Aug. 21, 1928. 1,681,390

F. W. BOLD

TIME FUSE FOR AERIAL BOMBS

Filed June 28, 1923 3 Sheets-Sheet 1

Fig. 1.

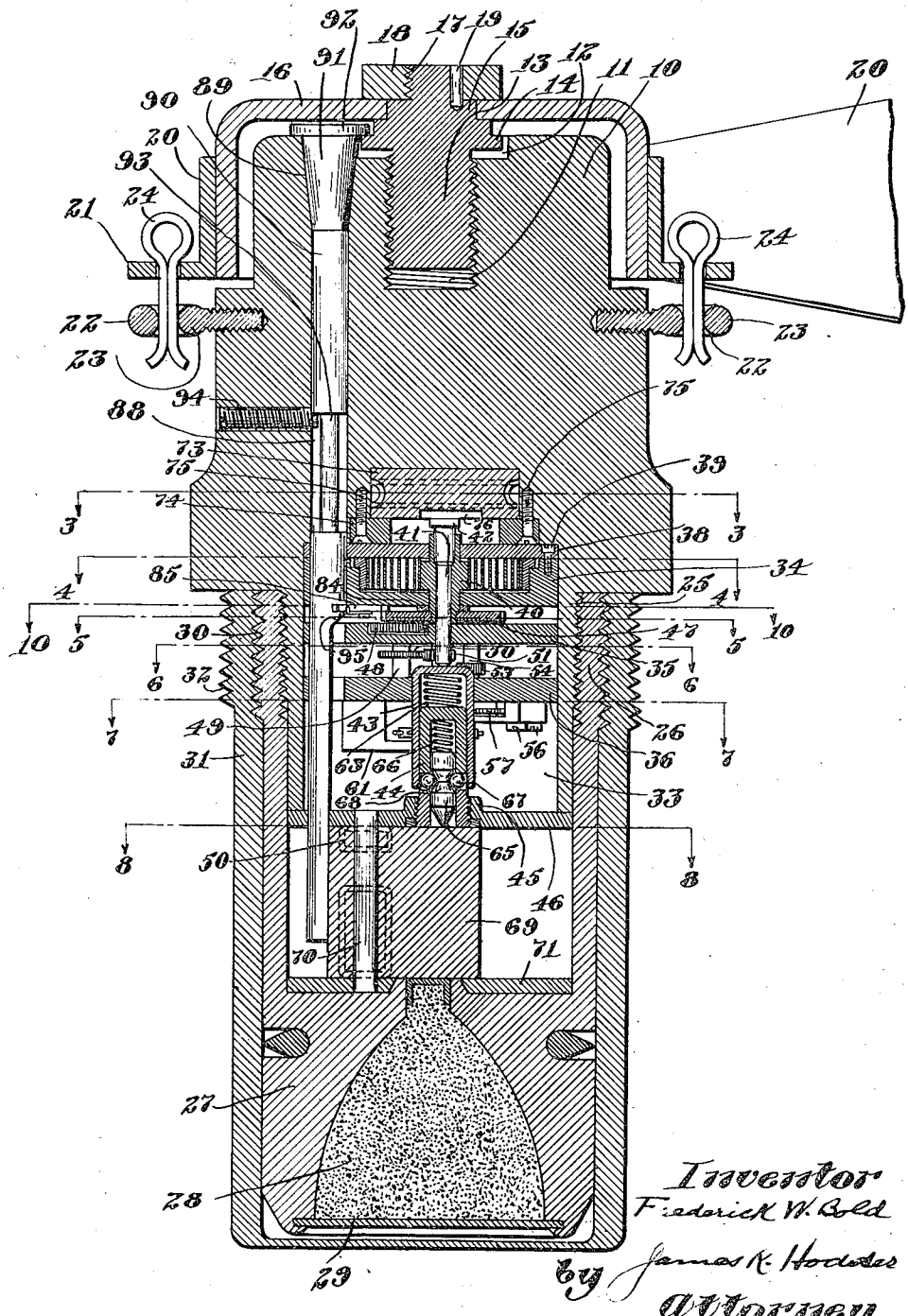

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Fig. 2.

