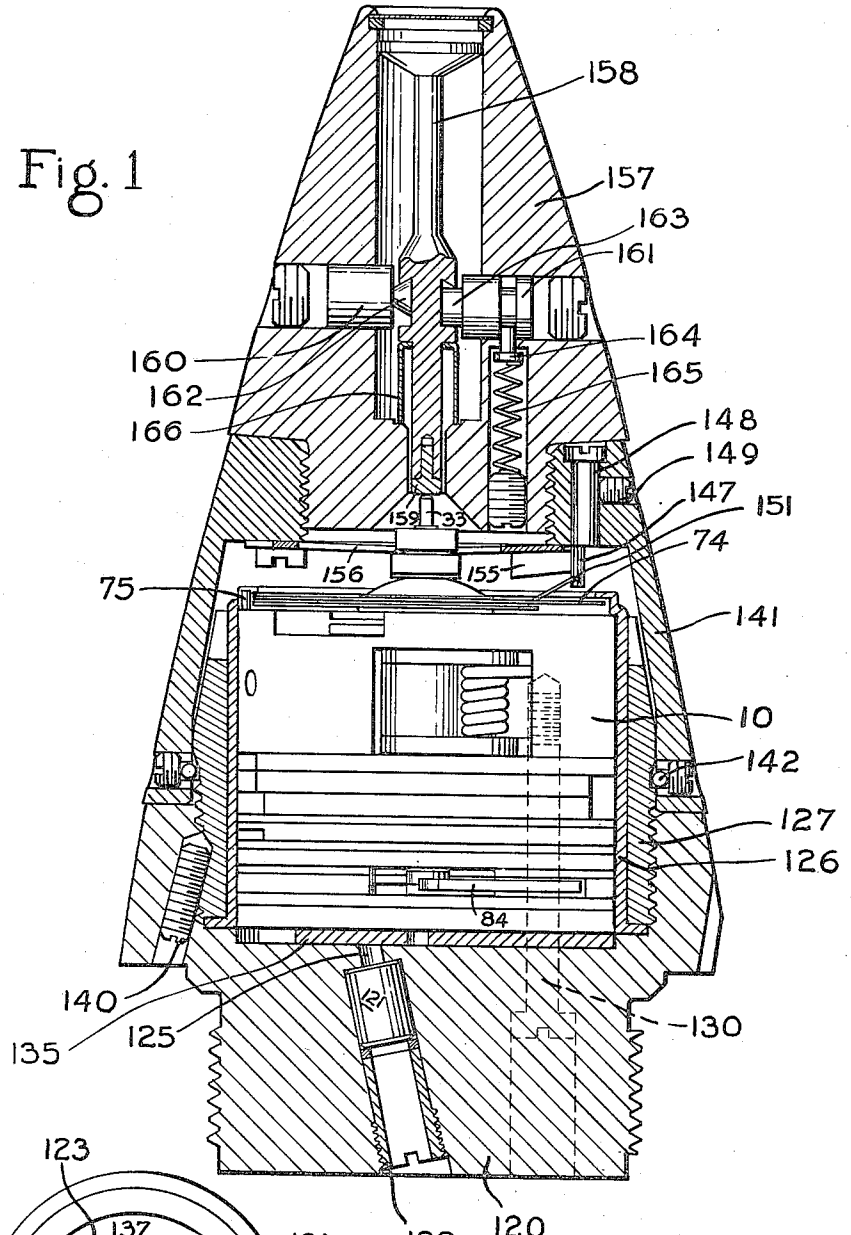
Nov. 21, 1950 J. FINK 2,531,121

MECHANICAL TIME FUSE

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Fig. 1



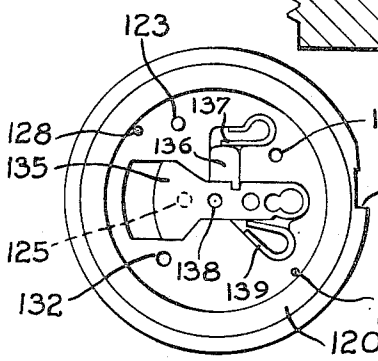


Fig. 10

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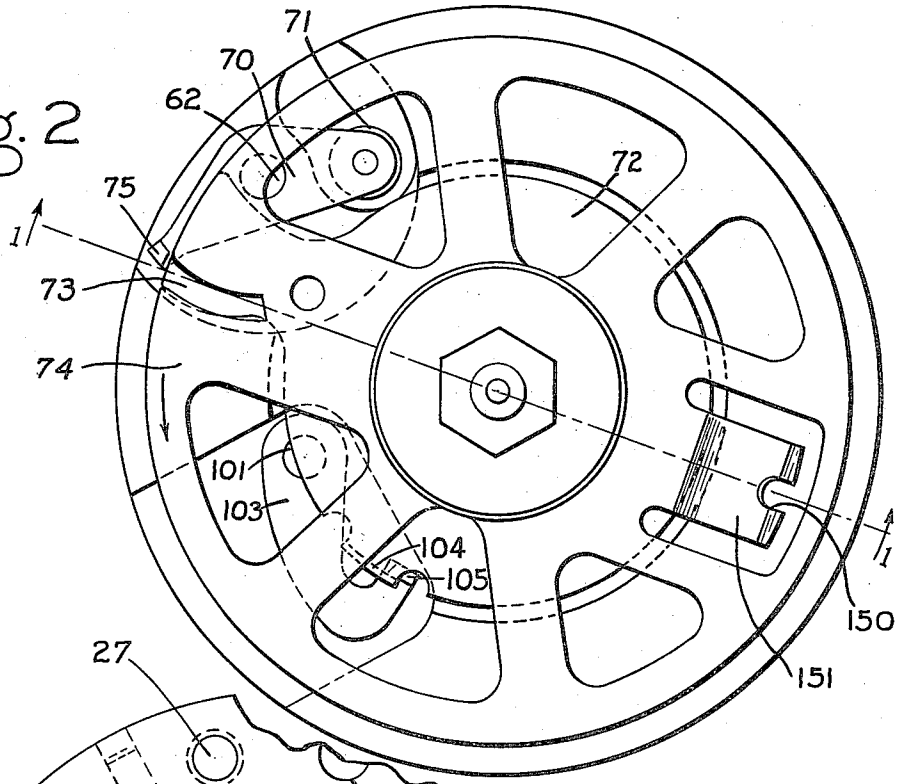
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Fig. 2



