FAIL-SAFE MECHANICAL TIMER

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Filed: Aug. 7, 1970
Appl. No.: 61,958

U.S. Cl. 74/112, 58/116, 74/1.5, 74/142
Int. Cl. F16b 27/04
Field of Search 74/1.5, 142, 112; 58/116, 23 TF, 58/23 D; 102/84; 185/DIG. 1

Fail-safe mechanical timer is provided having the speed retarding timing mechanism in series between the input power source and the timer output shaft.

14 Claims, 8 Drawing Figures
FAIL-SAFE MECHANICAL TIMER

BACKGROUND OF THE INVENTION

In many fuze armed systems, a mechanical timer is provided to insure that the arming is not completed until the device to be armed has traveled a safe distance from the launch site. The timing mechanism generally includes gear trains which are driven by a spring. The speed of rotation of the gear trains is generally retarded by some type of mechanism, such as an escapement, to provide the desired delay time. Prior timing mechanisms have the output shaft driven directly by the spring input power source, with the retarding escapement driven either ahead of the output, or else in series through the output. In either the series or parallel arrangements, defects in the escapement train manifested by, for example, broken gear shafts, gears with stripped teeth, gears which are misaligned, and therefore not meshing properly, or by some defect of the escapement mechanism, would disconnect the escapement speed retarding mechanism and allow the input power source to rotate the timer output shaft at high speed causing the timer to function early. Early timer functioning can be disastrous because premature arming of the fuze could occur immediately upon launch.

The prior art has attempted to prevent such failures from occurring by using escapement mechanisms having some type of speed malfunction and precluding arming by causing cessation of the mechanism. These malfunction sensing and mechanism stopping devices are relatively complex and subject to failure, thereby preventing remedying the problem at hand.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide a truly fail-safe mechanical timer.

It is another object of this invention to provide a mechanical timer that cannot speed up as a result of damage, but can only slow down or stop.

It is a further object of this invention to provide a timer to prevent premature detonation of, for example, a bomb, despite any damage to the timer mechanism resulting from shock, fire, or other action.

Briefly, a fail-safe mechanical timer is provided wherein the speed retarding mechanism is placed in series between the power source and the timer output shaft such that any failure which disconnects the speed retarding mechanism also removes the connection between the power source and the timer output shaft, causing the output shaft to stop.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and objects of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawings, in which:

FIGS. 1A and 1B represent block diagram formats of conventional mechanical timers, and FIG. 1C represents applicant's mechanical timer;

FIG. 2 is a sketch of a simplified conventional mechanical timer;

FIG. 3 is a sketch of a simplified first embodiment of a mechanical timer, according to the invention;

FIG. 4 is a sketch of an embodiment of the invention using a "tuned" escapement as the speed control.

FIG. 5 is a sketch of an embodiment of the invention using a "tuned detached" escapement as the speed control, and

FIG. 6 is a sketch of an embodiment of the invention using a tuning fork as the speed control.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. 1A and 1B set forth, conceptually, conventional mechanical timers whereby an input power source 10 drives directly a timer output shaft 12. The speed of the timer output shaft 12 is restrained by a speed retarding mechanism 14. FIG.
The previously described embodiment of the invention employs a "runaway" escapement as the speed retarding mechanism. For many applications, "runaway" escapements have sufficient timing accuracy to provide sufficiently long time delays. However, if greater timing accuracy is desired, then a "tuned" escapement speed control can be employed. This is illustrated in FIG. 4.

The input power to the embodiment of FIG. 4 is applied to an input shaft 210 by, for example, a spring powered gear and gear train (not shown). Also attached on shaft 210 is an escape wheel 212. The pallet teeth 214 and 216 of a pallet 218 cooperate with the escape wheel 212. An escapement spring 220 is inserted in an arbor 224 of the pallet 218 and arranged between a pair of spring supports 222.

As in the previously described embodiment, the oscillating motion of the pallet is used to drive a ratchet. The ratchet comprises a pawl 226, pivoted at 228 and biased by a spring 230. Pawl 226 drives a ratchet wheel 232 arranged on a shaft 234. A hold back pawl 236 is pivoted at 240 and held against the teeth of ratchet wheel 232 by a spring 238.

The output of the timer is derived from a gear train (not shown) via shaft 234. As in the previous embodiment, the timing escapement speed retarding mechanism is placed in series between the input power source and the timer output shaft such that any failure will cause the output shaft to stop rather than have the possibility of speeding up.

If still greater timing accuracy or longer time delay is desired, then a "tuned, detached" escapement, such as a combination of an escape wheel, lever, balance wheel and hairspring, speed control can be employed. This is illustrated in FIG. 5.

