United States Patent

Pindell, Jr. et al.

[15] **3,635,011**

[45] **Jan. 18, 1972**

[54] **ELAPSED-TIME INDICATOR**

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[22] Filed: **Jan. 14, 1970**

[21] Appl. No.: **2,899**

[52] **U.S. Cl.** ....**58/41 A,** 58/145

[51] **Int. Cl.** **G04c 1/04,** G04b 5/04

[58] **Field of Search** ....58/40, 41, 41 A, 53, 145, 140, 58/28, 28 A, 28 B, 28 D, 107

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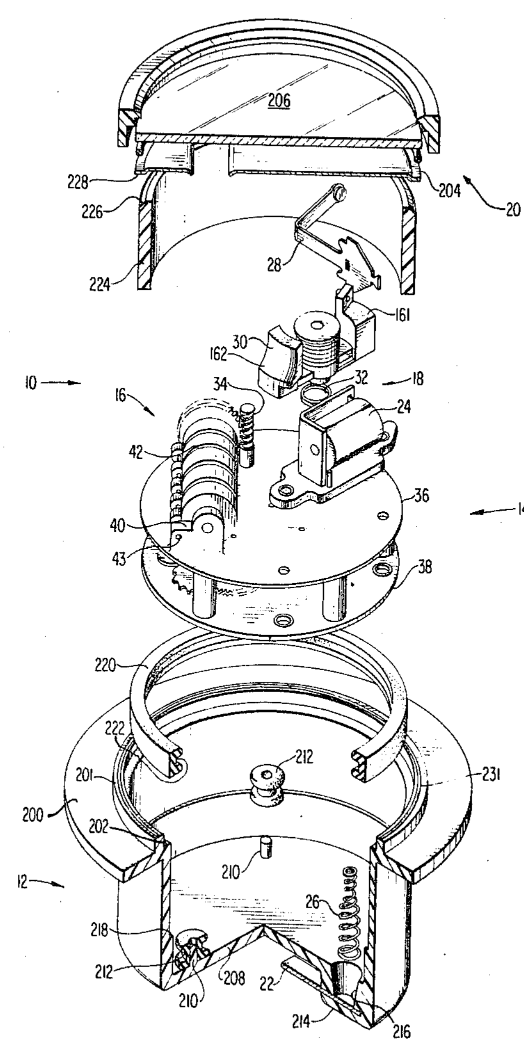
[57] **ABSTRACT**

The indicator has a casing carrying two plates mounting the gear train, motor assembly, escapement, and counter. The motor assembly includes a solenoid which impulses a flywheel to wind a mainspring which advances the counter through the gear train at a rate determined by the escapement. The plates and gearing are formed of plastic and this assembly is shock mounted in the plastic casing. Features hereof include a helical mainspring having opposite ends engaging between the baseplate and the flywheel respectively, direct pivotal mounting of the movement shafts in the plates without jewel bearings, a dynamically balanced armature for the motor assembly, coil spring leads from the motor assembly to the terminals on the plastic casing, and the application of ultrasonic welding techniques to the assembly.

27 Claims, 19 Drawing Figures



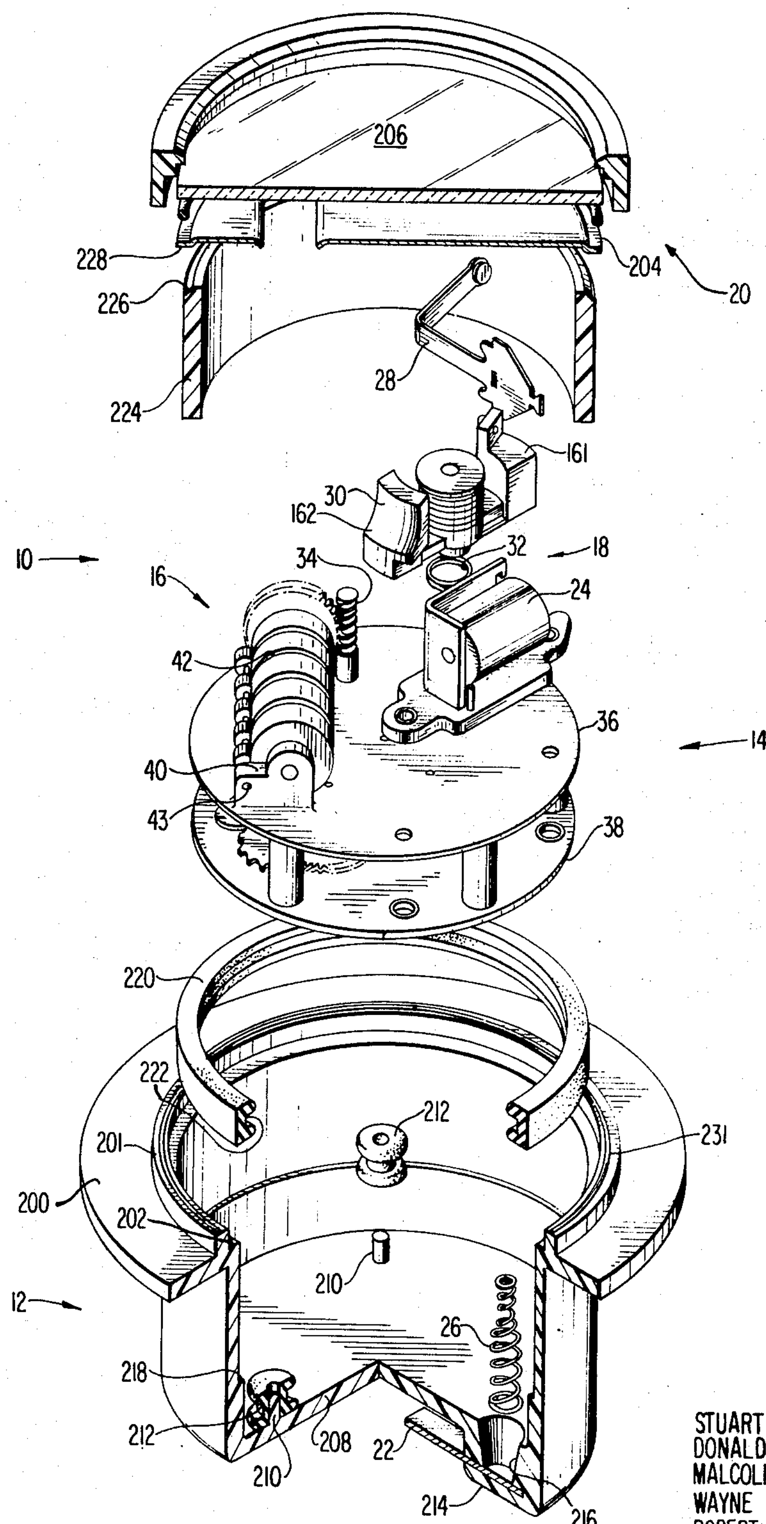


FIG. I

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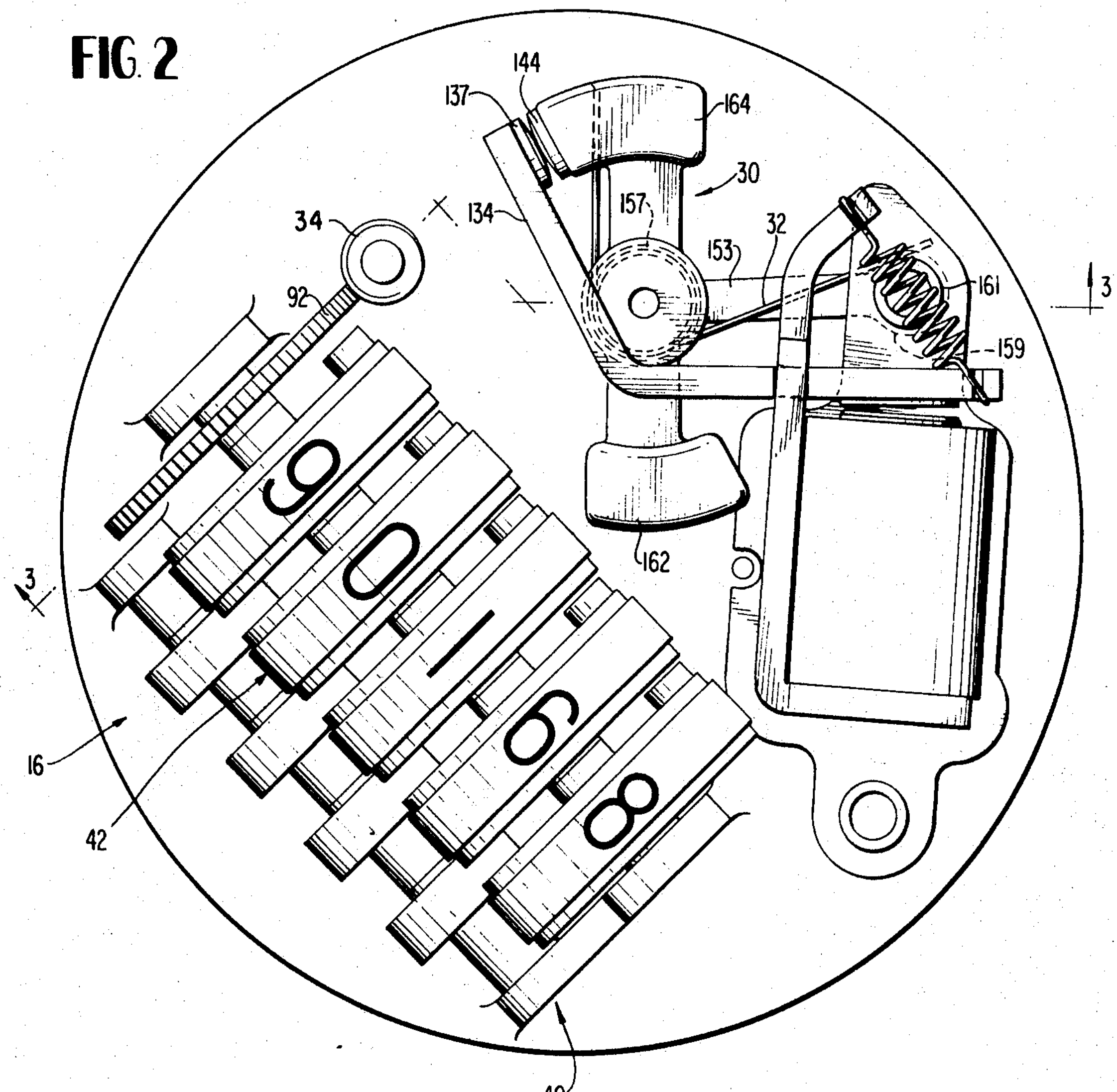
ATTORNEYS