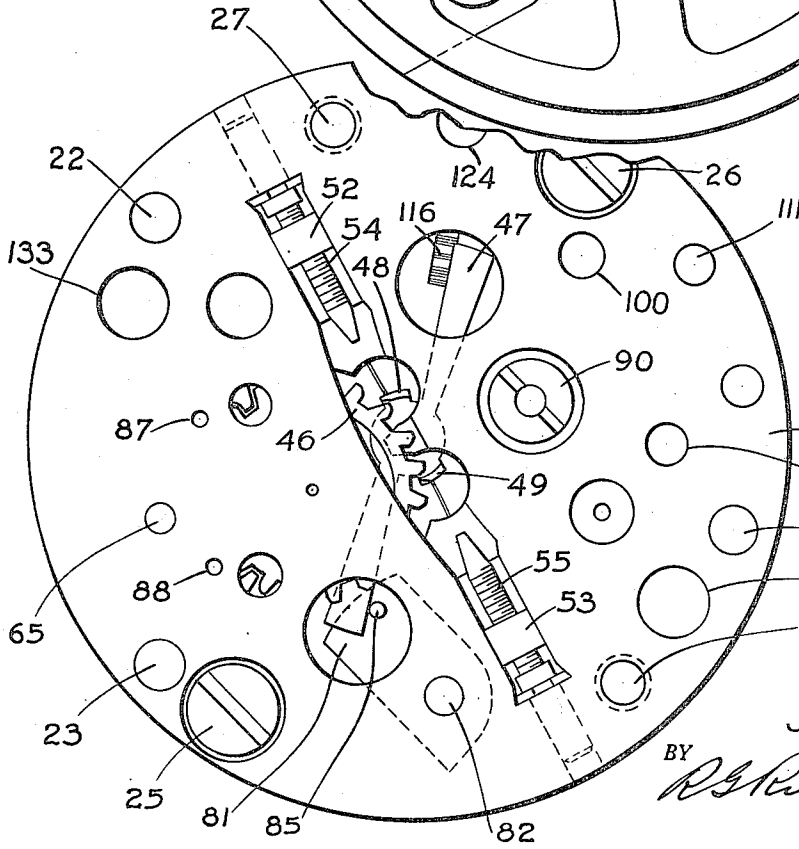


Fig. 3

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Fig. 4

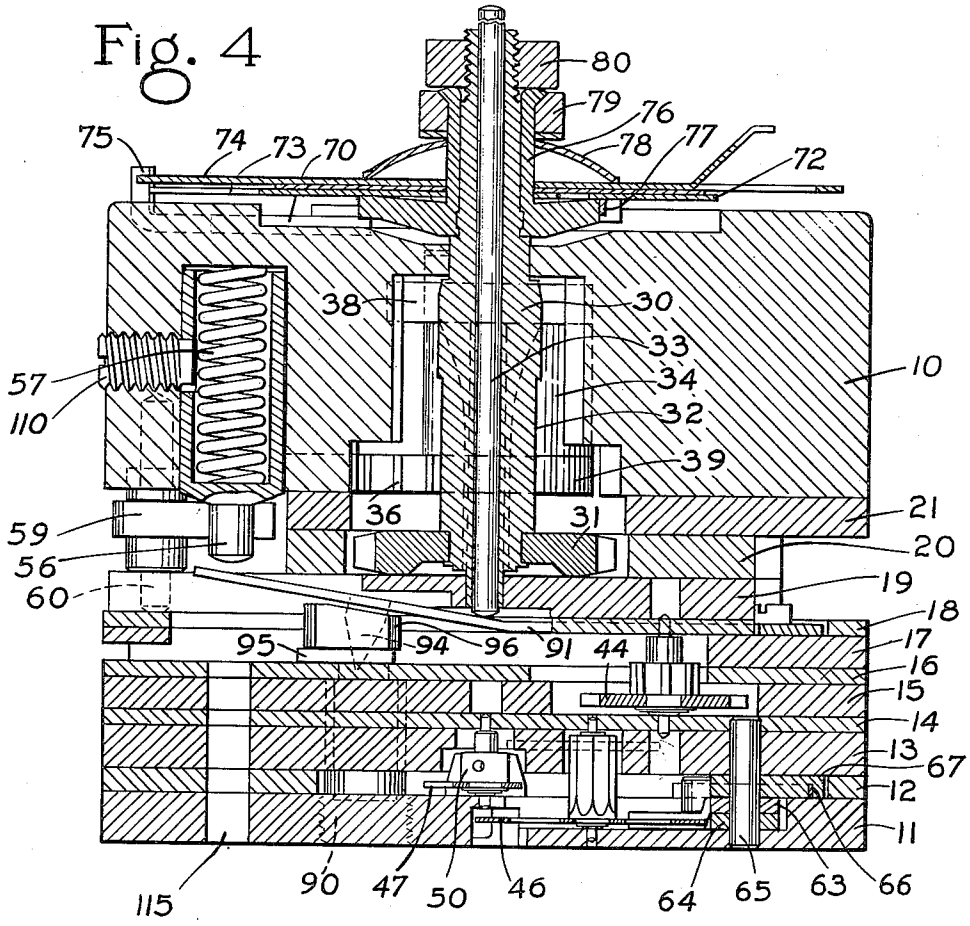
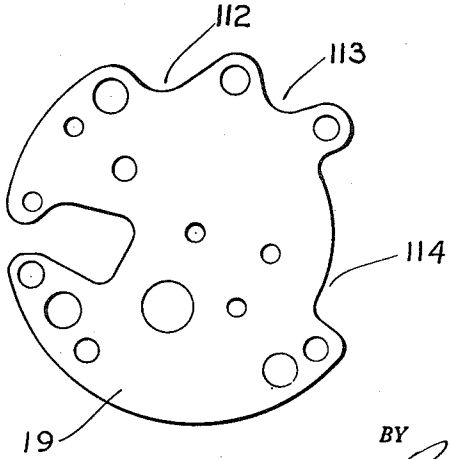


