United States Patent [19]

Robinson

[11] **3,924,399**

[45] **Dec. 9, 1975**

[54] **DIGITAL ALARM CLOCK**

[75] Inventor: **Ralph C. Robinson,** Morresville, N.C.

[73] Assignee: **General Time Corporation,** Thomaston, Conn.

[22] Filed: **Dec. 2, 1974**

[21] Appl. No.: **528,659**

Related U.S. Application Data

[60] Continuation of Ser. No. 100,836, Dec. 22, 1970, abandoned, which is a division of Ser. No. 863,886, Oct. 6, 1969, Pat. No. 3,597,918.

[52] **U.S. Cl.** ..... **58/16 D;** 58/125 C; 58/126 E

[51] **Int. Cl.²** **G04B 23/02;** G04C 21/28

[58] **Field of Search** ..... 58/7, 16, 16 D, 19, 21.15, 58/21.155, 125 R, 125 C, 126 R, 126 E; 235/1 C

[56] **References Cited**

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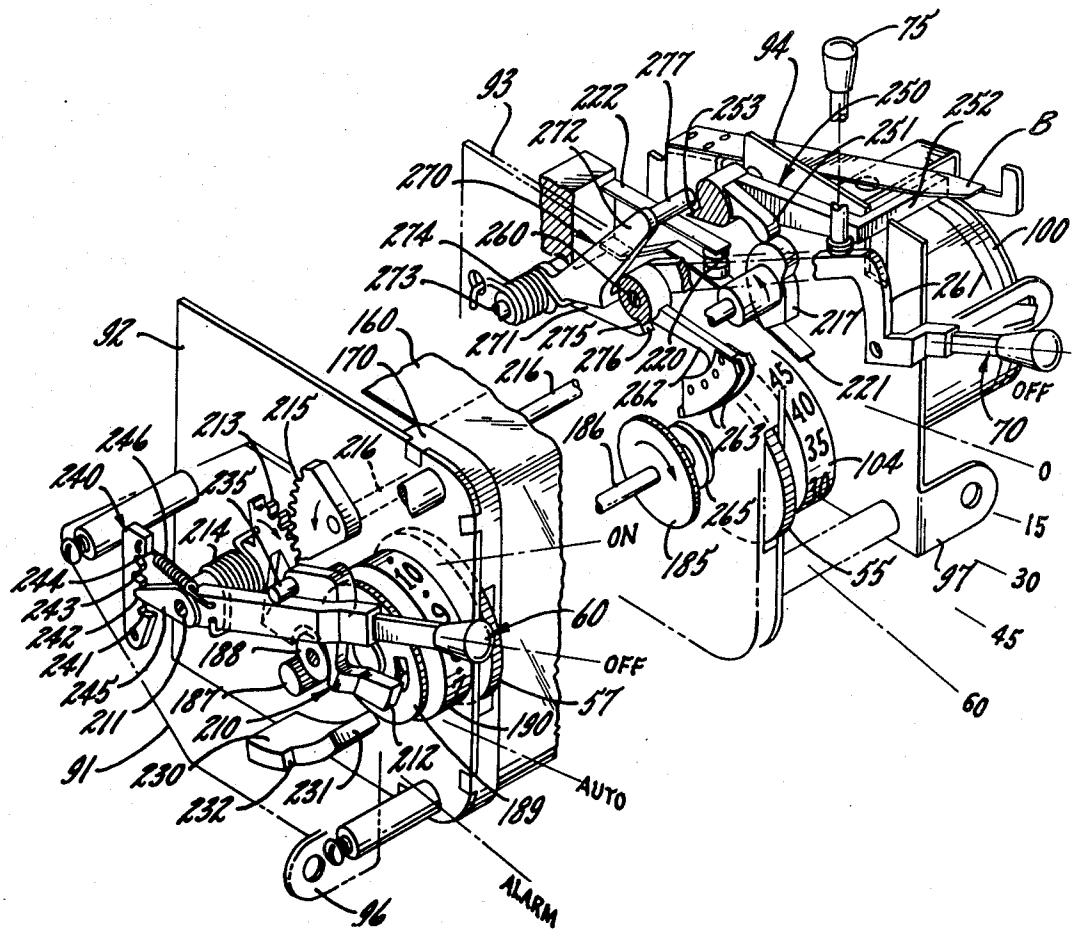
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Primary Examiner—Lawrence R. Franklin
Attorney, Agent, or Firm—Pennie & Edmonds

[57] **ABSTRACT**

A digitally indicating alarm clock having endless loops of tape to provide digital time indication, the tapes being driven by drums which are coupled together by Geneva-type mechanisms. A synchronous motor serves to drive the minutes tape through a timing train including a Geneva-type mechanism for step advancement of the "minutes" drum. An hour wheel coupled to the "minutes" drum, and cooperating with an alarm set wheel under the control of a function lever serves to operate a switch for turning on an associated radio and, a short time thereafter, for sounding an alarm. The alarm mechanism is advanced via a separate drive train which is independent of the "hours" drum. Portions of the driving and control mechanisms lie on opposite sides of the digital indicating assembly with the portions being interconnected by cross-shafts. A setable "sleep" lever cooperating with the timing train permits the user to fall asleep with the radio "on" with subsequent automatic turn-off. The "sleep" lever, by disabling of the alarm, also serves on actuation of an associated "drowse" button to give the user the operation of a few minutes of additional sleep after the alarm goes off.

6 Claims, 33 Drawing Figures



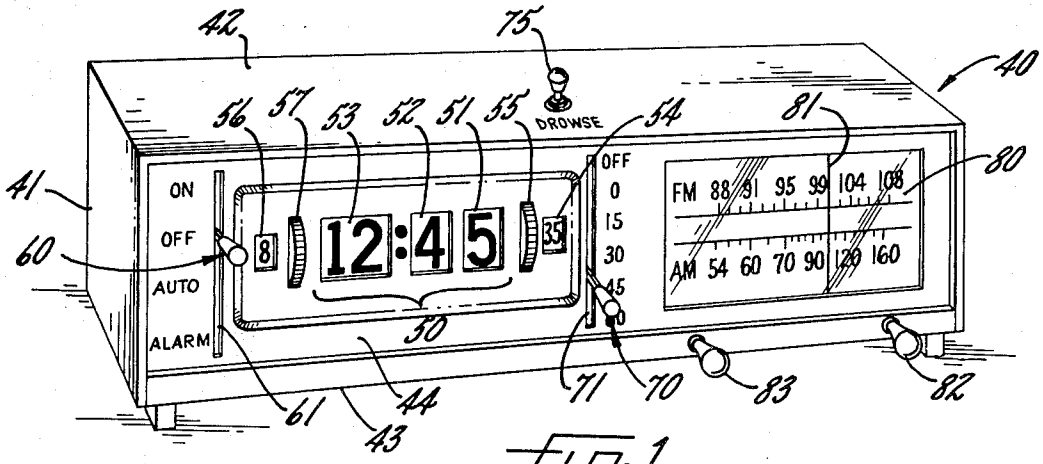


Fig. 1.

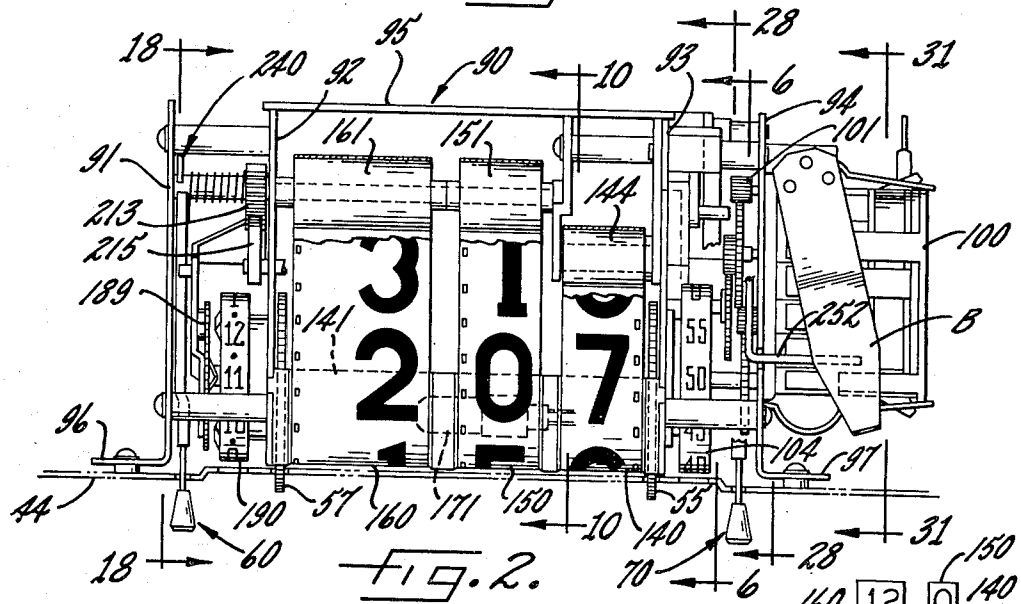


Fig. 2.

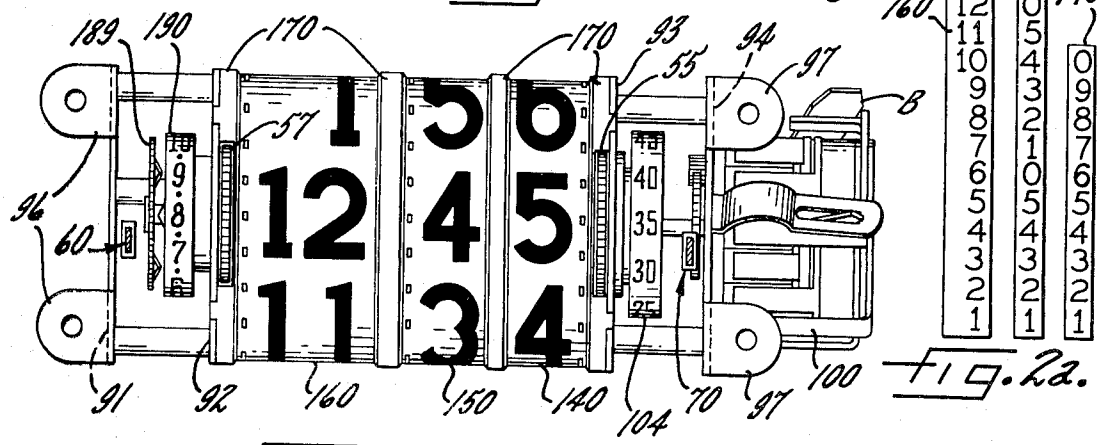


Fig. 3.

Fig. 2a.