FIG. 2



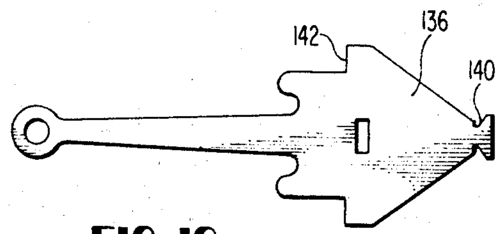


FIG. 10

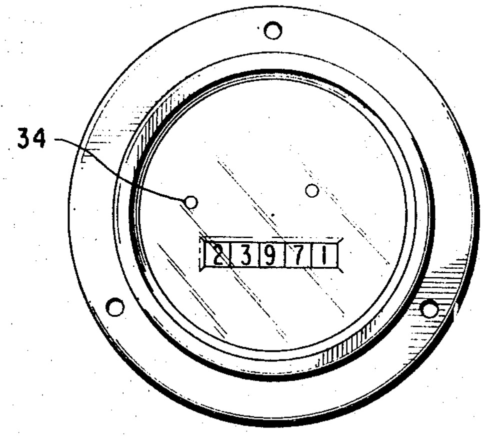


FIG. 14

FIG. 3

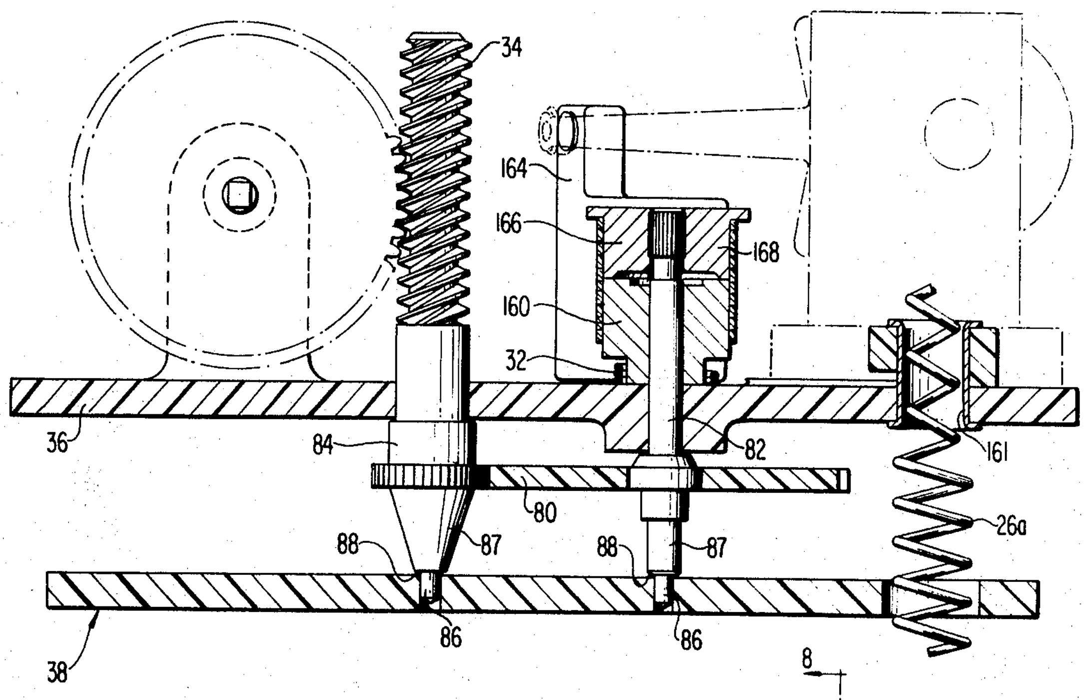
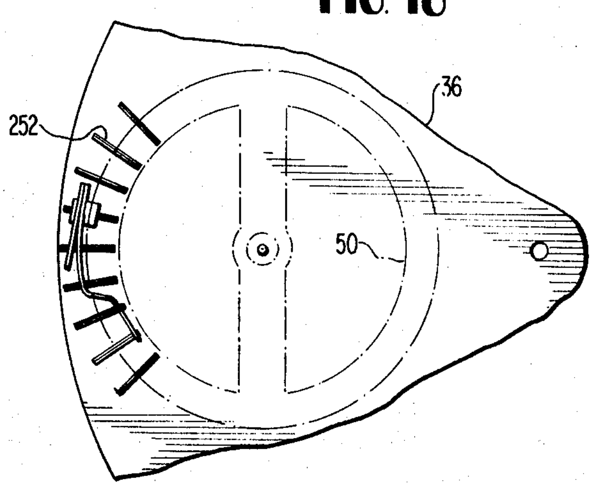


FIG. 18



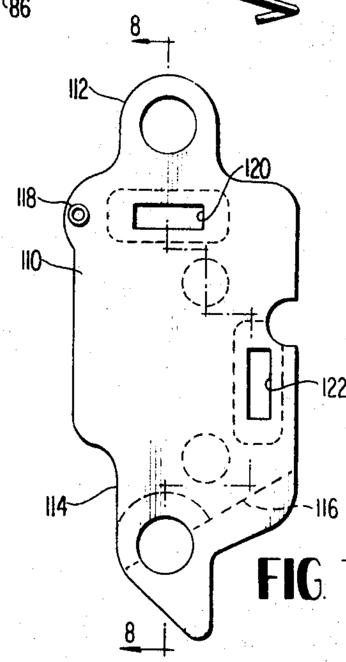


FIG. 7

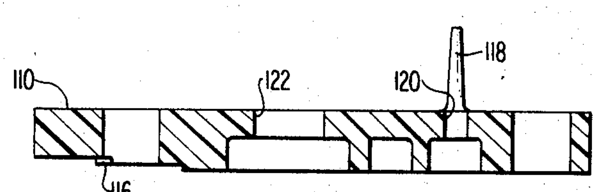
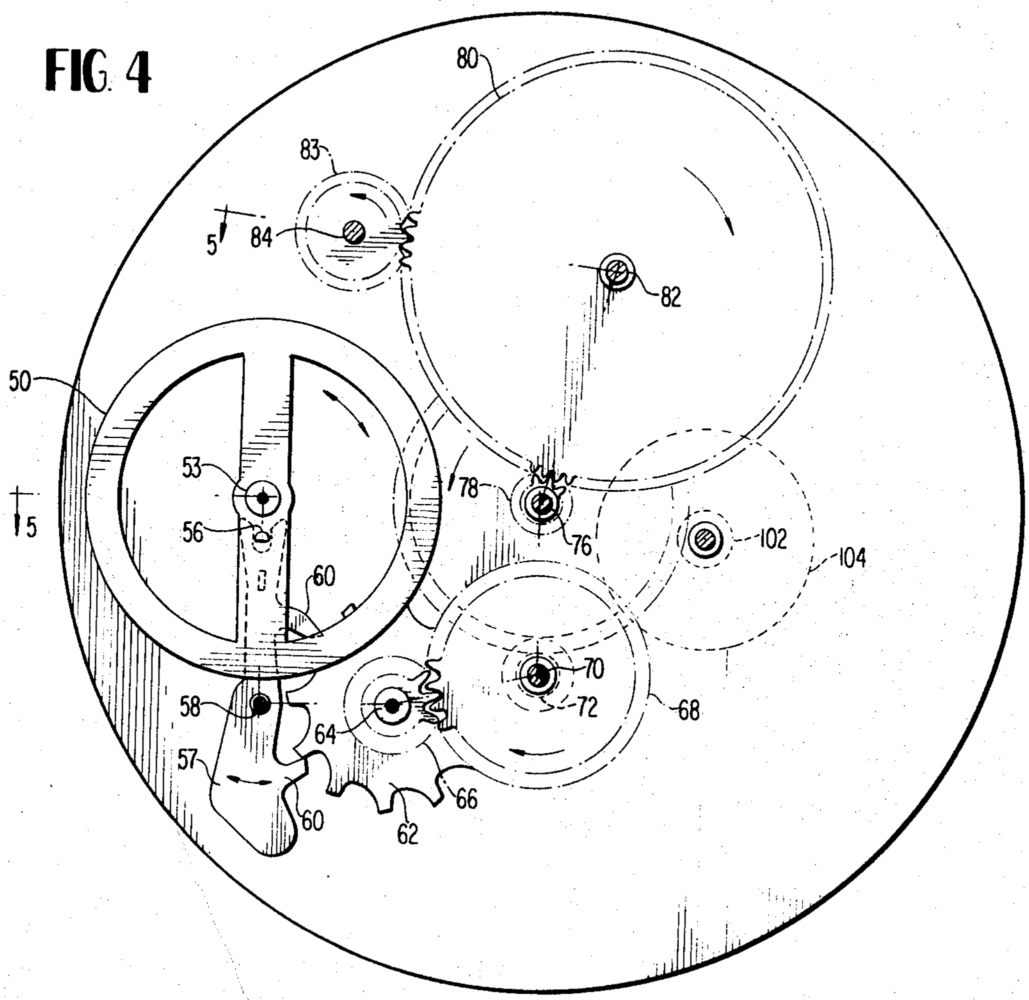


FIG. 8

FIG. 4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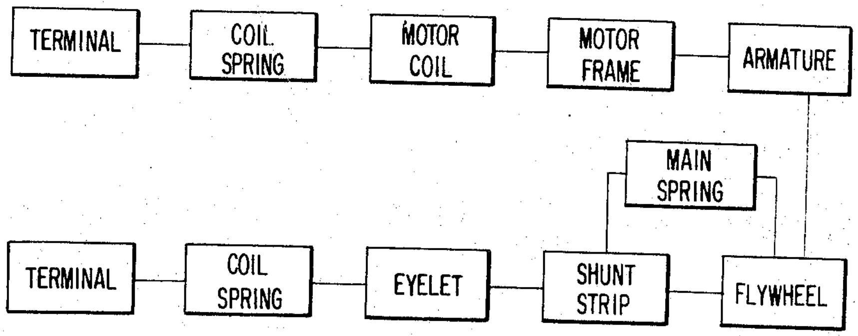

