

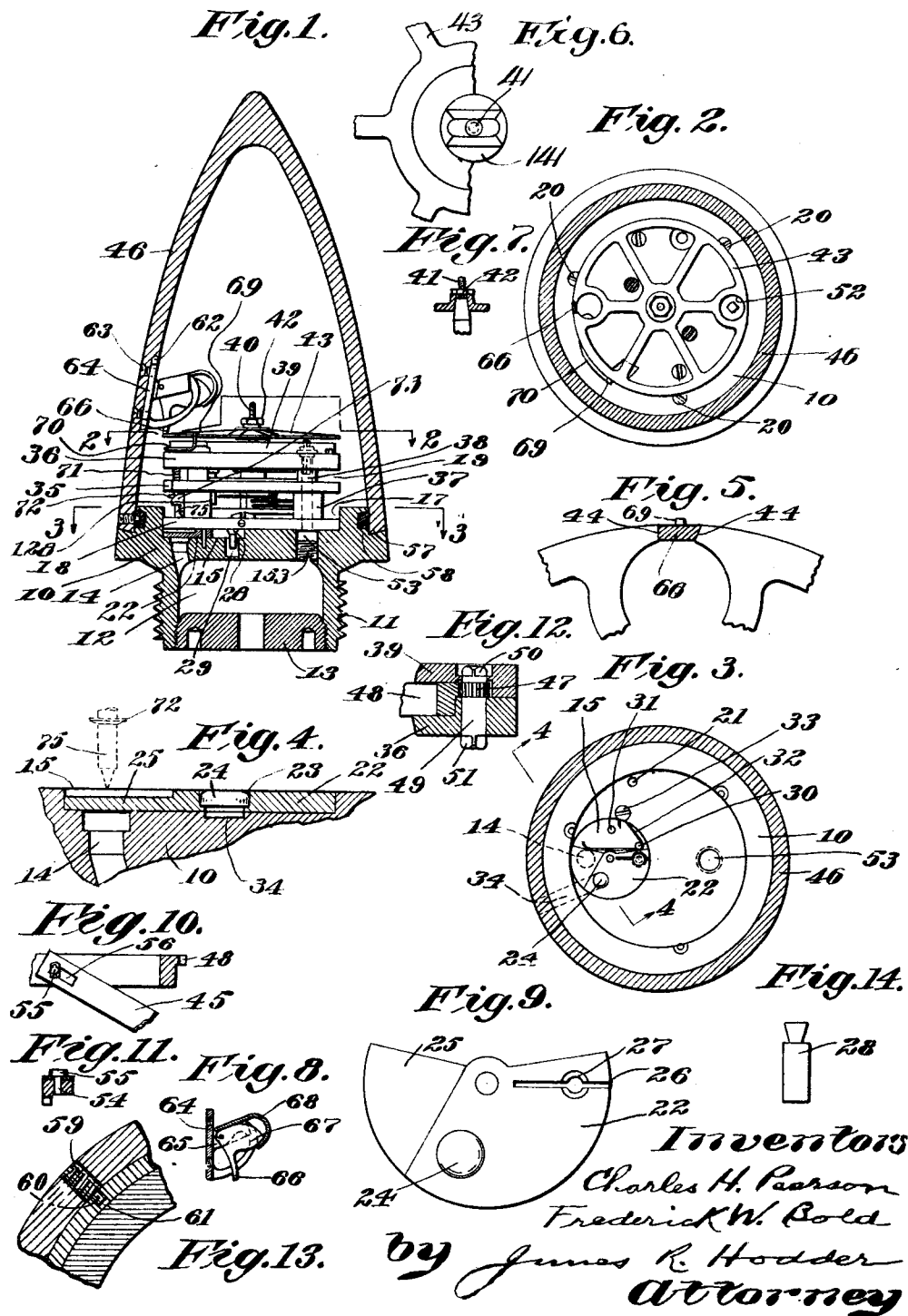
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C. H. PEARSON ET AL

FUSE

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UNITED STATES PATENT OFFICE.

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FUSE.