Fig. 9



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Fig. 5

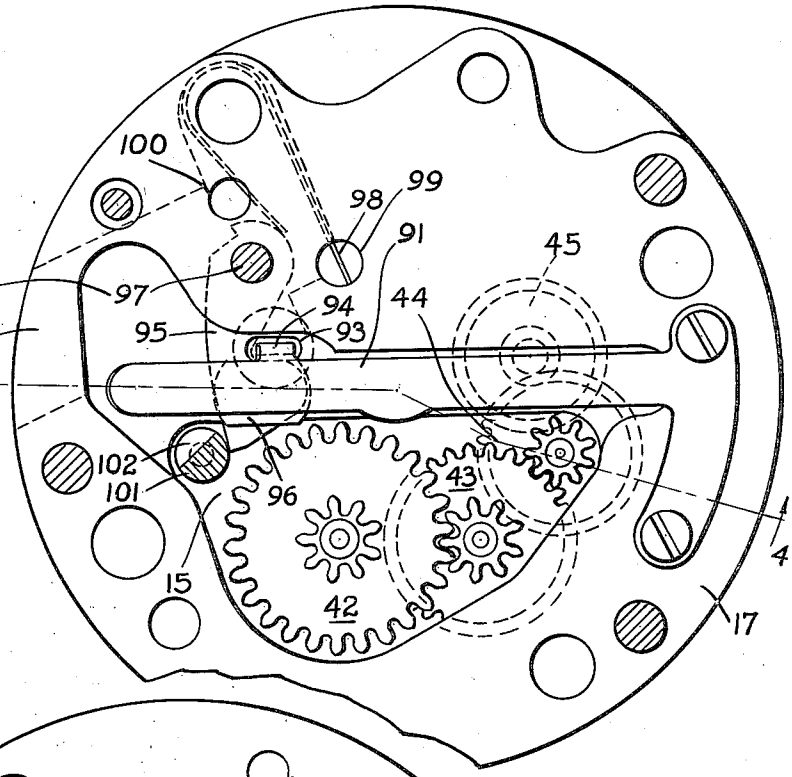
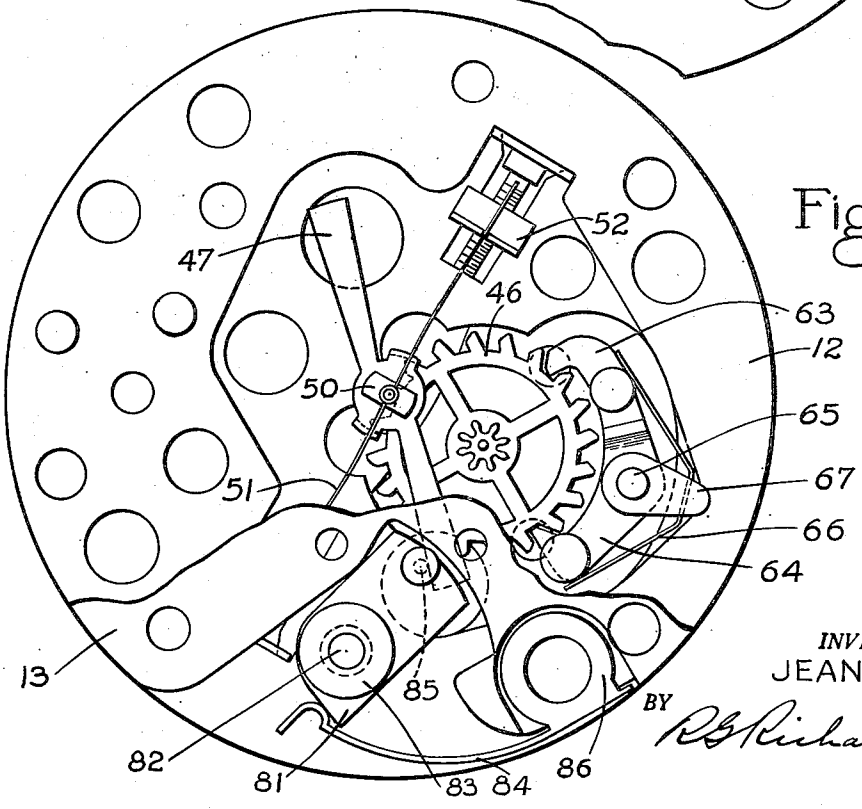


Fig. 6



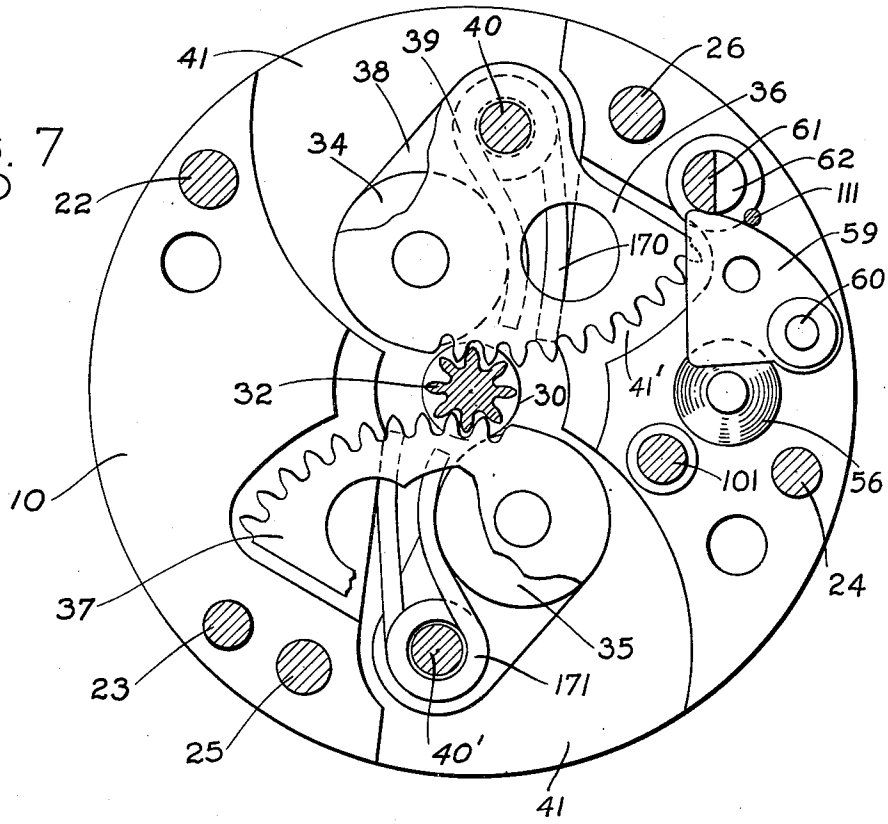
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Fig. 7



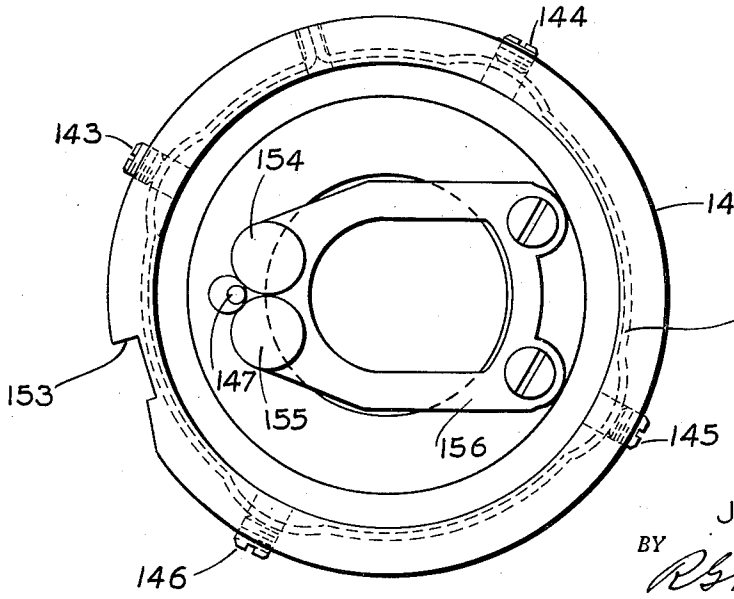


Fig. 8

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Patented Nov. 21, 1950 2,531,121

UNITED STATES PATENT OFFICE

2,531,121

MECHANICAL TIME FUSE

Jean Fink, Delavan, Wis., assignor to The George W. Borg Corporation, Chicago, Ill., a corporation of Delaware

Application October 5, 1944, Serial No. 557,285

5 Claims. (Cl. 102—71)

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The present invention relates in general to mechanical time fuses for projectiles and the object of the invention is to provide a new and improved fuse of this character.