TERMINAL
COIL SPRING
MOTOR COIL
MOTOR FRAME
ARMATURE
MAIN SPRING
TERMINAL
COIL SPRING
EYELET
SHUNT STRIP
FLYWHEEL

FIG. 19

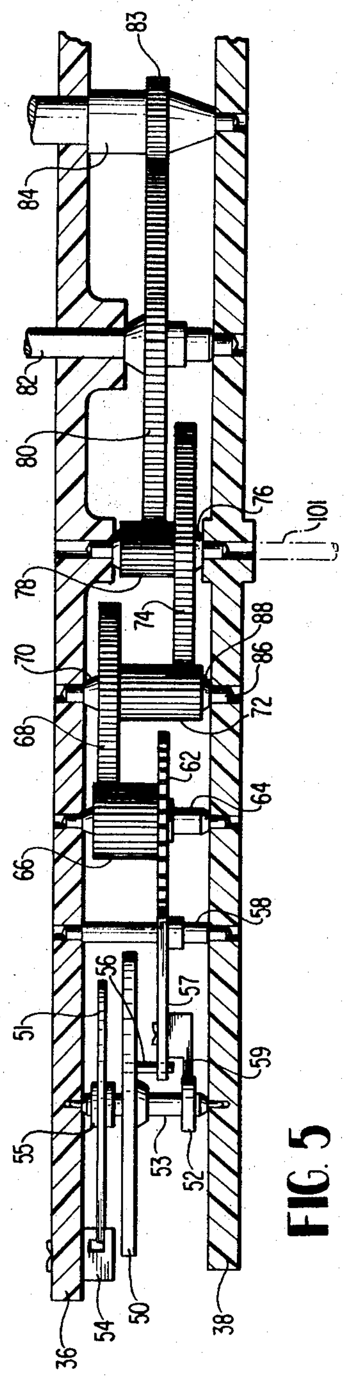
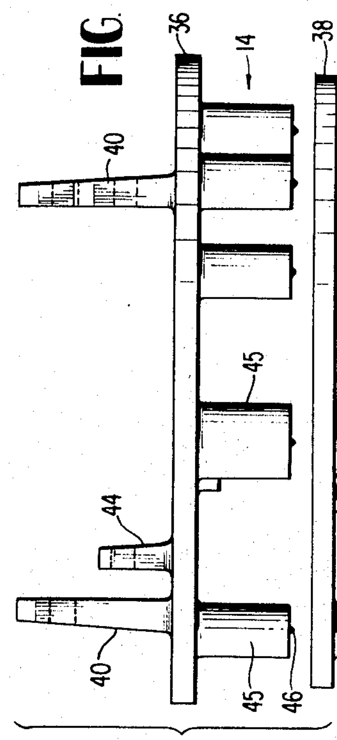


FIG. 5

FIG. 15



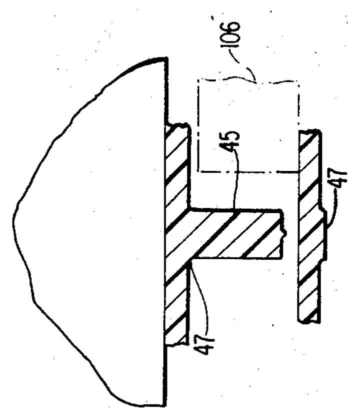


FIG. 16

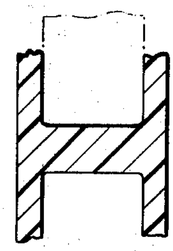
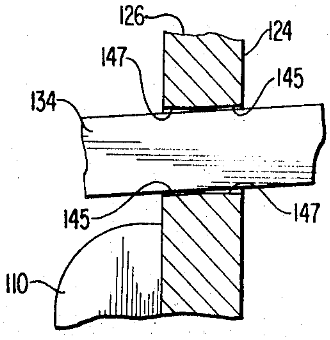


FIG. 17

FIG. 9



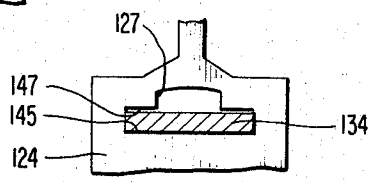
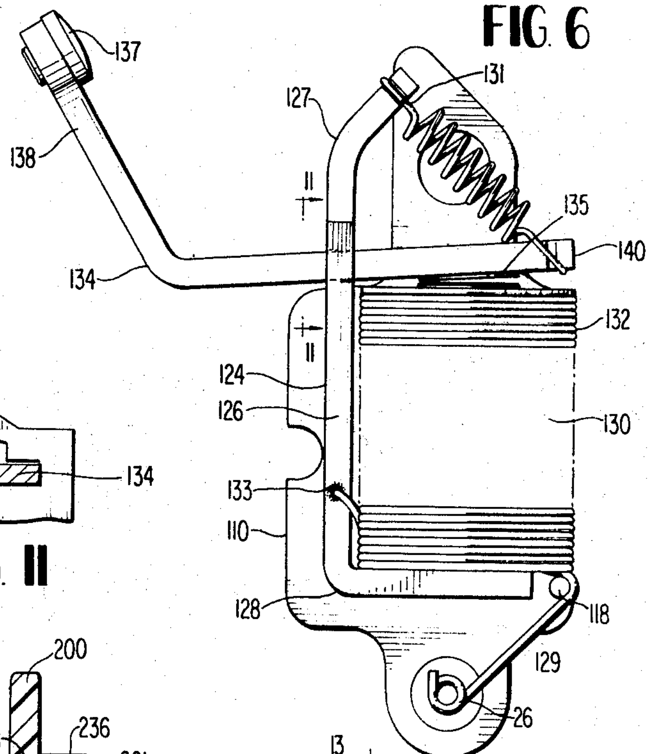


FIG. 11

FIG. 6



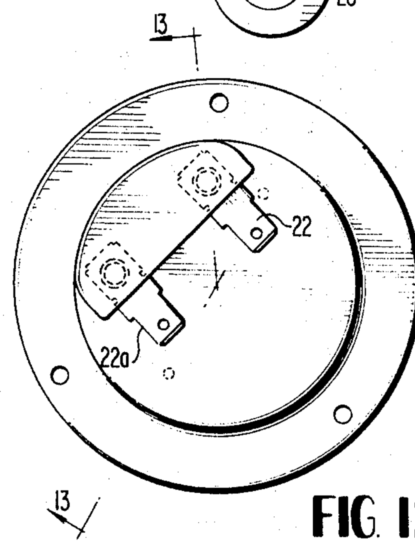


FIG. 12

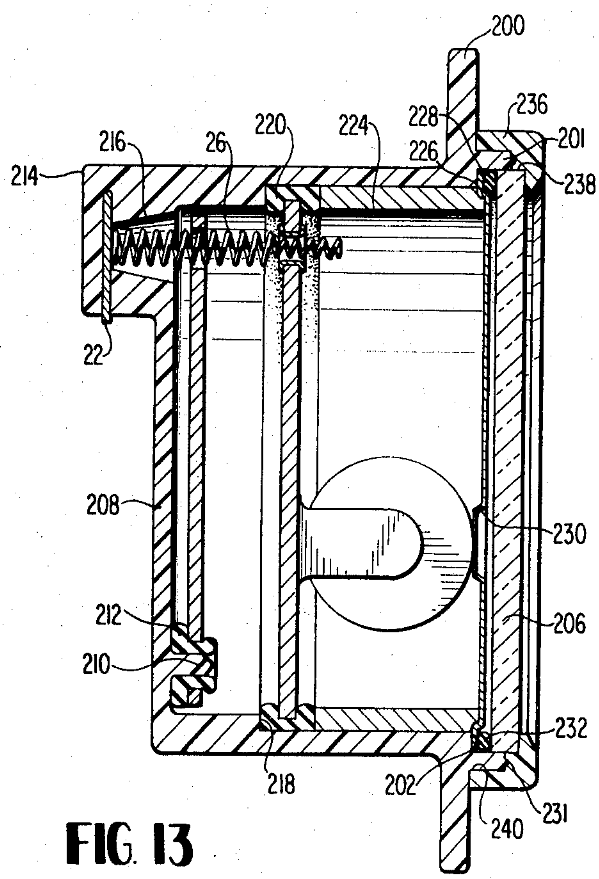


FIG. 13

ELAPSED-TIME INDICATOR

The present invention relates to an elapsed-time indicator and particularly relates to an improved electrically or mechanically actuated running time indicator particularly for use with intermittently operated equipment, machinery or the like to indicate aggregate running time.

Elapsed or running time indicators are most often employed with equipment or machinery which is intermittently operated where it is desirable to ascertain the accumulated time of actual operation. For example, it is often desirable to determine the total time that a periodically operated engine, i.e., an automobile engine, has been running, for example, for leasing purposes, maintenance scheduling and the like. The total time that machinery and the like is actually in use plays a direct role in many aspects of intermittently operated equipment utilization.

Prior elapsed-time indicators have employed an oscillating balance and escapement of the type used in watch- or clock-type movements to constrain the rundown of a mainspring driving an output shaft which, in turn, operates a running time indicator or counter. Devices of this type have employed a motor assembly including a solenoid operable to move an armature which impulses a flywheel which, in turn, winds the mainspring. The mainspring drives an output shaft through a gear train under the constraint of the escapement. After a predetermined rundown of the mainspring, a pair of contacts are closed to energize the solenoid and again impulse the flywheel thereby rewinding the main spring. In these known indicators, this sequential action is repeated for so long as energy is applied to the solenoid.

Prior devices of this type, however, have many inherent disadvantages among which are the relatively large number of parts which must be formed, machined, assembled, etc., to form the indicator, the relatively high cost of the indicator due to such large number of parts and the skilled labor required for their assembly, uncertain reliability, their inability for adaptation to certain environments, their relatively inefficient motor assemblies, the lack of capability for ready conversion between electrical and mechanical input thereby limiting their use, and inordinate shock and vibration sensitivity.