Application filed October 25, 1920. Serial No. 419,371.

To all whom it may concern:

Be it known that we, CHARLES H. PEARSON, a citizen of the United States, and resident of Brookline, in the county of Norfolk and State of Massachusetts, and FREDERICK W. BOLD, a citizen of the United States, and resident of Chelsea, in the county of Suffolk and State of Massachusetts, have invented an Improvement in Fuses, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

Our present invention relates to mechanical time fuses, and more particularly to mechanical time fuses adapted to be applied to ordnance shells for the purpose of detonating the charge therein after a predetermined length of time following the discharge of the shell from a gun.

In fuses of this character, where the operating parts are necessarily of delicate construction and are subject to the shocks of tremendous forces, such operating parts must not only be of reliable construction, but must be associated with and surrounded by safeguards to ensure positive safety to the operating parts, the shell to which such parts may be attached, and particularly to the operators who must handle them. So many different things may happen to a fuse under so many different conditions, that the prevention of accidents has actually become a prime object of inventors of this class of devices.

The most frequent cause of accidents has been the premature explosion of the shell charge by any accidental release of the firing pin because of shock or other reason causing the detonation of the primer of the fuse and the resultant discharge of the shell charge. In the prior application of Frederick W. Bold, Ser. No. 334,849, filed Oct. 31, 1919, an important safety device was devised, consisting in a shutter, either sliding or pivoted, between the primer and the firing pin, as a positive interposed member, and we have now still further improved this safety shutter utilizing it, or any similar movable member, to normally hold the primer out of firing position, and, by the firing of the gun, to automatically position it into firing position.

One of the principal objects of our invention, therefore, is to provide safeguards

against accidental explosions. One of these safety elements is a novel means for carrying the primer, and normally retaining it wholly out of alinement with the firing pin, and also entirely removed from and practically closing the passage leading to the detonating chamber. Our invention thus permits the use of high explosives with greater safety than has been possible prior to this invention. Preferably, we employ means to hold the primer out of firing position until such means is moved into position by the centrifugal forces generated by the rotation of the shell on its discharge from a gun, when the primer is automatically positioned and ready for the release of the firing pin by the timing mechanism.

Mechanical time fuses must be strong enough mechanically to withstand the shock of discharge and the tremendous centrifugal forces set up by the rotation of the shell after discharge. That such strength is essential will be obvious when it is understood that the shock of discharge is so great that it is generally accepted that the inertia of each grain of weight of the fuse becomes equal to as much as approximately two and eighty-five one-hundredths pounds (2.85); that is, the apparent weight of the fuse is equal to its actual weight multiplied some fourteen thousand times, and that the centrifugal force set up by the rotation of the shell is such that at a distance of approximately five eighths of an inch from the axis of the fuse such centrifugal force is approximately equal to the force due to the shock of firing. Notwithstanding the tremendous forces set up by the shock of firing and the rotation of the shell, the moving parts of a timing mechanism should run very accurately, for with the great velocity of a shell when in flight, any error in the running time of the fuse may make a tremendous difference in the results obtained. The carrying, or what may be termed the stationary parts of the fuse, must be, therefore, of such rigid construction as to be immune from the effects of all shocks and centrifugal force, while the moving elements, such as the time train and escapement, must be light in weight so as to run freely and without binding, as must also the firing pin and release mechanism therefor. One of the most important moving elements is the setting disc, plate or wheel,

that cooperates with the setting cap or head to set the timing mechanism and with the firing mechanism to release the firing pin at the proper instant. Such setting disc should
5 be light in weight, because it is carried on and rotated by the time train and yet should be rigid enough to prevent chattering or vibration when subjected to shock. We attain these results by making such setting
10 disc in the form of a concavo-convex or dished wheel, and preferably a spoked wheel to save weight. A beveled cut away portion in the rim cooperates with a spring pressed latch to connect the same temporarily with
15 a correspondingly beveled part carried by the setting cap or head and to automatically and surely seat together.

Another object of our invention therefore, is an improved form of setting disc
20 for fuses of this character.

