United States Patent [19]

Flumm

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[45] **March 20, 1973**

[54] **DIGITAL CLOCK AND METHOD OF OPERATION AND MAKING THE SAME**

[75] Inventor: **Paul T. Flumm**, Oakville, Conn.

[73] Assignee: **Robertshaw Controls Company**, Richmond, Va.

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[21] Appl. No.: **113,368**

[52] **U.S. Cl.** .....**58/125 C**, 58/2, 58/6 R, 235/91 R

[51] **Int. Cl.** **G04b 19/02**

[58] **Field of Search**.....58/2, 4 R, 6 R, 50, 125 C, 58/126 E; 235/117, 103, 91 R

[56] **References Cited**

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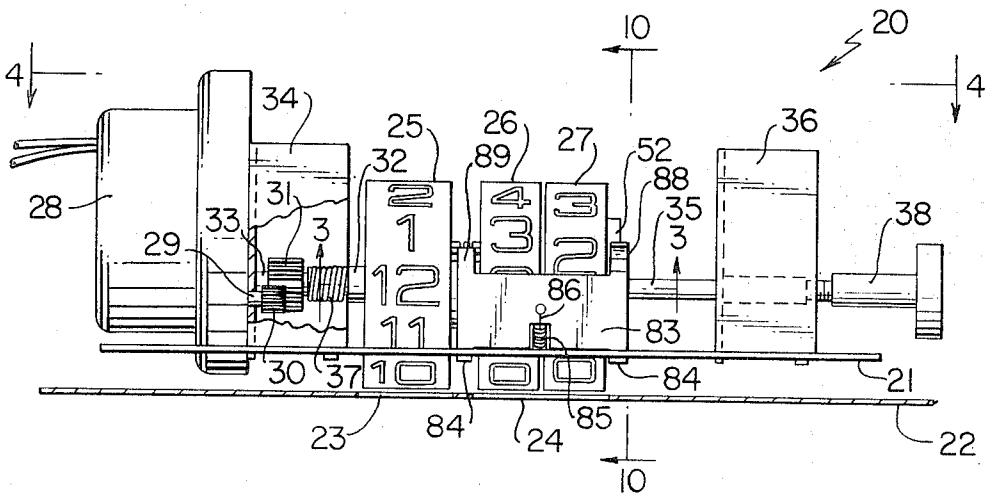
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Primary Examiner—Richard B. Wilkinson
Assistant Examiner—Stanley A. Wal
Attorney—Candor, Candor & Tassone

[57] **ABSTRACT**

A digital clock construction having a frame carrying a rotatable shaft driven by a timer at a predetermined rate. A plurality of time indicating wheels are rotatably mounted on the shaft. A first drive structure is carried by the shaft and is operatively associated with one of the wheels for incrementally rotating the one wheels relative to the shaft on a time basis as the shaft rotates. Other drive structure is operatively associated with the shaft and the remaining wheels to tend to rotate the remaining wheels as the shaft rotates. Latch structure is operatively associated with the one wheels and the remaining wheels for holding the remaining wheels from rotating relative to the frame except in a timed relation to the incremental movement of the one wheels relative to the frame.

