam 48 will result, the rider being axially displaced by spring 99 so that it rides on the lower portion of the cam surface, thereby displacing lever 95 to close contacts 41, 42 and 42, 43, contacts 44, 45 remaining closed. In this position, rapid impulses of reverse polarity are transmitted to the pilot secondary to cause it to catch up with the master clock, and to cause all the other secondaries to advance a corresponding degree. It will be noted that inasmuch as the rapid contacts 57, 58 are motivated by a spring driven means which does not necessarily stop when contacts 42, 43 are opened by the return of the cam rider to the intermediate position, that the rapid impulses will advance the pilot secondary beyond the intermediate position to a position one minute ahead of the master clock, whereupon the rider is forced onto the high portion of the cam surface, and displaced axially, in opposition to the action of spring 99, thereby opening contacts 44, 45 and permitting no impulses to be transmitted to the pilot secondary until the master clock catches up with it and the cam rider is returned to its normal position.

If the master clock is set behind the secondary pilot, the last described action takes place, the cam rider being axially displaced by the high portion of the cam surface to open contacts 44, 45 and render the secondaries inoperative until such time as the rider is restored to its normal position by the rotation of the cam rider by the master clock.

It will be further noted that any correction caused by the change of the setting of the master clock is a correction of the pilot secondary with respect to the master clock. Any scattering or errors of the other secondaries with respect to the pilot secondary which obtain before the correction, will remain after the correction; the scattering is corrected only between the fifty-ninth and sixtieth minutes. In other words, two types of correction are provided by the system described, a scattering correction, which corrects each secondary individually with respect to the master clock, and a group correction which corrects all the secondaries as a group to an extent determined by only one of the group, the pilot secondary.

A modification of the pilot is shown in Figures 5 to 9, inclusive, in which reference numeral 330 refers to the frame plates which are separated by suitable spacing members. Shafts 300 and 301 are suitably journaled in plates 330. Shaft 300 has affixed to it a gear 309, a cam 310 and hand 313, the hand being on a portion of the shaft which extends beyond the frame plate. Mounted on shaft 300 for rotation with respect to it is an assembly comprising sleeve 321 which extends through the frame plate and terminates in the dial 322 adapted to co-operate with hand 313. A gear 320 is affixed to the sleeve and is adapted to drive the same. An idler gear 315 and an associated pinion 317 are loosely mounted on sleeve 321 for rotation with respect thereto. A gear 305 and an associated pinion 306 are also loosely mounted on the shaft 300 for rotation with respect to the shaft.

Affixed to shaft 301 is a ratchet 302 and a disk 338, gear 304, cam 311 and hand 312, the hand being mounted at the end of the shaft at a point exterior of the frame plate. An assembly comprising a sleeve 324, a driving gear 316 and a dial 303 is loosely mounted on shaft 301 for rotation with respect thereto. The dial 303 is positioned exteriorly of the frame plate to cooperate with hand 312. Mounted on sleeve 324 for rotation with respect thereto are idler gear 318 and associated pinion 319. An idler gear 307 and an associated pinion 308 are loosely mounted on shaft 301 for rotation with respect thereto.

As the ratchet 302 is rotated by a pawl 335 gear 304 will drive idler gear and pinion 305 and 306, pinion 306 in turn driving idler gear 307 and associated pinion 308. Pinion 308 drives gear 309 which is affixed to shaft 300, the ratio of the above gearing being such that shaft 300 will make one revolution for every twelve revolutions of the shaft 301. A master clock through a gear 314 will drive idler gear 315 and associated pinion 317. Idler gear 315 drives the assembly comprising sleeve 324, gear 316 and dial 303 which are loosely mounted on shaft 301. Pinion 317 drives idler gear 318 and associated pinion 319, the latter pinion in turn driving the assembly comprising sleeve 321, gear 320 and dial 322, this assembly being loosely mounted on shaft 300 for rotation thereabout. Sleeve 321 has a slot therein to cooperate with the pin 326 mounted on a grooved collar 323, the collar being loosely mounted on shaft 300 for rotation and for axial displacement with respect to the shaft. Collar 323 carries a cam rider 328 which is adapted to co-operate with

the surface of cam 310. A similar collar 325 having a groove therein and a pin 327 affixed to one side thereof which is adapted to co-operate with a slot in sleeve 324 is loosely mounted on shaft 301 for rotation and axial displacement with respect thereto. Collar 325 carries a cam rider 329 adapted to co-operate with the surface of cam 311 so that the collar may be displaced along the shaft when relative rotation occurs between the collar and the cam.