In our present improved construction, the connection between the setting disc and the setting cap is such that the setting disc has practically no zero position; that is, the
25 setting disc may be moved into such a position that the firing pin release lever is in alignment with the notch in the setting disc, but such notch is filled by the connecting means from the setting cap and, therefore, there is no danger of premature
30 explosion from this cause. This construction has several advantages, one of which is the feature of being able to set the disk from either side of the zero point. For
35 example, assuming the setting cap to be resting in such a position on the base as to indicate that the setting disc is in zero position. In former construction, if it were necessary, say, to set the disc to release at 75,
40 the setting cap must necessarily have been rotated through practically a complete circle. This is not so in our present device where, assuming the setting disc and setting cap to be in the position above noted, if it
45 is desired to set the mechanism to be released at 75, the setting cap is merely rotated through a comparatively small angle to ring the 75 mark into position to set the disc.

The setting disc is mounted on the staff of the time train, and heretofore considerable difficulty has been experienced because of the seeming impossibility of obtaining
55 suitable and positive connection between such disc and staff. Where a circular connection between the two elements was relied upon, too close fitting was necessary to avoid objectionable back lash. Where a tapered connection was relied upon, relative
60 movement between the two elements was so likely to occur that doubt always existed as to whether or not the fuse was properly timed. We have overcome these objections by providing a non-circular connection with
65 the tapered connection, with the result that

the objections enumerated above are eliminated.

Still another object of our invention, therefore, is an improved form of connection between the setting disc and center
70 staff of the timing train.

An important element of the construction of this fuse is the connection between the setting cap or head and the setting disc. This connection must be a positive one in
75 order that the fuse may be properly set and yet must be capable of being positively broken by the shock of firing. We may also utilize the centrifugal force to aid in breaking such connection, if for any reason
80 the same should be delayed, and after such disconnection, the connecting member, in addition to being held out by the spring hereinafter referred to, is positively held
85 and maintained out of the way of the disc by the centrifugal force due to continued rotation of the shell. A further object of our invention, therefore, is an improved form of connection between the setting cap or
90 head and the setting disc.

In the prior application of Frederick W. Bold, Ser. No. 334,849, filed October 31, 1919, the spring ring located between the setting cap or head and the base of the fuse has been provided with V-shaped
95 depressions in which the pointed ends of adjusting screws fitted, and by means of which screws the tension of the spring was adjusted. Such a construction was unsatisfactory in some fuses, because under certain
100 severe conditions the V-shaped depressions and screw holes in cap became deformed, rendering it impossible to properly tension said spring. To overcome this difficulty is
105 a still further object of our invention wherein we provide an improved form of adjusting means for adjusting the tension between the setting cap or head and the base of the fuse. The shock due to firing
110 the shell from the gun is a source of failure of the timing apparatus to operate, due to the end of the driving spring of the said timing apparatus becoming disconnected from the winding gear. Therefore another
115 object of our invention is an improved means for connecting the end of the driving spring of the timing apparatus to the winding gear to prevent accidental disconnection.

A further object of our invention is an improved form of winding and testing means for the driving springs of fuses of this character, permitting the spring to be wound or tested from either end of the fuse
120 base, and when wound or tested from the lower end, this can be done with the cap in place.

In our present invention the primer is located in a rotatable plate preferably operable by centrifugal force, and normally out
130

of alinement with the passage leading to the detonating chamber. In order that the holding plate or shutter cannot be moved into position to aline said primer with said
 5 detonating chamber, we have provided a positive locking means therefor to be released or unlocked by the shock of firing the shell from a gun.

A further object of our invention, therefore, is improved safety devices for the rotatable plate or shutter, or the like means which is positioned between the firing pin and the charge.

As an additional safety feature, independent of all others and one that is of great importance, we so arrange the timing movement on the fuse base that when the neutral or safety point on the setting cap is set at the neutral or safety point on the
 15 base and with the firing pin control lever then in the pathway of the setting lever engaged in the slot in disc, it will be impossible for the firing pin to be released.