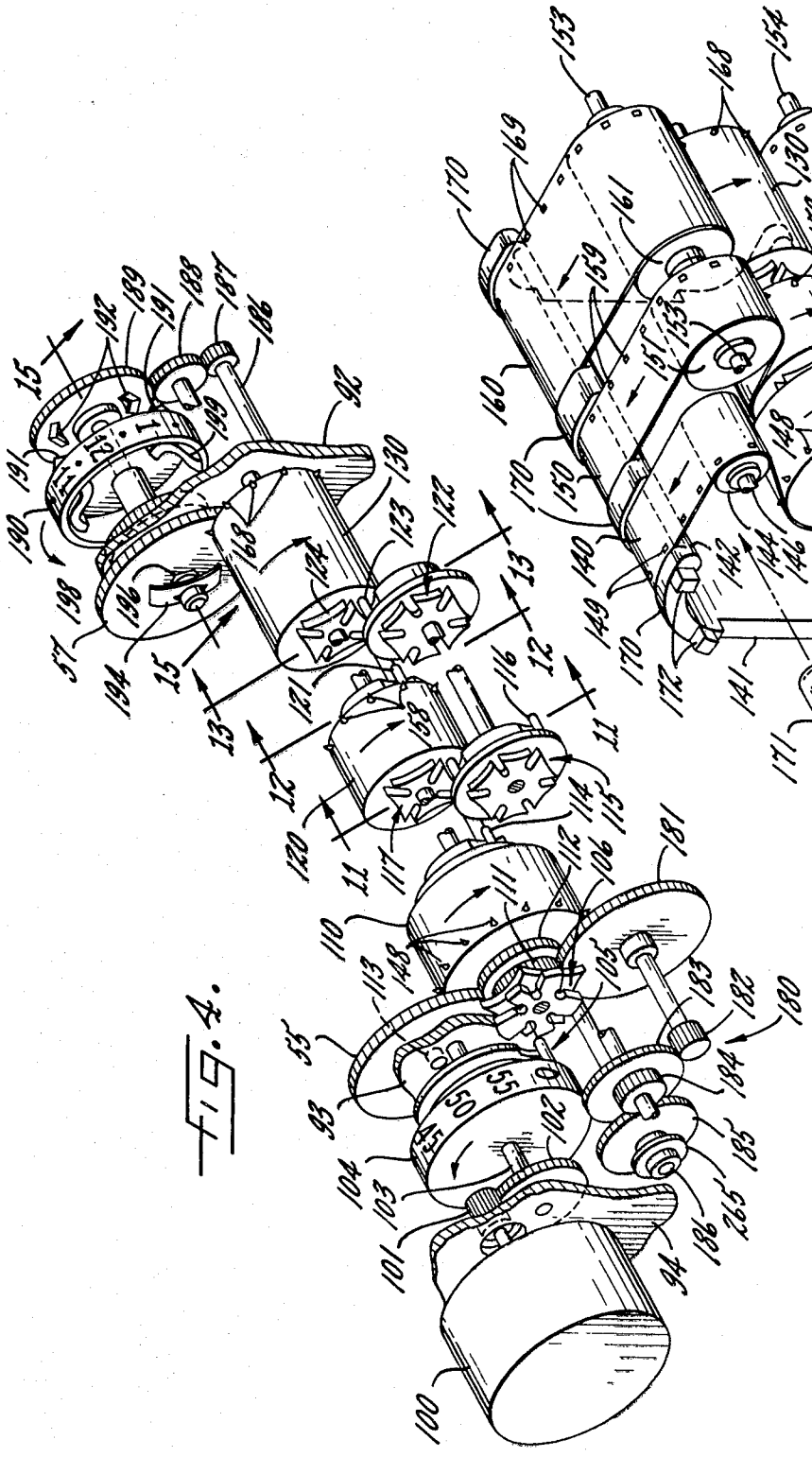
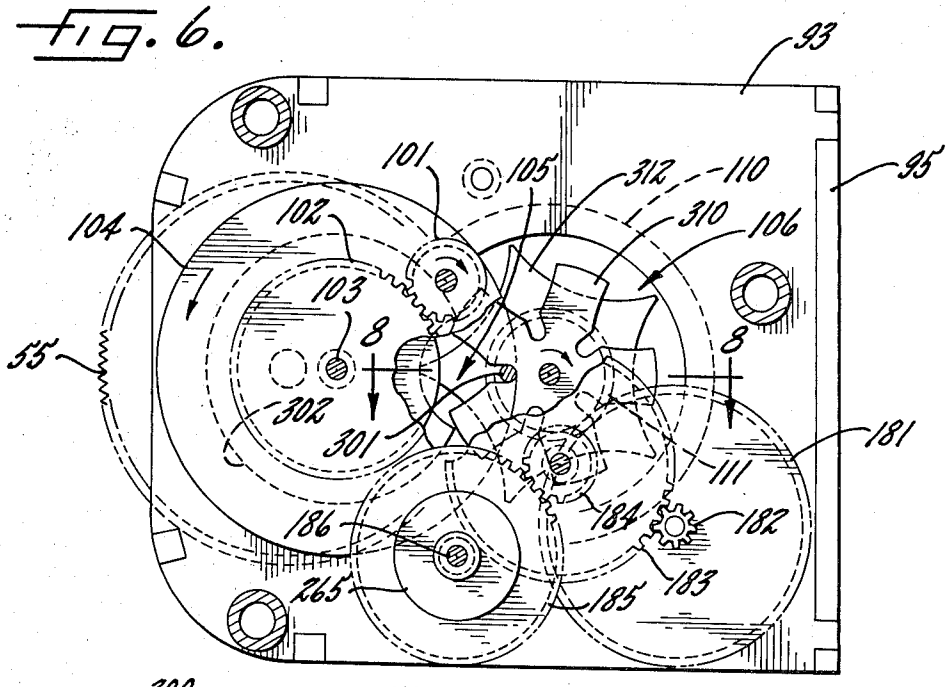


FIG. 4.

FIG. 5.

Fig. 6.



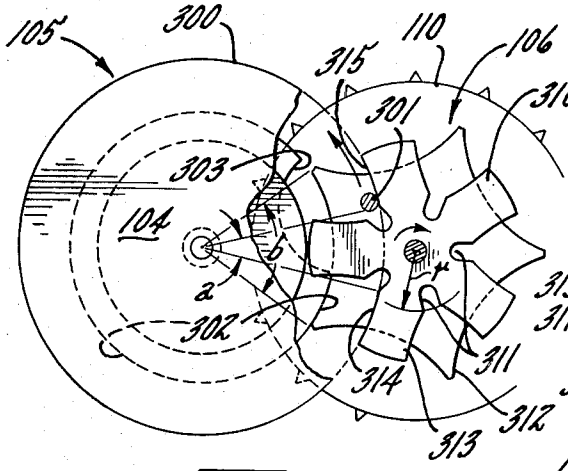


Fig. 7.

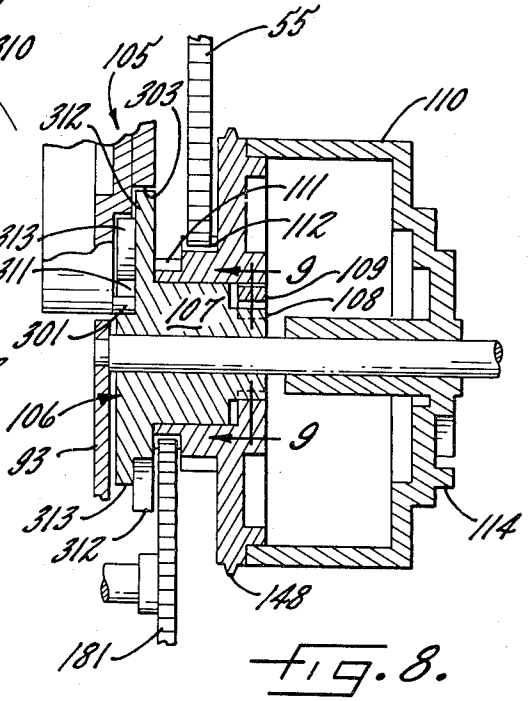


Fig. 8.

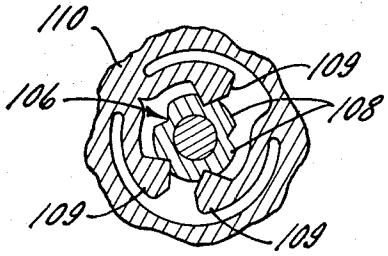
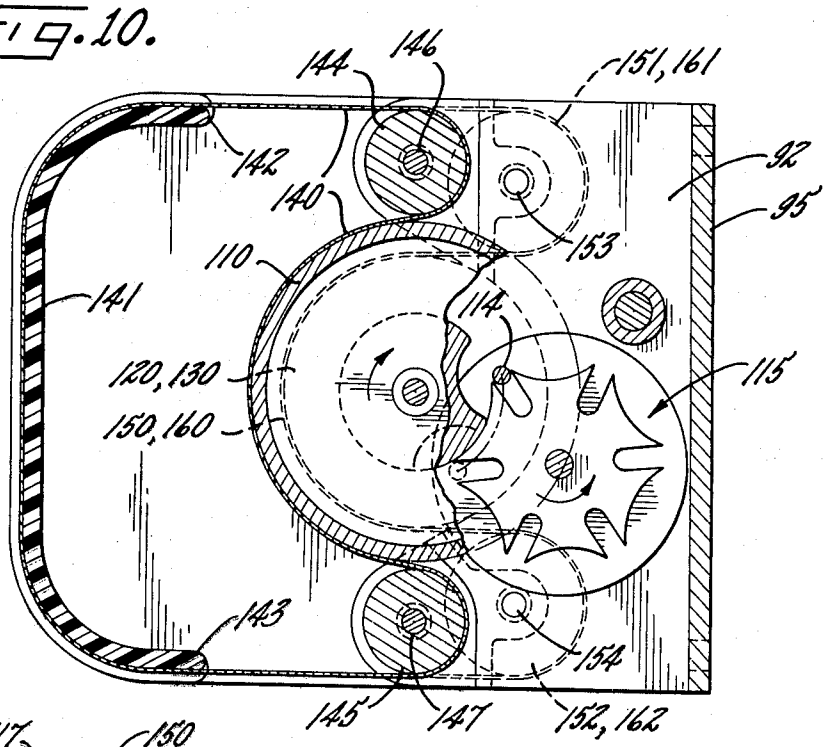


Fig. 9.

Fig. 10.



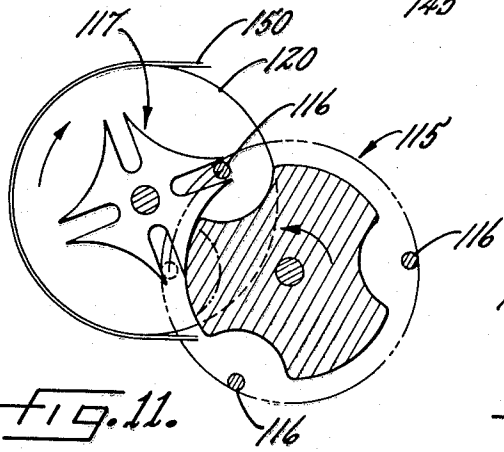


Fig. 11.

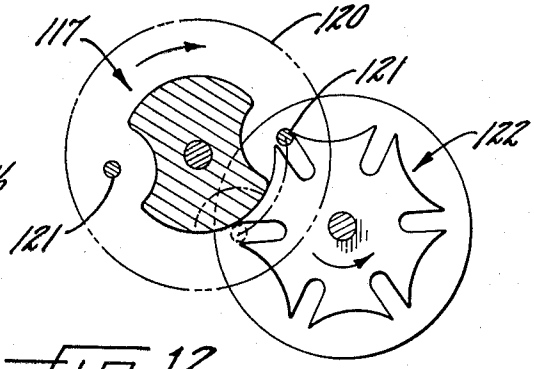


Fig. 12.

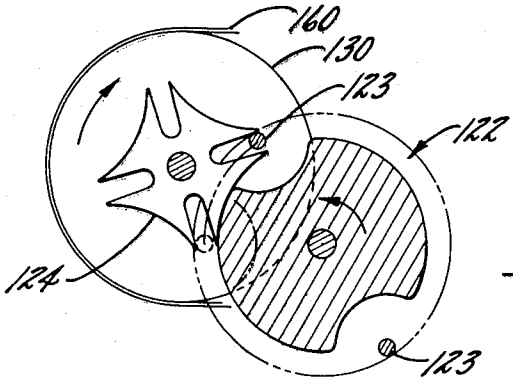


Fig. 13.

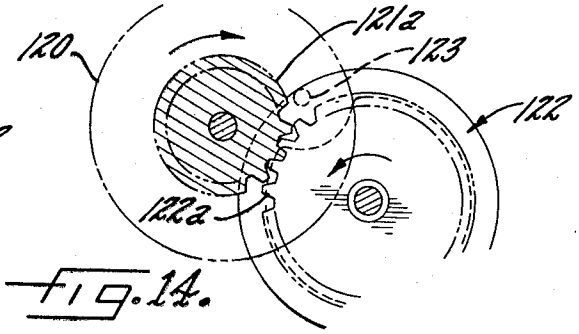


Fig. 14.