The sleeves 321 and 324 are driven by the master clock, the gearing being such that sleeve 324 will rotate once each hour, and that sleeve 321 will rotate once every twelve hours. The collars 323 and 325 are driven by the sleeves through pins 326 and 327 respectively, the driving connection between the collars and sleeves permitting the axial motion of the collars resulting from the action of the cams 310 and 311 on cam riders 328 and 329 respectively. The cams and the hour shaft 300 and minute shaft 301 on which they are mounted are driven by a secondary clock driving mechanism to be hereinafter described. Any discrepancy between the master clock and the pilot secondary will result in relative rotation of the sleeves and shafts and displacement of the collars. The hand 313, 312 on each shaft, and the dial 322, 303 on each sleeve will indicate such discrepancy to the operator. The axial displacement of the grooved collars may be utilized to open and close a set of contacts just as displacement of collar 91 operates contacts 41 to 45 in Figure 2.

Also mounted on frame plate 330 is a block of insulating material 351 in which are anchored conductors 352, 353, 354 and 355. Affixed to said conductors are resilient contacting members 356, 357, 358 and 359, respectively, as shown in Figure 7. A second resilient contact member 360 is affixed to conductor 354, the arrangement of these contact members being similar to those shown in Figure 2. Suitable screws such as 362 may be affixed to the lower part of the conductors to which wires may be connected. Contact members 356 and 357 are biased to open position as shown in Figure 7 while contact members 358 and 359 are biased to the closed position, provision being made to hold them in the open position as illustrated. Contact member 359 is biased against member 360 to the closed position, and is adapted to be opened when contact members 358 and 359 are moved to the right. An insulating strip 361 connects contact members 358 and 359 so that they may be moved in unison.

Journaled in suitable frame members 363 and 368 is a shaft 364 upon which is pivoted a lever 365, the upper end of the lever carrying an insulating projection 366 which engages contact member 358. It will be seen that as projection 366 is moved to the right all of the contacts will be opened, while if moved to the left of the position shown in Figure 7 resilient members 358 and 359 will be permitted to close all of the contacts. A pin 367 is also mounted on lever 365, the pin being adapted to ride in the groove of collar 325 so that displacement of the collar by the cam 311 will rotate the pivoted lever 365 to open or close the contacts. A stud 369 is affixed to a frame member 368 and carries at one end thereof a second lever 370 on a hub 370'. Lever 370 has a projecting pin 371 thereon which engages the side of lever 365 when lever 370 is moved clockwise about its pivot 369 and has a second projecting pin 372 on the reverse side thereof which is adapted to ride in the groove of collar 323 so that displacement of collar 323 will rotate lever 370 and thus bring pin 371 against the side of lever 365, said lever 365 having been moved to the left previously, thereby causing lever 365 to be detained in this position as long as rider 328 is on the outer cam portion of cam 310. This results in the contacts 356, 357, 358 and 360, 359 being held in the closed position. However, when the secondary of the pilot is in synchronous relationship with the master clock, the projecting pin 371 is held away and to the right of the side of lever 365, permitting lever 365 to be swung to the right when its associated pin 367 causes this movement upon displacement of collar 325, thus permitting the opening of contacts 360—359.

The secondary driving mechanism for the pilot is shown in Figures 8 and 9 wherein an armature 331 is carried on a member 332 pivoted on shaft 333 and biased by spring 334 to the retracted position. A pawl 335 is pivotally mounted at 336 on pivoted member 332 and is provided with a tooth 337 adapted to engage ratchet wheel 302 to rotate it one notch at a time. Ratchet 302 is affixed to shaft 301 which is suitably journaled in the frame plates 330 of the mechanism. Also mounted on shaft 301 and adapted to be rotated therewith is disk 338 having a slot 339 therein.

An electromagnet 340 is suitably mounted on plate 330 and is provided with a principal pole piece 341 to co-operate with armature 331, and an auxiliary pole piece 342 to co-operate with auxiliary armature 343, the latter armature being polarized, that is comprising a permanent magnet, so that current of normal polarity will attract both armatures while current of reverse polarity will attract armature 331 and repel armature 343.

Armature 343 is carried on lever 344 which is pivoted on shaft 345 suitably mounted in plates 330, said lever terminating in a projection 346 adapted to ride on the periphery of disc 338.

As the slot 339 is rotated into registry with the projection 346, the latter, upon energization of the magnet by current of normal polarity, will slide into the slot to prevent further rotation of disc 338 and ratchet 302.

