Nov. 30, 1965 E. CAPPELLARI 3,220,174

SPRINGLESS, TILTING PLATES CLOCK DRIVEN BY TWO OVAL GEARS

Filed March 3, 1964 4 Sheets-Sheet 1

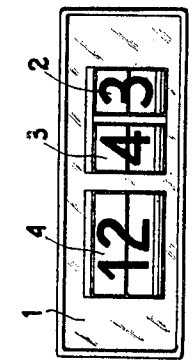


Fig.1

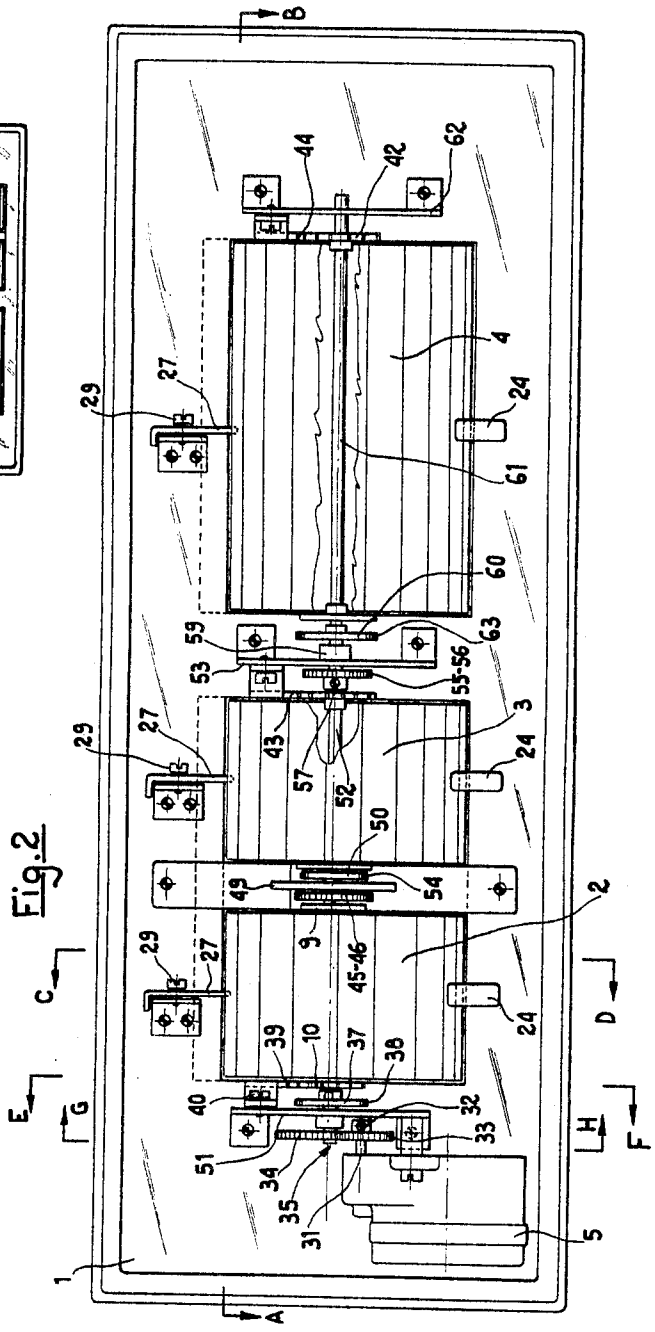


Fig.2

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SPRINGLESS, TILTING