Other objects and novel features of construction and arrangement of parts will appear as the description of the invention progresses.

In the accompanying drawings, illustrating a preferred embodiment of our invention,
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Fig. 1 is a sectional elevation;

Fig. 2 is a sectional plan view, taken on the line 2—2 of Fig. 1;

Fig. 3 is a sectional plan view, taken on
 35 the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary sectional view, taken on the line 4—4 of Fig. 3;

Fig. 5 is an enlarged detail of a portion of the setting disc;

40 Figs. 6 and 7 are detail views of the hub portion of the setting disc illustrating the method used to prevent rotation of said disc on the staff, and also showing the shoulder on said staff to prevent any set back movement of said disc on said staff on shock
 45 of firing;

Fig. 8 is a detail view of a lock for connecting the setting cap and setting disc together;

50 Fig. 9 is an enlarged detail view of the primer carrying plate or shutter;

Figs. 10 and 11 are detail views illustrating our improved means for attaching a driving spring to the winding gear;

55 Fig. 12 is a detail sectional view of the gear winding pinion, with the means for operating the same from the bottom or top of the movement;

Fig. 13 is a detail showing the improved means for tensioning the spring ring located between the setting cap and fuse base; and

Fig. 14 is an enlarged view of the plate or shutter stop pin.

65 Referring to the drawing, 10 designates a

fuse base, provided with exterior threads 11 by means of which it may be attached to a shell, and with a detonating chamber 12 on its lower end, this chamber being closed
 70 by the screw plate or plug 13 of usual construction. A passage 14 extends from the detonating chamber 12 to a depression 15 located in the upper portion of the fuse base 10. The upper face of the fuse base
 75 is recessed at 17 to receive the lower plate 18 of the clock or timing movement 19. Screws 20 hold the movement firmly in position in such recess, a dowel pin 21 in the lower face of the recess cooperating
 80 with a hole, (not shown) in the bottom plate of the movement 19 to position such movement.

Pivotaly mounted in the depression 15 is a segmental plate or shutter 22 provided with a recess or chamber 23 in which fits
 85 a primer 24. This segmental plate or shutter is cut away or reduced in thickness at the portion 25 to provide for the proper balancing of the shutter, while a radial slot 26 is provided at a side remote from the
 90 reduced portion 25. Intermediate the ends of the radial slot is a beveled hole 27 in which is placed a stop pin 28, shown enlarged in Fig. 14, this stop pin loosely fitting
 95 in a hole 29 in the fuse base 10 and under normal conditions holding the segmental plate or shutter in the position shown in Fig. 3, with the primer 24 out of alinement with the passage 14. A stop
 100 pin 30 embedded in the lower face of the depression 15 prevents anti-clockwise movement of the segmental plate or shutter 22 should, for any reason, the stop pin 28 become disengaged from the beveled hole
 105 27, while the second stop pin 31 likewise embedded in the lower face of the depression limits the clockwise movement of said segmental plate or shutter 22. A spring
 110 32 fastened at one end by the screw 33 lies parallel to the lower face of the depression 15, extending between the stop pin 30 and the segmental plate or shutter 22, with its free end in engagement with the said segmental plate or shutter, as clearly shown
 115 in Fig. 3, tending to hold such shutter in the normal or inoperative position. Located in alinement with the primer 24 and leading to the outside of the fuse base 10, is a vent 34 preferably closed on its outer end
 120 by a screw or plug (not shown) suitable to keep out dirt and dampness, but capable of being readily blown out by the primer should it prematurely be discharged and thus affording a free vent and ensuring
 125 safety to the charge in the shell. This construction provides positive safety means for the fuse, as except under conditions that can never be brought about until the shell to which the fuse is attached is discharged
 130 from a gun, the primer cannot be brought

into alinement with the passage leading to the explosive chamber, and until such time the plate or shutter practically closes the passage 14 leading to chamber 12.