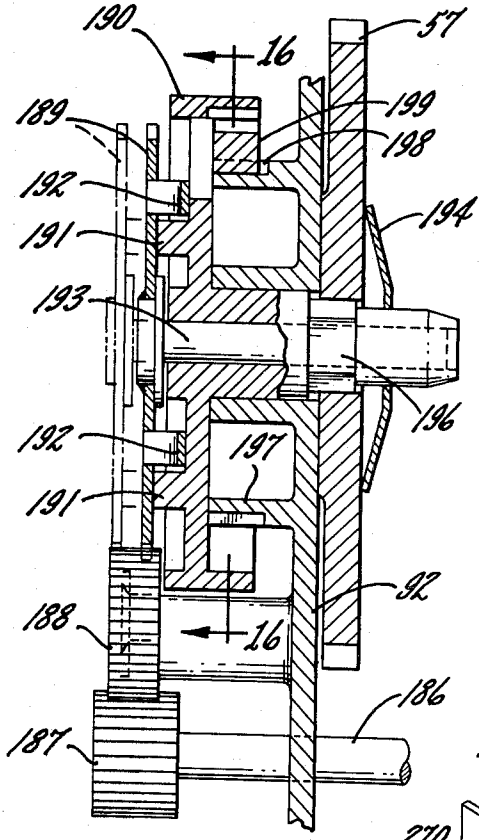


Fig. 15.

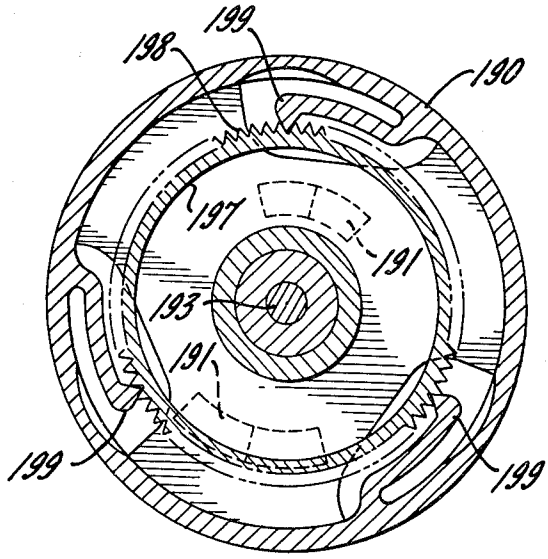


Fig. 16.

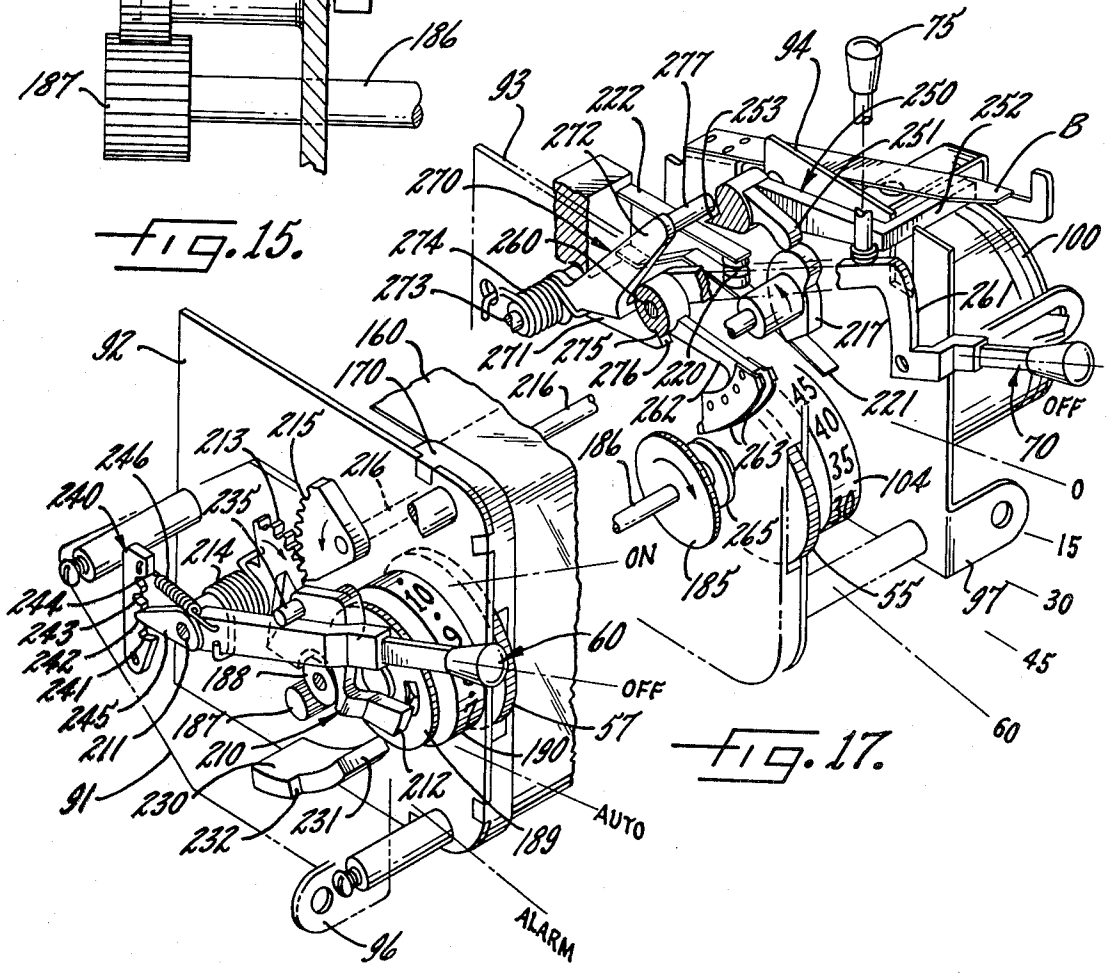
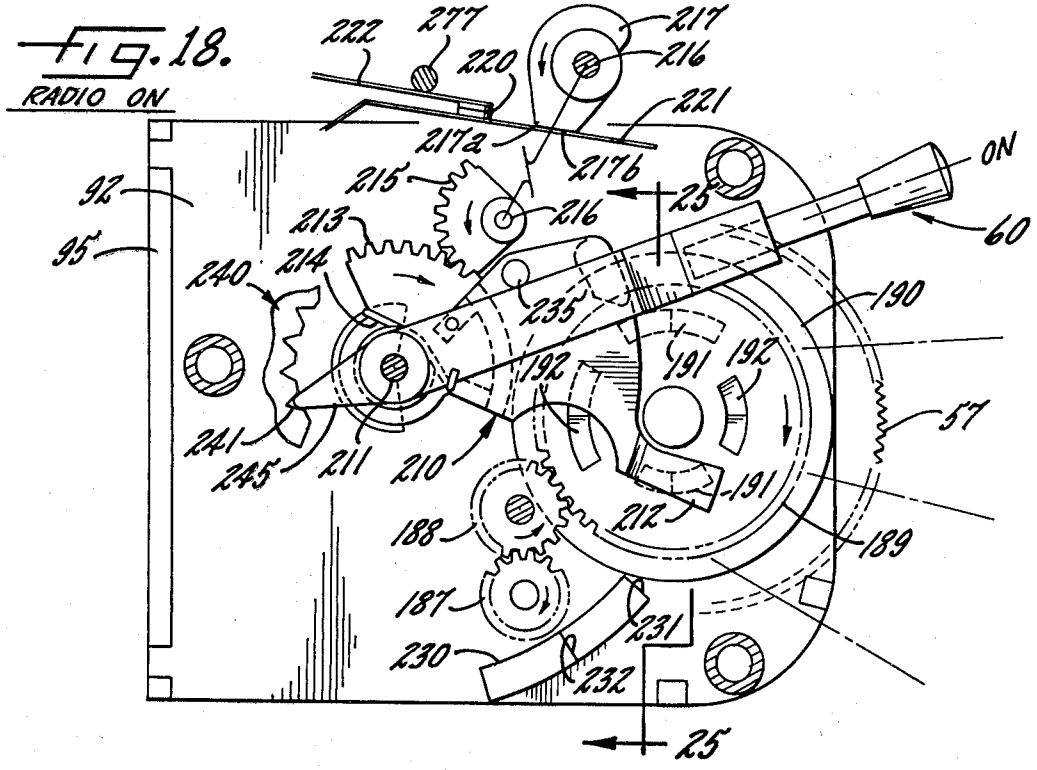


Fig. 17.

Fig. 18.
RADIO ON



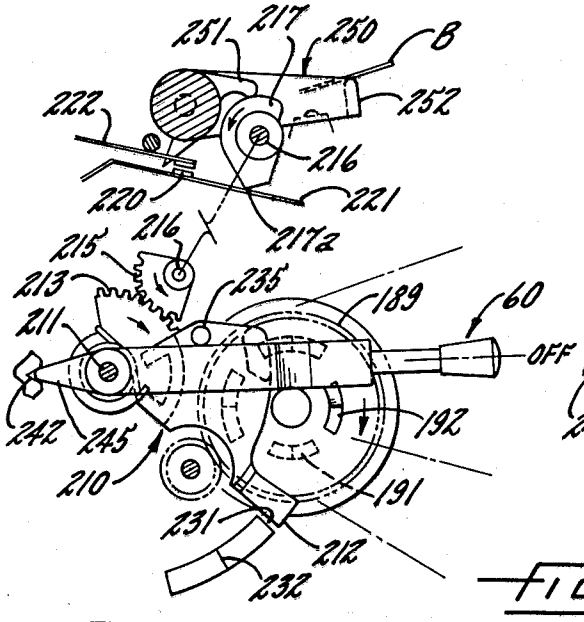


Fig. 19.
RADIO OFF

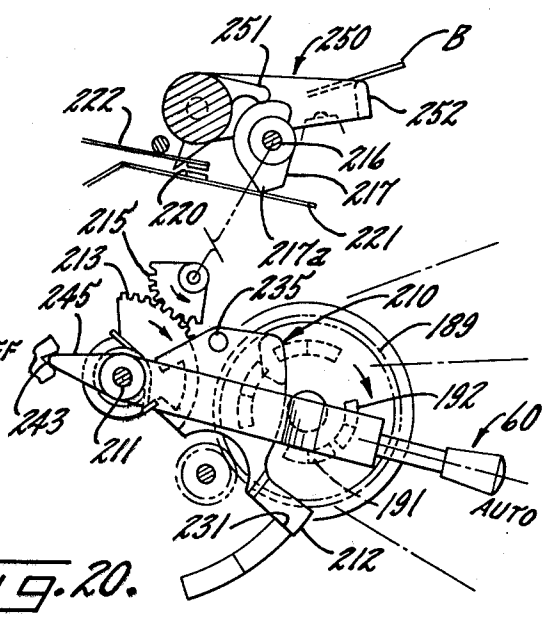


Fig. 20.
AUTO-BEFORE DROP FROM FIRST STEP

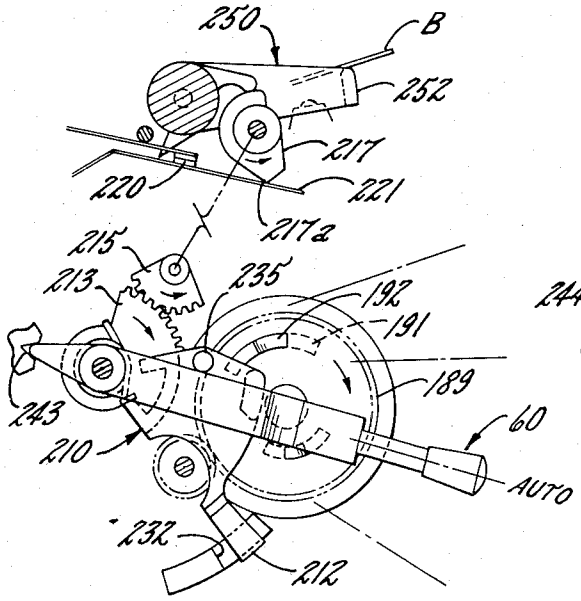


Fig. 21.