A spring 347, one end of which is suitably affixed to the frame of the secondary, biases pawl 335 into engagement with the ratchet so that upon energization of magnet 340, the pawl will be displaced to the right one notch in opposition to spring 334, permitting the tensioned spring upon de-energization of the magnet to return the pawl to its normal position, determined by a suitable stop, such as pin 348 affixed to frame plate 330, and to advance the ratchet one notch. However, in the fifty-ninth minute position of the secondary, the slot 339 being in registry with projection 346, will permit attraction of auxiliary armature 343 and rotation of lever 344 into such a position that pin 349 thereon engages a pin 350 on pawl 335, locking the pawl in displaced position as well as locking the ratchet against further rotation. An impulse of reversed polarity will repel armature 343, unlocking both the pawl and the ratchet for further action. The action of this modification is substantially the same as that described in connection with Figures 3 and 4.

Regarding the operation, it will be observed that cam 311 has an intermediate surface on which cam rider 329 rests, as shown in Figure 6, when the pilot secondary is in "on time" relationship with the master clock. At the same

time, cam rider 328 rests on the low surface of cam 310. Lever 365 holds contacts 356, 357, 358 in the open position, and contacts 360, 359 remain closed. Lever 370 is out of engagement with lever 365.

If a current interruption in the secondary line should occur, or if it should be desired to set the master clock ahead, cam rider 329 would be forced on to the high surface by the rotation of cam 311, displacing collar 325 and lever 365 to the left in opposition to spring 373, as shown in Figure 5, thereby permitting resilient members 358 and 359 to spring to the left and to close contacts 356, 357, 358, contacts 360, 359 remaining closed. As the high position of the cam surface extends only for about 180° of entire cam surface, the low and intermediate portions accounting for the remainder, the maximum slow correction of the pilot would be limited to about thirty minutes beyond which the rider would slip from the high to the low surface, were it not for the more slowly acting cam and rider 310 and 328, respectively, which within the maximum slow correction of the first cam, will have rotated sufficiently with respect to each other, to force the rider 328 on to the high portion of the cam surface, thereby displacing to the left, collar 323 and lever 370 so that pin 371 will engage lever 365 and keep it in displaced position and the contacts closed. When rider 329 has been rotated beyond the high portion of the surface of cam 311 to a position wherein spring 373 tends to urge it against the low portion and to open the contacts, the lever 370 will retain lever 365 in displaced position, due to the action of cam 310 and rider 328. The maximum slow correction will thus be lengthened from thirty minutes to as long as eleven hours provided that cam 310 and rider 328 normally make one revolution every twelve hours. Inasmuch as the high portion of the surface of cam 311 need be only long enough to hold lever 365 in displaced position until the slower acting cam and rider displace lever 370 into engagement with lever 365, the high portion may be made considerably shorter than thirty minutes, and the low portion correspondingly lengthened, thereby increasing the maximum fast correction over that afforded by the type of pilot illustrated in Figure 2.

It will be noted that contacts 356, 357, 358, 360 and 359 in Figure 7 correspond to contacts 41, 42, 43, 44, and 45, respectively, in Figures 1 and 2 and that they are connected into the circuit correspondingly. Consequently, with respect to the function of either pilot in the circuit of Figure 1 the operation of the two pilots herein disclosed is substantially identical.

Figure 10 illustrates a simplified circuit, wherein the scattering correction only is provided, the pilot being omitted. The primed reference numerals indicate elements substantially identical to those elements in Figure 1 bearing the corresponding unprimed reference numerals.

Upon closing of the minute contacts 40', a circuit is established from negative terminal 200 of rectifier 3' through conductor 202, contacts 40, conductors 203 and 204, relay 69, conductors 205 and 206 to positive terminal 201. Energization of relay 69' establishes a circuit from negative terminal through conductor 207, contacts 70', 71', conductor 208, contacts 66', 63', conductors 209, 21' through the secondaries, conductors 20', 210, contacts 64', 68', and conductor 206 to positive terminal 201.

A few seconds before the fifty-ninth minute position of the master clock M', contacts 38' are closed so that on the fifty-ninth minute a circuit is established from negative terminal 200 through conductor 202, contacts 40', conductor 211, contacts 38', conductor 212, relay 51', conductors 213, and 214 to positive terminal 201. Energization of relay 51' releases spring driven rapid contactor 50' which rapidly closes and opens contacts 57', 58', thereby establishing a circuit from negative terminal 200 through conductor 215, contacts 58', 57', conductor 204, relay 69', conductors 205, 206 to positive terminal 201. The rapid energization and de-energization of relay 69' causes rapid impulses to be sent out over lines 20' and 21' permitting all secondaries which have not yet become locked in the fifty-ninth minute position, to advance rapidly until they do become locked.