5 The clock or timing movement 19 comprises the bottom plate 18, middle plate 35 and top plate 36, spaced apart from each other by a plurality of pillars, 37 and 38, being shown in the drawing, and the cover plate 39 is secured to the top plate 36. The center staff 40 is mounted in bearings in the middle plate 35 and cover plate 39, and extends above said cover plate. The extreme end of the staff is threaded at 41 to receive a nut 42, while the portion below the threaded portion 41 and above the cover plate 39 is tapered, as clearly shown in Fig. 7. In addition to being tapered, this latter portion is milled on opposite sides, and with a shoulder thereon, as shown in Fig. 6, to provide a positive connection between said staff and the setting disc 43, preventing the hub of said disc from being moved by either the shock of firing or centrifugal force. This setting disc 43 is cup-shaped, as shown in Fig. 1, to prevent vibration and "chattering" and thereby eliminate any possible derangement of the parts of the device due to such vibrations of the disc. Such stiffening of the disc may be by ribs, corrugations or equivalent reinforcements. To reduce weight as much as possible, the setting disc 43 is made in the form of a spoked wheel, as clearly shown in Fig. 2, the rim being cut away at one point, as shown in Fig. 5, the sides of this cut away portion being beveled at 44, for the purpose to be hereinafter described.

Fuses of this type are generally stored completely assembled, as shown in Fig. 1, with the driving spring 45 of the clock or timing movement wound up.

We have devised an improved means for winding the driving spring which may be operated from either the top or the bottom of the clock or timing movements. The pinion 47 that meshes with the winding gear 48 is formed on or attached to a shaft 49, the upper and lower ends 50 and 51, respectively, are squared, as shown in Fig. 12. This shaft 49 is mounted with its bearing in 36 and 39, being top and cover plates, respectively, 39 being recessed in upper side to allow key to be inserted over square, and also cut away for the pinion 47. The setting disc 43 is provided with a perforation 52 through which the socket wrench or key may be inserted when it is desired to wind the spring 45 from the top of the timing movement, while the fuse base 10 is provided with a hole 53 in alinement with suitable holes in the bottom and middle plates 18 and 35 respectively, so that after the device is assembled and shipped to its destination, the mainspring may be wound or

tested by removing the plug 13 and the screw 153 and inserting the socket wrench or key through the hole 53 in the fuse base 10 to engage the lower portion 51. The headless screw 153 closes the hole 53 from the detonating chamber. In testing the mainsprings in fuses of this character and also on inspecting after being fired in a protected or dummy shell, it has been found that some of the said springs become unhooked rendering them inoperative. To obviate this difficulty and ensure proper action of the device, we have devised an improved form of attachment between the outer end of the driving spring and the winding gear. This attachment is illustrated in Figs. 10 and 11 and consists essentially of a stud 54 riveted in a hole in the annular wall of the winding gear 48, this stud being provided with a head 55 having parallel sides perpendicular to the thickness of the winding gear, this head being parallel to and spaced apart from the annular wall of the winding gear a distance slightly greater than the thickness of the spring 45, the outer end of which is provided with a slot 56 longer than the head of the stud and slightly wider than the width of the head between its parallel sides. To assemble the winding gear and spring, the slot in the outer end of the spring is slipped over the head of the stud and the spring 45 is then rotated into position. The manner in which this is done will be obvious from an inspection of Fig. 10.

The upper outer portion of the fuse base 10 is cut away at 57 to provide a bearing surface for the setting cap or head 46. On the vertical face of the cut away portion 57 is a groove, cut at right angles to said face except that one edge of said groove is slightly beveled, in which groove is placed a ring 58 of spring metal of the same shape and to fit said groove. This ring has holes or recesses in it to receive the reduced ends of the screws 59, the shoulders of said screws to press against the front of said ring to properly tension the cap and ring thereby enabling setting and holding the cap in any desired position. A plurality of headless screws 59 are threaded through the cap 46 at various points about the periphery of the cap. With this construction, there is no tendency, as in prior constructions where a pointed screw engages a wedge shaped depression in the spring ring, to expand the screw hole in the setting cap or head. By this device, also, the power required to turn the cap or head 46 during the setting operation, may be varied to suit any requirement.