AUTO ~ AFTER DROP FROM FIRST STEP

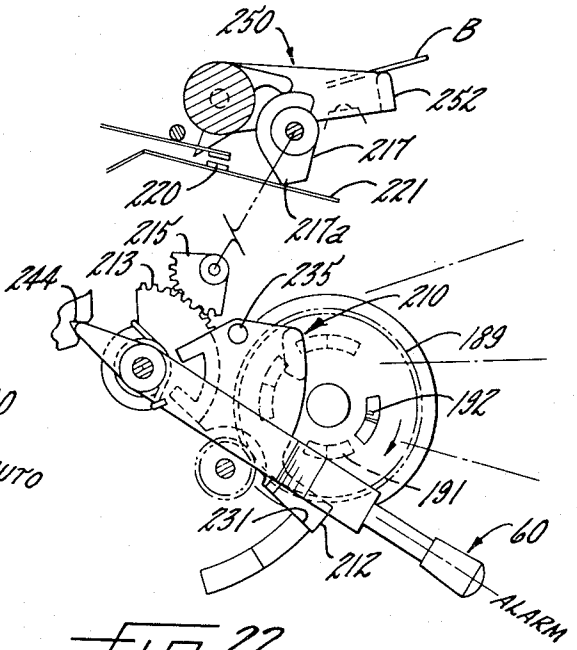


Fig. 22.

ALARM ~ BEFORE DROP FROM FIRST STEP

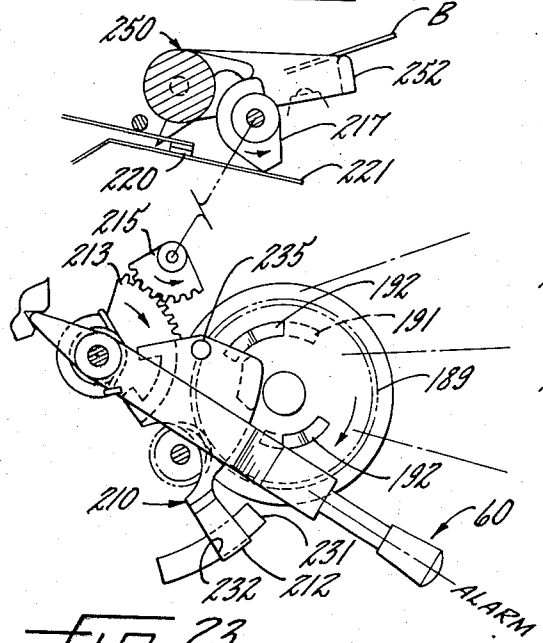


Fig. 23.

ALARM ~ BEFORE DROP FROM SECOND STEP

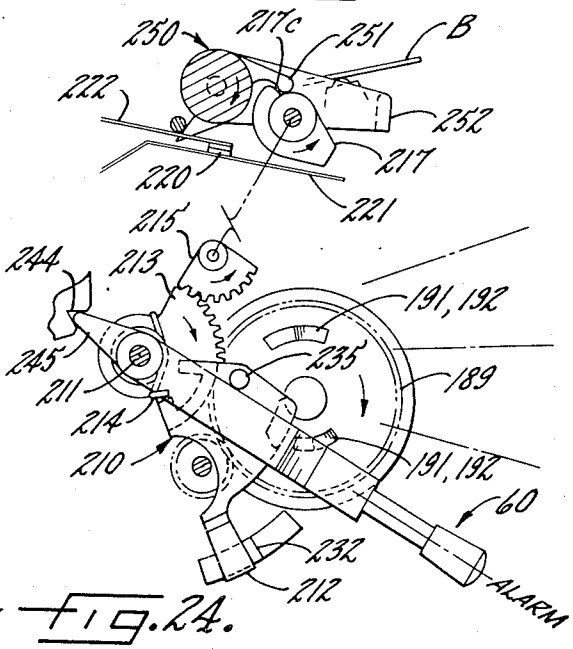


Fig. 24.

ALARM ~ AFTER DROP FROM SECOND STEP

Fig. 25.
LATCHED POSITION

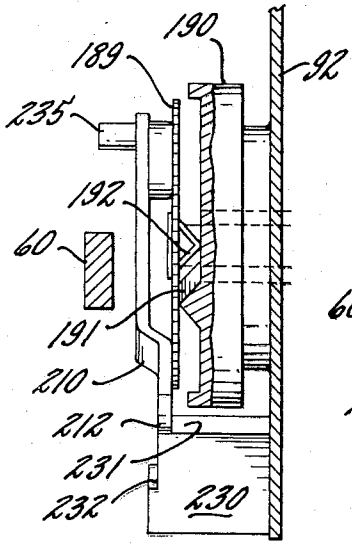


Fig. 26.
DROP FROM FIRST STEP

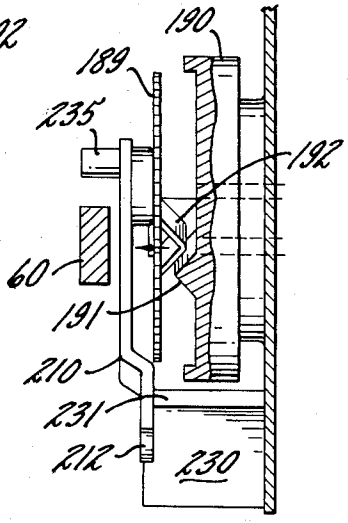
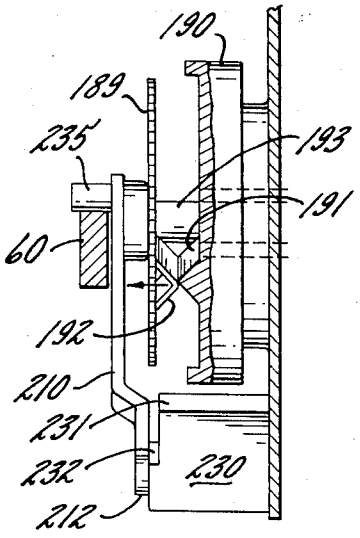