The present invention provides an improved elapsed-time indicator which minimizes or eliminates the above discussed and other shortcomings of prior indicators of this type and provides various advantages in construction, mode of operation, and result over prior elapsed-time indicators. Generally, the present invention provides an elapsed-time indicator having a pair of spaced plates mounting a clockwork movement including a gear train and escapement therebetween. Where an electrical input is provided, an electromagnet and counter are mounted on a baseplate. The electromagnet may be electrically connected, for example, to the ignition circuit or other circuit of the associated machine or the like, which circuit is indicative of the running time thereof, A flywheel, which forms a part of the electrical circuit through the indicator, lies in electrical contact with and is impulsed by the armature of the electromagnet to break the electrical contact and to wind a helical mainspring, the latter having opposite ends connected to the flywheel and the baseplate. The run down of the mainspring drives the flywheel shaft through a one-way clutch arrangement and also drives a worm gear connected to the counter. The run down of the mainspring is under the control of the escapement through the gear train. When the mainspring is fully run down, the flywheel completes an electrical circuit with the electromagnet and thereby the latter is energized to impulse the armature and hence the flywheel to again rewind the mainspring whereupon the timing cycle is repeated and continued for such time as electrical energy is applied to the terminals of the indicator. The foregoing clockwork and counter subassembly is shock mounted in a plastic casing and has coil lead springs from the electromagnet to the terminals on the rear face of the casing. Where a mechanical input is required, one of the shafts of the movement is extended externally of the casing and adapted for connection with the mechanical drive, the motor assembly being omitted in this form. An idler gear may also be provided in the movement whereby, in the mechanical version, either direction of rotation of the mechanical input can be accommodated.

It is a significant feature hereof that the present indicator is formed of a minimum number of parts whereby the cost and labor of producing the same has been significantly reduced in comparison with prior indicators of this type. For example, whereas 117 parts were required to form an elapsed time indicator of the type identified as Model No. 571 constructed by the Hamilton Watch Company, the present indicator requires 54 parts. A significant factor in accomplishing this parts reduction without sacrificing reliability and accuracy and in fact increasing the reliability and accuracy of the present indicator as compared with prior indicators, has been the use of plastic materials and plastic welding techniques. Particularly, the functions per part ratio have been substantially increased. To our knowledge, a very substantial proportion of the parts forming prior indicators of this type have been formed of metal and this requires machining and other metal fabricating operations in order to maintain the required tolerances, fit, etc. The formation of certain of these and other parts of a plastic material was not heretofore believed feasible since it was not considered that the finished parts when assembled would have the degree of precision necessary to perform their intended functions, long wear, life, and other properties characteristic of clockwork mechanisms. Problems in the use of plastics, for example, mold shrinkage, dimensional and life stability, moisture resistance, lubrication of relatively movable plastics parts and the like have long mitigated against the use of plastic parts in a clockwork mechanism. It has been found, however, that these and other problems can be overcome and the accuracy and reliability of the present indicator are considerably enhanced with the use of carefully designed plastic parts and novel plastic fabricating techniques. For example, the two baseplates forming the support structure for the counter, solenoid and movement are each integrally molded of a plastic material consisting of a glass fiber filled nylon with a natural lubricant added, typically molybdenum disulphide. One of the plates is molded to provide the pillar posts, the support brackets for the counter, and openings for the shafts of the movement with the marginal portions about the openings providing integrally formed bearing surfaces for such shafts. These functional parts heretofore required the formation of separate, usually metal, parts, and it will be seen that these parts and their functions, by the present invention, have been incorporated into a single, readily formed plastic part. Certain of the gear wheels and shafts of the clockwork train are also integrally molded thus further increasing the function per part ratio. It is a further significant feature hereof that conventional jewel bearings mounting the shaft ends of the movement may be eliminated. Generally, annular shoulders are formed on the shaft ends and bear on the marginal portions about the openings in the plastic plates. The plastic plate and shafts are self-lubricating, and it has been found that they are reliable and accurate within accepted limits and have a significantly longer wear life than comparable metal to metal bearings.

Another aspect of the present invention includes a dynamically balanced and positively locked armature mounted on the electromagnet in a manner providing long wear life and consistent performance throughout the life of the motor. Also, the armature is carried by the motor frame in a manner as to positively lock the arm to the motor assembly thereby resisting shock and vibration as well as to increase the metal to metal interface whereby the magnetic reluctance is minimized. Notwithstanding such positive lock, the return spring for the armature is extremely light and has high resistance to vibration and chatter. Other features of the motor assembly provide a self supporting coil wound directly on the core, the adjacent wire strands being bonded one to the other. The coil size is reduced as compared with electromagnets previously employed in indicators of this type, and this results in a reduction in the length of the magnetic path, as well as providing for lighter mountings. A high coil resistance is provided to reduce the contact current whereby the life of the electrical contacts is substantially increased. Moreover, a wide voltage range can be impressed on the coil thereby adapting the indicator for use with a wide variety of machines operable at different voltages.

In another aspect hereof, the indicator casing and the movement are formed to permit ease of assembly, provide for shock mounting of the movement in the casing, and permit ready electrical connection between the leads to the electromagnet and the terminals mounted on the rear face of the casing. To this end, a substantially cylindrical one-piece integrally molded cup-shaped casing having an integrally molded terminal block formed on its rear face is provided. A pair of integrally formed locating pins project inwardly from the rear face of the casing. A pair of openings are formed in the second plate of the movement and a pair of coil lead springs connected to the motor assembly extend through the second plate. Grommets are provided about the locator pins and when the movement is positioned within the case, an annular grommet seats the first plate of the movement against a corresponding shoulder in the casing thus shock insulating the movement from the casing. The locator pins engage through the second plate openings to laterally orient the movement relative to the casing and thereby locate the ends of the lead springs against the terminals at the rear face of the casing. As will be appreciated, the movement can thus be simply dropped into the casing over the locating pins. A bezel is then applied about the opposite end of the casing sealing the dial plate and crystal to the casing.

The assembly of the present indicator is further facilitated by the employment of ultrasonic welding techniques whereby the plates of the movement can be welded one to the other with the gear train therebetween and the bezel ultrasonically welded to the casing after the movement has been inserted therein. To this end, dimples are formed on the ends of the integrally molded pillar posts of the baseplate. Slightly raised cylindrical projections or energy pads are formed on one side of the other plate adjacent its connection with the ends of the pillar posts. With spacer blocks interposed between the plates to maintain a predetermined spacing therebetween, an ultrasonic horn is brought to bear against the opposite side of the one plate in alignment with the raised projections or energy pads on the one plate. When ultrasonic energy is applied, the plastic material at the ends of the posts melts, starting with the dimpled portions thereof. When energy to the ultrasonic horn is interrupted, the melted plastic hardens and welds the one plate to the other. By this method, the normal connecting means usually providing for connecting the plates of typical clock movements and which include numerous parts requiring machining, assembly, etc., are entirely eliminated. Moreover, after the movement is inserted into the casing, the bezel is then applied about the open end of the casing and ultrasonically sealed thereto to provide a watertight, high-integrity casing.

As can be seen by the foregoing brief discussion of certain of the salient features of the present elapsed time indicator, the use of plastics and plastic welding techniques are widely used throughout the manufacture and assembly of the indicator. This substantially reduces the number of parts required as well as facilitating their formation and assembly. By integrally molding many of the parts previously formed separately and by rearranging and adding and/or subtracting certain parts and their functions, the function per part ratio is significantly increased in relation to the almost 1-to-1 function per part ratio found in previous indicators of this type.

Accordingly, primary and other objects of the present invention are to provide a low-cost, reliable, and readily and easily assembled elapsed-time indicator: wherein the use of plastics and plastic welding techniques are used extensively throughout the formation of the indicator parts and their assembly whereby a substantial reduction in the number of parts and an increase in the function per part ratio is effected; wherein jewel and other metal to metal bearings in the movement are entirely eliminated through the use of a gear train formed essentially of plastic materials or where jewel bearing may be selectively employed as desired, wherein certain wheels and pinions of the gear train are integrally molded of plastic; having a pair of plates which mount both the gear train and escapement as well as the counter and motor assembly including the electromagnet, flywheel and mainspring when an electrical input is provided; wherein the supports carried by the baseplates for mounting the movement, counter, motor assembly and the like are integrally molded therewith whereby such supports are provided solely by two plates; wherein a plastic molded casing having integrally molded electrical terminals and movement aligning pins is provided; wherein the movement can be readily and easily assembled into the casing with the terminals making electrical contact with the motor assembly of the movement through a pair of helical springs; wherein the movement is shock mounted within the casing; wherein the dial plate and crystal are clamped to the casing and the movement retained in the casing by a bezel ultrasonically welded to the casing; and wherein the resulting indicator is compact having minimum lateral and depth dimensions.

Still other objects of the present invention are to provide a motor assembly for timers and the like including a solenoid with a dynamically balanced armature; an armature which is positively locked to the base frame of the solenoid in a manner providing consistent performance and long wear life; a light return spring for the armature affording vibration and chattering resistant characteristics; and a more effective magnetic path through the solenoid.

Related objects of the present invention are to provide a unique bearing structure for shafts in timers and other horological devices wherein conventional jewels, jewel mountings and externally applied lubrication of the bearings as well as the labor involved in assembling and lubricating such jewelled bearings may be entirely eliminated; wherein shafts and bearing plates are formed of a self lubricating plastic material; wherein the wear life and reliability of the present bearing structure is substantially increased in comparison with conventional bearings in like devices; and wherein the bearing structure has increased shock and vibration resistant properties as well as a capability of operation under extreme environmental conditions.