PLATES CLOCK DRIVEN BY TWO OVAL GEARS

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Fig.3

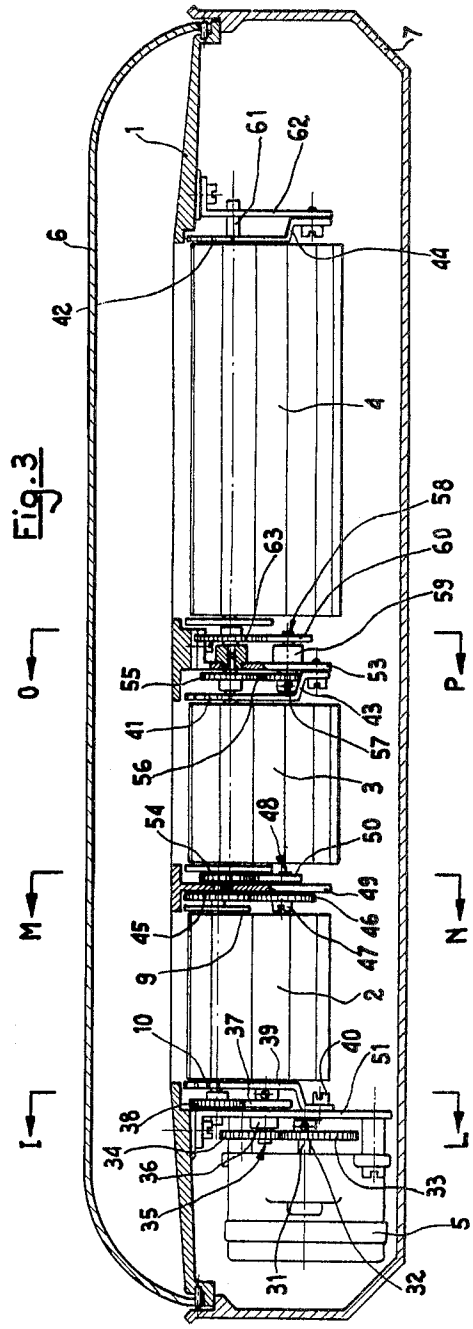


Fig.11

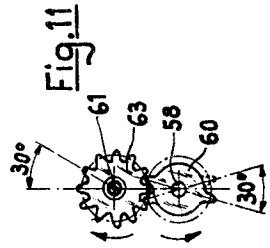


Fig.10

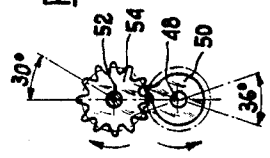
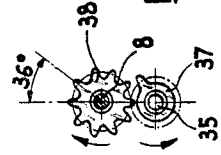