35 Claims, 13 Drawing Figures



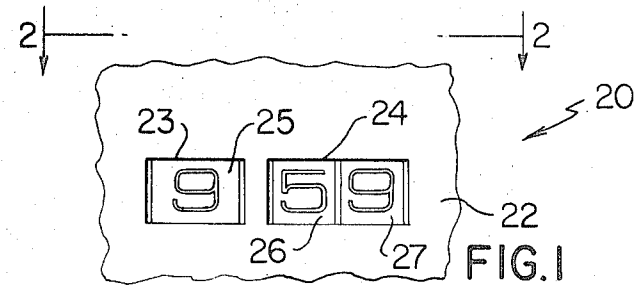


FIG. 1

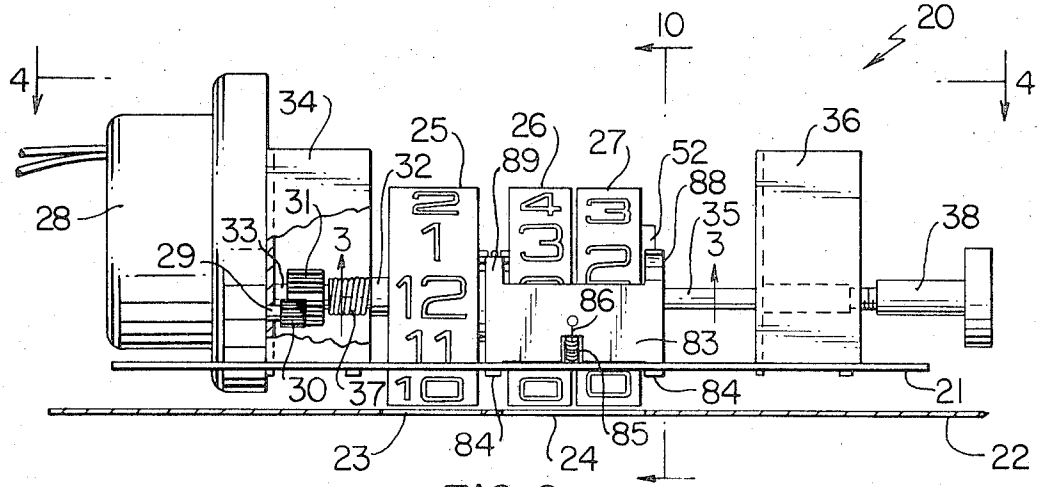


FIG. 2

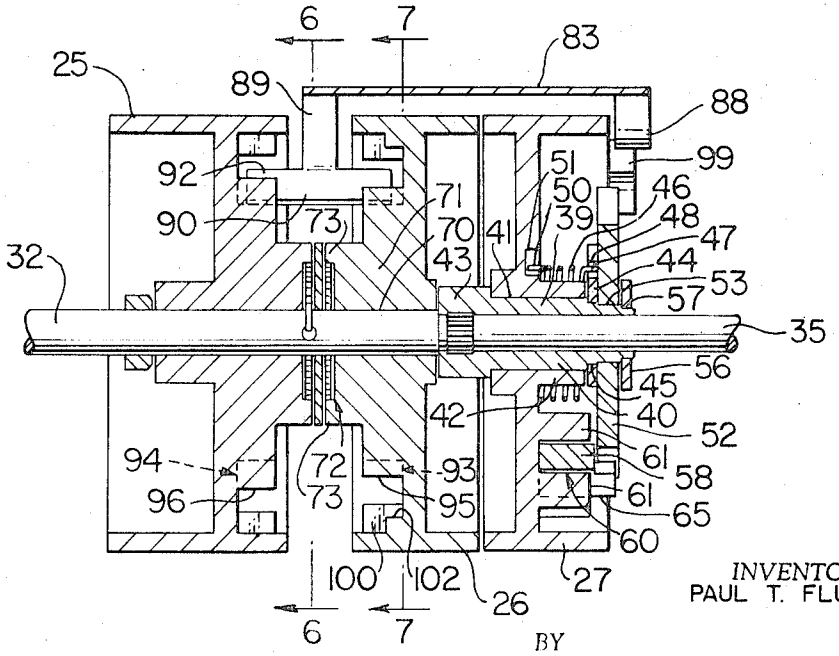


FIG. 3

INVENTOR.
PAUL T. FLUMM
BY
Cauley, Cauley & Towne
HIS ATTORNEYS

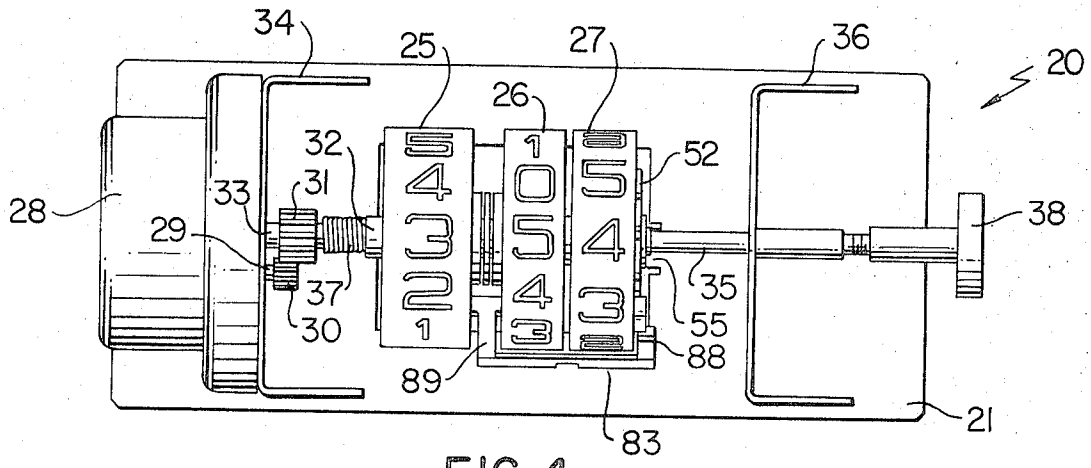


FIG. 4

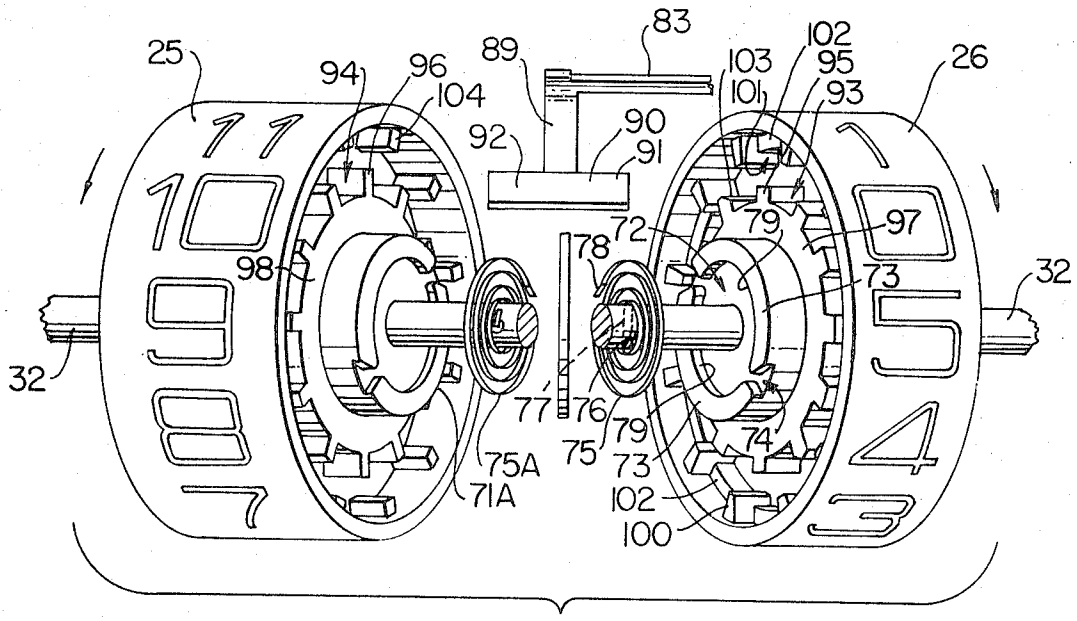


FIG. 5

INVENTOR.
PAUL T. FLUMM

BY

Cauda, Cauda & Tassone

HIS ATTORNEYS

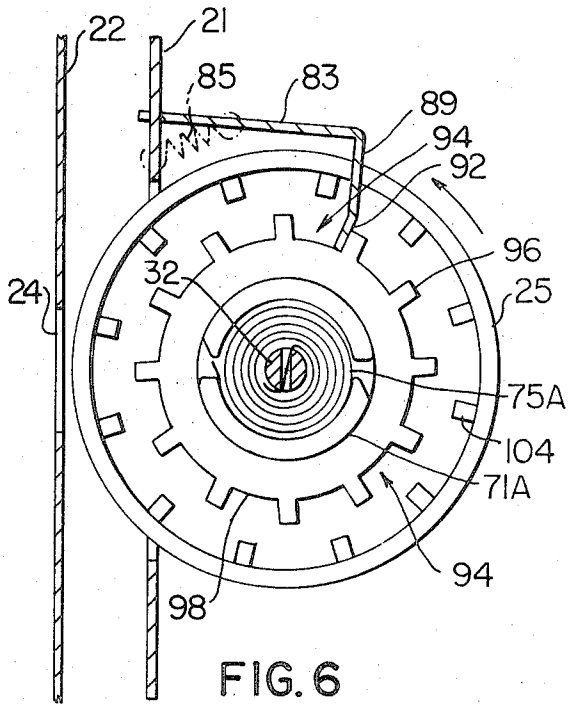


FIG. 6

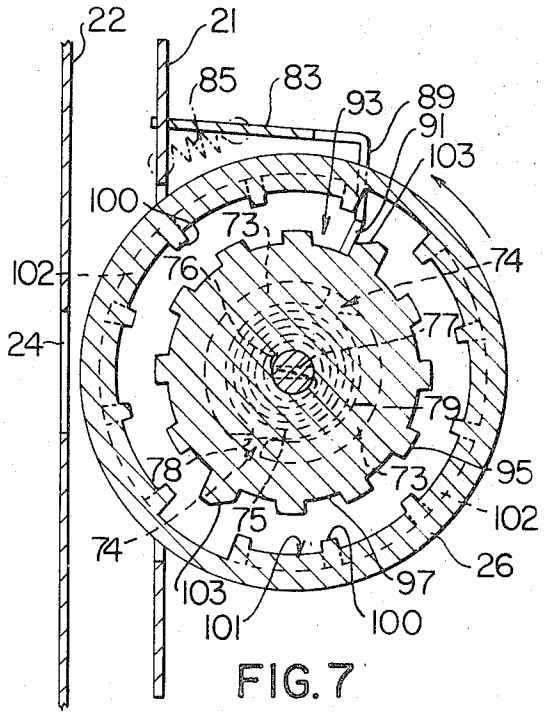


FIG. 7

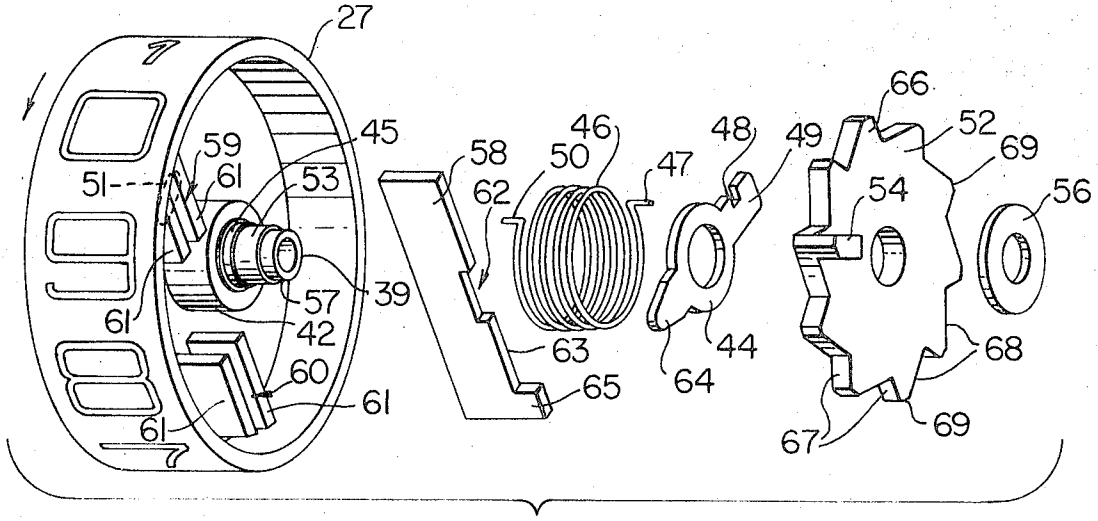


FIG. 8

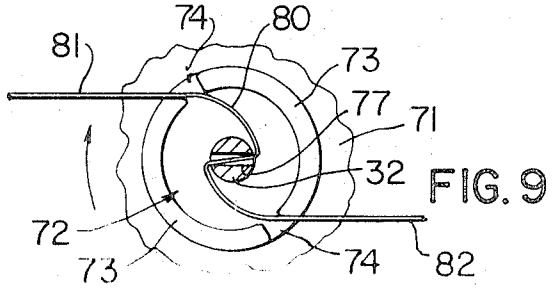


FIG. 9

INVENTOR.
PAUL T. FLUMM

BY

Cauley, Cauley & Tarone

HIS ATTORNEYS

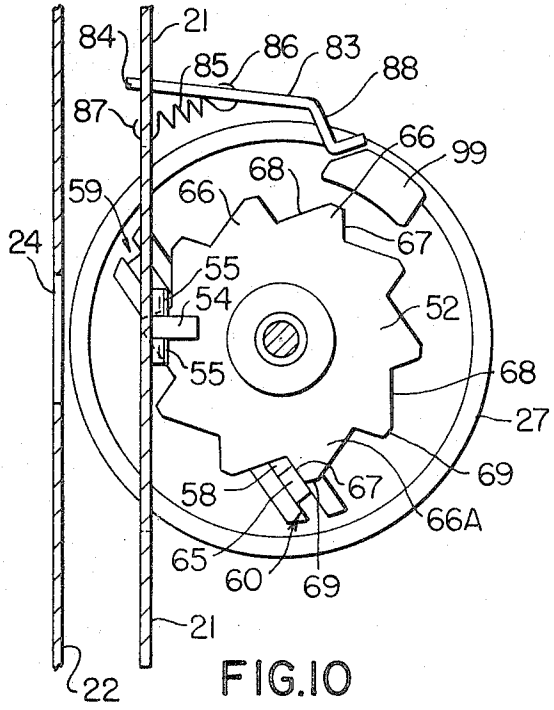


FIG.10

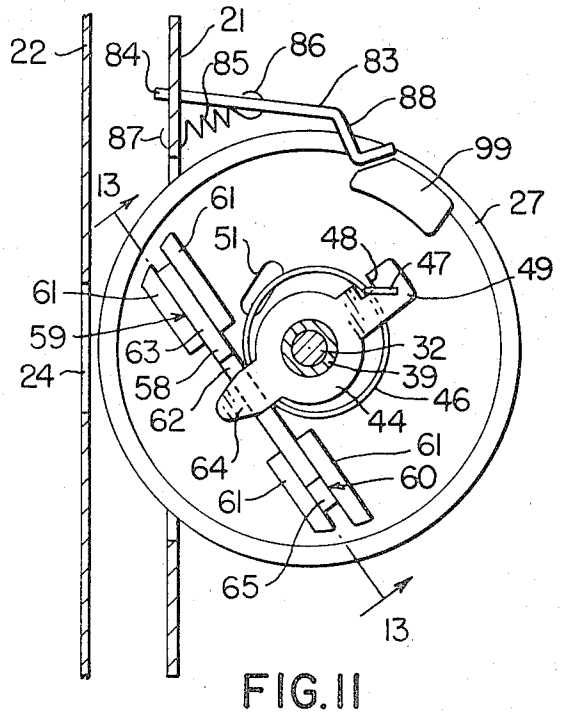


FIG.11

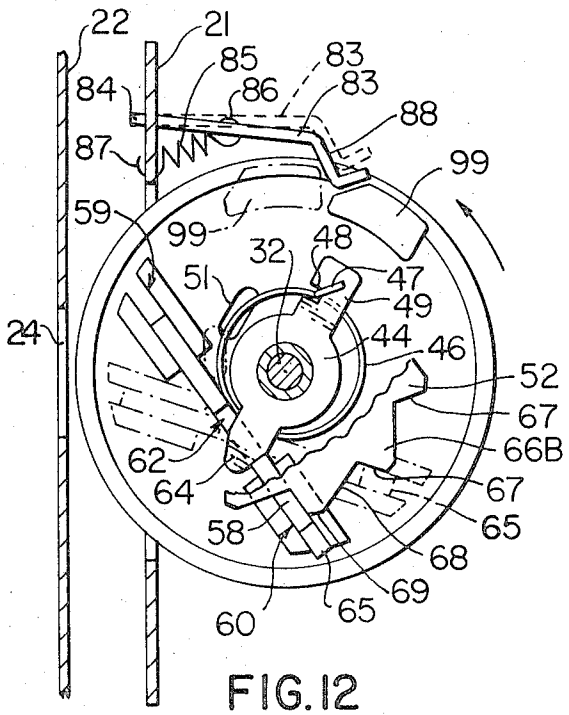


FIG.12

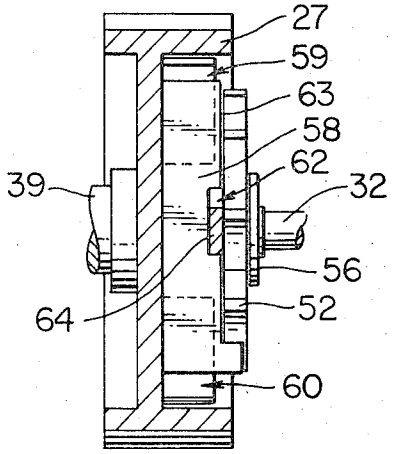


FIG.13

INVENTOR.
PAUL T. FLUMM

BY

Cardon, Cardon & Tassone

HIS ATTORNEYS

DIGITAL CLOCK AND METHOD OF OPERATION AND MAKING THE SAME

This invention relates to a digital clock mechanism as well as to various parts of such mechanism and the method of operation and the method of making the same.

It is well known that digital clock mechanisms have been provided wherein a plurality of time indicating wheels or drums are incrementally moved relative to the clock structure to indicate the time of day, such wheels or drums comprising an "hour" indicating drum, a "ten" minute indicating drum, and a "unit" minute indicating drum. Such clock mechanisms can employ Geneva gears between each adjacent pair of drums for the purpose of incremental drive of such drums. However, it has been found that the loading which is imparted to the clock driving mechanisms for the geared drive between each pair of adjacent drums is not uniform so that at such times as nine hours, fifty-nine minutes and fifty-nine seconds, the clock mechanism is required to move several drums and Geneva gears simultaneously thereby causing considerable interrupted loading on the clock driving mechanism.

Other forms of digital clock mechanisms utilized provide the time of day readings printed on multiple leaves which trip sequentially for different readings every minute. However, this system requires many such leaves and a different printing on each leaf.

Accordingly, one of the features of this invention is to provide digital readings of time of day utilizing a minimum number of components and with a uniform light loading being imposed upon the clock driving mechanism at all times.