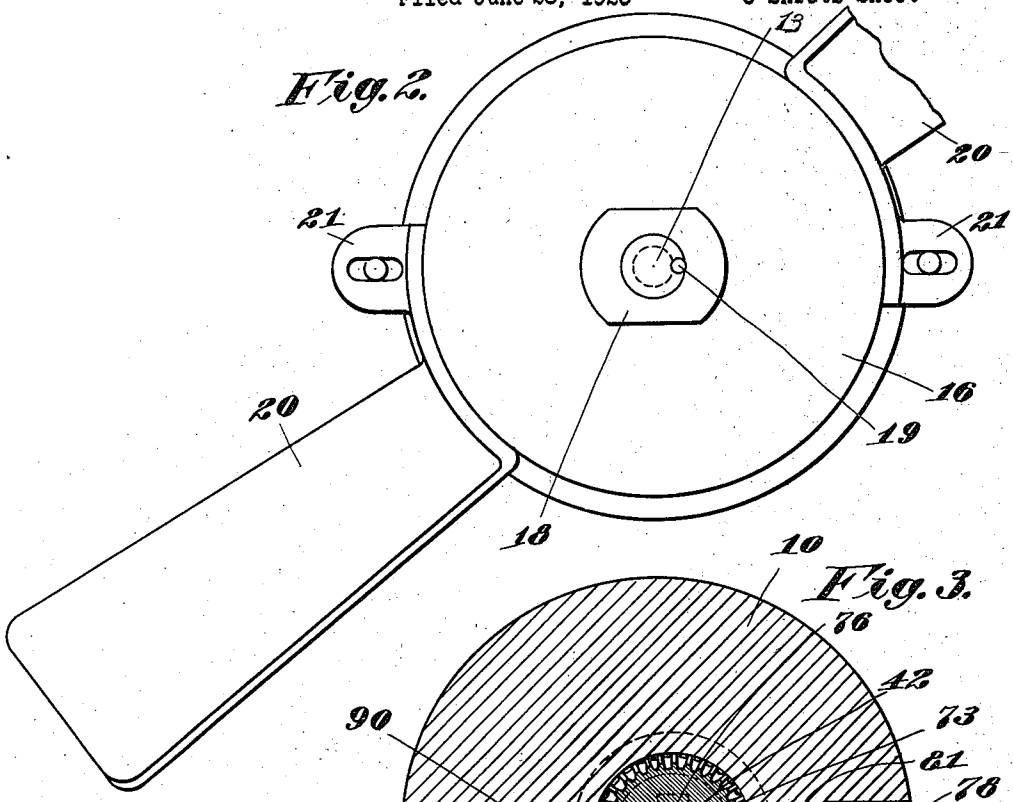


Fig. 3.