These and further objects and advantages of the invention will be more apparent upon reference to the following specification, claims and appended drawings wherein:

FIG. 1 is an exploded perspective view of the various parts comprising the elapsed-time indicator of the present invention with certain of the parts being illustrated in cross section;

FIG. 2 is a plan view of the counter and motor subassemblies hereof mounted on the upper plate of the movement;

FIG. 3 is a cross-sectional view thereof taken about on lines 3—3 in FIG. 2;

FIG. 4 is a plan view of the movement subassembly looking downwardly on the lower mounting plate in FIG. 1;

FIG. 5 is a cross-sectional view thereof taken generally about on line 5—5 in FIG. 4;

FIG. 6 is a plan view of the motor subassembly hereof;

FIG. 7 is a plan view of the motor mount thereof;

FIG. 8 is a cross-sectional view thereof taken about on line 8—8 in FIG. 7;

FIG. 9 is an enlarged fragmentary cross-sectional view of the motor subassembly illustrating the pivotal joint between the armature and the motor frame;

FIG. 10 is a plan view of a blank for the armature;

FIG. 11 is a cross-sectional view of the motor in the motor subassembly taken generally about on line 11—11 in FIG. 6;

FIG. 12 is a plan view of the rear face of the elapsed-time indicator;

FIG. 13 is an enlarged cross-sectional view thereof taken generally about on line 13—13 in FIG. 12;

FIG. 14 is a plan view of the elapsed-time indicator;

FIG. 15 is a side elevational view of the movement mounting plates prior to assembly;

FIG. 16 is a fragmentary cross-sectional view thereof illustrating their assembly by application of an ultrasonic horn and spacer block;

FIG. 17 is a fragmentary cross-sectional view of the finally assembled baseplates,

FIG. 18 is a fragmentary plan view of the lower mounting plate illustrating the bench marks used for visual estimation of the amplitude of the balance wheel excursion during assembly of the indicator; and

FIG. 19 is a schematic illustration of the electrical circuit for the elapsed-time indicator hereof.

Referring now to the drawings, there is shown in FIG. 1, an elapsed-time indicator generally indicated at 10 comprising a cylindrical casing 12, a watch- or clock-type movement carried between a pair of movement plates and generally indicated at 14, a counter 16 driven by movement 14, a motor assembly 18 utilized when an electrical input is provided the indicator and a bezel and dial assembly 20. To assist in an understanding of these various parts and their assembly which are described in detail hereinafter, a generalized description of the overall operation of the indicator is now provided.

Where the aggregate running time of a periodically operated machine is to be calculated and the machine has an electrical circuit which is indicative of its running time, i.e., an ignition circuit, the indicator is connected in the machine circuit at a pair of terminals 22 disposed on the rear face of casing 12. The running time electrical signal energizes a solenoid 24 via a coil spring lead 26 and the armature 28 of solenoid 24 is impulsed to drive a flywheel 30 against the bias of and thereby wind a mainspring 32 which is connected to flywheel 30. The shaft mounting the fly wheel also mounts a wheel of the clockwork movement. This shaft is coupled to the flywheel through a one-way clutch arrangement and is rotated by the mainspring in a timed fashion through a gear train and escapement assembly to be described. Another shaft is coupled to the movement 14 and mounts a worm gear in driving engagement with counter 16. When mainspring 32 runs down and returns flywheel 30 into contact with armature 28, the electrical circuit is again completed and the armature is impulsed to rotate flywheel 30 against the bias of and to again wind mainspring 32. This operation is repeated for so long as the electrical signal indicative of the running time of the associated machine is applied to the indicator and the aggregate running time is digitally displayed by counter 16. The foregoing description with respect to the lead in terminals, solenoid flywheel and armature assembly is applicable where an electrical input is provided the indicator and these parts are omitted when the indicator is to be employed with a mechanical rotary input. In the latter instance, the fourth wheel of the movement is replaced with a wheel having an extended shaft attachable to the mechanical rotary input of nearly constant torque. In this manner, there is a direct mechanical drive to the movement and the counter is advanced through the worm gear similarly as before. The movement can be adjusted to accommodate a rotary mechanical input in either direction. A detailed description of the various parts and assemblies will now be provided.

Referring now to FIGS. 1 and 3 there is illustrated a pair of plates 36 and 38 which mount movement 14 and counter 16 as well as the motor assembly 18 when an electrical input is anticipated. Baseplate 36 comprises a circular disc carrying on one face a pair of upstanding brackets 40 for mounting counter 16. Brackets 40 are suitably formed to carry the shaft 41 mounting the graduated dials 42 of counter 16: One of the brackets 40 is extended to mount one end of a second counter shaft 43 while a separate bracket 44 is formed on plate 36 to mount the opposite end of shaft 43. On the opposite face of baseplate 36, there are provided a plurality of laterally spaced pillar posts 45, preferably five in number, having dimples 46 formed on their ends for reasons described hereinafter. A plurality of slightly raised cylindrical bosses 47 are formed on the upper face of bottom plate 38 at positions in alignment with pillar posts 45 whereby, when plates 36 and 38 are secured one to the other, pillar posts 45 are joined to the plate 38 in a manner to be set forth thereby retaining the movement 14 between plates 36 and 38. Suitable openings are formed through each of plates 36 and 38 for receiving the corresponding ends of the shafts forming a portion of movement 14.

It is a particular feature of the present invention that the foregoing structure comprising brackets 40 and 44, posts 45, dimples 46, bosses 47 and the openings for the shafts of the movement is formed integrally with the associated plate. Particularly, the plates are integrally molded of plastic with the brackets 40 and 44, posts 45, dimples 46, and bosses 47 integrally molded with the associated plates. The plastic material may comprise, for example, 30 percent short glass fiber filled —5 percent molybdenum disulphide filled nylon. In prior indicators of this type, the counter brackets and pillar posts were formed separately and required separate assembly thereof to the respective plates, such formation and assembly being entirely eliminated herein by use of integrally molded movement plates without loss of function, strength, and reliability of such parts.

The movement 14 will now be described. With reference to FIGS. 4 and 5, there is illustrated a balance wheel 50, a suitable hairspring 51, and a safety roller 52 carried by a balance wheel shaft 53. Hairspring 51 is connected at one end to a stud 54 staked to plate 36 (or to a slotted post raised from plate 36, not shown) and is connected at its opposite end to a collet 55 carried on shaft 53. A roller pin 56 is carried by balance wheel 50 and periodically engages within the forked end of a pallet 57 carried on a pallet shaft 58. A guard pin 59 is staked to pallet 57 and cooperates with roller 52 in the usual fashion to insure that the pin 56 and pallet 57 are always in proper relative position. A pair of arms 60 is carried by pallet 57 on opposite sides of its pivotal axis and the arms alternately engage the teeth on an escape wheel 62 carried on an escape wheel shaft 64. Shaft 64 also carries an escape wheel pinion 66 which lies in mesh with the fifth wheel 68 of movement 14, wheel 68 being carried on a shaft 70. Shaft 70 also carries a fifth wheel pinion 72 which lies in mesh with the fourth wheel 74 mounted on a shaft 76. Shaft 76 carries a fourth wheel pinion 78 which lies in mesh with a third wheel 80 carried on a shaft 82. Wheel 80 lies in mesh with gear teeth 83 formed on a shaft 84 which extends through baseplate 36 and carries worm 34 on its upper end.

In a manner to be explained in detail hereinafter and wherein an electrical input is provided, mainspring 32 imparts a torque to the third shaft 82, for example, in the clockwise direction as seen in FIG. 4. The rotation of third wheel 80, however, is restrained by the escapement through the fourth and fifth wheels 74 and 68 respectively. The mainspring thus also imparts a torque to the balance-hairspring assembly of the escapement to release the movement and provide a timed rotation of third wheel 80 under the bias of mainspring 32. The second wheel shaft 84 in mesh with wheel 80 thus rotates in a timed fashion.

Particularly, the torque imparted to the escape wheel 62 through wheels 68 and 74 from wheel 80 pivots pallet 57 about its axis 58, which, in turn, initially impulses the balance wheel 50 in, for example, a counterclockwise direction as seen in FIG. 4. Escape wheel 62 is also unlocked and rotates until locked by the upper pallet arm 60 as seen in FIG. 4. The balance wheel 50 continues on its counterclockwise oscillatory excursion until the hairspring is wound. The balance wheel 50 then returns in the opposite direction and roller pin 56 engages in the forked end of pallet 57 to impulse the pallet in a counterclockwise direction thereby releasing escape wheel 62. Escape wheel 62 rotates a predetermined distance until locked by the lower pallet arm 60 as seen in FIG. 4. Balance wheel 50 continues on its clockwise oscillatory excursion with pin 56 being impulsed from within the forked end of pallet 57. Upon completing its clockwise oscillatory excursion and winding the hairspring, the balance wheel returns in the opposite counterclockwise direction to engage the pin 56 in the forked end of pallet 57 whereby the escape wheel 62 is again released and stepped in a counterclockwise direction until locked by the upper arm 60. So long as torque is applied to escape wheel 62 via wheels 68, 74, and 80 and associated pinions, the escapement operation continues and the escape wheel rotates unidirectionally thereby permitting continued and unidirectional rotation of third wheel 80 in a timed fashion. With staff 84 lying in meshing engagement with third wheel 80, staff 84 is driven in rotation substantially continuously as long as torque is applied to the third arbor 82 by mainspring 32.

As seen in FIGS. 2 and 3, counter 16 is mounted between brackets 40 and comprises the counter wheels 42 which bear timekeeping indicia about their peripheries in the usual fashion. The counter wheels 42 are driven by a counter wheel 92 which lies in mesh with worm gear 34 carried on the end of the second wheel staff 84. Thus, continued rotation of the staff 84 drives counter wheel 92 which, in turn, operates wheels 42 which rotate in a timed fashion to provide a digital aggregate running time readout through dial assembly 20.

It is an important feature hereof that certain of the parts thus described comprising the movement 14 are molded of a plastic material. For example, each of the shafts 70 and 76, as well as their associated movement wheels, are each integrally molded of plastic.

It is another important feature hereof that jeweled bearings as previously employed in indicators of this type may be entirely eliminated. To accomplish this, the ends of each of the various shafts of the movement are stepped to provide a reduced diameter cylindrical end portion 86 (FIGS. 3 and 5) and enlarged diametrical portions 87 forming annular shoulders 88 therebetween. To secure the shafts and their associated parts between plates 36 and 38, the reduced opposite end portions 86 are inserted into aligned openings in plates 36 and 38 with the annular shoulders 88 on the associated shafts bearing on face portions of the plates about the openings. Opposite annular bearing surfaces are thus formed. It will, of course, be appreciated that shafts 82 and 84 extend through the plate 36 and are necessarily of greater diameter than the other shafts of the movement. Shafts 82 and 84 are provided with a similar bearing arrangement with reduced and enlarged diameter portions forming an annular shoulder providing the bearing surface with plate 36. This unique bearing assembly thus eliminates the precision jewels, additional mountings and assembly steps normally required in prior clockwork or watch movements. Moreover, external lubrication required in previous clockwork or watch bearing structures is entirely eliminated by the foregoing bearing structure as the plastic materials from which the shafts and plates are formed is self-lubricating.