Fig. 27.
DROP FROM SECOND STEP



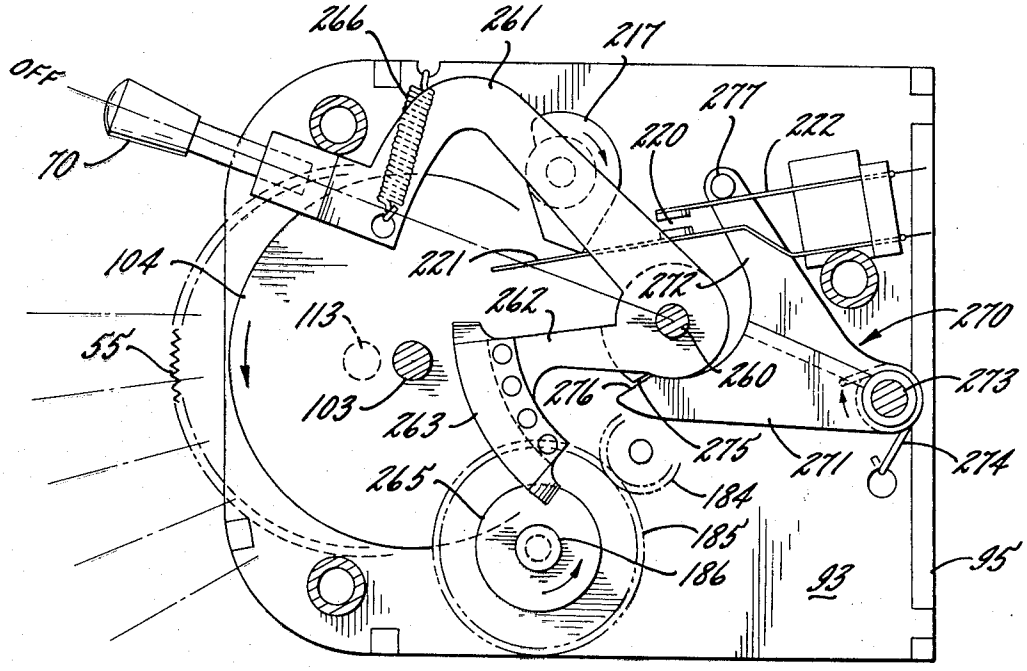


Fig. 28.
RADIO OFF

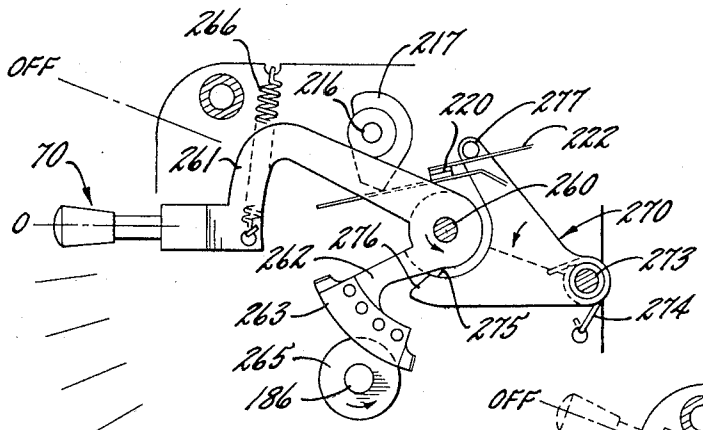


Fig. 29.
SLEEP ~ RADIO ON

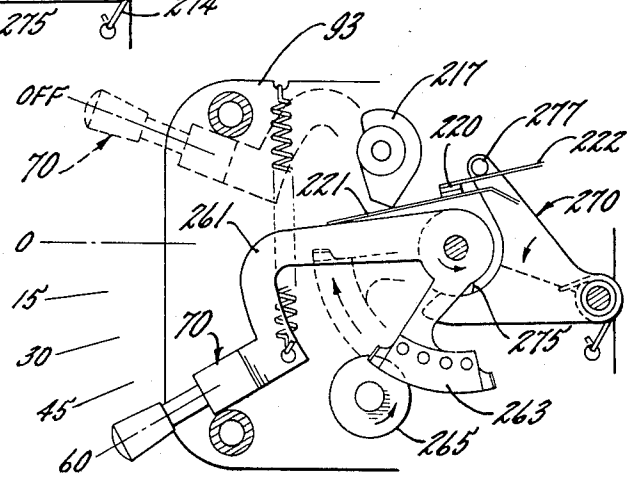


Fig. 30.
SLEEP ~ RADIO ON
TIME SET

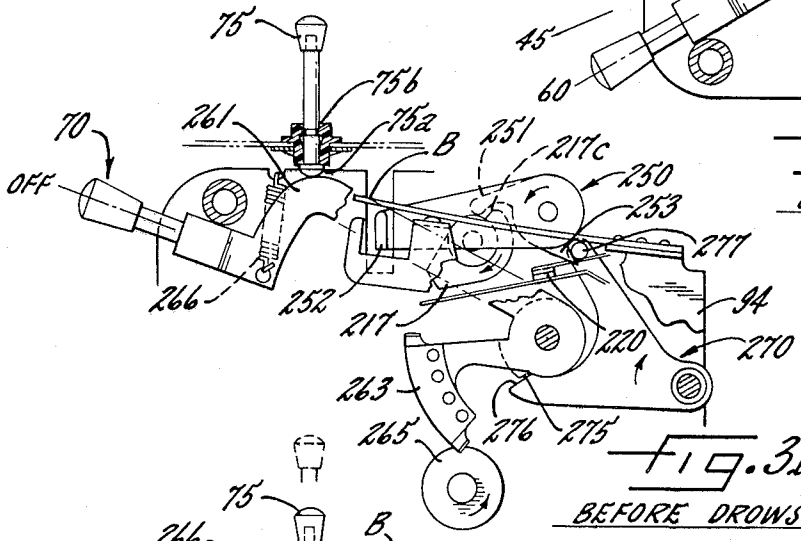


Fig. 31.
BEFORE DROWSE CYCLE

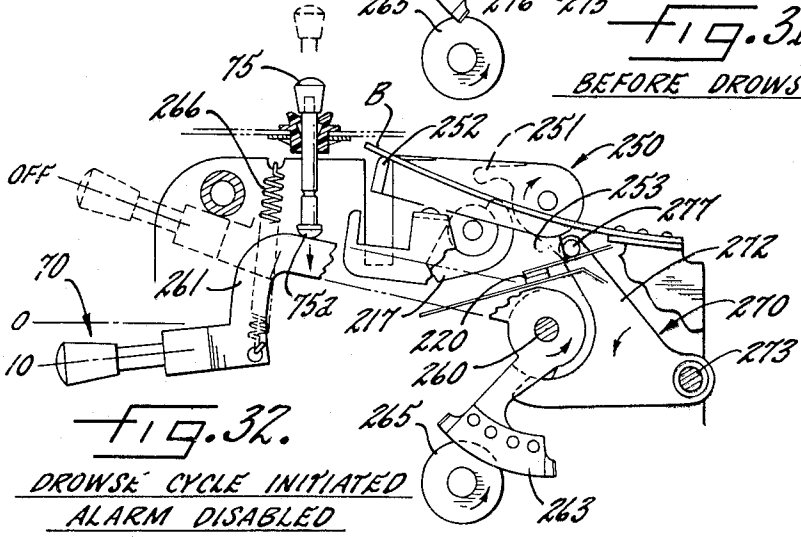


Fig. 32.
DROWSE CYCLE INITIATED
ALARM DISABLED

DIGITAL ALARM CLOCK

This application is a continuation of copending application Ser. No. 100,836, filed Dec. 22, 1970, now abandoned, which application is a division of application Ser. No. 863,886, filed Oct. 6, 1969, now U.S. Pat. No. 3,597,918, which issued on Aug. 10, 1971.

It is an object of the present invention to provide a digital alarm clock which is easily read and which employs numerals of large size considering the compactness of the enclosure in which the device is housed.

It is a further object of the present invention to provide a digital alarm clock mechanism which is particularly well suited for integration with a radio for turning on the radio at a preset time and for sounding an alarm a short time thereafter.

It is more specifically an object of the present invention to provide a digital alarm clock having indicating tapes displayed at a front panel, the tapes being driven by drums which are advanced in stepped fashion and which are located in alignment rearwardly of the front panel. Auxiliary forwardly offset drums are used for direct display of "seconds" and "alarm set" functions and both a time set wheel and alarm set wheel are located forward of the driving drums for direct fingertip access for setting purposes.

It is another object of the present invention to provide an alarm set wheel and an hour wheel having cooperating cams or the like for triggering at a pre-set time and in which the hour wheel is driven in one-minute steps rather than being continuously driven by the synchronous drive motor.

It is an object of the invention in one of its aspects to provide a novel function selector arrangement in which a selector lever is movable between "on," "off," "auto" and "alarm" positions to provide maximum choice and flexibility of the mode of operation of the clock but in which the various modes of operation are brought about, with digital display, using a mechanism which is simpler and more reliable than that used for conventional "clock hand" display. In this connection it is an object to provide a digitally indicating clock timer in which the seconds drum, alarm set drum, time set wheel and alarm set wheel are symmetrically distributed on opposite sides of digital time display to provide a pleasing and balanced appearance and with the associated mechanisms at each side being coupled by a simplified arrangement of cross shafts so that the control mechanism, although divided, may be as simple and inexpensive as that of conventional clocks where all of the mechanism may be closely integrated at a single location.

It is yet another object of the present invention to provide a digitally indicating timer for controlling an associated radio which includes a "sleep" lever for enabling the user to fall asleep with the radio on, with subsequent automatic turn-off, and which also includes a "drowse" button for operating the sleep lever to disable the alarm buzzer blade or the like for temporary shut-off of the buzzer blade when the user desires to have a few minutes of additional sleep.

It is, generally stated, an object of the present invention to provide a digitally indicating clock-timer which is ideally suited for use in controlling a bedside radio but which is not limited thereto and in which the digitally indicating drive and display may be employed for many other designs of clocks or timers covering a wide

range of price and size, or for other devices requiring display of numerals in successive orders, wherever digital display is desired. In this connection, it is an object to provide a digitally indicating clock-timer which may be manufactured and assembled at low cost using inexpensive plastic components which operates freely and which hence may be driven from a low power source and which does not require exercise of exacting tolerances in the manufacture or assembly of the parts.

Other objects and advantages of the invention will become apparent upon reading the attached detailed description and upon reference to the drawings in which:

FIG. **1** shows a bedside radio alarm clock employing the features of the present invention;

FIG. **2** is a top view of the mechanism employed in FIG. **1** with the housing removed and with certain portions broken away for maximum visibility;

FIG. **2***a* is a view on a reduced scale of the development of the tapes employed in the construction of FIG. **2**;

FIG. **3** is a front view, in elevation, of the mechanism shown in FIG. **2**;

FIG. **4** is an exploded perspective of the drive train and geneva drive mechanism for the drums associated with the respective loops of tape as well as the train for driving the hour wheel which is associated with the alarm set wheel;

FIG. **5** is a rear view of the drum and tape assembly;

FIG. **6** is a transverse section looking along the line **6—6** in FIG. **2**;

FIG. **7** is a fragmentary view based upon FIG. **6** and showing the first geneva switchover;

FIG. **8** is a fragmentary horizontal section taken along the line **8—8** in FIG. **6**;

FIG. **9** is a detailed fragmentary section of the minute drum "friction" looking along the line **9—9** in FIG. **8**;

FIG. **10** is a vertical section taken between the "minutes" and "tens-of-minutes" drums looking along the line **10—10** in FIG. **2**;

FIGS. **11, 12** and **13** show geneva profiles looking along correspondingly numbered section lines in FIG. **4**;

FIG. **14** shows an alternate form of dividing stage employing meshed gears;

FIG. **15** is a fragmentary sectional view taken through the alarm set wheel, alarm drum and hour gear looking along the lines **15—15** in FIG. **4**;

FIG. **16** is a transverse section showing the alarm set friction taken along the line **16—16** in FIG. **15**;

FIG. **17** is a perspective view of the function selector mechanism, simplified and slightly distorted, with parts broken away, to reveal the operating relationships;

FIG. **18** is a stop motion view of the function selector mechanism in the "radio on " condition looking along the line **18—18** in FIG. **2**;

FIG. **19** is a view similar to FIG. **18**, and slightly reduced in scale, showing the selector mechanism in the "off" condition;

FIG. **20** is a stop motion view similar to FIG. **19** showing the selector lever in the "auto" condition with the trip lever in latched condition;

FIG. **21** is a view similar to FIG. **20** but showing the trip lever following drop-off for turning on of the radio switch;

FIGS. **22, 23** and **24** are stop motion views showing the selector lever in the "alarm" position with the trip lever latched, and in the first and second positions of

drop-off respectively;

FIGS. 25, 26 and 27 are fragmentary sections taken through the alarm set cams corresponding to FIGS. 22–24 respectively;

FIG. 28 is a vertical section taken along the line 28—28 in FIG. 2 showing the sleep lever in profile prior to actuation;

FIG. 29 is a stop motion view based upon FIG. 28 showing the effect of moving the sleep lever from the "off" position to the zero reference position;

FIG. 30 is a view similar to FIG. 29 but showing movement of the sleep lever to the end of its range corresponding to a sixty minute sleep interval;

FIG. 31 is a diagram showing the sleep lever in the "off" position and with the buzzer blade turned on prior to pressing of the drowse button; and

FIG. 32 is a view similar to FIG. 30 showing the turning off of the buzzer blade resulting from actuation of the drowse button.

While the invention has been described in connection with certain preferred embodiments, it will be understood that I do not intend to be limited to the particular embodiments which are illustrated, but intend on the contrary to cover the various alternative or equivalent constructions which are included within the spirit and scope of the invention.

Turning now to FIG. 1 there is shown a clock radio 40 contained in a flat rectangular housing or enclosure 41 having an upper wall 42, a lower wall 43 and a front panel 44. The front panel 44 has provision for digital display of the time as indicated at 50 through a horizontal set of apertures 51, 52, 53 which display the minutes, tens-of-minutes and hours respectively. A further aperture 54 provides direct reading of "seconds." An adjacent knob or wheel 55 projects through the panel and is manually movable for setting the time. At the left of the digital indication is an aperture 56 which shows the pre-set time for sounding of the radio and alarm with an adjacent adjusting knob or wheel 57 for changing the alarm setting.

Projecting through the front panel is a selector lever 60 which is rockable upwardly and downwardly within a slot 61 for setting in any one of four positions which have been designated "on," "off," "auto," and "alarm." The "on" and "off" settings permit direct on-off control of the radio. The "auto" setting causes the radio to turn on at a pre-set time. Moving the lever 60 to the "alarm" position causes the radio to be turned on at a pre-set time followed, a few minutes thereafter, by sounding of an alarm device such as a conventional buzzer blade.

Where it is desired to fall asleep with radio music, but with automatic shut-off of the radio occurring after a pre-set interval, a sleep control lever 70 is provided which is rockable within a slot 71, lever 70 having an "off" position and scale calibrated from 0 to 60 minutes. A "drowse" button 75 is provided at the top of the housing and may be pressed to turn off the alarm, when it sounds, for a short time interval to secure a few minutes of additional drowsy sleep.

Enclosed within the right-hand portion of the housing is a radio having a dial 80, a movable pointer 81 thereon, a tuning control 82 and volume control 83. The construction of the radio is beyond the scope of the present invention and it will suffice to say that the radio control switch to be described serves to turn the radio on and off under manual or automatic control as desired.

Turning next to FIGS. 2 to 5, the clock-timer is shown, minus the enclosure mounted in a frame 90 having parallel plates 91, 92, 93, 94, with a pack plate 95, and interconnected by suitable posts or spacers to provide a compact and integrated timing unit. Brackets 96, 97 on the end plates serve as a mounting for the front panel 44.

For the purpose of driving the clock-timer, a motor 100 of the conventional a-c. synchronous type, with a buzzer blade B, is provided having an output pinion 101. The output pinion meshes with a gear 102 which is coupled by a shaft 103 to the seconds drum 104 providing direct indication of seconds through the aperture 54. The seconds drum carries a pin 105 which serves as the input element to a geneva stage having a five-station output element or star wheel 106, which will later by discussed in greater detail. It will suffice for the present to say that the geneva output element 106 has an integral shaft 107 which terminates in a "friction" or incremental clutch 108 (hereinafter referred to as an "incremental clutch") in the form of a star wheel having cooperating pawls 109 (see FIGS. 8 and 9). The pawls are formed integrally inside of a drum 110 having an integral output gear 111 and integral setting gear 112. The gear 112 meshes with the time setting wheel 55 mounted on a stub shaft 113, the wheel 55 projecting through the front panel for easy access as shown in FIG. 1.

For the purpose of steppingly driving the drum of next higher order at a reduced or divided speed, the minutes drum 110 includes a pin 114 which forms the input element of a geneva stage having a six-station output element or star wheel 115. Integrally included on the output element 115 are pins, three in number, indicated at 116 forming the input element of a second geneva stage having a four station output element 117. The latter is integral with a tens-of-minutes drum 120.