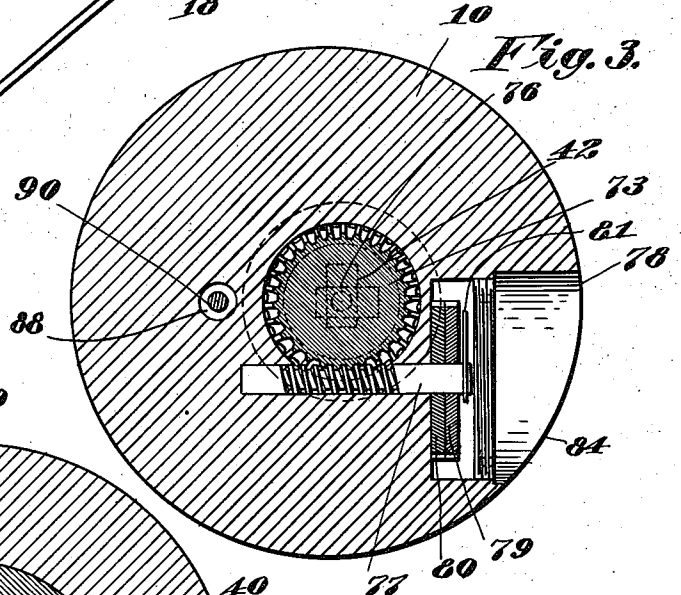
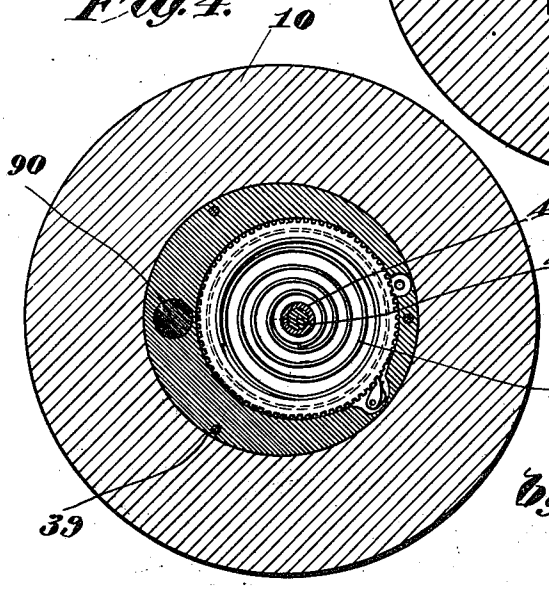


Fig. 4.



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Filed June 28, 1923 3 Sheets-Sheet 3

Fig. 5.

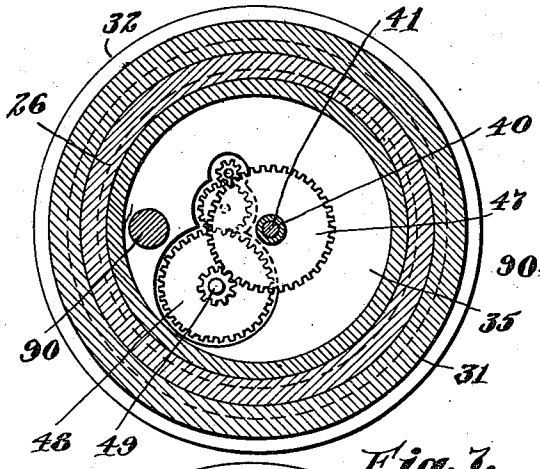


Fig. 6.

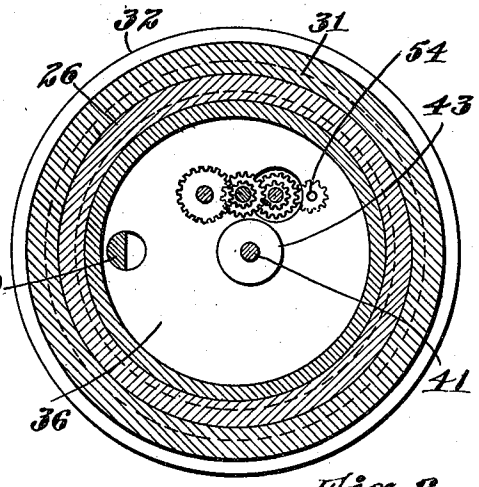


Fig. 7.

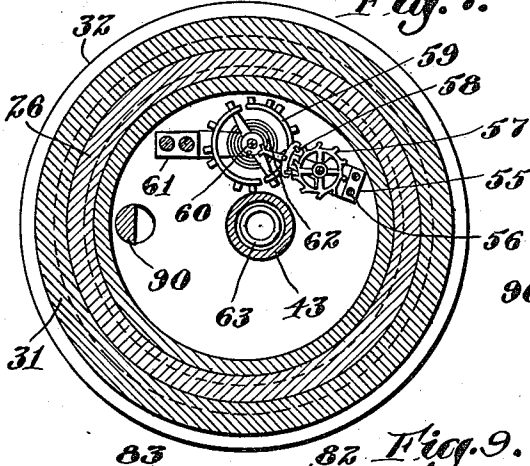


Fig. 8.