A special feature of the invention is a mechanical time fuse provided with means whereby the detonator may be exploded by point impact as well as by timing mechanism. In view of this feature, the invention may be referred to as a combination time and point impact fuse.

Another feature involves the provision of both spring power means and centrifugal power means to operate the timing mechanism. The spring power means supplies sufficient power to run the timing mechanism when the fuse has a low rotational speed and the centrifugal power means supplies the additional power which is required to overcome the increased friction when the fuse has a high rotational speed. The fuse is adapted for use in shells which have a low rotational speed, therefore, as well as in shells such as anti-aircraft shells which have a relatively high rotational speed.

The foregoing and other features, including new and improved safety devices for arming the fuse, will be described fully hereinafter, reference being had to the accompanying drawings, in which—

Fig. 1 is a view of the new fuse complete with the body or base which screws into the shell, the lower or setting cap, the upper cap or nose of the fuse, and the timing mechanism. The timing mechanism is shown in elevation and the other parts are shown in section;

Fig. 2 is a top view of the timing mechanism, or fuse proper;

Fig. 3 is a bottom view of the same;

Fig. 4 is a section through the timing mechanism on the line 4—4, Fig. 5;

Fig. 5 may be regarded as a horizontal section taken along the dividing line between plates 17 and 18, Fig. 5, and shows certain parts as they appear when looking down on plate 17;

Fig. 6 is a view similar to Fig. 5, but looking down on plate 12. A part of plate 13 is also shown;

Fig. 7 is a view of the fuse block 10 as seen from below, with the driving mechanism and firing pin release mechanism;

Fig. 8 shows the interior of the setting cap and the means for coupling the setting cap to the base of the fuse;

Fig. 9 is a plan view of plate 19, showing the cut outs for balancing the fuse; and

Fig. 10 is a top view of the base of the fuse.

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Referring to the drawings, the timing mechanism or fuse proper may conveniently be described first. The parts are supported by a frame comprising a so-called fuse block 10, which may be an aluminum die casting, and a stack of circular brass plates 11 to 21, inclusive. These plates are properly located relative to each other and to the block 10 by means of three dowel pins 22, 23 and 24, shown in Fig. 3, and are clamped to the block 10 by two machine screws 25 and 26. There are in addition two screws 27 and 28 for holding the plates together as a unit to enable the plates to be assembled independent of the block. These last mentioned screws pass downward through the plates and are threaded into the bottom plate 11.

The main shaft of the timing mechanism is indicated at 30, Fig. 4, and has two bearings, one in the block 10 and the other in the plate 19. At its lower end and just above the plate 19 the shaft carries the gear wheel 31, which is the first wheel of the gear train. Above the gear wheel 31 is the pinion 32, formed integrally with the shaft. The shaft 30 is hollow and contains a pin or rod 33 which forms part of the point impact firing mechanism, as will be described shortly.

The shaft 30 is driven in part by means of two weights 34 and 35 which move outward by centrifugal force when the shell containing the fuse is fired and rotate the shaft by means of two toothed sectors 36 and 37 which are in engagement with the pinion 32. Referring to Figs. 7 and 4, the weight 34 is a short section of brass rod and is rigidly secured to two links 38 and 39 which are pivoted on the pin 40 supported between the block 10 and plate 21. The lower link 39 carries the integrally formed toothed sector 36. The weight 34 and the links 38 and 39 are located in a deep recess 41 in block 10, which provides space for rotation of weight 34 in a clockwise direction about pin 40 as seen in Fig. 7. The sector 36 overlaps the margin of the recess 41 and extends into a shallow recess 41'.

The arrangement of the other weight 35 and associated parts is the same as described in connection with weight 34. The two weights engage the main shaft 30 when the timing mechanism is fully wound, and the shaft accordingly functions as a positive winding stop. In Fig. 7 the parts are shown in fully wound position.

The power is also supplied to the shaft 30 by means of the two helical springs 170 and 171, which surround the pins 40 and 40', respectively, on which the supporting links for the weights 34 and 35 are pivoted. As shown clearly in the case

of spring 171, one end of the spring rests against the wall of recess 41 in the block 10 while the other end of the spring bears against the weight 35. The other spring 170 is arranged the same way. These springs are tensioned when the fuse is wound and are quite stiff. They supply sufficient power to drive the timing mechanism when the shell in which the fuse is used has a low rotational speed such as 2000 R. P. M., for example, being assisted by the driving weights 34 and 35 which, however, do not supply much power at such a low rotational speed. In shells having higher rotational speeds the weights are more effective and supply an increasing amount of power which is approximately in proportion to the increase in friction which is manifested at such higher speeds.

The gear train is of known construction, but will be described briefly. The gears and associated pinions are located in openings or recesses in the plates and are supported on arbors which have bearings in the plates. The general arrangement will be understood from Fig. 4, which shows how gear 44 and its associated pinion are supported on an arbor which has bearings in plates 18 and 14.

The first wheel of the gear train is the gear 31 mounted on shaft 30, as already mentioned. The gear 31 meshes with the pinion which is associated with gear 42. The gears 42, 43 and 44 are the second, third and fourth wheels of the gear train, respectively, and are shown in Fig. 5. The fifth wheel 45 is indicated by dotted lines and drives the escape wheel 46, which can be seen in Fig. 6.

The escape wheel is mounted on an arbor which has bearings in plates 11 and 14, as shown in Fig. 4, and drives the oscillatable pallet arm 47 by means of the two pallets 48 and 49 formed integrally therewith. The pallet arm is mounted on a member 50 which has pivots formed at its opposite ends which have bearings in plates 11 and 14. The member 50 has a transverse perforation through which the hairspring 51 extends and in which it is fixed by a wedge. The ends of the hairspring are located in slots cut in downwardly extending projections on the two nuts or blocks 52 and 53 which are slidable in recesses cut in plate 11. The nuts 52 and 53 may be moved along these recesses in either direction by means of the adjusting screws 54 and 55 to adjust the effective length of the hairspring and thus regulate the rate of the timing mechanism.

The gear train is normally locked by two dogs or detents 63 and 64, Figs. 4 and 6, which engage the teeth of the escape wheel 46. These detents are located in a recess in plate 11 and are pivoted on the pin 65. A spring 66, supported on spring retainer 67, presses the two detents 63 and 64 against the escape wheel. The spring retainer is also supported on the pin 65 but is prevented from rotating by reason of the fact that its outer rounded end lies in a recess in plate 12. The spring 66 does not actually bear against the detents 63 and 64 but against the two weights with which the detents are provided, which are effective to operate the detents to release the escape wheel when the fuse is rotated.