A few seconds before the sixtieth minute position of the master clock, contacts 36' are closed establishing a circuit from negative terminal 200 through conductors 202, 216, contacts 36', conductor 217, relay 60', conductor 218 to positive terminal 201. Energization of relay 60' causes displacement of contact members 63' and 64' so that contacts 63', 66' and 64', 68' are broken, and contacts 63', 65' and 64', 67' are made thereby reversing the polarity of the sixtieth minute impulse sent out on the energization of relay 69', and releasing all the secondaries simultaneously to the sixtieth minute position.

It will be noted that in connection with the above description of our invention we have shown certain modifications whereby a time controlled system is disclosed which will provide scattering correction only, or scattering and group correction, and wherein the maximum group correction may be extended to any limits by modifying the gear ratios, or by adding additional cam elements to the modified pilot construction described. The secondary apparatus is designed to operate not only clocks but also time stamps and printing recorders of all types, and the system is adapted for other types of control of secondary apparatus than time control. It is understood, consequently, that certain modifications and changes in the apparatus or circuits disclosed, and in the shape, size and proportions of the parts or elements thereof may be effected without departing from the spirit of our invention as defined in the subjoined claims.

We claim:

1. A secondary apparatus of the polarized magnet type comprising an electromagnet having a principal pole piece and an auxiliary pole piece, an armature for said principal pole piece, a polarized armature for said auxiliary pole piece, means for advancing said apparatus, said means being actuated by said principal armature, locking means for locking said principal armature in attracted position, said locking means being actuated by said polarized armature, and means for rendering said locking means inoperative in certain positions of said advancing means.

2. In a secondary apparatus for use in a corrective time controlled system, a magnet and an armature for advancing said apparatus step by step, said magnet being responsive to impulses of both normal and reversed polarity, locking means for engaging said armature and locking it in its attracted position, an auxiliary polarized armature co-operating with said magnet for actuating said locking means, and means for per-

mitting said locking means to engage said armature only during a predetermined chronological condition of said apparatus, disengagement being effected only upon receipt of an impulse of reversed polarity.

3. In a time controlled system, master apparatus, a plurality of secondary apparatus, an electric circuit including each of said secondary apparatus and said master apparatus, means for transmitting a series of rapid impulses during a corrective period determined by said master apparatus, means for locking each of said secondary apparatus in a position corresponding to said corrective period, means for releasing each of said secondary apparatus immediately after said corrective period by the transmission of a reversed polarity impulse by said master apparatus, and means for the transmission of a series of rapid impulses of reversed polarity to all of said secondary apparatus immediately after each current interruption in said circuit.

4. In a time controlled system, master apparatus, a plurality of secondary apparatus, means for transmitting to each of said secondary apparatus a series of rapid impulses during a corrective period, said corrective period being determined by said master apparatus, means whereby each secondary may be rendered inoperative during a locking portion of its cycle when said locking portion overlaps said corrective period, means for synchronizing the release from inoperative position of each secondary apparatus at the termination of said corrective period, and means effective following a current interruption for correcting all secondaries to an equal extent so as to bring one of said secondaries into synchronism with said master apparatus.

5. In a time controlled system, the combination of master apparatus, a group of secondary apparatus, means to correct each secondary apparatus individually at predetermined intervals, and means to correct the secondaries as a group to an extent determined by the correction necessary to bring one selected member of said group into synchronism with said master apparatus, said group correction means being operable immediately after said master apparatus and said selected apparatus have fallen out of synchronism.

6. In a time controlled system including master apparatus and secondary apparatus, a circuit including said master and said secondary apparatus, means to transmit advancing impulses at regular intervals to said secondary apparatus, means to transmit a series of rapid corrective impulses to said secondary apparatus at longer intervals, means to lock said secondary apparatus in a position corresponding to the position of said master apparatus during the transmission of said corrective impulses, means to transmit an impulse of reverse polarity immediately subsequent to said series of rapid corrective impulses to release said locking means, and means operative upon every current interruption in said circuit to control said transmission means whereby immediately upon resumption of the current in said circuit a series of rapid corrective impulses of reverse polarity will be transmitted to said secondary apparatus.