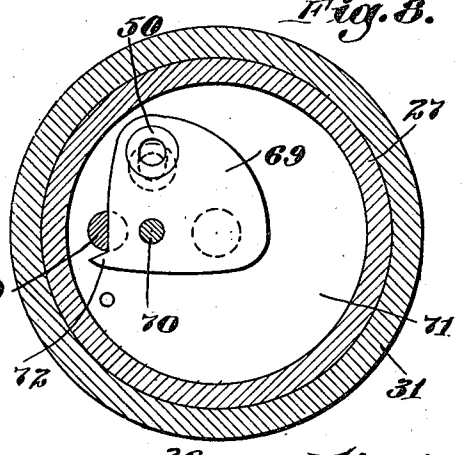


Fig. 9.

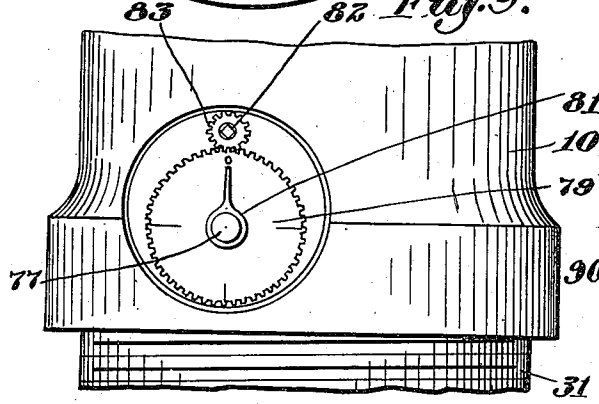
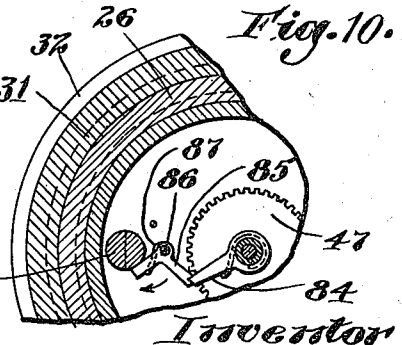


Fig. 10.



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Patented Aug. 21, 1928. 1,681,390

UNITED STATES PATENT OFFICE.

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TIME FUSE FOR AERIAL BOMBS.

Application filed June 28, 1923. Serial No. 648,378.

My present invention relates to fuses, and more particularly to an improved time controlled detonating fuse for use in connection with aerial bombs and the like.

In designing a controlling fuse for determining the time of detonation of an aerial bomb, a considerably different problem is presented than that presented by the designing of a controlling fuse for high explosive shells thrown from a gun. While the shock to a fuse controlling mechanism, when a shell to which the fuse is attached is discharged from a gun, is a heavy shock, and the timing control mechanism for the fuse must be designed to withstand such shock, yet such shock is comparatively slight compared with the shock imparted to the timing mechanism of a controlling fuse attached to an aerial bomb when such bomb strikes the ground after having been thrown from any considerable height. In comparison, the shock imparted to a timing fuse attached to a high explosive shell is a "cushioned" shock as compared to the "hammer blow" shock imparted to the timing mechanism of a fuse attached to an aerial bomb. This for the reason that the shock imparted to the high explosive shell fuse time train is due to comparatively slow burning powder while the shock imparted to the aerial bomb timing fuse train is imparted when the aerial bomb strikes the earth or on a building or any other place where its flight is suddenly halted.