Fig. 6 also shows the starting lever 81. Fuses such as disclosed herein are self-starting, but occasionally one is encountered which will fail to start if the pallet arm happens to be in a particular position relative to the escape wheel. The provision of the starting lever avoids any possibility of trouble due to starting failure. The starting lever 81 is pivoted on a pin or stud 82 which is fixed in plates 11 and 12. The lever has a headed sleeve 83 similar to a tubular rivet which is provided to give an increased length of bearing surface on the pin. The lever is located in a recess in plate 13, this plate being partly shown in Fig. 6. The next plate above, plate 14, has a similar recess or cut-out to provide room for the member 83 and for the enlarged head of pin 85. The pin 85 is located at the end of lever 81 and extends downward past the pallet arm 47. The lever and pin can be seen also in Fig. 3. A spring 84, Fig. 6, bears against the end of lever 81 and normally maintains it in the position in which it is shown. This spring has an ear 86 which fits into an annular recess in plate 3 which surrounds the hole for screw 25 and is held in position by said screw and plate 14.

The starting lever operates by centrifugal force when the shell containing the fuse is fired and rotates in a clockwise direction as seen in Fig. 6 until it engages the edge of the cut-out in plate 13. During this movement the pin 85 slides along the edge of the pallet arm 47 and gives it a flip which insures starting of the timing mechanism. The lever is locked in operated position by spring 84, which bears against the side of the lever instead of the end thereof shortly before the lever becomes fully operated.

The locking means for the escape wheel and the starting lever are so related that a higher rotational speed is required for operation of the starting lever than is required for operation of the locking means to unlock the escape wheel. This result is attained by proper proportioning of the parts and by regulating the tension in springs 66 and 84, and insures that the escape wheel will be unlocked when the starting lever operates. Another reason for the lower operating speed for the locking means is that the detents are maintained in operated (unlocked) position by centrifugal force and must remain in operated position throughout the flight of the shell, including the end portion of the flight during which the rotational speed falls off considerably.

The primary function of the timing mechanism is to release the firing pin and fire the shell at the expiration of a predetermined time. The arrangement by which this is accomplished will now be described.

The firing pin is shown in Fig. 4, where it is indicated by the reference character 56. It comprises a short lower rod section and an upper cylindrical section which is slidable in a bore in block 10. The cylindrical portion of the firing pin is hollow and contains a helical spring 57. When the firing pin is cocked, as it is shown in Fig. 4, the spring 57 is compressed between the firing pin and the end of the bore in block 10. The firing pin is held in cocked position by the engagement of the shoulder at the bottom of the cylindrical section with the centrifugally operated locking member 59 which is mounted on a short heavy shaft 60 having bearings in the block 10 and in plate 19. Fig. 7 shows clearly how the member 59 extends beneath the shoulder on the firing pin to hold it in cocked position. The shoulder is slightly inclined as shown in Fig. 4 to enable it to slip off member 59 easily when the latter is rotated.

The locking member 59 is itself normally locked by a cam 61 on shaft 62. This shaft

extends through the block 10 and has bearings in the block and in plate 19. The cam 61 is formed by cutting away the shaft on one side, as shown in Fig. 7, where the shaft passes the member 59. At the other end the shaft is provided with a lever 70, Fig. 2, secured to the shaft in any suitable manner. The lever 70 has a weight 71 at one end whereby the lever is adapted to rotate shaft 62 when the weight moves outwardly by centrifugal force. The lever and weight are located in suitable recesses formed in the block 10, as shown in Fig. 2.

Movement of lever 70 and rotation of shaft 62 are normally prevented by means of a so-called safety disc 72 on the main shaft 30. This disc has an arm 73 which is in the path of a projection 75 on the lever 70, when the fuse is in unset condition, as shown in Fig. 2. There is also a timing disc 74 on the main shaft which prevents movement of lever 70 after the fuse is set and until the timing mechanism has measured off the time interval determined by the setting operation. The construction and arrangement of these parts can be explained in connection with Fig. 4.

There is a flanged sleeve 76 which has a press fit on the shaft 30, the shaft being knurled where the sleeve is attached in order to avoid any chance of the sleeve rotating relative to the shaft. The safety disc 72 is assembled on sleeve 76 next to the flange and has a downwardly projecting ear 77 which enters a peripheral slot in the flange and prevents rotation of the safety disc relative to the sleeve 76 and shaft 30. The sleeve and safety disc are thus fixed on the main shaft and rotate with it. The timing disc 74 is assembled on the sleeve 76 above the safety disc 74, there being a washer interposed between the two discs, and is held in place by means of a conical spring washer 78 and a ring 79. The end of sleeve 76 is expanded by a spinning operation to secure the ring 79. The timing disc 74 is thus frictionally secured to the main shaft 30, and may be rotated independent of the shaft in order to set the fuse.

The end of shaft 30 which projects above the sleeve 76 and ring 79 is threaded and carries a nut 80 which is screwed down tight against the end of the sleeve 76. The fuse may be wound by applying a wrench to the nut and rotating the shaft.

When the fuse is wound the gear train runs in a reverse direction. The detents 63 and 64 lock the escape wheel 46 against backward as well as forward rotation and accordingly they must be disengaged from the escape wheel before the fuse can be wound. For hand winding this is accomplished by means of a tool having two tapered pins which enter the holes 87 and 88, Fig. 3, and force the detents away from the escape wheel. The starting lever 81, which otherwise would interfere with the oscillation of the pallet arm, is assembled in operated position and is only moved to its normal position after the fuse is regulated. In this connection it will be noted that the lever is accessible through an opening in plate 11, as shown in Fig. 3.

When the fuse is fully wound the tool for disengaging the locking detents from the escape wheel is removed while the winding power is on in order to permit the detents to engage the escape wheel and prevent the gear train from running down. Or, if more convenient, the pallet arm may be held until the tool can be removed.

The member 59 is not only locked by the cam 61 as described but is positively held against rotation by means of a so-called set-back pin 111, Figs. 3 and 7. Fig. 3 shows one end of the pin, which is located in a passage formed by aligned holes in plates 11 to 19, inclusive. The pin projects through plate 19 for a distance about equal to the thickness of member 59 and this projecting portion being engaged by member 59, the latter is prevented from rotating, even if it is released by cam 61. Fig. 7 shows the projecting portion of pin 111 in section so that its location relative to member 59 may be understood. Set-back pins such as described have been used before in other fuses and accordingly no further explanation will be required.