In particular, one embodiment of the digital clock structure of this invention comprises a frame means carrying a rotatable shaft and a timer for rotating the shaft at a predetermined rate. A plurality of time indicating wheels or drums are rotatably mounted on the shaft. A first drive means is carried by the shaft and is operatively associated with one of the wheel means for incrementally rotating that one wheel means relative to the shaft on a time basis as the shaft rotates. Other drive means are operatively associated with the shaft and the remaining wheel means to tend to rotate such remaining wheel means as the shaft rotates. However, a latch means is operatively associated with the one wheel means and the remaining wheel means for holding the remaining wheel means from rotating relative to the frame means except in a timed relation to the incremental movement of the one wheel means. In this manner, a single driving shaft can be employed for supplying a driving torque to successive wheel means which are then operated by a latch release mechanism as will be apparent hereinafter.

Accordingly, it is an object of this invention to provide an improved digital clock having one or more of the novel features set forth above or hereinafter shown or described.

Another object of this invention is to provide improved parts for such a digital clock construction or the like.

Another object of this invention is to provide an improved method of operating a digital clock structure, the method of this invention having one or more of the

novel features set forth above or hereinafter shown or described.

Another object of this invention is to provide an improved method for making certain parts of such a digital clock structure.

Other objects, uses and advantages of this invention are apparent from a reading of this description which proceeds with reference to the accompanying drawings forming a part thereof and wherein:

FIG. 1 is a fragmentary front view of the improved digital clock of this invention.

FIG. 2 is a cross-sectional view taken substantially on line 2—2 of FIG. 1.

FIG. 3 is an enlarged, fragmentary, cross-sectional view taken on line 3—3 of FIG. 2.

FIG. 4 is a view taken in the direction of the line 4—4 of FIG. 2.

FIG. 5 is an exploded perspective view of the two left hand time indicating wheel means of FIG. 3.

FIG. 6 is a fragmentary cross-sectional view taken on line 6—6 of FIG. 3.

FIG. 7 is a fragmentary cross-sectional view taken on line 7—7 of FIG. 3.

FIG. 8 is an exploded perspective view of the right hand wheel means and its operating drive structure of FIG. 3.

FIG. 9 is a schematic view illustrating one method of making the drive means between the shaft of the clock mechanism and one of the wheel means thereof.

FIG. 10 is an enlarged, fragmentary, cross-sectional view taken on line 10—10 of FIG. 2.

FIG. 11 is a view similar to FIG. 10 with part of the structure removed.

FIG. 12 is a view similar to FIG. 11 and illustrates the structure in different operating positions thereof.

FIG. 13 is a fragmentary cross-sectional view taken on line 13—13 of FIG. 11.

While the various features of this invention are hereinafter described and illustrated as being particularly adapted to provide a digital clock structure, it is to be understood that the various features of this invention can be utilized singly or in any combination thereof to provide structure for other purposes as desired.

Therefore, this invention is not to be limited to only the embodiment illustrated in the drawings, because the drawings are merely utilized to illustrate one of the wide variety of uses of this invention.

Referring now to FIGS. 1-3, the improved digital clock of this invention is generally indicated by the reference numeral 20 and comprises a frame means 21 suitably supporting in any desired manner a front panel 22 having window means 23 and 24 cut therethrough for respectively exposing an "hour" wheel means or drum 25 and a pair of wheels or drums 26 and 27 respectively being the "ten" minute and "unit" minute wheels for the clock 20. In this manner, the digital clock 20 of this invention indicates the time in hours by the "hour" wheel 25 being exposed at the window means 23 and indicates the minutes by the combination of the wheels 26 and 27 being exposed at the window means 24 as illustrated in FIG. 1.

For reasons that will be apparent hereinafter, the "hour" wheel or drum 25 is numbered on the outer periphery thereof from "one" to "twelve"; the "ten"

minute wheel or drum 26 is numbered on its outer periphery in two repeating series of numbers from "-zero" to "five"; and the "unit" wheel or drum 27 is numbered from "zero" to "nine" about its outer periphery. The window means 23 and 24 in the front panel 22 of the clock 20 and the size of the numbers on the wheels 25, 26 and 27 are so constructed and arranged that only one number of each wheel 25, 26 and 27 is viewable at any one time.

The drive mechanism for the wheels 25, 26 and 27 will be hereinafter described and such drive mechanism is so constructed and arranged that the same provides a rapid and incremental movement of the unit wheel 27 once every minute with the "ten" minute wheel 26 making one rapid and incremental movement for every ten incremental movements of the "unit" wheel 27. the "hour" wheel 25 makes one rapid and incremental movement thereof for every one-half revolution of the "ten" minute wheel 26.

As previously stated, one of the features of this invention is to provide a drive to the wheels 25, 26 and 27 which will not impose severe loading on the driving mechanism at various times in the operation of the wheels 25, 26 and 27 while still utilizing a minimum number of components and with a uniform light loading imposed upon the clock driving mechanism.

Such unique driving mechanism will now be described.

As illustrated in FIGS. 2 and 4, the frame means 21 carries an electrical timer motor 28 having an output shaft 29 provided with a pinion gear 30 thereon for mating with a pinion gear 31 carried by a shaft means 32. The shaft means 32 includes a first part 33 journaled in suitable bearings of a part 34 of the frame means 21 and a second part 35 journaled in suitable bearing means of another part 36 of the same means 21. The shaft parts 33 and 35 are operatively interconnected together by suitable clutch means 37 so that rotation of the shaft part 33 by the pinion gear 31 being driven by the timer motor 28 will cause like rotation of the shaft part 35 in unison therewith but will permit the shaft part 35 to be turned relative to the shaft part 33 when the operator rotates a time resetting knob 38 relative to the frame means 21 to operate the wheels 25, 26 and 27 independently of the timer motor 28, such as for setting the wheels 25, 26 and 27 in a proper start time position thereof to be thereafter continuously operated by the timer motor 28.

Thus, it can be seen that the shaft means 32 is rotatably mounted to the frame means 21 and as long as the timer motor 28 is driving the pinion gear 31, the shaft means 32 has both parts 33 and 35 rotating in unison to provide a driving force for the wheels 25, 26 and 27 as will be apparent hereinafter.

The wheels or drums 25, 26 and 27 are respectively rotatably mounted on the shaft means 32 to be movable relative thereto as will be apparent hereinafter.

In particular, a bushing 39 is press fitted on the shaft means 32 to rotate in unison with the shaft part 35 and has a stepped cylindrical portion 40 loosely passing through an opening 41 provided in an inner hub 42 of the "unit" minute wheel 27 so that the wheel 27 is rotatably mounted on the shaft means 32. The hub 42 of the wheel 27 is confined between an enlarged cylindrical portion 43 of the bushing 39 and a driving dog 44 press fitted onto a smaller cylindrical portion 45 of the bushing 39 to rotate in unison therewith and disposed on the right hand side of the wheel 27 as illustrated in FIG. 3.

A torsion spring 46 is disposed about the hub 42 of the wheel 27 and has one end 47 hooked in a notch 48 of an arm 49 of the dog 44 and the other end 50 thereof hooked into an opening 51 of the wheel 27 so that as the dog 44 rotates in a counterclockwise direction in FIGS. 11 and 12 by the shaft means 32 being continuously driven in a counterclockwise rotation by the timer motor 28, such rotation of the driving dog 44 relative to the wheel 27 tends to wind up the spring 46 so as to store energy therein in a manner to subsequently cause movement of the wheel 27 in a counterclockwise direction as will be apparent hereinafter. When the torsion spring 46 is initially assembled between the driving dog 44 and the wheel 27, the same is provided with a preset windup thereof so that the normal bias of the spring 46 is to tend to rotate the wheel 27 in a counterclockwise direction in FIG. 12 relative to the dog 44 in all positions of the dog 44 relative to the wheel 27 as will be apparent hereinafter.