Fig.9



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SPRINGLESS, TILTING PLATES CLOCK DRIVEN BY TWO OVAL GEARS

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Fig.4

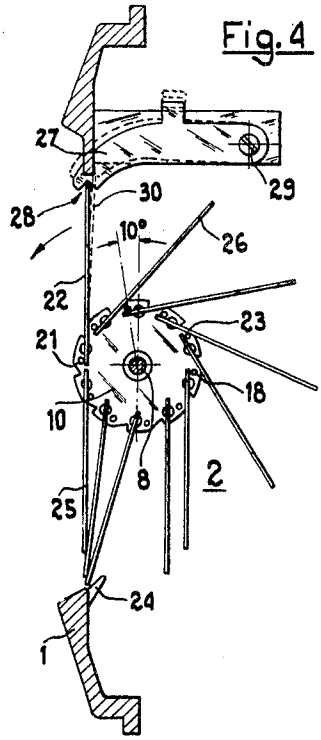


Fig.5

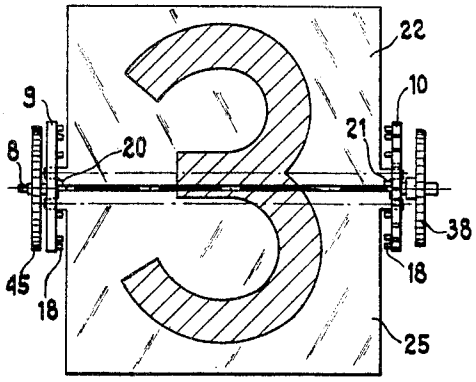


Fig.6

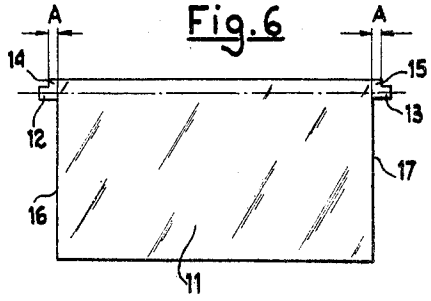


Fig.7

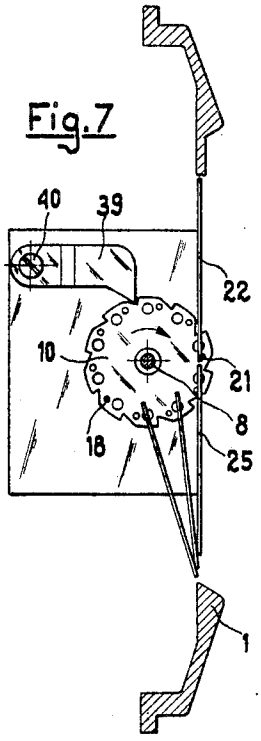


Fig.8

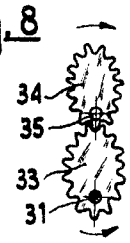
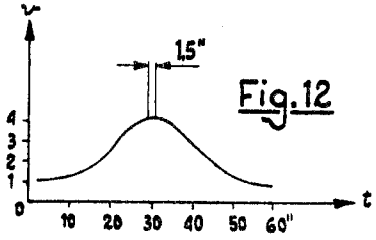


Fig.12



SPRINGLESS, TILTING PLATES CLOCK DRIVEN BY TWO OVAL GEARS

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Fig.13

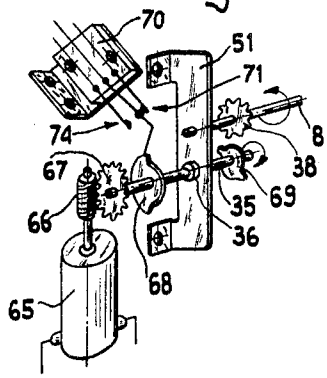


Fig.14

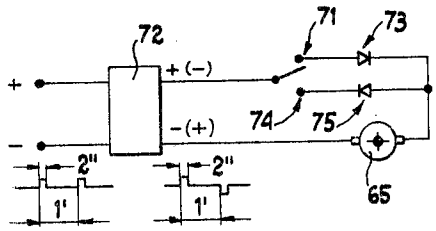


Fig.15

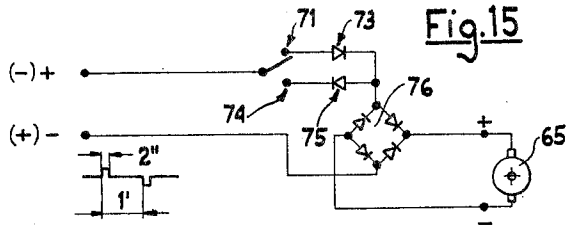


Fig.16

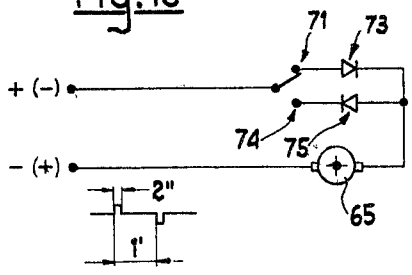
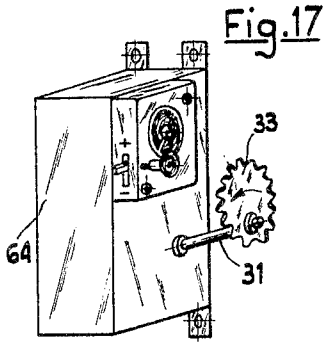


Fig.17



United States Patent Office 3,220,174 Patented Nov. 30, 1965

3,220,174

SPRINGLESS, TILTING PLATES CLOCK DRIVEN BY TWO OVAL GEARS

Elio Cappellari, Milan, Italy, assignor to Enrico Boselli S.p.A., Milan, Italy, an Italian joint-stock company

Filed Mar. 3, 1964, Ser. No. 349,082
Claims priority, application Italy, Mar. 6, 1963, 4,731/63, Patent 689,108
6 Claims. (Cl. 58—2)

This invention relates to a springless clock, having tilting plates hinged on horizontally rotary drums and carrying the hours and minutes indications, and driven by two oval gears.