The detonator is a brass capsule 90 which contains an explosive and is threaded into a passage formed by aligned holes in plates 11 to 15 inclusive. The slotted and perforated end of the capsule 90 can be seen in Fig. 3. It is behind the plane on which the sectional view Fig. 4 is taken and in this figure is indicated by dotted lines.

The arrangement for firing the detonator may be explained in connection with Figs. 4 and 5. There is a fairly stiff flat firing spring 91 which is secured to plate 17 by two screws and which extends to the left beneath the pin 33 and the firing pin 56, as shown in Fig. 4. Recesses are provided in plates 17, 18 and 19 to accommodate the spring 91. At a point about midway between the pin 33 and firing pin 56 the spring 91 is provided with an offset prong 94, the point of which lies in a slot 93 in plate 16 just above the detonator 90. This slot may be seen in Fig. 5. It will be clear from the foregoing that spring 91 may be depressed by either the firing pin 56 or by pin 33, which is part of the point impact firing mechanism, to cause the prong 94 to strike the detonator and explode it.

Operation of spring 91 to fire the detonator is normally blocked by a safety device which includes the lever 95 and weight 96. The safety lever 95 rests on plate 16 and is located in a recess milled out on the under side of plate 17. The shape of this recess is indicated by a dotted line in Fig. 5. The lever is pivoted on the pin 97 which is supported by plate 16 below the lever and by plates 17 and 18 above. The recess for lever 95 also contains a spring 98, one end of which presses against the lever 95. The other end of the spring has an abutment against the side of hole 99, which is drilled through plate 17 only, to intersect the recess and eliminate the rounded corner that would otherwise be present to invite creeping of the spring.

As will be seen from Figs. 4 and 5 the weight 96 is located squarely beneath the firing spring 91 and since the lever 95 rests on plate 16 and bridges the recess in this plate which is beneath spring 91 the spring is positively blocked against operation by either the firing pin 56 or pin 33. The lever 95 is operated by centrifugal force acting on weight 96 when the shell containing the fuse is fired and rotates on the pivot pin 97 in a clockwise direction. The rotation of the lever enables the weight 96 to move out from under the firing spring 91 and arm the fuse. The lever is locked in operated position by the spring 98, the end of which drops into a notch at the end of the lever.

While the safety lever 95 is operated by centrifugal force as explained, its operation does not take place immediately after the shell is fired, but is delayed for one-half second (or other desired interval) by the timing mechanism. As can be seen from Fig. 5, the rotation of lever 95 is nor-

mally prevented by the shaft 101 which is engaged by the end of the lever. At its lower end the shaft 101 is of reduced diameter and has a bearing in plate 15. The shaft extends upward through the plates above plate 15 and through block 10, where it has another bearing. At the upper end of the shaft the operating lever 103 is secured, said lever being located in a recess in block 10. The end of lever 103 extends beneath the safety disc 72 and is bent at a right angle to form a hook 105 which engages an oppositely formed hook 104 at the edge of the safety disc. Thus the lever 103 is normally locked and cannot rotate shaft 101 but when it is released by the safety disc, the lever moves under the influence of centrifugal force and rotates shaft 101 in a clockwise direction, as seen in Figs. 2 and 5. The shaft 101 is cut away at 102 where it passes the safety lever 95, as shown in Fig. 5, whereby such rotation is effective to release the lever.

The various recesses or cutouts in the plates which are required for mounting of the parts tend to unbalance the fuse and in order to prevent such unbalance other cutouts are made which would not be otherwise required. This is illustrated in Fig. 9, which shows plate 19, having recesses 112, 113 and 114, which are provided to balance the fuse. Plate 20 has a recess corresponding to recess 114, while plates 15 to 18, inclusive, have recesses corresponding to recesses 112 and 113.

This substantially completes the description of the timing mechanism, so-called herein to distinguish it from the complete fuse, which includes the base, setting cap and upper cap or nose. The timing mechanism assembly as shown in Fig. 4 is generally referred to as a fuse, since it includes a considerable number of parts in addition to those which are actually included in the timing mechanism. There are a few points involved in the assembly and regulation of the fuse, meaning the fuse as shown in Fig. 4, which it was not convenient to discuss before and which may be dealt with at this time.

The helical spring 57 in the firing pin is very stiff and consequently the firing pin has to be assembled in the block 10 by means of a suitable fixture provided for this purpose and adapted to supply sufficient power to force the firing pin into the block and compress the spring. After the firing pin has been cocked in this manner the screw 110 is inserted and the block is removed from the fixture. The screw 110 is threaded into a tapped hole in the side of block 10 and has an unthreaded part at the end which enters a slot in the firing pin to hold it in place. After the block has been assembled to the rest of the fuse the screw 110 is removed and the firing pin is held in cocked position by the locking member 59, as previously described.

Before it is assembled to the base the fuse must be regulated and since the rotation of the fuse affects its rate the fuse is timed while it is being rotated to simulate its rotation during the flight of the shell in which it is to be used. The spinning of the fuse for regulating purposes of course results in the operation of the timing mechanism, which in turn brings about the release of the safety lever 95 by the safety disc 72, and the release of the locking member 59 by the timing disc 74.

As regards the safety lever 95 it may be explained that the lever is reset by turning the fuse on its side and by introducing a suitable tool in the hole 100, Fig. 5. This hole extends through plates 11 to 17, inclusive, and can be seen also in Fig. 3. The tool may be a rod with a wedge shaped end which can be passed into hole 100 far enough so that the end is beyond the spring and then rotated. As soon as the spring 98 is compressed enough so that the end of the spring clears the notch in the lever the weight 96 will drop into position beneath the firing spring 91 by gravity.

When the locking member 59 is released by the timing disc it remains held by the set-back pin 111 and does not release the firing pin. This saves the time that would otherwise be required for cocking the firing pin after each run of the fuse during the regulating operation. However, the firing pin release must be tested and to do this the set-back pin is moved by hand to set back position and the fuse is run again. After this run the firing pin will have to be cocked, assuming that it was released properly, which is accomplished by means of a cocking device which includes means for holding the fuse and a rod adapted to enter the hole 115 and to which power may be applied to restore the firing pin to cocked position.

The reference character 116, Fig. 3, indicates the sloping end of a slot which is milled in the edge of plate 13 to provide a light passage used in timing the fuse during the rate regulating operation. Timing apparatus in which such a light passage is used is disclosed in the application of Thomas B. Gibbs, Serial No. 385,029, filed March 24, 1941, now Patent No. 2,360,053.