A toothed wheel 52 is rotatably mounted on another cylindrical portion 53 of the bushing 39 and is held stationary so as not to rotate thereon by a tang extension 54 of the member 52 being received between two lugs or embossments 55 of the frame means 21 as illustrated in FIG. 10 whereby the member 52 is held stationary while the shaft 32 rotates relative thereto. The wheel 52 is held on the portion 53 of the bushing 39 by being disposed between the larger cylindrical portion 45 on one side thereof and a washer-like retainer 56 disposed on the other side thereof and being press fitted on a smaller cylindrical portion 57 of the bushing 39.

The "unit" minute wheel 27 carries a slide member 58 which is adapted to slide relative to the wheel 27 by being received in slot means 59 and 60 formed respectively between cooperating pairs of ears 61 as illustrated in FIGS. 8 and 11. The slide member 58 has a notch 62 formed on the edge 63 thereof for receiving a driving arm 64 of the driving dog 44 which will cause sliding movement of the slide member 58 in a manner hereinafter described. The slide member 58 also has a tang 65 extending from the side edge 63 thereof to serially engage the teeth 66 of the stationary member 52 in a manner hereinafter described.

Each tooth 66 of the wheel 52 has a surface 67 on one side thereof which will be serially engaged by the tang 65 of the slide member 58 while the opposed side 68 of each tooth 66 will be non-engaged by such slide member 58.

In particular, as illustrated in FIGS. 10 and 11, as the shaft means 32 is rotating in a counterclockwise direction, the wheel 27 is held from rotating therewith because the tang 65 of the slide member 58 is engaging against the side 67 of the particular tooth 66A illustrated in FIG. 10 whereby the torsion spring 46 is being wound up as the driving dog 44 rotates relative to the wheel 27 in a counterclockwise direction. However, as the driving dog 44 rotates relative to the wheel 27, the driving arm 64 thereof is causing the slide member 58 to move or slide from the position illustrated in FIG. 11 to the position illustrated in FIG. 12 where the tang 65 now clears the end 69 of the particular tooth 66A and

the wheel 27 will be rapidly rotated by the stored energy in the torsion spring 46 in a counterclockwise direction relative to the drive shaft 32 and, thus, relative to the driving dog 44 so that the slide member during such rotation of the wheel 27 is caused to slide inwardly. Such inward sliding movement of the slide member 58 causes the tang 65 to engage against the surface 67 of the next adjacent tooth 66B on the member 52 as illustrated in FIG. 12 and thus stopping any further movement of the wheel 27 until the driving dog 44 again causes the slide member 58 to slide relative to the surface 67 of the tooth 66B to have the tang 65 thereof clear the end 69 of such tooth 66B in the manner previously described.

The incremental movement of the wheel 27 relative to the frame means 21 provided by each adjacent pair of teeth 66 on the stationary member 52 indicates a new "unit" minute reading at the window means 24 of the front panel 22. Since the driving motor 28 rotates the shaft means 32, one complete revolution every 10 minutes, there are ten teeth 66 on the member 52 so that with every one revolution of the shaft means 32, the same will have caused ten incremental movements of the wheel 27 so as to provide one complete revolution of the wheel 27 for every complete revolution of the shaft 32. However, since the shaft means 32 is rotating relatively slowly, the incremental movement of the wheel 27 to change the minute indication thereof takes place so rapidly through the stored up energy or force of the tension spring 46, there is no discernible movement of the numbers on the wheel 27 except at the instant of change-over.

Each tooth 66 of the stationary member 52 is so arranged that when the side 67 thereof is engaged by the tang 65 of the slide member 58, the particular tooth 66 presents a profile that is parallel to the sliding movement of the slide member 58 in the slots 59 and 60 so that the wheel 27 remains substantially perfectly stationary during the sliding movement of the slide member 58 until the tang 65 clears the end 69 of the particular tooth 66 so as to permit incremental movement of the wheel 27 in the manner previously described.

The "ten" minute wheel 26 has an opening 70 passing through the hub 71 thereof so that the wheel 26 can be loosely mounted on the shaft means 32. The hub 71 has its left-hand end, as viewed in FIGS. 3 and 5, provided with a recess 72 defining a pair of arcuate ridges 73 separated from each other by an opening or slot 74 at each pair of adjacent ends of the arcuate ridges 73. A torsion spring 75 has one end 76 hooking through an opening 77 passing through the shaft means 32 while the other end means 78 of the spring 75 is disposed in coil relation within the recess 72 so that the outermost coil of the spring 75 is disposed in sliding but frictional driving relation with the inner surface 79 of the arcuate ridges 73 as illustrated by dashed lines in FIG. 7 for the "ten" minute wheel 26. A like spring 75A is provided for a like hub 71A of the "hour" wheel 25 with the spring 75A being provided by full lines in FIG. 6.

The springs 75 and 75A are so constructed and arranged, in a manner hereinafter described, that as the shaft 32 rotates in a counterclockwise direction as illustrated in FIGS. 6 and 7 with the wheels 25 and 26 being restrained from rotating therewith in a manner hereinafter described, the springs 75 and 75A store up energy so that when one or both wheels 26 and 25 are free to move, the stored energy in the respective spring 75 or 75A will cause its particular wheel 26 or 25 to be driven in a counterclockwise direction until movement of such wheel 26 or 25 is restrained as will be apparent hereinafter whereby the shaft means 32 and torsion springs 75 and 75A provide the sole driving means for the wheels 26 and 25 as will be apparent hereinafter.

However, it has been found that when forming the springs 75 and 75A, the springs 75 and 75A should have the inner coils thereon provided with a performing bias that normally tends to cause rotation of the respective wheel 26 or 25 in a counterclockwise direction in FIGS. 6 and 7 while the outermost coils thereof retain a greater degree of compression against the inner wall of the hub 71 or 71A of the wheel 26 or 25 to provide slipping but driving friction therebetween.

This is accomplished by having each of the springs 75 and 75A formed from ribbon stock and wound into an opening 74 of the particular wheel 26 or 25 after the leading end 76 thereof has been fastened to the shaft 32. Such ribbon stock, such as for making the spring 75, should be under tension for approximately the first half of the length of the ribbon material being wound into the recess 72 of the hub 71 of the wheel 26 followed by the remaining length of material being permitted to enter the spring nest or recess 72 free from all restraint. Thus, the inner coils of such wound tension spring 75 will have a preforming bias to tend to rotate the wheel 26 in a counterclockwise direction in FIG. 7 whereas the outer coils thereof will have a greater compressive force against the inner wall 79 of the rib means 73 to provide a driving friction therewith.

It is believed that this method of assembly of the springs 75 and 75A provides the respective torsion springs 75 and 75A with a varying preset characteristic through its various coils. Thus, if the wheel or drum 26 is restrained from turning on the drum shaft 32 and the drum shaft 32 is rotated in a counterclockwise direction as illustrated in FIG. 7, the inner coils of the spring 75 are enabled to store a degree to torque, without any significant reduction in pressure by the outer coils of the spring 75 against the inner diameter 79 of the ridges 73. This store-up of energy in the spring 75 will continue until the "wind-up" begins to release the tension of the outer turns of the coil 75 which at that point the outer turns become free and slip around the inner wall 79 of the recess or spring nest 72. During such slipping, the outer coils of the spring 75 resume their tension and again resume their grip against the inner wall 79 of the recess 72. The inner coils of the spring 75, however, retain a sufficient torque to provide an adequate reserve of power for rotating the wheel 26 when rotational movement of the wheel 26 is permitted as will be apparent hereinafter.

However, it is believed that if the springs 75 and 75A were wound freely into the recesses 72 over the entire length of the springs 75 and 75A, all of the coils would have similar preformed characteristics such that the transfer of any torque from the drum shaft 32 to the springs 75 and 75A causes the torque to be immediately transferred to all coils thereby causing an inter-

mediate slipping of the outer coils in the spring nests 72 and, thus, preventing any adequate storage of power.