Similarly, for establishing a speed dividing ratio to the next drum in the series, the drum 120 carries pins 121 which constitute the input element of a geneva stage using a star wheel 122 having six stations. Directly coupled to the star wheel 122 are pins 123 of a second geneva stage having a star wheel 124 with four stations. The star wheel 124 is integral with an hour drum 130.

In accordance with the present invention, each of the drums 110, 120 and 130 drives an endless loop of tape having a cycle of numerals thereon, in successive orders, for direct time indication, with the tape being substantially longer than the periphery of the drum in a "low integer" ratio, and with the number of stations in the geneva output stage being equal to the number of numerals on the tape multiplied by the ratio of drum periphery to tape length. Thus referring to FIG. 5, and taking the minutes drum 110 by way of example, the drum serves to drive a tape 140 having a set of numerals 1 to 9 plus zero (see FIG. 2a), the tape being in the form of an endless loop having twice the length of the periphery of the drum 110, making the periphery-to-tape length ratio one-half. Thus the ten numerals on the tape, multiplied by one-half, equals 5, which is the number of stations in the associated geneva output element 106.

For the purpose of reducing the required headroom, the tape is disposed about the drum 110 in a re-entrant C formation, with the drum occupying a central position. More specifically in carrying out the invention, the tape 140 is trained about a vertical guide member

141 which spans all three of the tapes and which has upper and lower curved guide surfaces **142, 143.** Tangent with respect to the guide surfaces **142, 143,** and spaced rearwardly therefrom, are idler rollers **144, 145** mounted upon shafts **146, 147.** The upper and lower passes of the tape thus may lie adjacent, and parallel to, the top and bottom walls of the enclosure. For the purpose of maintaining synchronism between the drum **110** and the tape **140,** the drum is provided with sprockets **148** which engage sprocket holes **149.**

The adjacent tens-of-minutes tape, indicated at **150** is trained about the drum **120** to form the tape into the same re-entrant, C configuration. However, in the case of the tape **150,** the tape is three times the length of the periphery of the drum **120,** resulting in a length ratio of one third. It is one of the features of the construction that two complete cycles of numbers in the series from 1 to 5 and 0 are carried by the tape **150** making a total of **12** numerals which, when multiplied by the length ratio (**1/3**) results in a geneva output element, or star wheel, **117** having a total of four stations. The tape is disposed about idler rollers **151, 152** mounted upon shafts **153, 154.** Sprockets **158** engage sprocket holes **159.**

Turning to the final tape in the series, which is the hours tape indicated at **160,** such tape is, in accordance with the invention, chosen to produce a length ratio of one-third which, when multiplied by the number of numerals on the tape (**12** — see FIG. **2a**), results in the use of a geneva output element **124,** integral with the drum **130,** having four stations as shown. As in the case of the previous tapes, the tape is folded re-entrantly and is supported upon idler rollers **161, 162** which are in alinement with the idler rollers **151, 152** and carried upon the same shafts **153, 154.** Similarly, for preserving synchronism, the drum **130** is provided with sprockets **168** which engage sprocket holes **169** formed in the tape.

For the purpose of guiding the tapes smoothly in parallel paths for purposes of display, the vertical guide member **141** is formed with shallow grooves or tracks defined by spaced ridges **170.** Moreover, the guide member **141** is formed of transparent or translucent plastic material having one or more lamps **171,** generally alined with the viewing windows in the front panel, for illuminating the numerals on the tapes by transmitted light. Preferably the tapes are made of flexible plastic with translucent numerals on an opaque background, although opaque numerals on a translucent background may be employed as a matter of choice. The portions of the panel which separate the windows, **51-53** serve to mask any light which is transmitted through the sprocket holes **149-169.** Conveniently, the edges of the guide member **141** may be formed with protuberances **172** which engage registering openings formed in the edges of the frame plates **92, 93** so that the guide member is firmly locked between the frame plates; moreover, the frame plates thus complete the ends of a light housing, defined in part by the upper and lower edges of the guide member, and may be painted white, to improve the efficiency of illumination.

Further in accordance with the present invention an overall geneva drive ratio between the adjacent drums is determined taking into account the "value ratio" of the numerals on the tapes, the periphery-to-tape length ratios, and the ratio of the number of numerals on the adjacent tapes. More specifically, a geneva ratio, GR, is chosen in accordance with the following relationship:

$$GR = VR \cdot \frac{L1}{L2} \cdot \frac{N1}{N2}$$

where VR is the value ratio, L1 and N1 are the length ratio and numeral positions on the tape of lower order and L2 and N2 are the length ratio and numeral postions corresponding to the tape of higher order. With respect to the geneva mechanism between the minutes drum **110** and tens-of-minutes drum **120,** the value ratio of the numerals is 1:10. The length ratios, as previously stated, are one half and one-third, respectively. The number of numeral positions on the tapes are **10** and **12,** respectively. Entering these amounts in the relationship set forth above results in an overall drive ratio between the drums **110, 120** of **1:8.**

For the purpose of selecting the other parameters of the reduction system, use is made of the following relationship:

$$GR = \frac{P1}{S1} \cdot \frac{P2}{S2}$$

where P1 and S1 are the number of pins and stations, respectively, in the first, or auxiliary, stage and P2, S2 are the pairs and stations, respectively in the second geneva stage. Since GR in the present example must be **1:8** and since S2, as previously determined, is **4,** then

$$\frac{P1 \cdot P2}{S1} = 1/2$$

This relationship is satisfied by employing a single pin and six stations in the first stage, and three pins for driving the four station output member **117** in the second stage.

The overall ratio of reduction between the tens-of-minutes drum **120** and the hour drum **130,** and the number of pins and stations to be used in the auxiliary geneva stage, is determined in the same way. The value ratio between the tens-of-minutes numerals and the hours numerals is 1:6. The length ratios L1, L2, in the case of the drums **120, 130** are both 1:3. The number of numerals N1, N2, on both of the tapes is **12.** This results in an overall geneva ratio GR of 1:6. Since the number of geneva stations on the drum **130** has been previously determined as **4,** then

$$\frac{P1 \cdot P2}{S1} = 2/3.$$

Such relationship is satisfied by employing a first geneva stage of two pins and six stations and by employing two pins at the input of the second stage, just as has been shown in the drawings.

By adhering to the procedures set forth above, operation of the digital tape display assembly is as follows: The motor **100,** with its gearing **101, 102,** drives the seconds drum **104** at the rate of one revolution per minute. Driven through the geneva stage **105, 106,** the minutes drum rotates at an average speed of 1/5 r.p.m. Multiplying this by the drum-to-tape ratio (½) results in a tape cycle speed of one tenth cycle per minute, or ten minutes per cycle, appropriate for the minutes tape. By reason of the **1:8** reduction from drum **110** to drum **120,** drum **120** rotates at an average speed of 1/40

r.p.m. Multiplying this by the length ratio gives a tape cycle time of 1/120 minute. Since there are two cycles on the tape **150,** the numeral cycle time is 1/60 cycle per minute, or 60 minutes per cycle, which is appropriate for the tens-of-minutes tape. By reason of the final 1:6 reduction, the hours drum rotates at an average speed of 1/240 r.p.m. With a length ratio of 1:3 the tape cycle time is 1/720 cycle per minute equal to 12 hours per cycle.

In accordance with one of the aspects of the present invention, means responsive to the periodic advancement of the minute drum **110** are provided for operating an electrical circuit to turn on the associated radio, and for operating an alarm device such as the buzzer blade, at a pre-set time. Thus, referring to FIG. **4,** a second drive train **180** is provided including a first gear **181** having a pinion **182** driving a gear **183** and pinion **184,** with the latter meshing with an output gear **185** mounted on a cross shaft **186** which extends transversely within the mechanism. At the remote end of the shaft **186** is a pinion **187** and idler **188** which drives an hour wheel **189** on a twelve hour cycle. For the purpose of producing relative endwise movement of the hour wheel **189** at a pre-set time, an alarm set drum **190** is provided having cam surfaces **191,** which cooperate with cam follower surfaces **192** on the hour wheel. As shown in FIG. **15,** the hour wheel has a shaft **193** which is axially slidable and which is biased, by a leaf spring **194,** in a direction to keep the cams in engagement.

For the purpose of setting the phase position of the alarm set drum **190,** an alarm set knob or wheel **57** (see also FIG. 1) is provided which is accessible through the front panel and which is directly keyed to the alarm set drum **190.** Such keying is brought about by forming the hub of the drum into a hexagonal cross section as indicated at **196** to mate with a correspondingly shaped hole at the center of the alarm set wheel **57.** In order that the alarm set drum may be retained at the set position, an incremental clutch is provided in the form of a set of stationary detent teeth which cooperate with pawls formed on the interior of the alarm set drum. Thus as shown in FIGS. **15** and **16,** the frame plate **92** has an integral, axially extending flange **197** which projects into the interior of the alarm set drum and which has, formed on its outer surface, a set of teeth **198.** The teeth are engaged by flexible pawls **199** formed integrally with the alarm drum. To set the time of turning on the radio, or for sounding of the alarm, the alarm set wheel **57** is rotated with fingertip pressure until the set time appears in the viewing window **56.** This establishes the desired relative phasing of the cam and cam follower surfaces **191, 192** so that, as the set time approaches, the cam surfaces begin to ride up on one another to produce progressive axial movement of the hour wheel **189** toward the position which is shown by the dot-dash outline in FIG. **15.**

By reason of coupling of the gearing **180** to the minute drum, the advancement of the hour wheel is not continuous, as in conventional alarm mechanisms, but is on the contrary in the form of successive steps, one occurring each minute. As will be seen, this is of advantage in producing finite steps of endwise crowding movement of the hour gear **189** against the trip lever which it engages thereby bringing about a more decisive drop-off of the trip lever from its cooperating stops to perform the desired control functions. A further important advantage which resides in the direct coupling of the hour wheel to the minute drum is that it permits simultaneous coordinated setting of the hour wheel and minute drum **110,** as well as the associated drums **120, 130,** by manual turning of the time set wheel **55** without requiring any corresponding rotation of the motor, drive train, and geneva which serve to drive the minute drum under normal conditions. Thus it will be noted, in connection with FIG. **8,** that rotation of the time set wheel **55** acting upon the circular rack **112** on the minutes drum not only directly rotates the minutes drum but also, through circular rack **111,** rotates the input gear **181** of the hour wheel gear train so that the hour wheel is locked into synchronism with the drums and with the tapes which are keyed to the drums. Since the geneva **105, 106** is effectively locked against actuation "backwardly," the teeth **108** (see FIG. **8**) which are on the hub of the output element **106** remain stationary so that the pawls **109,** which form a part of the drum, click idly over the teeth until the desired time setting is achieved.

In carrying out the invention means including a trip lever having cooperating stops are provided for sensing the relative crowding movement of the hour gear which occurs at the pre-set time so as to produce drop-off of the trip lever accompanied by successive angular indexing movements which are utilized to turn on the radio switch, and the alarm device in spaced succession. Thus, referring to FIG. **17,** a trip lever **210** is provided rotatable about a transverse shaft **211** and having a tip portion **212** which is in the path of endwise movement of the hour gear **189.** Formed integrally with the trip lever is a circular rack **213.** For the purpose of biasing the trip lever clockwise, a spring **214** is engaged behind the rack. In order to transmit the angular indexing of the trip lever to the opposite end of the mechanism, a second circular rack **215** is mounted upon an elongated shaft **216** which carries a control cam **217** at its opposite end. Cooperating with the control cam is a radio switch **220** having a lower blade **221** and an upper blade **222,** the lower blade **221** being extended, as shown, to serve as a cam follower for the cam **217.**

Arranged in the path of movement of the trip lever **210** is a stationary stop **230** having a first step **231** and a second step **232.** To control drop-off from the steps **231, 232** and hence to control the mode of operation of the control switch and buzzer blade, and, indeed, for disabling the switch and buzzer blade when desired, a function lever is provided which is settable at selected levels in the path of downward movement of the trip lever. The function lever, indicated at **60,** is pivoted for rocking movement about the shaft **211,** making the function lever coaxial with the trip lever **210** which it controls. So that the function lever, in its various positions, may obstructingly support the trip lever **210** against downward movement, the trip lever is provided with an integral pin **235** which overhangs the lever. To hold the lever **60** in its set position, a detent **240** is used in the form of a small pivoted arm having notches **241-244** for reception of a pawl-like projection **245** integrally formed at the rear end of the function lever **60,** the member **240** being biased by a spring **246** to provide a desired level of detent force. In order that the detent mechanism might be independent of the biasing force of the spring **214** on the trip lever, such spring is, as shown, anchored at one end on the function lever.