As already well known, such clocks of the prior art are comprisive of tilting plates hinged on vertically revolving drums, where said plates are guided and driven by spiral springs, being the minute units drum driven by quick tripping systems, whereby the plates are subjected to dynamic stresses, while the drive of decade drum is derived from the drive of unit drum by means of cams or of cams and of a kinematism consisting of a lever, a pawl and a driving spring, and the drive of hours drum is derived from the main drive mechanism either directly or through a similar system comprisive of cams and of a kinematism consisting of a lever, pawl, ratchet wheel and driving spring. In said clocks, the hours are indicated by number larger than those of the minutes, whereby the readings can be made only from a distance smaller than that from which the hours would be clearly visible.

The above and further drawbacks are obviated by this invention, that consists in a tilting plates type clock, characterized in that the plates are hinged on horizontal drums, and are tilted by two side pins, acting against the end of each plate, near to rotation center thereof, pushing same plate beyond the vertical, whereby it is tilted without need of springs; that the minute units drum is driven by a motor, that causes the quick indexing thereof through two oval gears which are pivoted on two opposite foci; that the drive of minute decades drum is derived from the unit minutes drum through conventional gears and a one-tooth gear; that the drive of hour units drum is derived from that of minute decades drum in a manner similar to the previously described one, without need to have recourse, neither directly nor indirectly to main driving mechanism; that the size of hour numbers is similar to that of minute numbers, whereby both indications can be read from the same distance.

The above and further objects and advantages of the invention will be better appreciated from a consideration of the following description of a preferred embodiment form thereof, taken with the accompanying drawings, being both description and drawings given only as a not restrictive example. In same drawings:

FIG. 1 is a front view of the clock according to the invention.

FIG. 2 is a rear view of the clock dial, with tilting plates, supports and driving mechanism.

FIG. 3 is a cross-section of clock, taken on the line A–B of FIG. 2.

FIG. 4 is an enlarged partial section, taken on the line C–D of FIG. 2.

FIG. 5 shows a plate supporting roller, with two plates only, that are hinged on supporting disks.

FIG. 6 shows a structural detail of a tilting plate.

FIG. 7 is a partial section taken on the line E–F of FIG. 2.

FIG. 8 is a partial section taken on the line G–H of FIG. 2.

FIG. 9 is a partial section, taken on the line I–L of FIG. 3.

FIG. 10 is a partial section, taken on the line M–N of FIG. 3.

FIG. 11 is a partial section taken on the line O–P of FIG. 3.

FIG. 12 is the diagram showing the variation of speed of driven oval gear, as function of the time.

FIG. 13 shows the driving device of the minute units drum, powered by a D.C. small motor, that is fed by current pulses which are sent each minute from a centralized timing plant.

FIG. 14 is the connection diagram of the driving arrangement as shown in the FIG. 13, by assuming that unidirectional pulses be sent each minute, and that the D.C. motor be of the series-wound type.

FIG. 15 is the connexion diagram of the driving arrangement as shown in the FIG. 13, by assuming that polarized pulses be sent each minute, and that the D.C. motor be of the shunt-wound type.

FIG. 16 is the connection diagram of the driving arrangement as shown in the FIG. 13, by assuming that polarized pulses be sent each minute, and that the D.C. motor be of the series-wound type.

FIG. 17 shows the driving mechanism, consisting of a balance movement, for the minute plate drum.

Referring now in particular to FIGS. 1 and 2 of accompanying drawings, the clock according to this invention essentially consists of a panel-dial **1**, that serves also as support for the tilting plate drums **2**, **3**, **4**, and that shows three windows in which the tilting plates successively appear; of the driving mechanism **5**; of the means by which the drums are connected with one another; of a protective transparent casing **6** for the dial, and of a case **7** wherein all mechanisms as fitted on the dial rear side are enclosed.

The tilting plate drum **2**, as shown in FIGS. 4 and 5, consists of a shaft **8**, whereon two disks **9** and **10** are keyed, being each of such disks formed with 10 holes, located near their outer edge, and spaced 36 deg. from one another.