In practice, it has been found that the outer free end 78 of the spring 75 or 75A will tend to move from one slot 74 to the other 74 thereby loosing approximately one-half turn of pretension in the spring 75 or 75A. With an adequate length of spring material, the remaining angular storage of torque can be more than adequate for the thirty degree advance in angle which is required of each drum 26 and 25 during their respective incremental movement as will be apparent hereinafter.

An alternate method of assembling the spring material in the recesses 72 and 72A of the wheels 26 and 25 is illustrated in FIG. 9. As illustrated in FIG. 9, the ribbon material 80 is fed through the opening 77 in the shaft means 32 from one slot 74 and back out through the other slot 74 so the two ends 81 and 82 of the ribbon material 80 extends from the hub 71. Subsequently, upon rotating of the shaft means 32 in the direction of the arrow in FIG. 9, the two ends 81 and 82 are respectively drawn into the recess 72. The respective ends 81 and 82 of the ribbon material 80 may be of equal length or in any desired proportional lengths whereby it is believed that the method illustrated in FIG. 9 provides a relatively simple method of forming the springs 75 and 75A after the wheels 26 and 25 have been disposed on the shaft means 32.

A latching member 83 is pivotally carried by the frame means 21 and as illustrated in FIG. 2, has a pair of ears 84 respectively passing through suitable slots in the frame means 21 to permit pivotal movement of the latch member 83 relative thereto. A tension spring 85 has one end 86 interconnected to the latch member 83 and the other end 87 interconnected to the frame means 21 in the manner illustrated in FIGS. 10 and 11 whereby the tension spring 85 tends to pivot the latch member 83 in a downward direction toward the frame means 21.

The latch member 83 has an arm or tang 88 on the right side thereof as illustrated in FIG. 2 and another arm or tang 89 on the other end thereof, the arm 89 having a cross member 90 provided with opposed ends 91 and 92 respectively being received in notches 93 and 94 respectively formed between adjacent and radially outwardly directed rectangular teeth 95 and 96 arranged circumferentially about larger hub portions 97 and 98 of the respective wheels 26 and 25. In this manner the natural force of the tension spring 85 is to pull the latch member 83 in such a direction that the cross member 90 of the arm 89 rests against the hubs 97 and 98 of the wheels 26 and 25 between adjacent pairs of teeth 95 and 96 thereof so that further downward movement of the latch member 83 relative to the frame means 21 is prevented from the full line position illustrated in FIGS. 10–12.

In this manner, as long as the cross member 90 of the arm 89 of the latch member 83 is disposed between adjacent pairs of teeth 95 and 96 on the wheels 26 and 25 as illustrated in FIG. 3, the torsion springs 75 and 75A cannot rotate the wheels 26 and 25 as the teeth 95 and 96 are abutting against the cross member 90 even though the shaft means 32 is being continuously rotated by the timer motor 28.

However, the "unit" wheel 27 carries a cam member 99 which is engageable against the arm 88 of the latch member 83 in the manner illustrated in FIG. 12 during the incremental movement of the wheel 27 from its "9" indicating position back to its "0" indicating position where the cam member 99 momentarily moves from the full line position illustrated in FIG. 12 to the dash-dotted line position illustrated in FIG. 12, causing a camming of the latch member 83 momentarily upwardly to the dotted line position thereof and then back to its full line position.

In this manner, the cam 99 is adapted to move the latch member 83 upwardly in FIG. 12 a sufficient distance to cause the end 91 of the cross member 90 to rise above the height of a particular tooth 95 on the wheel 26 so that the stored energy in the spring 75, once the arm 90 has cleared the particular tooth 95, will rotate the wheel 26 only one increment because the tension spring 85 will again pull the latch member 83 downwardly once the latch member 83 has its member 90 clear one tooth 95 so that the member 90 will again be inserted in the next notch 93 of the wheel 26 so that the wheel 26 will only move one increment when the latch member 83 is momentarily moved upwardly by the cam member 99. In order to insure that the wheel 26 will move only one increment when the latch member 83 is moved upwardly by the cam member 99 on the wheel 27, the wheel 26 is provided with an outer circumferential row of a plurality of radially disposed and inwardly directed teeth 100 providing spacing 101 therebetween so that when the cross member 90 of the latch member 83 is moved upwardly to clear the teeth 95, the cross member 90 is moved into a notch 101 between adjacent teeth 100 so that the wheel 26 cannot advance more than one increment of movement since an upper tooth 100 will engage against the cross member 90 or a lower tooth 95 will engage against the same depending upon the position of the cross member 90 at that particular time in the incremental movement of the wheel 26.

When the arm 90 clears a tooth 95 on the wheel 26 by the cam member 99 moving the latch member 83 upwardly during each complete revolution of the "unit" minute wheel 27, the "hour" wheel 25 should not move with the "ten" minute wheel 26 except only after every one-half revolution of the wheel 26 whereby the teeth 96 on the wheel 25 are so constructed and arranged that the same will not be cleared by the end 92 of the cross member 90 of the latch member 83 when the cross member 90 just clears the teeth 95 of the wheel 26 whereby the wheel 25 is still restrained from rotating by its teeth 96. In order to insure that the cross member 90 will not be raised to too great an extent to clear the teeth 96 on the wheel 25, certain of the spaces or notches 101 between the teeth 100 on the wheel 26 are filled with ribs 102 to prevent the cross member 90 from moving upwardly into the notch 101 to a degree to permit the cross member 90 to clear the teeth 96 on the wheel 25.

However, when the wheel 26 is to be moved one increment from its "five" indicating position to its next "zero" indicating position, the particular tooth 95 being cleared by the cross member 90 has a cam extension 102 thereon which, when engaged by the end 91 of the cross member 90 of the latch member 83 when the

same is being raised by the timer or cam means 99 on the wheel 27, will cam the latch member 83 further upwardly by the force of the wheel 26 now being rotated in a counterclockwise direction in FIG. 7 by the stored energy of the spring 75 and, since the corresponding notch 101 at the cam extension 102 is not provided with rib 102, the cross member 90 of the latch member 83 can be raised sufficiently that the same will have its end 92 clear a tooth 96 on the "hour" wheel 25 so that wheel 25 can be advanced one increment by its torsion spring 75A. In order to assure that the wheel 25 will only be advanced one increment during such movement of the latch member 83, inwardly directed teeth 104 are provided on the wheel 25 in a manner similar to the teeth 100 on the wheel 26 so that the teeth 104 provide a safety means whereby the wheel 25 will only turn one increment each time the latch member 90 reaches a tooth 95 on the wheel 26 that has the cam extension 103 thereon, which situation occurs at every half revolution of the "ten" minute wheel 26.

Thus, it can be seen that during the operation of the clock structure 20, the shaft means 32 is being continuously rotated by the timer motor 28 in a counterclockwise direction in FIGS. 6, 7, 10, 11 and 12 while causing incremental movement of the "unit" minute wheel 27 through the driving dog 44 and slide member 58 in the manner previously described so that for every complete revolution of the shaft means 32, the wheel 27 will make ten increments of movements thereof from a "zero" position thereof back to a "zero" position thereof and when the wheel position of the wheel 27 moves from a "nine" position thereof to a "zero" position thereof, the timing member or cam 99 will cause an actuation of the latch means 83 which permits the wheel 26 to move one increment and when the wheel 26 is changing from a "five" indicating position thereof to a "zero" indicating position thereof, the wheel 26 will have a cam member 103 thereof further camming the latch member 83 to permit the "hour" wheel 25 to make one increment of movement thereof.