7. A secondary corrective clock system comprising a master clock, a plurality of secondary clocks, means controlled by said master clock for transmitting advancing impulses to said secondary clocks at intervals of one minute, means to lock said secondary clocks in the fifty-ninth minute position thereof, means controlled by said master clock for transmitting a series of corrective rapid impulses to said secondary clocks between the fifty-ninth and sixtieth minute impulses, means controlled by said master clock for reversing the polarity of the sixtieth minute impulse for releasing said secondary clocks, means for comparing the chronological positions of said master and one of said secondary clocks and operable immediately upon registering a discrepancy therein to control said transmitting means and said polarity reversing means to correct all of said secondary clocks.

8. In a corrective time controlled system including master apparatus and secondary apparatus, electromagnetic means for advancing said secondary apparatus step by step, a circuit including said electromagnetic means over which advancing impulses of normal polarity and advancing impulses of reverse polarity may be transmitted, means controlled by said master apparatus for transmitting impulses at regular intervals throughout a predetermined chronological cycle, and for transmitting rapid impulses during a corrective period of said cycle, means controlled by said master apparatus for reversing the polarity of said impulses immediately following said corrective period, locking means for engaging said electromagnetic means and for rendering inoperative said secondary apparatus at a predetermined position in its cycle of operation, said locking means being adapted to disengage said electromagnetic means upon receipt of an impulse of reverse polarity whereby synchronism between said secondary apparatus and said master apparatus is established immediately following said corrective period, a pilot for comparing the chronological positions of said master apparatus and said secondary apparatus and operable upon registering a discrepancy therein to control said impulse transmitting means and said polarity reversing means whereby synchronism may be established between said secondary apparatus and said master apparatus without regard to said chronological positions and their relation to the corrective period.

9. Master apparatus for use in a corrective time system comprising a source of current, an outgoing control circuit extending to secondary apparatus, means for transmitting current impulses over said control circuit at regular recurring intervals, means for transmitting a plurality of current impulses at a rapid rate during one of said intervals, means for transmitting at least one impulse of special characteristic immediately following the transmission of said series of rapid impulses, and means for transmitting a plurality of impulses of said special characteristic at a rapid rate following each interruption of current from said source.

10. In a time controlled system, a pilot to correct secondary apparatus with respect to master apparatus comprising a rotatable cam having an intermediate surface and two extreme surfaces, a rotatable cam rider to co-operate with said cam, one of the group comprising said cam and said cam rider being driven by said master apparatus, and the other by said secondary apparatus, and one member of said group being displaceable by said co-operation, contact means operable by said displaceable member to control the operation of said secondary, said rider being adapted to ride on said intermediate surface when said master and said secondary apparatus are in on time relationship with each other, and to ride on one of said extreme surfaces when said secondary is fast, and on the other when slow.

11. In a time controlled system, master apparatus, secondary apparatus, and a pilot comprising two sets of rotatable co-operating members, each set comprising a cam member and a rider member, one of which members is axially displaceable, and one member in each set being driven by said master apparatus and the other member being driven by said secondary apparatus, one of said sets being adapted to rotate once each hour, and the other of said sets being adapted to rotate once each twelve hours, contact apparatus for controlling said secondary apparatus, said contact apparatus being controlled by said displaceable member of said one hour set, and means for retaining said displaceable member of said one hour set in displaced position when said displaceable member of said twelve hour set is displaced.

12. In a time controlled system, a pilot comprising primary means for comparing the chronological positions of master and secondary apparatus, said means being operable within a predetermined cycle of operation to control the transmission of impulses to a group of secondary apparatus, and auxiliary comparing means adapted to co-operate with said primary means to control said transmission of impulses, said auxiliary means being operable beyond the limits determined by the cycle of operation of said primary means.

13. In a time controlled system, a pilot comprising primary means for comparing the chronological positions of master and secondary apparatus, said means being operable within a predetermined cycle of operation to control the transmission of impulses to a group of secondary apparatus, and auxiliary comparing means adapted to co-operate with said primary means to control said transmission of impulses, said auxiliary means being operable beyond the limits determined by the cycle of operation of said primary means, said primary and auxiliary comparing means including in each instance a rotatable endwise cam and a co-operative rotatable cam rider, one of which is longitudinally displaceable.

14. In a time controlled system, a pilot comprising primary means for comparing the chronological positions of master and secondary apparatus and operable when said secondary apparatus is slow to transmit rapid impulses thereto and when said secondary is fast to cease the transmission of impulses thereto, said comparing means being limited in its operativeness to a difference in chronological position of a definite extent, and auxiliary comparing means adapted to co-operate with said primary comparing means to increase the extent of said difference over which said primary comparing means is operative.

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