With the function lever set in the "off" position, as illustrated in FIGS. **17** and **19,** the cam **217,** at the end of the cross shaft **216,** is oriented so that a cam projection **217***a* (see FIG. **19**) bears downwardly against the

switch blade **221** thereby separating the contacts **220**. With such contacts, in series with the power circuit of the radio, opened, the radio will remain turned off. Any endwise crowding movement of the hour wheel **189** which may occur at the time for which the alarm drum happens to be set will result in axial movement of the trip lever, but such movement will be idle since the pin **235** on the trip lever is "hung up" on the function lever.

In order to insure that, when the function lever is in its "off" position, the buzzer blade B of the alarm will also be silent, an alarm shut-off lever **250** is provided having a cam follower arm **251** which engages the cam **217** and a blade engaging arm **252** which extends at right angles under the tip of the buzzer blade. Thus when the function lever, and the cam **217** which it controls, are in the "off" position, the cam follower arm **251** is upraised forcing the associated arm **252** upwardly against the buzzer blade to raise the latter away from the magnetic influence of the motor.

When it is desired to turn the radio on, the function lever **60** is raised to its uppermost, or "on" position which raises the trip lever **210** by reason of engagement with the pin **235** thereon resulting in rocking at the circular racks **213, 215** so that the shaft **216** and cam **217** are indexed clockwise. This rocks the high point **217***a* of the cam away from the switch blade **221** so that the cam presents a "flat" **217***b* to the blade, permitting the blade to rise thereby to bring the contacts **220** into engagement to turn the radio on. Such indexing movement of the cam **217** does not affect the height of the cam follower arm **251** on the alarm shut-off lever **250** so that the buzzer blade continues to be held in its disabled position.

In order to turn the radio on at a pre-set wakeup time, without however actuating the buzzer blade, the function lever **60** is moved downwardly one step from its "off" position into its "auto" position. This movement lowers the trip lever onto the step **231** which puts the trip lever into a condition of readiness for dropping off of the step upon being pushed by the hour gear upon reaching the pre-set wakeup time. Thus, as shown in FIG. **20,** movement of the function lever into the "auto" position seats the trip lever in latched position on the step **231,** with adequate clearance below the pin **235** on the trip lever to permit the trip lever to index downwardly in the direction of the second step **232.** The indexed rocking of the cam **217** which accompanies the setting of the function lever in the "auto" position brings the high point **217***a* of the cam downwardly against the switch blade **221** to open the contacts. The cam follower arm **251** on the alarm shut-off lever **250** remains unaffected, and the buzzer blade therefore continues to be held in its disabled position.

Upon passage of time, the hour wheel **189** rotates around into a position where the cam follower **192** engages the cam **191** on the alarm set drum, thereby crowding the hour wheel **189** endwise in the direction of the arrow shown in FIG. **26.** The hour wheel **189,** advancing in oneminute steps, reaches a point where the resulting step of endwise movement is sufficient to cause the tip **212** on the trip lever to "clear" the first step **231,** thus permitting the trip lever to index clockwise until the pin **235** thereon bottoms on the function lever **60,** which is the condition shown in FIG. **21.** The resultant rocking at the circular racks, accompanied by counterclockwise indexed rocking of the shaft **216** and cam **217,** brings the high point **217a** of the cam into an angled, or nonalined, position with respect to the switch blade **221,** thereby permitting the contacts **220** to close, turning on the radio. Continued rotation of the hour wheel **189** will occur, with increasing engagement of the cam surfaces **191, 192,** and with additional endwise crowding movement of the hour wheel **189,** but this will be ineffective to produce further indexing of the trip lever since the trip lever is hung up on the function lever and thus blocked against any further drop-off. As shown in FIG. **21,** even though the contacts **220** close, the cam follower arm **251** continues to be held in its upraised position for continued disabling of the buzzer blade.

When it is desired to have the alarm sound to ensure the sleeper is awakened shortly after the radio turns on, the function lever is moved downwardly an additional step from the "auto" to the "alarm" position as illustrated in FIG. **22.** Under such circumstances, the function lever is at a sufficiently low level so that the trip lever has complete freedom of movement and may drop off of both of the steps **231, 232** at the pre-set time in spaced succession. When the function lever is lowered into the "alarm" position shown in FIG. **22,** the tip **212** of the trip lever is seated upon the first step **231.** As the pre-set time is approached, the cam surfaces **191, 192,** crowd the hour wheel **189** endwise so that the trip lever **210** drops from the first step **231** as shown in FIG. **23.** The resulting indexing of the cam **217** in the counterclockwise direction permits the contacts **220** to come together to turn on the radio, just as the case of the condition shown in FIG. **21.** However, in this instance, the stop pin **235** on the trip lever remains unobstructed, and the further crowding movement of the hour wheel **189,** as the cams **191, 192** come increasingly into engagement, results in drop-off of the trip lever at the second step **232** accompanied by an additional step of indexing movement of the trip lever and its associated cam **217.** This additional (counterclockwise) movement of the cam **217** causes the cam follower arms **251** to reach a point of drop-off indicated at **217***c* on the cam, permitting the cam follower arm to move downwardly accompanied by retreating movement of the arm **252** downwardly away from the buzzer blade, lowering the buzzer blade into its active, or sounding position. The user of the clock, upon being awakened, can then shut off the buzzer blade by moving the function lever upwardly into its "auto" position or he can shut off both radio and buzzer blade by moving the function lever upwardly into its "off" position, thus re-establishing the condition discussed in connection with FIG. **19.**

It will be noted that the wide range of control functions have been accomplished both reliably and simply, using a minimum number of parts —and those of low tolerance requirements— even though the function lever, alarm set drum and associated trip lever are located at one end off the mechanism with the switching and control functions being accomplished at the other end.

Further in accordance with the invention, a "sleep" control member is provided cooperating with a disc which is coupled to the minutes drum **110** for periodic advancement and which is settable into an "overlapping" relation with the disc to provide a desired length of "sleep" interval during which the radio plays and following which the radio is automatically turned off. More specifically in accordance with the invention, a sleep control member is provided which, during the "sleep" interval turns the radio on by acting upon the

second one of the two contact blades so that contact may be made regardless of the set position of the regularly controlled contact blade. Thus, referring to FIGS. **17** and **28**, a sleep control lever **70** is provided pivoted about a shaft **260** and having a first arm **261** and a second arm **262**. The arm **262** carries an opposed pair of frictionally engaging elements **263**. Arranged in the path of movement of the friction engaging elements is a "sleep" disc **265** which is mounted at the end of the cross shaft **186** which drives the hour wheel **189**. The associated gearing is such that the disc rotates at a rate of ⅓ revolution per hour. The sleep lever **70** is maintained in its upraised position by a spring **266** which maintains the friction elements **263** out of effective engagement with the disc **265**. Interposed between the sleep lever **70** and the switch contact is a sleep actuator lever **270** having a first arm **271** and a second arm **272**. The lever is pivoted for rotation about a shaft **273** and is upwardly biased by a spring **274**. Integrally formed on the arm **262** of the sleep lever is a cam surface **275** which engages the cam follower surface **276**, the surfaces being faced sufficiently abruptly so that the actuator lever **270** undergoes its entire range of movement incident to movement of the sleep lever from its off position to a zero reference position which establishes the beginning of the time scale. For pressing the upper blade **222** of the switch downwardly to engage the contacts during the sharp downward movement of the lever **270**, a transversely extending pin **277** is provided at the upper end of the arm **272**.

The effect of moving the sleep lever **70** from its off position to its zero reference position is shown in FIG. **29**. Here it will be noted that the friction elements **263** advance into initial engagement with the disc **265**. At the same time, rotation of the arm advances the cam surface **275** against the cam follower surface **276** so that the lever **270** rocks counterclockwise bringing the pin **277** down against the blade **222** to close the contacts, thereby turning the radio on. Further downward rocking of the sleep lever with respect to the calibrated scale causes increasing engagement of the friction elements **263** with the sleep disc **265**, the limit of such engagement, corresponding to a "sleep" interval of sixty minutes, as illustrated in FIG. **30**.

After the sleep lever has been set to the selected time interval, for example, a full sixty minutes, the subsequent rotation of the shaft **186** and the sleep disc **265** thereon, step by step with advancement of the minute drum **110**, causes the friction elements **263** to be "walked" in the clockwise direction as indicated by the dotted arrow in FIG. **30** until the zero reference position is reached, illustrated in FIG. **29**, whereupon the friction elements "clear" the disc **265** permitting the sleep lever to be drawn into its upraised "off" position illustrated in FIG. **28**. The return movement is accompanied by drop-off at the cam surfaces **275**, **276**, thereby permitting the actuator lever **270** to rotate clockwise under the influence of the spring **274** to release the upper switch blade **222** so that the contacts are opened to turn off the radio.

The step by step advancement of the sleep disc **265**, brought about by its direct coupling to the minutes drum **110** provides more decisive and precise release of the sleep lever, for turning off the radio, than is possible where the disc is continuously driven.

In accordance with one of the aspects of the present invention, the sleep lever is coupled, not only to the radio controlling contacts, but also to the buzzer blade disabling member and a "drowse" button is provided for pressing the sleep lever into the sleep range by a predetermined small amount of time, on the order of ten minutes, so that when the buzzer sounds to awaken the sleeper at a predetermined time the sleeper may, by pressing the "drowse" button, disable the buzzer blade for the predetermined short period of time to achieve a few minutes of drowsy sleep. At the end of the "drowse" period, when the "sleep" lever is "walked" to its released position, its upward movement, from reference to "off" position, serves to release the buzzer blade so that it may again sound, the drowse function being repeatable as often as desired.

Referring to FIG. **31**, the parts are in the condition immediately following the sounding of the alarm. That is, the cam follower arm **251** on the alarm shut-off lever **250** has cleared the point of drop-off **217***c* of the cam **217** (see also FIG. **24**) so that the arm **252** has been lowered out of engagement with the buzzer blade B, freeing the buzzer blade for vibration. The "drowse" button, indicated at **75**, has a pad abutment **75***a* at its lower end which is in alignment with the arm **261** of the sleep lever **70**. Moreover, the alarm shut-off lever **250** is provided with a third arm **253**, formed integrally therewith, which lies in the path of movement of the pin **277** on the actuator lever **270**, which is the same pin that operates the switch contacts. Consequently, when the "drowse" button **75** is pressed downwardly into its bottomed position, the sleep lever is rotated counterclockwise, to its reference position accompanied by engagement of the pin **277** on the lever **270** with the third arm **253** on the alarm shut-off lever **250**, thus rocking the shut-off lever so that the arm **252** thereon crowds upwardly against the buzzer blade B lifting it out of the magnetic influence of the motor and shutting off the sound. The final portion of the movement of the drowse button **75** causes the sleep lever to be moved downwardly into its "10 minute" position illustrated in FIG. **32**, accompanied by engagement of the friction elements **263** with the sleep disc **265**. The radio contacts, during the drowse cycle, remain closed and the radio continues to play softly. At the expiration of the ten minute drowse interval, the sleep lever is restored to its reference position where it is free to be drawn upwardly by the return spring **266**. The resultant drop-off at the cam surfaces **275**, **276** frees the lever **270** so that the pin **277** thereon moves clear of the arm **253** of the alarm shut-off lever dropping the arm **252** away from the buzzer blade so that the buzzer blade may resume sounding. The sound may be terminated by moving the function lever to the "auto" position or, indeed, to the "off" or "on" positions whichever may be desired.