Thus, the wheels 27, 26 and 25 are respectively being driven by the shaft 32 only through the stored energy in the individual spring means 46, 75 and 75A so that at the time of a complete change-over for moving the wheel 25 one increment, no greater loading is imposed on the shaft 32 as in the prior art whereby the three wheels 27, 26 and 25 will all advance at a rapid rate under the influence of the respective torsion springs 46, 75 and 75A at what may be considered as an instantaneous and synchronized change in the setting of the indicated time of the clock 20. For example, when the clock mechanism is indicating the time 9 hours and 59 minutes as illustrated in FIG. 1, all three wheels 27, 26 and 25 will slip one increment relative to the panel 22 to indicate ten o'clock and such movement of all three wheels 27, 26 and 25 provides no greater loading on the shaft 32 than when the same is merely moving the wheel 27 while the other wheels 26 and 25 are remaining stationary.

Accordingly, it can be seen that this invention not only provides an improved digital clock mechanism, but also this invention provides improved parts for such a clock mechanism and improved methods of operating such a clock mechanism and making the parts thereof.

While the form of the invention now preferred has been disclosed as required by the patent statute, other forms may be utilized all coming within the scope of the claims which follow.

What is claimed is:

1. A digital clock comprising a frame means carrying a rotatable shaft and a timer for rotating said shaft at a predetermined rate, a plurality of time indicating wheel means rotatably mounted on said shaft, a first drive means carried by said shaft and being operatively associated with one of said wheel means for incrementally rotating said one wheel means relative to said shaft on a time basis as said shaft rotates, other drive means operatively associated with said shaft and the remaining wheel means to tend to rotate said remaining wheel means as said shaft rotates, and latch means operatively associated with said one wheel means and said remaining wheel means for holding said remaining wheel means from rotating relative to said frame means except in a timed relation to the incremental movement of said one wheel means, said latch means comprising a single latch member pivotally mounted to said frame means.

2. A digital clock as set forth in claim 1 wherein said one wheel means comprises a "unit" minute indicator.

3. A digital clock as set forth in claim 2 wherein said remaining wheel means comprises two wheel means one of which comprises a "ten" minute indicator while the other comprises an "hour" indicator.

4. A digital clock as set forth in claim 3 wherein said one wheel means is numbered from "0" to "9" about its outer periphery, said "ten" minute indicator wheel means is numbered from "0" to "5" in two series about its outer periphery, and said "hour" indicator wheel means is numbered from "1" to "12" about its outer periphery.

5. A digital clock as set forth in claim 4 wherein said timer and said shaft are so constructed and arranged that said shaft makes one revolution every 10 minutes.

6. A digital clock as set forth in claim 1 wherein said first drive means comprises a torsion spring operatively interconnected to said shaft at one end of said spring and drivingly interconnected to said one wheel means at the other end thereof to tend to rotate said one wheel means as said shaft rotates.

7. A digital clock as set forth in claim 1 wherein said other drive means comprises torsion spring means having one end means operatively interconnected to said shaft and having the other end means thereof drivingly interconnected to said remaining wheel means to tend to rotate said remaining wheel means as said shaft rotates.

8. A digital clock as set forth in claim 7 wherein said remaining wheel means comprises a pair of wheel means and said other drive means comprises a torsion spring for each of said wheel means of said pair thereof.

9. A digital clock as set forth in claim 8 wherein each torsion spring has an inner end means interconnected to said shaft and an outer end means disposed in sliding and compressed relation against its respective wheel means so as to tend to cause rotation of the respective wheel means as said spring is being rotated by said shaft.

10. A digital clock comprising a frame means carrying a rotatable shaft and a timer for rotating said shaft

at a predetermined rate, a plurality of time indicating wheel means rotatably mounted on said shaft, a first drive means carried by said shaft and being operatively associated with one of said wheel means for incrementally rotating said one wheel means relative to said shaft on a time basis as said shaft rotates, other drive means operatively associated with said shaft and the remaining wheel means to tend to rotate said remaining wheel means as said shaft rotates, and latch means operatively associated with said one wheel means and said remaining wheel means for holding said remaining wheel means from rotating relative to said frame means except in a timed relation to the incremental movement of said one wheel means, said other drive means comprising torsion spring means having one end means operatively interconnected to said shaft and having the other end means thereof drivingly interconnected to said remaining wheel means to tend to rotate said remaining wheel means as said shaft rotates, said remaining wheel means comprising a pair of wheel means and said other drive means comprising a torsion spring for each of said wheel means of said pair thereof, each torsion spring having an inner end means interconnected to said shaft and an outer end means disposed in sliding and compressed relation against its respective wheel means so as to tend to cause rotation of the respective wheel means as said spring is being rotated by said shaft, each torsion spring being coiled upon itself between said shaft and its respective wheel means, each torsion spring having its inner coils providing a performing bias to tend to rotate said respective wheel means and having its outer coils providing a greater degree of compression against said respective wheel means to drivingly interconnect said spring thereto while permitting sliding movement therebetween.

11. A digital clock as set forth in claim **10** wherein each torsion spring has said inner coils thereof formed under tension and has said outer coils formed freely.

12. A digital clock comprising a frame means carrying a rotatable shaft and a timer for rotating said shaft at a predetermined rate, a plurality of time indicating wheel means rotatably mounted on said shaft, a first drive means carried by said shaft and being operatively associated with one of said wheel means for incrementally rotating said one wheel means relative to said shaft on a time basis as said shaft rotates, other drive means operatively associated with said shaft and the remaining wheel means to tend to rotate said remaining wheel means as said shaft rotates, and latch means operatively associated with said one wheel means and said remaining wheel means for holding said remaining wheel means from rotating relative to said frame means except in a timed relation to the incremental movement of said one wheel means, said first drive means comprising a torsion spring operatively interconnected to said shaft at one end of said spring and drivingly interconnected to said one wheel means at the other end thereof to tend to rotate said one wheel means as said shaft rotates, said first drive means also comprising another latch means, said other latch means being operatively associated with said shaft and said one wheel means to cause incremental latching and unlatching of said one wheel means relative to said frame means whereby said one wheel means an incremental movement relative to said frame means each time said latch means unlatches said one wheel means to cause said torsion spring to move said one wheel means relative to said shaft.

13. A digital clock as set forth in claim **2** wherein said other latch means comprises a stationary member having a plurality of teeth about its outer periphery, a slide member movably carried by said one wheel means and having a tang serially engageable with said teeth, and a drive member operatively interconnected to said shaft to rotate in unison therewith and being operatively interconnected to said slide member to cause the same to slide relative to said one wheel means and its tang to slide relative to a respective tooth of said stationary member to cause said one wheel means to be latched from movement relative to said frame means until said tang clears that respective tooth to unlatch said one wheel means and have said torsion spring rotate said one wheel means one increment until said tang engages the next adjacent tooth on said stationary member that latches said one wheel means from movement until that tooth is cleared by said tang in the above manner.

14. A digital clock as set forth in claim **13** wherein each tooth of said stationary member provides a profile to said tang of said slide member when engaged thereby that is parallel to the sliding movement of said slide member relative to said one wheel means.

15. A digital clock as set forth in claim **13** wherein said stationary member has ten such teeth about its outer periphery whereby said one wheel means makes ten increments of movement relative to said frame means for each revolution of said shaft relative to said frame means.

16. A digital clock comprising a frame means carrying a rotatable shaft and a timer for rotating said shaft at a predetermined rate, a plurality of time indicating wheel means rotatably mounted on said shaft, a first drive means carried by said shaft and being operatively associated with one of said wheel means for incrementally rotating said one wheel means relative to said shaft on a time basis as said shaft rotates, other drive means operatively associated with said shaft and the remaining wheel means to tend to rotate said remaining wheel means as said shaft rotates, and latch means operatively associated with said one wheel means and said remaining wheel means for holding said remaining wheel means from rotating relative to said frame means except in a timed relation to the incremental movement of said one wheel means, said other drive means comprising torsion spring means having one end means operatively interconnected to said shaft and having the other end means thereof drivingly interconnected to said remaining wheel means to tend to rotate said remaining wheel means as said shaft rotates, said remaining wheel means comprising a pair of wheel means and said other drive means comprising a torsion spring for each of said wheel means of said pair thereof, said latch means being adapted to cause incremental latching and unlatching of each of said pair of wheel means relative to said frame means in a timed relation to said incremental movement of said one wheel means whereby said wheel means of said pair thereof make incremental movement relative to said frame means when said latch means unlatches the respective wheel means to cause its torsion spring to move that wheel means relative to said shaft.