As shown in the FIG. 6, each plate of drum **2** is made of a flat metal or plastic sheet, and consists of a middle section **11**, of two oppositely directed side pins **12** and **13**, extending into the holes **9** and **10**, and acting as journal pins; of two stepped sections **14** and **15**, that extend from the two vertical sides of the plate **16** and **17**, for an amount A slightly larger than the length of small pins **18**, that are secured on the disks **9** and **10**. The pins **18** are provided, i.e. in a number equal to that of the holes as formed on the disks **9** and **10**, and to that of plates, being same pins located in the positions as shown in the FIG. 4, i.e. along a circle having a diameter slightly larger than that along which the holes wherein the plates are journalled, are formed, and again at a center-to-center spacing of 36 deg., but staggered of ab. 10 deg. in anticlockwise direction, in respect of latter holes.

The pins **18** are fitted, in both disks **9** and **10**, in the same locations in respect of the holes of related disk; however, they are directed towards the plate. As shown in the FIGS. 4 and 5, each pair of opposite pins **20** and **21**, acting on the same plate **22**, are designed to exert a thrust against the plate stepped sections **14** and **15**, and since latter sections are located below the center of rotation of plate, this latter is caused to rotate in the direction of the arrow.

All other pins **18** of both disks **9** and **10**, by acting on the stepped sections **14** and **15** of related plates, that momentarily are on the upper half of drum, will keep them in their proper positions, thereby preventing that the rear end of a plate, e.g. the end **23**, may strike against the surface of the preceding plate.

The lip **24**, that extends from the panel-dial **1**, is intended to prevent all possible swinging motions of the

plate 25 that is tilted after each indexing of drum, and to act as an extension of same plate 25, directed downwardly in an approximately vertical direction.

At each indexing of drum 2 around its axis 8, the plate 22, due to thrust exerted by the rungs 20 and 21, will lift the pawl 27, which end is formed with a notch 28, having two sides inclined at ab. 90 deg., and that is loose fitted on the pin 29.

After the drum 2 has been indexed for ab. 3 deg., the plate 22 will be released from the pawl 27, and since it has been turned, in the meantime, beyond the vertical line, a tilting for ab. 180 deg. thereof takes place, due to the force of gravity, whereby it takes the place of plate 25. Simultaneously, due to the action of same rungs 18, and of further indexing of drum 2, the plate 26 will be also advanced in the same direction of the arrow, thus lifting again the pawl 27, owing to the downward crooked shape thereof. When the position shown by broken lines 30 is taken by the plate 26, i.e. after it has been lifted above the lowest end of pawl 27, same plate will be moved toward its vertical position, due to the action of the inclined plane, of notch 28 and of the weight of pawl, and more precisely it will be moved into the upper apex of said notch 28. The plate can freely perform such small rotation in the forward direction, since such motion takes place in the direction as allowed by the pins 18.

Finally, it must be observed that the plate can be freely tilted for ab. 180 deg., as stated above, because the length of pins 18 is smaller than the already stated level A.

A special feature of the above described type of plates, and of the arrangement thereof on horizontal drums, consists in the fact that same plates are tilted by the mere force of gravity, and that the plate supporting disks can be suitably masked on the front side of dial.

The above described operation of drum 2, having ten tilting plates that are numbered from 0 to 9 inclusive, is referred to that of minute figures.

Such operation is similar to that of minute decade drum 3, that consists of 12 plates, numbered from 0 to 5 inclusive for two successive times, as well as to that of hour drum 4, carrying 12 or 24 plates, that respectively are numbered from 1 to 12 inclusive, or from 0 to 23 inclusive, and that therefore are not again described, for brevity's sake.

The minute unit drum 2 is driven by the shaft 31, that is powered by a synchron motor 5 at the speed of one complete turn per minute.

The oval gear 33 (FIGS. 2, 3, 8) fast with the shaft 31 by means of the pressure screw 32, is in mesh with a further oval gear 34, keyed on the shaft 35, that is supported by the bearing 36, and whereon the one tooth gear is also keyed.

Said one tooth gear 37 gets engaged at each revolution with a tooth of gear 38 that is keyed on the shaft 8, and remains engaged therewith for 36 deg. and since 10 teeth are formed on said gear 38, an angular rotation of 36 deg. will be also accomplished by the shaft 8. Consequently, owing to what is stated above, a new pair of plates, carrying the number subsequent to preceding one, according to already described progressive and cyclic numbering, shall appear in the window of dial 1.