Preferably the drowse button **75** is provided with a detent **75***b* so that it remains extended even though the sleep lever **70** is moved downwardly to initiate a sleep cycle.

While it is one of the features of the invention that two successive geneva stages are employed between successive tape drums, the second stage being effective to advance the drum of higher order by a one numeral increment and the first stage serving in an auxiliary capacity to achieve the desired overall reduction between the adjacent drums, it will be understood that the auxiliary function may be performed by means other than a geneva stage without departing from the teachings of the present invention. For example, instead of the auxiliary geneva stage **121**, **122** employed between the

drums **120, 130,** a gear reduction may be used to provide the necessary dividing ratio. Thus, instead of employing the pins **121** on the drum **120** a gear **121***a* may be used as shown in FIG. **14.** Similarly, the star wheel **122** which cooperates with the pin may be replaced by a meshing gear **122***a*. Where it is desired to continue to use two pins **123** for driving the star wheel **124** on the hours drum, the gears **121***a*, **122***a* may have the same reduction ratio as the geneva stage **121, 122** for which it is substituted. However, if it is desired, in the interest of further simplification, to utilize only a single pin **123** in the second geneva stage, this may be done provided that compensation occurs by making the ratio of the gears **121***a*, **122***a* 2:3 (corresponding to a reduction of 1-1/2:1) as shown in FIG. **14.** The use of such auxiliary gearing to replace a geneva stage has the advantage of reducing the peak torque loading which the drive motor is required to overcome. It will, similarly, be apparent that the auxiliary geneva stage **114, 115** between the minutes and tens-of-minutes drum may, if desired, be replaced by gears having a 1:6 speed reduction ratio without departing from the present invention; alternatively, if the pins **116** are reduced to 1, a 1:2 gear will suffice.

Still other means may be used, if desired, for effectively "throwing away" the redundant revolutions of the drum of lower order in accordance with my teachings, for example, the pin which drives the star wheel associated with the drum of higher order may be movable into an "enabled" position at the completion of a cycle of numerals on the drum of lower order and restored to a "disabled" position during the nonsignificant revolutions of the drum of lower order, as covered in my copending application Ser. No. 100,763, filed Dec. 22, 1970 and now U.S. Pat. No. 3,745,852.

It will be apparent that while I have discussed and shown certain preferred embodiments, it will be understood that minor changes may be made without departing from the invention. For example, while I have shown a series of window apertures **51-53,** a single, elongated aperture, while not as desirable, may be used. And while I referred to a drowse "button" **75,** it will be apparent that this is a general term and that any equivalent member may be used to depress the sleep lever. Similarly while the term "lever" has been used for convenience, for example as applied to the function lever **60,** it will be apparent that such member need not, as a matter of necessity, be pivoted and that the member **60** could be mounted for translation upwardly and downwardly without affecting the result. Also, while a buzzer blade constitutes a common form of alarm, it will be understood that the invention is not limited to use with a buzzer blade and that other alarm sounding devices may be readily substituted. Even the term "geneva" used throughout is not intended to be limited to the particular shapes of indexing elements which are shown but it is intended to cover a mechanism which produces periodic angular indexing of one rotating element by another related by a predetermined dividing ratio.

It is to be particularly noted that while the drum and tape display mechanism is particularly well suited for use in a clock, radio timer, or the like driven by an a-c. motor, it is not necessary to use an a-c. motor and any desired drive may be employed in which the shaft **103** which actuates the initial geneva mechanism is synchronously driven with respect to passage of time. Indeed, while the drum and tape display is ideally suited for order-by-order direct indication of time, the tapes may be calibrated and the geneva reduction ratios accordingly adjusted, for decimal or other specific successive orders of numerals. In this connection, while it is preferred to have a simple periphery-to-tape length ratio of, say, 1:3 or 1:2, as here employed, it is not necessary that the numerator of the ratio be one, and the numerator may be some other small integer without in any way affecting the invention or the procedures employed in arriving at the fruits of the invention. Where gears (FIG. **14**) are used as an auxiliary dividing stage, the numerator and denominator integers determining the dividing ratio may be somewhat higher than where a geneva mechanism is used (but still to be considered low) since the number of gear teeth may be adjusted to compensate for an unusual periphery-to-tape length ratio.

While it is one of the features of the construction that a single set of contacts suffices for the switching function, with the blades of such contacts being individually controlled, the term switch as used herein shall include without its scope the possible use of more than one set of contacts connected in parallel with one another.

It is one of the features of the present invention that a special geneva construction **105, 106** is employed for indexing the minute drum in order to obtain rapid indexing movement of the minute numerals combined with freedom from jamming when torque is applied "backwardly" through the geneva connection incident to setting of the minutes drum by the time set wheel **55.** It will be recalled, in connection with FIG. **6,** that the minutes drum is forceably moved during a setting operation accompanied by idle clicking at the driving inremental clutch. The friction consists of pawls **109** on the drum which are in detenting engagement with a circle of teeth **108** on the hub of the geneva output element **106.** The output element of the geneva mechanism is called upon to resist the setting torque, which torque tends to drive the geneva mechanism "backwardly" from output to input.

While it is true that conventional geneva mechanisms are inherently irreversible and include a locking provision to prevent rotation of the output member except during actual indexing, the indexing angle and the locking angle are substantially equal, so that positive locking is achieved only at the expense of requiring a large indexing angle. In a digitally indicating clock or timer the positive locking required to resist torque applied backwardly through the mechanism results in such a large indexing angle that the minute numerals are advanced slowly, and are hence obscured over a major portion of the cycle, rather than being indexed rapidly, from one to the rest, into viewing position.

In accordance with the invention, therefore, a geneva mechanism is provided having a pin and disc input and having a rotatable output assembly including an index member in the plane of the pin and an adjacent locking member in the form of an escalloped polygon presenting arcuate edge portions for engaging the periphery of the disc, with the index member being distinguished by use of short radial notches in the vicinity of the axis for rapid indexing upon engagement by the pin and with radially extending spokes interposed between the notches presenting lateral surfaces for positively blocking the output assembly against rotation during the intervals immediately preceding and immediately following the indexing stroke. Thus referring to FIGS. **6–8** which show a geneva mechanism consisting of an input

105 and an output 106, the input has a rotatable carrier 300 carrying a short pin 301 which is transported in a circular orbit with the pin arranged parallel to the axis. In the present instant, the carrier function is performed by one side of the "seconds" drum 104. Integral with the carrier 300 is a locking disc 302 which has a radius smaller than the pin radius and which is arcuately relieved, as indicated at 303, in the vicinity of the pin. In the output assembly 106, positioned in the plane of the pin, is an indexed member or star wheel 310. Adjacent the indexed member, and secured to it, preferably by molding integral with one another, is a locking member 312 which lies in the plane of the disc 302 and which is in the form of an escalloped polygon presenting arcuate edges mating with the periphery of the disc. The indexed member 310 is distinguished by the use of short indexing station notches 311 which are positioned closely to the axis and which have a radial extension, indicated at *r*, which is extremely short, thereby to secure a minimum indexing angle, indicated at *a*.

In carrying out the invention, the engagement of the locking member 312 with the periphery of the disc 302 is not relied upon during the time just prior to, and just following the indexing stroke, when a geneva mechanism is most vulnerable to jamming. Instead, the indexing member is provided with relatively narrow, spoke-like extensions 313 interposed between the shallow notches 311 and which present lateral surfaces 314, 315 which are dimensioned to be in blocking engagement with the pin as the pin respectively approaches and leaves the region of indexing. In short, the indexing member, itself, performs a locking function in cooperation with the indexing pin during that critical time just before and just after indexing when the regular arcuate locking surfaces (on the member 312) are not fully effective. The result is that a locking angle *b* is achieved (FIG. 7) which may be several times larger than the indexing angle. It may also be noted that the speed-up in the indexing movement of the minutes drum is reflected in a proportional speed-up in indexing of the drums of higher order.

While it would be possible to use geneva mechanisms of such jam-proof design in the other geneva locations, it is not necessary to do so since the geneva mechanism 105, 106 which drives the minutes drum is the only one in the system which is subject to substantial amounts of torque "backwardly" through the mechanism.

I claim as my invention:

1. In a digitally indicating clock, the combination comprising a plurality of endless loops of tape arranged side by side carrying cycles of numerals respectively representative of minutes, tens-of-minutes and hours in successive orders, means including a front panel having a viewing area for viewing said cycles of numerals, the tapes having respective drums for driving the same, geneva mechanisms interposed between the adjacent drums, a seconds drum having seconds indicia on the periphery thereof, a motor and first drive train for driving the seconds drum, a geneva mechanism interposed between the seconds drum and minutes drum for periodic stepped advancement of the latter, an hour wheel, an hour wheel drive train, an alarm set wheel adjacent the hour wheel, said hour wheel and said alarm set wheel having cooperating cams for producing relative endwise movement when the wheels come into a predetermined condition of register, said hour wheel drive train being coupled to the minutes drum for periodic advancement of the hour wheel, and means responsive to the relative endwise movement of the wheels for controlling the operation of apparatus from an "off" condition selectively and sequentially to conditions of "auto-on" and "alarm," said means including a trip lever, said trip lever being pivotally mounted adjacent the wheels for cooperable endwise movement with the wheels, means biasing said trip lever in one direction about said pivot point, means in the path of said trip lever for limiting biased pivotal movement of said trip lever in response to the relative endwise movement of the wheels, a circular rack on said trip lever, a second circular rack gear cooperable with said trip lever rack gear and rotatable through an angular displacement representative of pivotal movement of said trip lever, means interconnecting said second circular rack gear and controlled apparatus, and a function lever for selectively disabling movement of said trip lever.

2. The combination as claimed in claim 1 in which the minutes drum has a time set wheel positively coupled to it and in which a incremental clutch is interposed immediately ahead of the minutes drum for permitting rotation of the minutes drum and hour wheel gear train by the time set wheel free of rotation of the seconds drum and the geneva mechanism which is associated therewith.

3. The apparatus of claim 1 wherein said limiting means includes a stop providing first and second steps, said stop being mounted adjacent said wheels, each of said steps being configured so that said trip lever moves under bias control to and from the steps in timed succession incident to endwise wheel movement, and said function lever cooperable with said trip lever to determine selectively of operation by limiting pivotal movement of said trip lever.

4. The apparatus of claim 3 wherein said controlling means further includes switch means providing a pair of switch contacts, and said interconnecting means includes a cam, a shaft for mounting said cam at one end and a driven element at the other end, said driven element being driven directly by said drive element for operating said switch means so that said controlled apparatus is first in a condition of selective "auto-on" when said trip lever is permitted movement from said first to second step.

5. The apparatus of claim 4 including a buzzer blade, said cam moving said buzzer blade relative to said synchronous motor when said trip lever moves from said second step to a condition of selective "alarm."

6. The apparatus of claim 1 further including a rotating disc coupled to said second drive train means, means including a sleep control lever having a frictional element movable into a "sleep" range in which said disc is engaged in overlapping relation, said control lever being biased for movement to an "off" position clear of said disc upon elapse of a time interval which depends upon the degree of overlap, a switch for turning on said controlled apparatus, and means independent of the position of said trip lever for turning on said switch thereby to turn on said controlled apparatus during the time said control lever is in the "sleep" range.

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