17. A digital clock as set forth in claim 16 wherein said latch means comprises a latch member movably carried by said frame means and being movable between a latching position for said pair of wheel means and respective unlatching positions for said pair of wheel means, said one wheel means having time means operatively associated with said latch member for tending to move said latch member from said latching position thereof to both of said unlatching positions thereof in a timed relation to movement of said one wheel means.

18. A digital clock as set forth in claim 17 wherein one of said wheel means of said pair thereof has means for preventing said latch member from moving to its unlatching position for the other wheel means of said pair thereof except in a timed relation to movement of said one wheel means of said pair thereof.

19. A digital clock as set forth in claim 18 wherein said one wheel means makes one complete revolution before said time means thereof causes said latch member to move to its unlatching position for said one wheel means of said pair thereof.

20. A digital clock as set forth in claim 19 wherein said means of said one wheel means of said pair thereof permits said latch member to move to its unlatching position for said other wheel means of said pair each one-half revolution of said one wheel means of said pair thereof.

21. A drive means for a digital clock or the like comprising a shaft adapted to be rotatably carried by a frame means and be continuously rotated in one direction by a timer motor, a time indicating wheel means rotatably mounted on said shaft, and a coiled torsion spring having an inner end means thereof operatively interconnected to said shaft and having an outer end means disposed in sliding and frictional engagement with said wheel means to tend to cause rotation of said wheel means in said one direction as said shaft is rotated in said one direction, said torsion spring being coiled upon itself between said shaft and said wheel means, said torsion spring having its inner coils providing a performing bias to end to rotate said wheel means in said one direction relative to said shaft and having its outer coils providing a greater degree of compression against said wheel means to drivingly interconnect said spring thereto while permitting sliding movement therebetween.

22. A drive means as set forth in claim 21 wherein said torsion spring has said inner coils thereof formed under tension and has said outer coils formed freely.

23. A drive means for a digital clock or the like comprising a frame means, a shaft rotatably carried by said frame means and being adapted to be continuously rotated in one direction by a timer motor, a time indicating wheel means rotatably mounted on said shaft, a torsion spring operatively interconnected to said shaft at one end of said spring and drivingly interconnected to said wheel means at the other end thereof to tend to rotate said wheel means in said one direction as said shaft rotates in said one direction, a latch means carried by said frame means, said latch means being operatively associated with said shaft and said wheel means to cause incremental latching and unlatching of said wheel means relative to said frame means whereby said wheel means makes an incremental movement relative to said frame means each time said latch means unlatches said wheel means to cause said torsion spring to move said wheel means relative to said shaft, said latch means comprising a stationary member having a plurality of teeth about is outer periphery, a slide member movably carried by said wheel means and having a tang serially engageable with said teeth, and a drive member operatively interconnected to said shaft to rotate in unison therewith and being operatively interconnected to said slide member to cause the same to slide relative to said wheel means and its tang to slide relative to a respective tooth of said stationary member to cause said wheel means to be latched from movement relative to said frame means until said tang clears that respective tooth to unlatch said wheel means and have said torsion spring rotate said wheel means one increment in said one direction until said tang engages the next adjacent tooth on said stationary member that latches said wheel means from movement until that tooth is cleared by said tang in the above manner.

24. A drive means as set forth in claim 23 wherein each tooth of said stationary member provides a profile to said tang of said slide member when engaged thereby that is parallel to the sliding movement of said slide member relative to said wheel means.

25. A drive means as set forth in claim 24 wherein said stationary member has ten such teeth about its outer periphery whereby said wheel means makes ten increments of movement relative to said frame means for each revolution of said shaft relative to said frame means.

26. A drive means as set forth in claim 23 wherein said slide member has a notch therein receiving said drive member whereby rotational movement of said drive member causes sliding movement of said slide member.

27. A drive means as set forth in claim 23 wherein said one of said torsion spring is interconnected to said drive member.

28. A drive means as set forth in claim 23 wherein said wheel means has two pairs of spaced ears disposed in spaced apart aligned relation, said slide member being slidable in the space between each pair of ears to be guided thereby.

29. A drive means as set forth in claim 28 wherein said slide member has a notch therein receiving said drive member whereby rotational movement of said drive member cause sliding movement of said slide member in the space between each pair of ears.

30. A drive means as set forth in claim 29 wherein said notch in said slide bar is located in the space between said aligned pairs of ears.

31. A method for driving time indicating wheel means of a digital clock or the like comprising the steps of rotatably mounting said wheel means on a shaft that is rotatably mounted to a frame means, continuously driving said shaft in one direction by a timer motor, incrementally rotating one of said wheel means relative to said shaft on a time basis as said shaft rotates by a first drive means operatively interconnected to said shaft and to said one wheel means, and incrementally rotating the remaining wheel means in a timed relation to the incremental movement of said one wheel means by other drive means operatively interconnected to said shaft and to said remaining wheel means, said step of incrementally rotating said remaining wheel means

including the steps of holding said remaining wheel means from rotating relative to said frame means by a single latch member pivotally mounted to said frame means and unlatching said latch means from said remaining wheel means by pivoting said latch member in a timed relation to the incremental movement of said one wheel means.

32. A method as set forth in claim **31** wherein said steps of incrementally rotating said wheel means relative to said shaft comprises the step of operatively interconnecting said wheel means to said shaft with torsion spring means.

33. A method for driving time indicating wheel means of a digital clock or the like comprising the steps of rotatably mounting said wheel means on a shaft that is rotatably mounted to a frame means, continuously driving said shaft in one direction by a timer motor, incrementally rotating one of said wheel means relative to said shaft on a time basis as said shaft rotates by a first drive means operatively interconnected to said shaft and to said one wheel means, and incrementally rotating the remaining wheel means in a timed relation to the incremental movement of said one wheel means by other drive means operatively interconnected to said shaft and to said remaining wheel means, said step of incrementally rotating said remaining wheel means including the steps of holding said remaining wheel means from rotating relative to said frame means by latch means and unlatching said latch means from said remaining wheel means in a timed relation to the incremental movement of said one wheel means, said steps of incrementally rotating said wheel means relative to said shaft comprising the step of operatively interconnecting said wheel means to said shaft with torsion spring means, said step of operatively interconnecting said wheel means to said shaft with torsion spring means including the step of operatively interconnecting each wheel means to said shaft with a separate torsion spring.

34. A method of making a drive means for a digital clock or the like comprising the steps of providing a shaft adapted to be rotatably carried by a frame means and be continuously rotated in one direction by a timer motor, rotatably mounting a time indicating wheel means on said shaft, interconnecting a coiled torsion spring to said shaft and said wheel means by operatively interconnecting an inner end means of said spring to said shaft and disposing an outer end means of said spring in sliding and frictional engagement with said wheel means to tend to cause rotation of said wheel means in said one direction as said shaft is rotated in said one direction, and coiling said torsion spring upon itself between said shaft and said wheel means so that said torsion spring has its inner coils providing a performing bias to tend to rotate said wheel means in said one direction relative to said shaft and has its outer coils providing a greater degree of compression against said wheel means to drivingly interconnect said spring thereto while permitting sliding movement therebetween.

35. A method as set forth in claim **34** wherein said coiling step forms said inner coils under tension and forms said outer coils freely.

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