On the interior wall of the cap or head 46 is attached, in longitudinal groove 62, by the screws 63, a plate 64 carrying spaced bearings 65 in which is pivotally mounted an irregular shaped member comprising a latch 66 and cam 67. Also mounted in the bearing

ings 65 is a curved spring 68, the outer free end of which engages with the cam member 67. This construction is clearly shown in Fig. 8, and it will be seen that with the free end of the spring 68 in the position shown, that the latch member 66 will be held to the right, and in engagement with the cut away portion of the rim of the setting disc 43. The sides of the latch are beveled to correspond with the bevel of the cut away portion of the said rim and the tension of the spring 68 holds the said beveled end in engagement with said cut away portion, ensuring a connection between the setting cap or head 46 and the setting disc 43. When the shell, to which the fuse is attached, is discharged from a gun, shock of firing causes the irregular shaped members comprising the latch 66 and cam 67 to be rotated on the bearing against the tension of spring, and moves the beveled end of the latch out of engagement with the cut away portion of the rim of the setting disc or plate, in which position it will be held by the free end of the spring bearing against the other surface of the cam than that shown in Fig. 8, and also by centrifugal force. With the latch 66 in engagement with the cut away portion of the rim of the setting disc 43, such disc may be rotated by means of the setting cap or head to set the timing movement.

The operation is as follows, it being assumed that the fuse has been properly assembled with the latch 66 in place at neutral point and the primer in place. Before the bursting charge is put into the chamber 12 and in order that the parts of the device may be disturbed as little as possible, the operator or inspector, in order to ascertain if the operating spring of the clock or timing movement is wound up, removes the plug 13 from the bottom of the fuse base, and the screw 153 from the hole or passageway 53, inserts a socket wrench or key through the passage 53 into engagement with the lower end of the winding shaft 51 and tests the condition of the operating spring. Assuming that such spring is found to be wound up, or if not it is then wound up, the screw 153 is replaced in hole 53, the bursting charge loaded into the chamber 12 and the plug 13 screwed into the bottom of the base. The fuse base is then screwed into the nose or upper part of a shell. When the fuse is about to be fired, the operator rotates the setting cap or head 46 to set the cut away portion of the rim of the setting disc 43 at the point where it is desired to release the firing mechanism associated with the clock or timing movement. As above pointed out, the setting of the fuse may take place from either side of the zero mark on the setting cap. If now, the shell, with fuse attached, is placed in a gun and the gun discharged, the shock of firing does several things; the

clock or timing movement is started in operation by the release of latch 66 from the disc, and the sliding sleeve 128 is removed from its lever holding the timing movement from rotation, as explained in said prior application of Frederick W. Bold, the extension 69 of the release lever 70 slides on the moving periphery of the setting disc 43; the pin 28 in the wedge shaped hole 27 in the cover plate or shutter 22 is pulled out of said hole and falls into and is wedged in the hole 29 in the fuse base 10, the beveled end of the latch 66 moves to the left upon the bearing 65 as viewed in Figs. 1 and 8, out of the cut away portion in the rim of the setting disc, and the free end of the spring 68 engages with the other face of the cam 67 to hold the said beveled end permanently out of such cut away portion; all of the above things happen practically simultaneously and as the shell starts to rotate at the instant of discharge, because of the rifling of the gun, the following may be said to happen simultaneously with the above: The cover plate or shutter 22 is rotated by centrifugal force in clock-wise direction to bring the primer 24 into alinement with the passage 14 leading to the chamber 12, the setting disc 43 will be rotated by the clock or timing movement until the cut-away portion of the rim comes into alinement with the extension 69 of the release lever 70, the tension of the spring 71 is sufficient to cause, by means of the collar 72 and beveled trigger 73, the rotation of the shaft 74, and the release and operation of the firing pin 75, resulting in exploding, in regular order, the primer, the bursting charge in chamber 12 and the shell charge.

From the above, it is obvious that until after the shock of firing and also until the shell is set in rotation by the rifling of the gun, and until the centrifugal force generated by such rotation is equal to or greater than a certain predetermined amount, it will be impossible to detonate the charge of the shell, and even not then unless the setting cap has been moved away from its normal neutral location.