Where an electrical input is provided, third wheel 80 provides, in a manner to be described, the input torque to the escapement and counter drive shaft 84. However, when a mechanical input is provided, the shaft 76 is replaced by an elongated shaft as indicated by the dashed lines 101 in FIG. 5 for connection with the mechanical input, and it will be seen that the movement 14 and counter shaft 84 will operate as previously described provided a counterclockwise mechanical input torque operates on elongated shaft 101. If a clockwise mechanical input torque is provided, the indicator is modified by removing the fifth pinion 72, inserting a fifth idler gear 100 having a pinion 102 in mesh with wheel 74 and a wheel 104 in mesh with wheel 68, and providing a counter drive shaft 84 having a reversely threaded worm 34 at its upper end. Thus, with a clockwise input, idler gear 100 and its associated pinion 102 convert this reverse or clockwise directional input such that the fifth wheel 68 and escape wheel 62 rotate in directions similarly as described previously. In other words, the escapement must be torqued in one direction only, and the above modification to the movement gears the escapement to receive a torque in its operable direction. With the movement modified to receive a clockwise input, the third wheel 80 rotates counterclockwise and drives the counter drive shaft 84 in a clockwise direction. A reversely threaded worm would then rotate the counter drive wheel 94 in the same direction as previously.

Referring now to FIGS. 15–17, the plates 36 and 38 are secured one to the other with the movement retained therebetween through the unique cooperation between formation of the pillar posts 45, dimples 46 and bosses 47 upon alignment of the plates and application of an ultrasonic welding technique. To this end, and after the movement shafts are aligned and inserted into the corresponding openings in the plates, a pair of spacer blocks 106 are inserted between the plates, preferably at diametrically opposite positions about plates 36 and 38. The end of a resonant or ultrasonic horn 108 is then brought to bear against bosses 47. When electrical energy is applied to a sonic converter, the horn is caused to vibrate. The vibrations are transmitted through the bosses (energy pads) 47 and the plate to the dimples 46 and the intense movement between the dimple and plate melts the dimple and the plastic begins to flow. The bottom plate is progressively moved toward the baseplate with the ultrasonic energy being continuously applied until the bottom plate bears against the spacer blocks 104 at which time the plates are located relative to each other in predetermined accurate spaced relation. The ultrasonic horn is then removed and the melted plastic hardens to weld the pillar post to the baseplate thereby forming integral movement plates. Each of the pillar post to plate joints are simultaneously formed by a single horn which contacts each of the energy pads during the welding operation. In this manner, the movement is retained between the plates without employing and assembling the various parts normally required to secure a movement in place.

Where an electrical input is provided the present indicator, motor assembly 18 is mounted to the outer face of baseplate 36 and applies a substantially continuous torque to third wheel 80 during the time period in which and for so long as the electrical signal is applied to the indicator. As seen in FIGS. 6–8, the motor assembly 18 comprises a mounting plate 110 having lugs 112 and 114 projecting from opposite ends with lug 114 being undercut as at 116 for purposes as will become clear. Mounting plate 110 is formed of a plastic material, preferably the material hereinbefore specified, and an upstanding post 118 is provided adjacent one edge of plate 110. A pair of stepped openings 120 and 122 are formed through mounting plate 110 and receive stake portions of a motor frame 124. Motor frame 124 comprises a side portion 126, an end portion 128 forming a right angle with side portion 126, and a curved opposite end extension 127 having slotted edges 131. Frame 124 is preferably formed of a ferrous material such as nickel plated ingot iron. A T-slot 127, illustrated in FIG. 11, is formed in the end of side portion 126. An opening 129 is formed through end portion 128 of frame 124 and receives a reduced diameter end portion of a magnetic core 130, frame end portion 128 providing the sole support for the core 130. Core 130 is substantially coextensive with side portion 126 of frame 124 and carries a coil 132, one end of which is turned about post 118 and wound about and preferably soldered to the inner end of coil lead spring 26. The other end of coil 132 connects with frame 124 and is preferably soldered in a slot formed along an edge of side frame portion 126 as indicated at 133.

An armature 134 is pivotally mounted in the T-slot 127 of frame 124, and comprises, as seen in FIGS. 6 and 10, a substantially triangularly shaped base 136 carrying an arm section 138 bent intermediate its end portions to form an included obtuse angle with base 136. An electrical contact 137 is provided on the outer end of arm 138. The base 136 of armature 134 is pivotally received within T-slot 127. Shoulders 142 (FIG. 10) are provided on the base 136 and butt the inside face of side frame portion 124 adjacent T-slot 127 when the armature and frame are assembled. A slotted enlargement 140 is formed on the end of the armature base portion 136 for purposes as will become clear.

Armature 134 is formed in a manner such that it is dynamically balanced about an axis coincident with its pivotal axis in frame portion 124. Thus, the special orientation of the indicator does not affect the position of the armature relative to the core.

It is a particular feature hereof that an efficient primary magnetic path through the hinge area of the armature and frame is provided. Specifically and with reference to FIG. 9, the opening through the top of the T-slot and which pivotally receives armature 134 is formed to provide a large area of metal contact when the armature is both spaced from and near core 130 (a residual disc 135 prevents contact and hence sticking between the armature and core). Opposite halves of the walls of the opening in the T-slot are tapered as at 145 such that they lie substantially parallel with the base 136 of armature 134 when the latter is spaced from core 130 as illustrated. The other opposite wall halves 147 are formed to lie substantially parallel to the base 136 of the armature when it lies in the illustrated position. These angled wall portions thus engage the armature in a manner providing greater metal to metal contact at the hinge interface in each position of the armature. The reluctance of the magnetic path in the hinge area is thus reduced thereby providing an efficient primary magnetic path in both the open and closed position of the solenoid.

A coil spring 150 is connected at one end to the slotted enlargement 140 or 134 with the opposite end being connected to the slotted extension 127 of frame 124. The spring 150 is preferably formed of phosphor bronze wire. Since the armature 134 is dynamically balanced, spring 150 is very light yet is sufficiently strong as to preclude chattering. Spring 150 also locks the armature 134 to frame 124 by biasing shoulders 142 against the inside face of frame 124.

Referring now to FIGS. 2 and 3 there is illustrated a flywheel 30 which, in conjunction with the solenoid, imparts a torque to third wheel 82 so long as electrical energy is applied to motor assembly 18. Flywheel 30 is formed of an electrically conductive material and comprises a hub 160 carrying a pair of diametrically outwardly extending arms, the outer ends of which carry suitably balanced weights 162 and 164. The weighted arm end 164 also carries an electrical contact 144. As seen in FIG. 3 third arbor 82 extends through baseplate 36 and through the bore in flywheel hub 160, hub 160 and arbor 82 being rotatable relative to one another. The outer end of arbor 82 is splined and is received within the bore of a drive hub 166 superposed over flywheel hub 160. A clutch spring 168 encompasses flywheel hub 160 and drive hub 166 whereby flywheel 30 is free to rotate in one direction and is clutched to drive hub 166 for combined rotation with the flywheel in the opposite direction.

A mainspring 32 is provided and comprises a helical spring disposed about a reduced-diameter lower base portion of flywheel hub 160. One end of the spring projects from the helical windings and extends to underlie the end lug 114 of motor mounting plate 110 butting the eyelet 161 exposed by the undercut shoulder 116 thereof. The opposite end of the helically wound mainspring 32 extends adjacent the underside of the flywheel associated with weight 164 and is inserted within a groove formed in the underface of weighted end 164 (FIG. 2). For reasons hereinafter amplified, a flat shunt strip 153 having diametrically enlarged centrally apertured ends 157 and 159 electrically connects between flywheel 30 and an eyelet 161 which secures motor mounting plate 110 to plate 36. Particularly, centrally apertured end 157 underlies the flywheel hub 160 about shaft 82 and centrally apertured end 159 underlies lug 114 about eyelet 161. Flywheel hub 160 is thus in continuous electrical contact with shunt strip 153.

Casing 12 (FIGS. 12–14) comprises a cup-shaped cylindrical member having a radially outwardly directed flange 200 and an axially extending rim 201 about its open end forming an internal shoulder 202 on which is received the dial 204 and crystal 206 in a manner to be presently set forth. The base 208 of casing 12 carries a pair of inwardly directed locating pins 210 over which are received suitable grommets 212 and which project within corresponding openings formed through bottom plate 38 of the movement when assembled within the casing 12. A boss 214 projects outwardly of the bottom portion 208 of casing 12 and mounts a pair of terminals 22, 22*a*. Casing 12 is formed of a plastic material and the terminals 22, 22*a* are integrally molded within boss 214. A pair of openings 216 are formed in boss 214 exposing the inner ends of terminals 22, 22*a* within casing 12. An annular shoulder 218 is also formed intermediate the ends of casing 12.

To dispose the movement 14, counter 16 and motor assembly 18 within casing 12, a mounting ring 220 having an internal slot formation 222 is disposed about baseplate 36. This assembly is then dropped within case 12 with coil spring lead line 26, 26*a* engaging through corresponding aligned openings in the base and bottom plates 36 and 38 respectively, the lower ends of the coil spring lead lines 26, 26*a* being disposed within openings 216 and bearing against the respective inner ends of terminals 22, 22*a*. The corresponding openings in the bottom plate 38 are slipped over the grommet carrying locating pins 210 and, in this configuration as seen in FIG. 13, the mounting ring 220 bears on shoulder 218. The grommets 210 in mounting ring 220 provide a shock mounting for the movement within casing 12 and, when the end of the coil spring lead line 26 is electrically connected with one of the motor coil 132, it will be seen that good electrical contact is made while retaining a shock mounting of the movement within the case 12.

To retain the movement, counter, and motor assembly within casing 12, a cylindrical sleeve 224 is disposed concentrically within casing 12 and bears against the outer side of mounting ring 220. The opposite end of sleeve 224 has an outer annular cutout portion 226 and this, together with the annular shoulder 202 formed on the end of casing 12, receives the marginal flange portion 228 of dial 204. Dial 204 has a pair of diametrical slots, not shown, which register with a pair of corresponding lugs, also not shown, formed on casing 12 such that a slot 230 opening through dial 204 is disposed in overlying registry with counter 16 such that the numerals on the counter wheels may be read through the front face of the dial. A gasket 232 is disposed about flange 228 of dial plate 204 and crystal 206 overlies gasket 232.