Should a uniform rotary motion be imparted to shaft 35, then the time as required to have the drum 2 indexed by 1/10 of turn would be of 60 sec./10=6 sec. which is too long.

Conversely, by the provision of the two oval gears 33 and 34, a speed variable according to diagram shown in FIG. 12 is imparted to shaft 35 whereby, by adjusting the one tooth gear 37 in such a manner as to get engaged with the gear 38 when the shaft 35 is turning at its max. angular speed, then the time as required to have the drum 2 indexed by 1/10 of turn, becomes 6 sec./4=1.5 seconds, which is wholly admissible, with the added advantage that such indexing of drum 2—and also of all other drums, as stated hereinafter—takes place under the form of an approximately uniform motion, and without submitting the plates to noticeable dynamic stresses.

To prevent that the drum 2 may be turned backward, owing to the weight of plates, after the one tooth gear 37 has been disengaged from the gear 38, the outer contour of disk 10 is formed with 10 saw tooth notches, with which gets engaged the pawl 39 (FIG. 7), that is kept against the disk by its own weight, and that is pivotally fitted on the threaded pin 40. For the same reason, as many saw tooth notches as the plates are, are cut on the outer contour of the two disks 41 and 42 of minute decades and of hours, and the pawls 43 and 44 are designed to get engaged therewith, thereby preventing the related plate drums from turning backward.

As stated before, at each indexing of drum, and angular motion of 36 deg. is imparted to gear 45 which, as shown in FIGS. 3 and 5, is keyed on the shaft 8. Such motion is transmitted, in the ratio 1:1, to gear 46, which which the former gear is engaged, and that is secured by the pressure screw 47, to the shaft 48, which is laid on the bearing 49, and whereon the one tooth gear 50 is also keyed.

At each whole turn of shaft 8 of the minute unit drum 2, that is laid on bearings 49 and 51, one whole turn is also accomplished by the one tooth gear 50, which is brought in the position as shown in the FIG. 10 when the plate carrying the number 9 appears in the plate window (see FIG. 4).

A gear 54, having 12 teeth, is keyed on the shaft 52 of the minute decade drum 3, which is laid in the bearings 49 and 53.

At the next indexing by 36 deg. of drum 2, the one tooth gear 50 gets engaged with the gear 54, thereby causing the shaft 52 of minute decade drum 3 to be turned by 30 deg. and reaching then the position as shown with broken lines in the FIG. 10.

As a consequence thereof, the number 0 will appear on the plates 22 and 25 of drum 2, while a decade number increased by one unit appears on the plates of drum 3.

The gear 55, also keyed on the shaft 52 of drum 3, gets engaged, in a 1:1 transmission ratio, with the gear 56, that is secured, by means of the pressure screw 57, on the shaft 58, which is laid in the bronze bush 59 carried by the support 53, and whereon the two teeth gear 60 is keyed. The two teeth of said gear 60 are spaced by 180 deg. from one another.

A gear 63, having 12 teeth, is keyed on the shaft 61 of hour drum 4, that is laid on the bearings 53 and 62. One tooth of gear 60 gets engaged with the former gear at each half turn of shaft 58.

When the number 59 appears on the minute plates, then the two teeth gear 60 will be in position as shown in FIG. 11.

At the next indexing by 36 deg. of shaft 8, the shaft 52 will perform an angular motion of 30 deg., the two teeth gear will be brought in the position as shown with broken lines in FIG. 11, while an angular motion, also of 30 deg. is imparted to shaft 61 of hour drum 4. Thus, in point of fact, the above-stated angular motion by 36 deg. of shaft 8 will result in the indexing by one pitch of all the three drums; more precisely, two 0 will appear on the plates of the two minute drums, while the indication of next hour shall appear on the plates of hour drum.

The two pressure screws 47 and 57 allow not only a mutual adjustment of drums, but also the taking-up of gear lost motions.

When 24 plates are carried by the hour drum 4, for the indication of hours from 0 to 23 inclusive, then the gear 63 shall have 24 teeth, and at each half turn of shaft 58, the shaft 61 will perform an angular motion of 15 deg.