After the fuse has been tested and regulated it is ready for assembly to the base 120, Fig. 1. The fuse is properly oriented on the base by means of a locating pin 123, fixed to the base and shown in Fig. 10, which enters the hole 124, Fig. 3. The fuse is clamped to the base by means of a flanged ring 126 and a threaded sleeve 127, as shown clearly in Fig. 1. The ring 126 is made very slightly shorter than the fuse, to insure a slight clearance between the lower flange on the ring and the base. The upper flange is stepped, that is, it comprises inner and outer flanges, of which the outer flange engages the block 10 of the fuse. The inner flange extends over the edge of the timing disc 74 and precludes flaring or warping of the disc on forward set back, which might be sufficient to cause the edge of the disc to clear the projection 75 and release lever 70 were it not prevented. This inner flange has a notch for accommodating the projection 75 and in order to insure proper alignment of the notch with the projection two locating pins 128 and 129 are provided in the base 120, which enter notches in the lower flange of the ring 126 when the ring is properly oriented. These pins are shown in Fig. 10.

Additional means for securing the fuse to the base 120 is provided in the form of two screws such as 130, Fig. 1, which pass through the base, the heads being countersunk, through the plates 11—21, and are threaded into the block 10. The holes in the base for these screws are indicated at 131 and 132, Fig. 10, while the corresponding holes in the plates are indicated at 133 and 134, Fig. 3.

When the fuse is properly assembled to the base 120, the opening in the detonator 90, Figs. 3 and 4, is in alignment with the opening 125 in the base. The opening 125 is a firing passage which leads to a chamber in which the booster detonator 121 is located. This chamber is partly closed by a threaded thimble 122, which retains the booster detonator in place.

Communication between the detonator 90 and the firing passage 125 is normally blocked by a centrifugal safety device, as shown in Figs. 1 and 10. This device includes a slide 135, located in a recess in the base and having an opening 138. The slide 135 is normally locked by a second slide 136, which is pressed against slide 135 by a spring 137. The slide 136 and spring 137 are also located in the recess in the base, the depth of which is slightly greater than the thickness of the slides. These slides are adapted to move radially under the influence of centrifugal force, first slide 136 and then slide 135. The movement of the latter slide brings the opening 138 into alignment with the firing passage 125, shown dotted in Fig. 10. The slide 135 is locked in operated position by spring 139, the end of which drops into a notch in the slide. It will be noted that the slides move in directions which are 90 degrees apart, so that an accidental shock which might momentarily displace slide 136 will have no effect on slide 135.

The sleeve is locked by means of a screw 140. After the sleeve 127 has been screwed down tightly the hole for screw 140 is drilled and tapped and the screw is inserted.

The setting cap is indicated at 141, Fig. 1, and is shown in Fig. 8. The setting cap rests on the base 120 and is rotatably secured thereto by means of the sleeve 127 and a retaining ring 142 made of stiff wire, which lies partly in a groove in the setting cap and partly in a groove in the sleeve. As shown in Fig. 8, before the setting cap is assembled to the base the ring 142 is located wholly in the groove in the setting cap, which makes it possible to place the cap in position on the base. The screws 143—146 are then turned in tightly which causes the ring to enter the groove in the sleeve at a plurality of points. The upper wall of the groove in the sleeve is tapered, which causes the setting cap to be held tightly to the base when the ring is forced into the groove.

When the setting cap is placed in position on the base 120 it must be so oriented that the setting pin 147 enters the notch 150 in the upwardly bent leaf 151 of the timing disc 74. Before tightening the screws 143—146, and while the setting cap is freely rotatable on the base, the fuse is set to zero by rotating the member 148 with a screw driver until the distance between the setting edge 152 on the base and the setting edge 153 on the setting cap is exactly correct. A suitable gauge is used for this purpose. The set screw 149 is then tightened up to lock member 148 and the screws 143—146 are turned in to couple the cap to the base as previously described. It will be appreciated that the nature of the coupling is such that considerable force is required to rotate the cap, which insures that the zero adjustment will not be disturbed by ordinary handling.

The setting cap 141 has a pair of weights 154 and 155, supported thereon by means of a spring 156, which are operated momentarily by set back when the shell in which the fuse is used is fired. The operation of the weights is effective to flatten out the leaf 151 on the timing disc 74 so as to disengage it from the setting pin 147. The arrangement will be clear from Fig. 1 and 8.

The upper cap or nose 157 is secured to the setting cap by screw threads and is assembled last. Within the nose there is a longitudinally movable striker 158 having a steel anvil at the lower end to engage the striker pin 33. The striker 158 is normally locked against movement by means of two centrifugally operated members 160 and 161 which are located in radially disposed bores and which have projections 162 and 163 at their inner ends which register with an annular groove in the striker. This groove has a tapered upper wall and since the projection 162 has a corresponding taper the member 160 is normally locked against outward radial movement. The projection 163 is cylindrical so that it does not interfere with movement of member 161, but the latter is locked by the set-back pin 164, the end of which enters an annular groove in member 161. Spring 165 normally holds the set-back pin in position. The shank of the pin has a close fit in the opening provided for it, while the head of the pin has a very loose fit in the bore which contains spring 165, so that when set back occurs the pin instantly tilts in one direction or another, depending on where it is engaged by the spring, and the shank of the pin cannot re-enter the opening in which it is normally located. The operation of the set-back pin releases the member 161, which moves outward by centrifugal force and withdraws the projection 163 from the groove in the striker. The locking member 160 is now able to move outward also, moving the striker 158 in a forward direction far enough to enable the tapered projection 162 to leave the groove in the striker. These operations unlock the striker for backward movement upon impact with an object against which the shell is directed.

After the striker 158 has been unlocked as described, it is still supported by the collapsible copper shell 166, which yields upon impact and permits the striker to fire the detonator by means of the pin 33 and firing spring 91. In fuses of the usual construction, which are not provided with locking means for the striker, the support 166 must have considerable strength to withstand the set back action on the striker and to give a reasonable amount of protection against accidental shocks. The stronger the support 166 is made, however, the less sensitive is the fuse to impact and accordingly it has been the practice to make the striker of magnesium, to reduce its weight to a minimum. This reduces the set back effect to a minimum and makes it possible to use a fairly weak support 166, with the result that the fuse is reasonably sensitive to impact. Magnesium is not a good material for the striker, however, being mechanically weak, and the use of a weak support 166 gives little protection against accidental shocks or blows impinging on the nose of the fuse during handling.

From the foregoing the advantages of the locking means for the striker will be appreciated. The striker is positively locked against displacement by any accidental blow, and a shell containing the fuse can be dropped to land on the nose without danger. The striker is also positively locked against set back, which permits it to be made of more substantial material than magnesium. Finally, the support 166, being relieved of its former functions, can be made very weak, strong enough only to prevent the actuation of the striker by rain drops encountered by the shell in its flight, with the result that the fuse has the maximum sensitivity.

The operation of the various parts has been explained more or less in the course of the preceding description. Nevertheless, it will be of assistance to a full understanding of the inven-

tion to give a brief resumé of the operations in the order in which they take place, omitting reference to details of construction which have already been described.

For this purpose it will be assumed that the complete fuse as shown in Fig. 1 is assembled into a shell. As shown in the drawing the base 120 is provided with screw threads by means of which the fuse is secured to the shell in the usual manner.