A bezel 236 having a stepped flange portion 238 is disposed about the outer end of casing 12 with the stepped flange portion bearing against the marginal portions of crystal 206 resiliently clamping it together with the dial 204 against the annular shoulder 202 of casing 12 and the cutout portion 226 of sleeve 224. The bezel 236 and casing 12 are formed of a plastic material and, to facilitate securement of bezel 236 to casing 12, an annular head 231 is provided on the annular face of rim 201. An ultrasonic welding horn, not shown, is then preferably applied to bezel 236 about its periphery whereby the head 231 is first melted to start the welding process with the portion 238 of bezel 236 being finally ultrasonically welded about the face of rim 201. The weld, to a limited extent, also occurs between the bezel and casing along the side of rim 201. In this manner it will be seen that the indicator has substantial air and water tight integrity while simultaneously providing a securement between the bezel and casing eliminates a large number of parts, i.e., nuts and the like, and various manufacturing operations heretofore employed to assemble an indicator of this type. It will of course be appreciated that other types of bezel to casing connections, such as a threaded or detented connection, could be utilized.

Referring now to FIG. 19, there is schematically illustrated an electrical circuit for the elapsed time indicator hereof having terminals 22 and 22*a* adapted for connection in the electrical circuit of a periodically operated machine, not shown. When the machine circuit is energized, solenoid 24 is energized by an electrical circuit completed through coil spring 26, motor coil 132 attached at one end to coil spring 26, motor frame 124 connected to the opposite end of motor coil 132, the armature 134 electrically connected through the pivotal joint thereof with the motor frame as previously described, shunt strip 153 and mainspring 32 in parallel, eyelet 161, coil spring 26*a* and the other terminal 22*a*. Energization of the solenoid pivots armature 134 and impulses the flywheel for rotation in a clockwise direction as seen in FIG. 2 from its normal position in contact with armature 134. Such rotation by flywheel 30 winds mainspring 32 thereby biasing flywheel 30 for rotation (counterclockwise) back to its normal position illustrated in FIG. 2. It will thus be appreciated that when the solenoid is actuated by the foregoing circuit, armature 134 pivots to strike flywheel 30 with the latter rotating about and relative to third arbor 82 and thereby winding mainspring 32. Simultaneously, electrical contact between the armature 134 and the flywheel is broken and the armature returns (counterclockwise as seen in FIG. 2) under the bias of spring 150 to its normal position with base portion 136 thereof spaced from the solenoid core. When flywheel 30 reaches the end of its clockwise oscillatory excursion, mainspring 32 is fully wound and drives flywheel 30 in the opposite counterclockwise direction. The clutch spring 168 couples the flywheel 30 to the drive hub 166 as the flywheel is returned to its rest position illustrated in FIG. 2 under the bias of mainspring 32.

Rotational movement of the flywheel back to its rest position, however, is constrained through the movement and escapement and to the second wheel staff 84 driving the counter wheel 92 through worm 34. As previously described, rotation of wheel 80 on arbor 82 is controlled by the escapement, the timed tooth by tooth release of unidirectionally rotating escape wheel 62 under the bias of the wheel 80 through the gear train restraining mainspring 32 from immediate rundown. The escapement is self-starting in response to an input torque applied through the gear train and this, as well as the details of the operation of the escapement, are fully set forth in copending application Ser. No. 774,123, filed Nov. 7, 1968, of common assignee herewith, the disclosure of which application is incorporated herein by reference in its entirety. When the flywheel again engages contact 137 on armature 134, the solenoid is energized via the foregoing described circuit and armature 134 again impulses flywheel 30 to wind mainspring 32. The one-way clutch arrangement permits rotation of the flywheel when impulsed by armature 134 without rotating third arbor 82. Thus a substantially uninterrupted and constant torque is applied to third arbor 82 and to the counter driving mechanism 34 and 92 for so long as electrical current is applied to the solenoid via the terminals 22 and 22*a*.

The elapsed time indicator hereof is also adapted for use with a rotary mechanical input. In this event, the motor assembly 18 is omitted and the fourth wheel shaft 76 is replaced by a shaft 101 which is elongated and adapted to extend through a suitable opening formed through the rear wall of the casing. Any suitable connection between the rotary input and the shaft 101 may be provided and may include a one-way clutch arrangement such as that described and illustrated in copending application Ser. No. 670,871 filed Sept. 27, 1967 of common assignee herewith. The action of the movement and counter will be similar as previously described with the motive force for the movement and counter coming from the extended shaft 101 rather than the shaft 82 as in the embodiment employing an electrical input.

Note in FIG. 4 that the rotary mechanical movement must be counterclockwise in order that pallet 57 and escape wheel 62 may cooperate to provide unidirectional motion to escape wheel 62 in a counterclockwise direction. Should the mechanical rotary input, however, be in the opposite rotary direction, i.e., clockwise, as seen in FIG. 4, the fifth pinion 72 is removed and a fifth idler gear wheel 104 and pinion 102 are inserted, pinion 102 being in mesh with wheel 74 and wheel 104 being in mesh with wheel 68. Also, a reversely threaded worm replaces the worm 34 on the drive for the counter. In this manner, the escapement runs in one direction for both electrical and mechanical inputs regardless of the direction of the latter. Note also in FIGS. 2 and 14 that the end face of the worm gear 32 is exposed through the dial face and may be marked with suitable indicia to provide a visual indication that the machine to which the indicator is attached is running.

As best seen in FIG. 18, a plurality of circumferentially spaced benchmarks 252 are integrally formed along the inner face of plate 36 in underlying relation to the peripheral rim of the balance wheel 50. The benchmarks are spaced adjacent the periphery of plate 36 and are equally spaced one from the other about a quarter of the circumference of the balance wheel. In this manner, a visual estimation of the amplitude of the balance wheel excursion can be obtained after assembly of the movement between the plates prior to insertion into casing 12. The performance of the movement can then be readily observed and the effective length of the hairspring 51 can be readily changed by means not shown herein.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the means and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. An elapsed-time indicator comprising a housing, a pair of mounting plates in spaced substantially parallel relation one with the other and carried within said housing, a timing device and drive assembly therefor including a movement comprised of a gear train and an escapement disposed between said spaced plates, a flywheel pivotally mounted on the side of one of said plates remote from said movement, a counter mounted on said one plate side and coupled to said gear train to indicate running time, means coupling said flywheel to one of the gears of said gear train for driving said gear train and said counter in response to pivotal movement of said flywheel in one direction, said coupling means permitting relative rotation between said flywheel and said one gear in response to pivotal movement of said flywheel in the opposite direction, a mainspring connected at one end to said flywheel for rotation therewith with the other end of said spring being fixed to said indicator, a motor assembly mounted on said one plate side for rotating said flywheel in the opposite direction to wind said spring, said flywheel being pivotable in said one direction under the bias of said spring to drive said one gear through said coupling and thereby drive said counter, said housing and said plates being cylindrical, means for shock mounting said plates within said housing including an annular shoulder formed internally about said housing, and annular cushion engaging about one of said plates and seating against said shoulder, and means retaining said cushion against said shoulder.

2. An indicator according to claim 1 wherein said motor assembly includes a solenoid, said housing having a rear wall, a pair of terminals carried by said rear wall externally of said housing, and means forming an electrical circuit with said solenoid including a pair of springs extending within said housing and electrically connecting with said terminals.

3. An elapsed-time indicator comprising a housing, a pair of mounting plates in spaced substantially parallel relation one with the other and carried within said housing, a timing device and drive assembly therefor including a movement comprised of a gear train and an escapement disposed between said spaced plates, a flywheel pivotally mounted on the side of one of said plates remote from said movement, a counter mounted on said one plate side and coupled to said gear train to indicate running time, means coupling said flywheel to one of the gears of said gear train for driving said gear train and said counter in response to pivotal movement of said flywheel in one direction, said coupling means permitting relative rotation between said flywheel and said one gear in response to pivotal movement of said flywheel in the opposite direction, a mainspring connected at one end to said flywheel for rotation therewith with the other end of said spring being fixed to said indicator, a motor assembly mounted on said one plate side for rotating said flywheel in the opposite direction to wind said spring, said flywheel being pivotable in said one direction

under the bias of said spring to drive said one gear through said coupling and thereby drive said counter, and said mainspring being helical and having an axis substantially coincident with the axis of rotation of said flywheel.

4. An indicator according to claim 3 wherein said flywheel includes a hub, said coupling means including a shaft, a drive member carried by said shaft for rotation therewith and a helically wound clutch spring encompassing said hub and said drive member, said spring being arranged such that the flywheel hub is drivingly connected with said drive member to rotate said shaft in response to pivotal movement of said flywheel in said opposite direction and is free for rotation relative to said drive member in response to rotation of said flywheel in said one direction.

5. In a horological device having an escapement controlling time indicia through a gear train, a drive assembly subcombination therefor comprising a gear in driving relation to said gear train, a pivotally mounted flywheel, means coupling said flywheel to said gear for driving said gear in response to pivotal movement of said flywheel in one direction, said coupling means permitting relative rotation between said gear and said flywheel in response to pivotal movement of said flywheel in the opposite direction, a helical spring having an axis substantially coincident with the axis of rotation of said flywheel, one end of said spring bearing against said flywheel for rotation therewith, the other end of said spring bearing against said device, and means for pivoting said flywheel in the opposite direction to wind said spring, said flywheel being pivoted in said one direction under the bias of said spring to drive said gear through said coupling means.

6. In a horological device according to claim 5 including a shaft carrying said gear, said flywheel being mounted for rotation about said shaft, said spring being helically wound about said shaft.

7. In a horological device according to claim 6 wherein said flywheel includes a hub, said coupling means including a drive member carried by said shaft for rotation therewith and a helically wound clutch spring encompassing said hub and said drive member, said spring being arranged such that the flywheel hub is drivingly connected with said drive member to rotate said shaft in response to pivotal movement of said flywheel in said opposite direction and is free for rotation relative to said drive member in response to rotation of said flywheel in said one direction.