Attempts have been made to adapt timing train mechanism for fuses suitable for detonating high explosive shells to like use in detonating the charge in an aerial bomb, but in no instance of which I am aware has this been successful. The greatest use in present day warfare for an aerial bomb is the advance mining of a selected territory prior to an attempt on the part of shock troops to take such mined territory from the enemy. Under these conditions, therefore, it is necessary, or at least advisable, to mine the desired territory a considerable time in advance of the expected assault, which time usually ranges from thirty six to seventy two hours and as the shock of landing of the aerial bomb must positively set in motion the timing train for detonating the fuse, and when it is remembered that a number of such aerial bombs may be dropped in a swamp or lakes or during the time between the dropping thereof and the detonating of the charge therein the country may be subjected to heavy rains or even floods, it will be apparent that it is essential to absolutely prevent access of moisture or dirt of any sort to the timing train as the presence thereof would prevent the functioning of the timing train and therefore the detonating of the explosive charge at the desired time. As the timing train for controlling the detonating of explosive charges in high explosive charges are primarily of two classes: those which detonate the charge on the shell reaching its destination and those which detonate the charge a predetermined time after the shell leaves the gun, and as such time in any event is exceedingly short as compared with the length of time the timing train of an aerial bomb must operate, it is practically impossible to adapt a fuse of a high explosive shell to an aerial bomb.

In my present invention, I have obviated the objections above noted and have designed a fuse for detonating the charge of an aerial bomb, the timing train of such fuse being positively set in motion by mechanism operated during the flight of the bomb and my improved device is provided with means for absolutely preventing the access of moisture or dirt of any kind to the timing train regardless of the length of time of exposure of such aerial bomb to moisture. In carrying out my invention, I arrange the fuse and the timing train therefor on a chamber in which is arranged the detonating charge for positively exploding the main explosive charge of the aerial bomb and arrange the two elements noted as a unit in substantially the longitudinal axis of the bomb and associate with said timing train a starting device which is operated by the resistance of the air during the dropping of the aerial bomb from any desired height, this starting means being formed integral with a plug or similar device whose function is to prevent entrance of moisture or dirt to the timing train contained within the fuse.

The principal object of my invention, therefore, is an improved detonating fuse for an aerial bomb or the like.

Another object of my invention is an improved starting means for starting the timing train of the fuse.

A further object of my invention is an improved means for preventing access of moisture or dirt to the timing train of the fuse.

A still further object is an improved set-

ting arrangement for determining the time of detonation of the fuse with respect to the time of starting of the timing train.

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

In the accompanying drawings illustrating the preferred embodiment of my invention,

Fig. 1 is a central longitudinal section through my improved detonating fuse and timing train;

Fig. 2 is a plan view;

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

Fig. 4 is a sectional plan view on the line 4—4 of Fig. 1;

Fig. 5 is a sectional plan view on the line 5—5 of Fig. 1;

Fig. 6 is a sectional plan view on the line 6—6 of Fig. 1;

Fig. 7 is a sectional plan view on the line 7—7 of Fig. 1;

Fig. 8 is a sectional plan view on the line 8—8 of Fig. 1;

Fig. 9 is a fragmentary side elevation showing the setting means with the cover plate therefor removed, and

Fig. 10 is a sectional plan view on the line 10—10 of Fig. 1, showing the starting mechanism of the timing train.

Referring to the drawings, 10 designates a body, preferably cylindrical in shape and provided at one end with a threaded hole 11 counterbored at its outer end at 12 and into the threaded portion 11 screws a threaded plug 13 provided with a portion 14 that enters the counterbored portion 12, the outer end of this plug 13 being reduced in diameter at 15 to receive a hub 16, the outer end of the plug 13 being threaded at 17 to receive a clamping nut 18 for the hub 16 and the nut 18 is prevented from rotating by means of a pin 19 locking the threaded portion 17 and nut 18 together. The hub 16 is cup-shaped, the walls thereof extending parallel to, and being of substantially the same diameter as, the body 10. Secured to the hub 16 and arranged diametrically of such hub are fan blades 20, each of the fan blades having formed integral therewith and at one side thereof perforated ears 21 which perforated ears, when the plug 13 is fully screwed into position in the threaded hole 11, are in alinement with perforations 22 in eyelets 23 screwed into the sides of the body 10, as clearly shown in Fig. 1. Passing through the alined perforations are cotter pins 24 and by means of which the hub 16 with its attached fan blades 20 is securely locked in position on the body 10.