The fuse is set by means of a fuse setting device which is provided with means for engaging the setting edges 152 and 153 to rotate the setting cap 141 relative to the base 120. Since the fuse is rigidly secured to the base the rotation of the setting cap rotates the timing disc 74 relative to the rest of the fuse. The direction in which the timing disc is rotated in the setting operation is shown by the arrow in Fig. 2, and the extent of rotation depends on the time interval desired, as will be understood.

When the shell is fired the operations which result from set back are the first to take place and occur simultaneously. Starting with the nose, and mentioning the operations briefly, the set-back pin 164 moves into the spring cavity and releases the locking member 161. In the setting cap the weights 154 and 155 strike the leaf 151 a blow which flattens it out and disengages it from the setting pin 147. Finally, in the timing mechanism the set-back pin 111 moves out of the path of the member 59 which supports the firing pin.

The next thing to take place is forward set back which occurs when the driving band strikes the rifling in the gun. Forward set back produces no useful effect. It tends to warp the timing disc 74 which is restrained, however, by the flange on the ring 126.

As the shell begins to travel down the barrel of the gun it is rotated by the rifling at an increasing speed and attains a high rotational velocity by the time it leaves the muzzle of the gun. Centrifugal force is thus developed which results in starting the timing mechanism and other operations which will be described briefly.

In the nose of the fuse the locking member 161, having been released by the set-back pin 164, moves radially outward, followed by a similar movement of the locking member 160. This unlocks the striker 158.

In the timing mechanism, the driving weights 34 and 35 start to move outward and together with the springs 170 and 171 apply a driving torque to the shaft 30. The escape wheel 46, normally locked by the two detents 63 and 64, is released by outward movement of these detents, and at the same time or an instant later the starting lever 81 rotates on its pivot to give an initial impulse to the pallet arm 47. The timing mechanism is thus started and continues to run from power supplied by the springs and the driving weights. In the operation of the timing mechanism the shaft 30, the safety disc 72, and the timing disc are rotated in a clockwise direction as seen in Fig. 2.

In the base of the fuse centrifugal force operates the slides 136 and 135 successively and the opening 138 in slide 135 becomes aligned with the firing passage 125 to provide communication between the detonator 90 and the booster detonator 121.

Centrifugal force also tends to operate the safety lever 95, the clocking member 59 for the firing pin, and the levers 70 and 103, but these parts are all restrained against movement for the time being.

The rotation of the safety disc 72 causes the hook 104 thereon to move relative to the hook 105 on the lever 103 and after an interval of one-half second has elapsed the hooks become disengaged, thus releasing lever 103. The lever accordingly rotates shaft 101 in a clockwise direction, Figs. 2 and 5, and releases the safety lever 95, which rotates in a clockwise direction on its pivot 97, due to centrifugal force acting on weight 96. This movement of the weight and lever leaves the firing spring 91 free to operate.

The fuse is now fully armed and ready to fire the shell, either by impact or at the expiration of the time interval for which the timing disc was set.

If the shell presently strikes the object toward which the shot was directed, the striker 158 is forced backward relative to the fuse and shell and the detonator 90 is exploded by means of the pin 33 and firing spring 91. The explosion of detonator 90 sets off the booster detonator 121 which explodes the booster charge usually provided below the fuse, which in turn explodes the main charge in the shell.

If the shell does not strike the target, the shell is exploded by operation of the timing mechanism. In the operation of this mechanism the safety disc 72 and the timing disc 74 rotate in a clockwise direction, Fig. 2, as previously mentioned. In approximately one second the arm 73 on the safety disc clears the projection 75 on lever 70, leaving the lever under the sole control of the timing disc 74. The rotation of the timing disc causes the notch with which it is provided to gradually approach the projection 75 and at the expiration of the time interval for which the fuse was set the notch becomes aligned with the projection, thus releasing the lever 70. Centrifugal force acting on weight 71 now rotates the lever 70 and shaft 62 and the latter releases the locking member 59. The member 59 is also acted on by centrifugal force and rotates in a clockwise direction, Fig. 7, to release the firing pin 56. Upon the release of the firing pin it strikes the firing spring 91 a blow which explodes the detonator 90 and the explosion of the shell takes place as previously described.

The rate of the timing mechanism is only very slightly affected by the rotational velocity of the shell, that is, the rate is substantially the same in a shell having a low rotational velocity as it is in a shell having a high rotational velocity. The fuse may be used with good results, therefore, in various kinds of shells.

The invention having been described, that which is believed to be new and for which the protection of Letters Patents is desired will be pointed out in the appended claims.

I claim:

1. In a combination fuse, clockwork mechanism including a hollow main power shaft and a gear train driven thereby, point impact firing mechanism including a striker pin extending through said shaft, a firing pin extending parallel to said striker pin, means including a timing disc on said main shaft for actuating said firing pin, a firing spring extending beneath said striker pin and said firing pin and adapted to be operatively engaged by said pins, a detonator, and means including said firing spring for exploding said detonator responsive to actuation of said striker pin or said firing pin.

2. In a mechanical time fuse, clockwork mech-

anism having a shaft, a safety disc and a timing disc adapted to be rotated by said shaft, said safety disc being fixed on said shaft and said timing disc being adjustable on said shaft to a variable starting position determined by setting the fuse, a detonator, a spring actuated firing pin, locking means for holding said firing pin in cocked position, a firing member adapted to be operated by said firing pin to explode said detonator, a centrifugally operated safety device normally blocking the operation of said firing member, latch means normally holding said safety device against operation, said latch means including a rotatably mounted shaft, means mounted on said shaft and controlled by rotation of said safety disc for releasing said safety device, and means controlled by rotation of said timing disc for releasing said locking means.

3. In a combination fuse, clockwork mechanism including a hollow main power shaft and a gear train driven thereby, centrifugally operated weight means for rotating said shaft, point impact firing mechanism including a striker pin extending through said shaft, a spring loaded firing pin, extending parallel to said striker pin, locking means for holding said firing pin in cocked position, means including a timing disc on said main shaft for unlocking said firing pin, a detonator, and a firing device adapted to be engaged and operated by said striker pin or said firing pin, depending on which is first actuated, to explode said detonator.

4. A combination fuse as claimed in claim 3, wherein the striker pin and the firing pin have a common arming device, comprising a centrifugally operated member normally preventing operation of said firing device.

5. In a mechanical time fuse, clockwork mechanism including an axial main shaft and a gear train driven thereby, a pinion on said main shaft, a pair of toothed gear sectors supported on pivot pins for cooperation with said pinion, a pair of helical coil springs surrounding said pins, respectively, each spring being angularly compressed with one end portion thereof engaging the associated sector and the other end portion thereof engaging a fixed part of the fuse, whereby said springs supply power to drive said shaft independent of rotation of the fuse, and weights mounted on said sectors to operate the same by centrifugal force and supply additional power to drive said shaft when the fuse is rotated.

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