The input power is supplied to an input shaft 126, by, for example, a spring powered gear and gear train (not shown). Also arranged on input shaft 126 is an escape wheel 128, the teeth of which cooperates with the pallet stones 130 of a pallet fork 132 which is pivoted at 133. The escape wheel has an intermittent clockwise rotation which counts the number of times a balance wheel 138 oscillates and also supplies to balance wheel 138 the energy it loses in friction. Escape wheel 128 advances one tooth for each complete oscillation of balance wheel 138. While letting escape wheel 128 advance, a lever 134 transmits energy to the balance wheel. Lever arm 134 is coupled to balance wheel 138 via a fork slot 136 and a balance wheel jewel 140. Balance wheel 138 has a conventional hairspring 142, therein, as shown. Restriction on the swing of the lever 134 is imposed by a pair of banking pins 144 in conventional fashion, while the open end of fork slot 136 allows jewel 140 to continue oscillation advancing by means of the balance wheel 138 to rotate freely until the restoring force of hairspring 142 overcomes the motion of the balance wheel, causing it to reverse its motion. The fork slot 147 on an output lever 146 cooperating with a second balance wheel jewel 148 provides oscillatory motion to a drive pawl 150, about a pivot 152. The lever 146 is retained by a pair of output banking pins 154. The drive pawl pivots about a point 151 located on lever 146 and is held against the teeth of a ratchet wheel 158 by a spring 156. Drive pawl 150 provides intermittent motion in the direction shown to ratchet wheel 158, which is restrained from turning backward by a holdback pawl 160 pivoted at 162 and held against the teeth of ratchet wheel 158 by a spring 164. The holdback arrangement is optional.

The output of the timer is derived at an output gear train (not shown) via shaft 166 attached to the ratchet wheel 158.

As with the previous embodiments, the timing escapement speed retarding mechanism is placed in series between the input power source and the timer output shaft such that any failure will cause the output shaft to stop rather than have the possibility of speeding up.

It will thus become obvious that any one of the very many escapements available in the prior art may be employed in the practice of the invention. The escapements illustrated herein are set forth only for illustrative purposes to show three principal classes of escapements, the two-center "untuned" or "runaway" escapement of FIG. 3, the two-center "tuned" escapement of FIG. 4 and the three-center "tuned, detached" escapement illustrated by the escapement of FIG. 5.

A variation of the embodiments previously shown is to make use of a resonant rod as the oscillatory speed retarding mechanism. Again, the speed retarding mechanism is placed in series between the input power source and the time output shaft. FIG. 6 illustrates an embodiment making use of a resonant rod and, in particular, a special case thereof, the tuning fork. A highly resonant rod or tuning fork 170 is used as the speed retarding control mechanism. In this embodiment, an input escape wheel supplies energy to a tuning fork in a similar manner as supplying energy to a balance wheel, whereby each complete oscillation cycle of a tuning fork advances an output ratchet wheel one tooth.

In particular, input power is applied to shaft 172 to drive escape wheel 174. Pallet fork 176 cooperating with the teeth of escape wheel 174 causes a lever 178 to oscillate about a pivot 180 between a pair of banking pins 182. Lever 178 drives one time 188 of tuning fork 170 via a drive jewel or bearing 184, causing time 188 to vibrate. Tuning fork 170 is fixed at 186. The vibration of time 188 causes in like fashion the vibration of time 190. Tine 190 is coupled to a drive pawl 192 which rotates a ratchet wheel 194. Pawl 192 is held against ratchet wheel 194 by a spring 204. The output shaft of the timer is shown at 196. A holdback pawl 198, pivoted about point 200 and spring loaded via a spring 202, may be used to arrest motion thereof, said pallets being coupled to said escape wheel; a balance wheel, coupled to the forked end of said input lever;
an output lever having a fork at a first end thereof, said forked end being coupled to said balance wheel; a ratchet coupled to said output lever; and an output member coupled to said ratchet.

10. A fail-safe mechanical timer in accordance with claim 9 further including a drive member pivotally coupled to said output lever for driving said ratchet.

11. A fail-safe mechanical timer, comprising: a resonant member; a mechanical spring driven source of rotating input power; means for supplying said input power to said resonant member; and an output member driven by said resonant member.

12. A fail-safe mechanical timer in accordance with claim 11, wherein said resonant member is a tuning fork having first and second tines.

13. A fail-safe mechanical timer in accordance with claim 12, wherein said resonant member is a tuning fork having first and second tines, said first tine being coupled to said means for supplying input power, with said driven output member being coupled to said second tine.

14. A fail-safe mechanical timer in accordance with claim 13, further including a ratchet coupled to said second tine of said tuning fork, whereby vibration of said tuning fork causes said drive member to move said ratchet unidirectionally and drive said driven member.