The end of the body remote from the threaded hole 11 is reduced in diameter and the portion of this end adjacent the full diameter of the body 10 is threaded at 25 to receive the corresponding threads 26 on the interior of the tubular end of the detonating charge holding chamber 27 in which is located the detonating charge 28, a cover plate 29 closing the front end of said detonating chamber. The tubular end of the detonating chamber 27 is externally threaded at 30 to receive the internally threaded end of an enclosing casing 31, which casing is of substantially the same internal diameter as the external diameter of the detonating chamber 27 and is of a length slightly greater than the length of such detonating chamber 27. The exterior of the enclosing casing 31 adjacent the full diameter of the body 10 is threaded at 32 to enable the entire mechanism to be screwed into position on an aerial bomb.

The lower end of the body 10, as viewed in Fig. 1, is counterbored at 33 to receive the timing train for the fuse, such timing train consisting essentially of a top plate 34, a middle plate 35, and a lower plate 36 spaced apart from each other in the usual manner. The top plate 34 is recessed on its top surface to receive the mainspring 37, this recess being closed by cover plate 38 attached to the top plate by screws 39, the inner end of the mainspring 37 being attached to a hollow hub 40 which finds a bearing, top and bottom, in the cover plate 38 and top plate 34 respectively. Rotatable with the hub 40, but slidable longitudinally with respect thereto, is a shaft 41, the upper end of which is non-circular in shape, as indicated by the numeral 42 for a purpose to be hereinafter described. The lower end of the shaft 41, as viewed in Fig. 1, extends downwardly through the middle plate 35 and is normally in engagement with the upper end of a cup-shaped member 43 that is slidably mounted on a second cup-shaped member 44, and in the lower plate 36, the lower end of this cup-shaped member being threaded into a central hub 45 on a cylindrical disc or plate 46. Secured to the lower end of the hollow hub 40 adjacent the middle plate 35 is a main wheel 47. This main wheel 47 communicates through appropriate gearing with a center wheel 48 attached to a shaft 49 rotatably mounted in bearings in the middle plate and lower plate 35 and 36 respectively. Secured to the shaft 49 between the middle and lower plates 35 and 36 respectively is a third wheel 50 which meshes with the fourth wheel 51 secured to a shaft 52 rotatably mounted in suitable bearings in the middle and lower plates 35 and 36 respectively. This fourth wheel 51 through appropriate gearing, shown in Fig. 6, is connected with the escape pinion 53 secured to the shaft 54 rotatably mounted in bearings in the middle and lower plates 35 and 36 respectively, and this shaft 54 extends downwardly through the lower plate 36 and fits a lower bearing in the pallet bridge 55 secured to the under side of the lower plate 36 by screws 56.

Secured to the shaft 54 between the pallet bridge 55 and the lower face of the lower plate 36 is the escapement wheel 57 and the rotative movement of this escapement wheel 57 is controlled by the escapement 58 that is, in turn, controlled by the balance wheel 59 attached to a shaft 60 rotatably mounted in the lower plate 36 and in the balance bridge 61, the movement of the balance wheel 59 being, in turn, controlled by the usual hair spring 62.