In the clock as hereinbefore described, the prime mover is represented by the synchronous small motor, by which the shaft 31 is driven at the speed of one turn per minute. However, recourse may be made, as prime mover, also

to a clockwork **64** (see FIG. 7) of the already well known type, and that is therefore only diagrammatically shown in the accompanying drawing, without describing it. By such a clock work, the shaft **31** will be driven also at the speed of one revolution per minute, and with a uniform motion.

The prime mover may also be a rotary armature polarized relay by which, as consequence of the polarized electrical pulses sent by a centralized timing plant, the shaft **8** of the minute unit drum **2** is turned by 1/10 of turn, at the sixtieth of each minute.

Such type of relay is already well known, whereby a description thereof can be dispensed with.

Finally—and in particular to the purpose of preventing the plates from being subjected to dynamic stresses—the prime mover may be represented by a D.C. small motor **65**, as shown in the perspective view of FIG. 13, and that at each pulse sent at each minute by a centralized timing plant, will impart, by the worm **66** and the worm wheel **67**, a 180 deg. rotary motion to shaft **35**, that is laid in the bronze bush **36** of support **51**, and whereon the cam **68** and the two teeth gear **69** are keyed. In the position as shown in FIG. 13, the micro-diversing switch **70** has been tripped in its contact position **71**, due to the fact that the larger diameter cam track section, having an amplitude of 180 deg., is entered into action while the shaft **35** was being turned.

In such a position, the two teeth of the gear **69** are not engaged with the gear **38** that is keyed on the shaft **8** of minute drum, as clearly shown in the FIG. 13.

When unidirectional current pulses are sent from the centralized timing plant (see FIG. 14), a reversing relay **72**, of the already known type, will provide for the conversion thereof into reversed polarity pulses, as shown in the two additional diagrams of FIG. 14, where the unidirectional pulses fed to relay **72**, and the pulses as delivered by same relay are shown.

When the D.C. motor **63** is of the series-wound type, it will rotate always in the same direction, whatever the polarity of voltage fed to their terminals may be, and due account is taken thereof in the connexion diagrams of FIGS. 14 and 16.

By assuming that the pulses as sent from the centralized timing plant at the sixtieth second of each minute, have a duration of 2 seconds, and that one second is required to have the shaft **35** turned by 180 deg., a pulse sent by the relay **72**, and having a polarity as marked in brackets in the FIG. 14, will pass through the diode **73**, thereby applying a voltage to fractional motor **65**, whereby the shaft **35** shall be moved by half a utrn. After such rotary motion, the arm of micro-diversing switch **70** will find itself on the smaller diameter track portion of cam **68**, thus changing same switch over the contact **74**. In the latter position, though the pulse as sent by the centralized timing plant is acting for one more second, the motor will stop itself, because the current is switched off by the diode **75**.

A tooth of the two teeth gear **69**, that is turned by 180 deg. along with the shaft **35**, gets engaged for 36 deg. with the gear **38**, whereby this latter is turned by 1/10 of revolution.

A new pulse, as reversed by the relay **72**, will cause the shaft **8** of the minute unit drum, to be indexed by 36 deg., whereby the circuit is brought back in the conditions as shown in the drawing, and the operation of clock is further repeated in the already described manner.

If polarized pulses are sent by the centralized timing plant, and if the D.C. motor is of the series-wound type, then the diagram of FIG. 16 is valid, being latter diagram, from the reversing relay **72** onward, similar to diagram of FIG. 14.

Finally, if polarized pulses are again sent by the centralized timing plant, being however the D.C. motor of the shunt-wound type, i.e. wherein the sense of rotation is changed with the polarity, then the diagram of FIG. 15 is valid, wherein unlike the preceding ones, a Groetz bridge rectifier **76** has been added, in order to have a fixed polarity voltage fed to said motor.

While a preferred embodiment form of the invention has been described and shown with some detail, it is to be understood that the description is for the purpose of illustration only, and is not definitive of the limits of the inventive idea. The right is reserved to make such changes in the details of construction and arrangement of parts, as will fall within the purview of the attached claims.