8. In a horological device according to claim 7 wherein said pivoting means includes an electromagnet having an armature pivotable to impulse said flywheel for rotary movement in said opposite direction.

9. In a horological device according to claim 7 in combination with said time indicia, said time indicia including a counter having a digital display and a drive gear, said gear train including a worm gear in driving relation to said counter drive gear.

10. An indicator according to claim 3 wherein said motor assembly includes a coil, a magnetizable core surrounded by said coil, means supporting one end of said core and including a frame portion projecting beyond the opposite end of said core, said frame portion having at least one slot, an armature pivotally mounted in said slot and having first and second portions, said first portion lying on one side of said frame portion and overlying said opposite core end, said second armature portion lying on the other side of said frame portion, means retaining said armature on said frame portion, one of the edge portions of said slot lying substantially parallel to the axis of rotation of said armature in said frame portion having first and second angularly related surfaces, the first surface of one edge portion extending from said one frame side to a point intermediate the width of said frame portion, the second surface of said one edge portion extending from adjacent the intermediate point to the other side of said one frame portion, a spring biasing said armature into a first position with the sides of said armature extending through said slot lying substantially flush with said first surface, said armature being pivotable in response to actuation of the electromagnet into a second position with the sides thereof extending through said slot lying substantially flush with the second surface.

11. An indicator according to claim 10 wherein said retaining means includes a shoulder on said armature for bearing against said one frame portion side, said spring connecting between said armature first portion and said frame portion biasing said shoulder against said frame portion.

12. An indicator according to claim 10 wherein each of the opposite edge portions of said slot has first and second angularly related surfaces, the first surface of the other edge portion extending from a point intermediate the width of said frame portion to the other side of said one frame portion, said first surfaces lying substantially parallel one to the other, the second surface of the other edge portion extending from adjacent the associated intermediate point to the one side of said other frame portion, said second surfaces lying substantially parallel one to the other, the sides of said armature in said first position lying substantially flush with said first surfaces and in said second position lying substantially flush with said second surfaces.

13. An indicator according to claim 11 wherein said frame portion includes a substantially T-shaped slot opening outwardly thereof, said armature having an intermediate portion of reduced width for engaging within said slot, said intermediate armature portion defining a pair of shoulders for bearing against said one frame portion side.

14. In the movement of a horological device, a bearing assembly comprising a pair of spaced mounting plates, a balance wheel including a balance staff terminating at one end in a reduced diameter stem forming an annular shoulder therewith, at least one of said plates having an opening to receive said stem with said shoulder bearing against the annular marginal portion of said one plate about said opening wherein said one plate is formed of a plastic material having a low coefficient of friction with a natural lubricant additive.

15. In a horological device having a gear train and escapement, a mounting plate subassembly comprising a pair of mounting plates molded of a plastic material, said plates having a plurality of openings formed therein to receive the opposite ends of shafts forming parts of said gear train and escapement, and a plurality of posts unitarily molded on one of said plates and projecting therefrom toward the other of said plates, end portions of said posts being welded to the other of said plates joining the latter one to the other with the gear train and escapement disposed therebetween.

16. In a horological device according to claim 15, including a pair of bosses unitarily molded on said other plate and projecting from said one plate, said bosses and said posts being correspondingly located about said plates.

17. In a horological device according to claim 15 including at least one dimple projecting from each of said post end portions to facilitate welding the plates one to the other.

18. In a horological device according to claim 17 including a pair of bosses unitarily molded on said other plate and projecting away from said one plate, said bosses and said posts being correspondingly located about said plates.

19. In a horological device according to claim 15 in combination with time-indicating indicia carried by one of said plates on the side thereof remote from the gear train and escapement, and bracket means projecting from said one plate for supporting said time indicia on said mounting subassembly, said bracket means being unitarily formed on said one plate.

20. An indicator comprising a timing device having a pair of mounting plates joined in spaced relation one from the other, a movement disposed between said mounting plates, an electrically actuated motor assembly carried by one of said plates, time indicating means carried by one of said plates and driven by said movement, a casing for said timing device, means mounting said timing device in said casing including shock-absorbing means insulating said plates from said casing, electrical terminals provided externally of said casing, means electri-

cally connecting said terminals to said motor assembly including a pair of springs, locating means provided within said casing, said motor assembly including a pair of contacts, and means on one of said plates cooperable with said locating means to align said springs with said contacts on said motor assembly.

21. An indicator according to claim 20 wherein said terminals have internal portions exposed within said casing and means for aligning one end of each of said springs with the associated internal terminal portions.

22. An indicator comprising a timing device having a pair of mounting plates joined in spaced relation one from the other, a movement disposed between said mounting plates, an electrically actuated motor assembly carried by one of said plates, time indicating means carried by one of said plates and driven by said movement, a casing for said timing device, means mounting said timing device in said casing including shock-absorbing means insulating said plates from said casing, electrical terminals provided externally of said casing, means electrically connecting said terminals to said motor assembly including a pair of springs, said casing being formed of a plastic material, said casing having an integrally molded boss projecting from one side thereof, said terminals including flat metal strips molded integrally with said boss and having an externally exposed portion, said boss having a pair of recesses opening within said casing and exposing respective inner portions of said terminals to the interior of said casing, and the ends of said springs being received within associated recesses to engage and make electrical contact with said inner portions of said terminals.

23. An indicator comprising a timing device having a pair of mounting plates joined in spaced relation one from the other, a movement disposed between said mounting plates, an electrically actuated motor assembly carried by one of said plates, time indicating means carried by one of said plates and driven by said movement, a casing for said timing device, means mounting said timing device in said casing including shock-absorbing means insulating said plates from said casing, electrical terminals provided externally of said casing, means electrically connecting said terminals to said motor assembly including a pair of springs, said casing being closed at one end and open at its opposite end and having an internal shoulder intermediate its ends, said terminals being located adjacent said closed end with said springs engaging at one end against said terminals and projecting inwardly of said casing toward said open casing end, said motor assembly including a pair of contacts, the opposite ends of said springs bearing against said contacts, said mounting means including a cushion disposed about one of said plates and engaging against said shoulder, and means clamping said cushion against said shoulder to retain said plates within said casing and including means closing the open end of said casing.

24. An elapsed-time indicator comprising a generally cylindrical housing, a pair of mounting plates in spaced substantially parallel relation one with the other and carried within said housing, said plates being disposed generally normal to the axis of said cylindrical housing, a timing device and drive assembly therefor including a movement comprised of a gear train and an escapement disposed between said spaced plates, a flywheel pivotally mounted on the side of one of said plates remote from said movement, a counter mounted on the side of said one plate remote from said movement and coupled to said gear train to indicate running time, means coupling said flywheel to one of the gears of said gear train for driving said gear train and said counter in response to pivotal movement of said flywheel in one direction, said coupling means permitting relative rotation between said flywheel and said one gear in response to pivotal movement of said flywheel in the opposite direction, a mainspring connected at one end of said flywheel for rotation therewith with the other end of said spring being fixed to said indicator, a motor assembly mounted on the side of said one plate remote from said movement for rotating said flywheel in the opposite direction to wind said spring, said flywheel being pivotable in said one direction under the bias of said spring to drive said one gear through said coupling and thereby drive said counter, wherein said plates are molded of a plastic material, said plates having a plurality of openings formed therein to receive the opposite ends of shafts forming parts of said gear train and escapement, and a plurality of posts unitarily molded on one of said plates and projecting therefrom toward the other of said plates, and portions of said posts being welded to the other of said plates joining the latter one to the other with the gear train and escapement disposed therebetween.

25. An elapsed-time indicator comprising a generally cylindrical housing, a pair of mounting plates in spaced substantially parallel relation one with the other and carried within said housing, said plates being disposed generally normal to the axis of said cylindrical housing, a timing device and drive assembly therefor including a movement comprised of a gear train and an escapement disposed between said spaced plates, a flywheel pivotally mounted on the side of one of said plates remote from said movement, a counter mounted on the side of said one plate remote from said movement and coupled to said gear train to indicate running time, means coupling said flywheel to one of the gears of said gear train for driving said gear train and said counter in response to pivotal movement of said flywheel in one direction, said coupling means permitting relative rotation between said flywheel and said one gear in response to pivotal movement of said flywheel in the opposite direction, a mainspring connected at one end to the flywheel for rotation therewith with the other end of said spring being fixed to said indicator, a motor assembly mounted on the side of said one plate remote from said movement for rotating said flywheel in the opposite direction to wind said spring, said flywheel being pivotal in said one direction under the bias of said spring to drive said one gear through said coupling and thereby drive said counter, said counter carries indicia bearing numbers indicative of elapsed time, means at one end of said cylindrical housing for displaying said indicia, said motor assembly including a solenoid, terminals carried by said housing adjacent to the opposite end thereof, and means for electrically connecting said terminals and said solenoid, an annular shoulder formed internally about said housing, an annular cushion engaging about one of said plates and seating against said shoulder, and means retaining said cushion against said shoulder, said electrical connecting means comprising a pair of springs.

26. An indicator according to claim 25 wherein said indicia bearing members include a plurality of wheels each carrying a plurality of digits, said coupling means including a counterdrive gear and a worm gear coupled to said gear train and in driving relation to said counterdrive gear.

27. An indicator according to claim 25 wherein said movement includes a balance wheel having a balance staff terminating at one end in a reduced diameter stem forming an annular shoulder therewith, at least one of said plates having an opening to receive said stem with said shoulder bearing against the annular marginal portion of said plate about said opening.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,635,011 Dated January 18, 1972

Inventor(s) Stuart M. Pindell, Jr., Donald J. Johnson, Robert E. Fickes, Malcolm R. Perry and Wayne K. Radcliffe

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In Col. 2, line 38, "nylon" should read --Nylon--.

In Col. 4, line 72, "Fig. 12" should read --Fig. 11--.

In Col. 10, line 24, "one" should read --one end--.

In Col. 12, line 19, "means" should read --meaning--.

In Col. 12, line 46, Claim 1, "and" should read --an--.

In Col. 14, line 50, Claim 16, "from" should read --away from--.

In Col. 16, line 4, Claim 24, "of" should read --to--.

Signed and sealed this 11th day of July 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

QRM PO-1050 (10-69)

USCOMM-DC 60376-P69
☆ U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334

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