When the setting cap is at neutral, or zero position, it will be noted by reference to Fig. 5, that the extension 69 of the release lever 70 is in alinement with the latch 66. It is obvious, therefore, that if the fuse is subjected to shock sufficient to start the timing train in operation, no damage can result as the latch 66 prevents the release of the firing pin. This is true even though the fuse be attached to a shell and fired from a gun, as neither the shock of firing nor the centrifugal force will be sufficient to move the latch 66 out of the path of movement of the extension 69. In order for the device to operate, therefore, it is necessary for the setting cap to be first moved from its neutral or zero position.

As the passage 14, leading to the chamber 12, is suitably filled with powder, pellets or the like, the plate or shutter 22 acts as a protecting shield covering said passageway and also acts as a safety device for preventing premature discharge of the said powder, pellets, or the like, by any premature detonation of the primer 24. This additional safety feature is an important characteristic of our invention.

As our invention relates to a type of device that is intricate in character, we have necessarily described the preferred embodiment thereof somewhat in detail. It is to be understood, however, that we may vary the construction and arrangement of the elements constituting our invention within considerably wide limits without departing from the spirit thereof.

Also our invention and certain features and advantages can be utilized in impact fuses as well as in time fuses, and therefore it is to be understood that we intend such features to be broadly covered by the appended claims.

Our present invention is further described and defined in the form of claims as follows:

1. In a time fuse, the combination of a base, a timing train mounted thereon, a firing pin controlled in its operation by said timing train, and a primer holding device, normally holding the primer out of the path of movement of the firing pin, means for retaining the said device in said position against accident, said means being operable to release the device on the shock of firing, said device being operable by centrifugal force to move the primer into alignment with said firing pin.

2. In a time fuse, the combination of a base, a timing train mounted thereon, a firing pin controlled in its operation by said timing train, a primer holding device normally holding a primer out of the path of movement of the firing pin, a safety pin detachably connected to said device and removable therefrom by the shock of firing to release said device, said device being operable by centrifugal force to move the primer into alignment with said firing pin.

3. In a time fuse, the combination of a time fuse setting disc, a beveled opening in the rim of said disc, a setting cap, means for connecting the setting cap and setting disc, having a beveled member fitting into said beveled opening and lying flush with

the periphery of the setting disc, and means for yieldingly holding said member in contact with the side or sides of the said opening.

4. In a time fuse, the combination of a base, a timing train mounted thereon, a driving spring for said train, and means for winding said driving spring from both the top and bottom of said base.

5. In a time fuse, the combination of a base, a timing train mounted thereon, a driving spring for said train, a non-perforated setting cap, and means for winding the driving spring with said cap in position.

6. In a time fuse, the combination of a base, a timing train mounted thereon, a driving spring for said train, a winding gear connected to said spring, a shaft having non-cylindrical key engaging ends associated with said timing train, a pinion on said shaft engaging with said winding gear, and a perforation in said base in alignment with said shaft, whereby said spring may be wound from the bottom of the base.

7. In combination with a setting plate provided with a radially extending slot and rotatable through an angle of 360°, a firing pin release lever adapted to move into said slot, and a setting means fitting into said slot and normally preventing movement of said lever into said slot.

8. In a time fuse, a base, a timing train, firing mechanism controlled thereby, a setting cap, a plurality of safety devices associated with said timing train and operable by the shock of firing and centrifugal force to permit the detonation of the fuse, in combination with connecting means between the setting cap and timing train for positively preventing operation of the firing mechanism while said setting cap is in neutral position.

9. In combination with a setting plate provided with a radially extending slot and rotatable in either direction on its axis through an angle of 360°, a firing pin release adapted to move into said slot, and a setting means fitting into said slot during the setting operation whereby the setting of the fuse may be made through the rotation of the setting plate in either direction.

In testimony whereof, we have signed our names to this specification.

CHARLES H. PEARSON.
FREDERICK W. BOLD.