What I claim is:

1. In a horological device: a frame structure including a vertical front wall portion having apertures therein, first, second and third drum assemblies supported for rotation about a common horizontal axis behind said wall portion for displaying time indications through the apertures thereof, each one of said assemblies comprising a shaft supported for rotation around said horizontal axis, two spaced parallel plates secured to said shaft, and a plurality of blades of essentially rectangular shape positioned between said plates, each blade having time indicating indicia thereon and being freely swingably connected to said plates for oscillation about a horizontal axis located adjacent one edge of such blade, the blades being evenly arranged on the plates with the axes of oscillation thereof forming a circle, whereby upon rotation of said assemblies the time indicating indicia sequentially appear at the apertures of said front wall portion as said blades are caused to sequentially drop from an up-turned vertical position to a down-turned vertical position, the blades related to said assemblies being correlated respectively to minutes, tens of minutes and hours, a time-controlled source of rotary motion having an output shaft driven at a rate of speed of one revolution per minute, a first elliptical gear wheel secured to said output shaft, a second elliptical gear wheel in mesh with said first gear wheel and driven thereby in rotation at one revolution per minute at sequentially accelerated and decelerated speeds, and first gear means connecting said second elliptical gear wheel to the shaft of said first assembly for imparting thereto a fractional rotation as said second elliptical gear wheel is accelerated to cause one blade of said first assembly to drop from said up-turned position to said down-turned position, second gear means connecting the shaft of said first assembly to the shaft of said second assembly for imparting to said second assembly a fractional rotation to cause a blade of said second assembly to drop from its up-turned position to its down-turned position as said first assembly has completed one revolution, and third gear means connecting the shaft of said second assembly to the shaft of said third assembly for imparting to said third assembly a fractional rotation to cause a blade of said third assembly to drop from its up-turned to its down-turned position as said second assembly has completed a given rotation, whereby each fractional rotation of each assembly is imparted by a temporarily accelerated motion through the shaft of said first assembly.

2. The combination of claim **1**, wherein the second assembly has ten swingable blades evenly arranged and having impressed faces sequentially impressed to display figures 0 to 5 and then 0 to 5 again, said third gear means connecting the shaft of said second assembly to the shaft of said third assembly to fractionally rotate said third assembly as the second assembly has completed half a revolution.

3. The combination of claim **1**, wherein said blades include oppositely protruding portions defining the axis of oscillation of said blades and protruding abutments on said portions, said plates having a plurality of holes in which said first protruding portions are rotatably accommodated, and inwardly protruding pins positioned on said plates to abut and engage said abutments for urging each blade to said up-turned position as said blade is upwardly rotated upon rotation of the associated assembly.

4. The combination of claim **1**, comprising a shaft se-

cured to said second elliptical gear wheel and driven at cyclically accelerated and decelerated speeds by said first elliptical gear, said first gear means comprising a one-tooth gear secured to said shaft and rotating concurrently with said second elliptical wheel, and a ten-teeth gear meshing with said one-tooth gear and secured to the said first assembly, said one-tooth gear being oriented in angular phased relation with said elliptical gears to engage said ten-teeth gear as said second elliptical gear is rotated at its greatest speed whereby said shaft of said first assembly is caused to rotate 36° as said second elliptical gear has completed one revolution, such that said first assembly and the second assembly driven by said first assembly are driven only when the rotational speed of the second elliptical gear is at its greatest in the cyclical rotary motion thereof.

5. The combination of claim 1, wherein said aperture defines a space coplanarly to two of said blades as in said up-turned and in said down-turned vertical position thereof, a pawl oscillatably supported above said aperture and having a down-turned notch releasably engaging the up-turned blades one by one to maintain such blades in said up-turned position until a further fractional motion of the assembly lowers said blade from engagement in said

notch, causing said blade to fall to its said down-turned vertical position.

6. The combination of claim 5, comprising means integrally formed in said wall portion at the lower edge of said aperture and positioned for temporarily retaining a number of fallen down-turned blades thereon to maintain the last fallen blade in said vertical down-turned position, until a further fractional motion of the assembly pulls one of said fallen blades off said abutment to permit the sequential and concurrent accommodation of the newly fallen blade in said position.

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LEO SMILOW, *Primary Examiner.*