Located between the upper end of the cup-shaped member 44 and the under face of the upper end of the cup-shaped member 43 is the compression spring 63 which tends to force such cup-shaped members apart, or the cup-shaped member 44 being immovable, the spring 63 tends to force the cup-shaped member 43 upwardly with respect to the member 44 as viewed in Fig. 1, and thereby tends to move the shaft 41 longitudinally of the hollow hub 40. Slidably mounted in the interior of the cup-shaped member 44 is a firing pin 65 and between the upper end of the firing pin and the lower face of the upper end of the cup-shaped member 44 is a compression spring 66 which tends to force the firing pin 65 downwardly, as viewed in Fig. 1, out of the cup-shaped member 44. The cup-shaped member 44 is provided with diametrically arranged passages on either side of its axis of suitable diameter to hold the balls 67 and it will be noted that the firing pin 65 intermediate its ends is provided with a V-shaped circular groove 68 in which the balls 67 fit and also it will be noted that the cup-shaped member 43 is of sufficient length, when the compression spring 63 is compressed, for the lower open end of such cup-shaped member 43 to practically cover the diametrically arranged holes in the cup-shaped member 44 and thus the cup-shaped member 43 acts to retain the balls 67 in the position shown and such balls 67, fitting under these conditions in the V-shaped groove 68 retain the firing pin 65 in its uppermost position, as viewed in Fig. 1, with the compression spring 66 under compression. The firing pin 65 is adapted to engage with a primer 50 located in a recess in a safety device 69 that is rotatably mounted on a shaft 70 secured with one end in the plate 46 and with the other end in a plate 71 spaced apart from such plate 46 and within the tubular end of the detonating chamber 27. The safety device 69 is provided with a catch 72 for a purpose to be hereinafter described.

The body 10 above the recess or counterbored portion 33 is counterbored to receive a worm wheel 73, such worm wheel being retained in rotated position within said recess by means of a ring 74 secured to the body 10 by screws 75. The under face of the worm wheel 73 is provided with a non-circular recess 76 in which may fit the non-circular projection 42 on the upper end of the slidable shaft 41 so that, when the non-circular projection 42 comes into registry with the non-circular recess 76, the spring 63 will be allowed to expand, forcing the shaft 41 longitudinally in the hollow hub 40, this movement also forcing the cup-shaped member 43 upward a sufficient distance to expose the transverse hole through the cup-shaped member 44, whereupon the compression spring 66 will expand, forcing the firing pin 65 downward and forcing the balls 67 out of the transverse hole. The worm wheel 73 is engaged and driven by a worm 77 rotatably mounted in a transverse hole in the body 10, the side of the body being recessed at 78 and the outer end of the shaft 77 extends into said recess. On the shaft 77 are two gears 79 and 80 respectively, the gear 79 being loose on the shaft while the gear 80 is fastened thereto. The outer face of the gear 79 is provided with graduations and secured to the outer end of the shaft is an indicating hand 81 adapted to cooperate with such graduations. The number of teeth on the shafts 79 and 80 differ by one tooth, and I preferably make the number of teeth on the shaft 79 thirty seven and the number of teeth on the shaft 80 thirty six. Rotatably mounted in the body 10 parallel to the shaft 77 and within the recess 78 is a shaft 82 and secured to this shaft is a pinion 83 which meshes with both of the gears 79 and 80, the outer end of the shaft 82 being made non-circular to receive a winding or setting key. The outer end of the recess 78 is threaded to receive a cover plate 84 which protects the gearing 83, 79, and 80 and prevents the entrance of moisture or dirt to such gearing, it being understood, of course, that the cover plate 84 is entirely within the surface of the body member 10. By rotating the pinion 83, a sufficient number of times to rotate the gear 80 through one complete revolution, the gear 79 will be rotated through a distance less than one complete revolution, such distance being equal to one graduation thereon, said graduation being brought into registry with the indicating hand 81 and also simultaneously the non-circular recess 76 in the under surface of the worm wheel 73 will be rotated relatively to the non-circular projection 42 on the upper end of the shaft 41.

Secured to the lower end of the hollow hub 40 adjacent the main wheel 47 is a radially extending arm which is normally engaged by one arm of a bell crank lever 85 pivotally mounted on a shaft 86 in the top plate 34 and secured to the other arm of such bell crank lever and surrounding the shaft 86 is a spring 87 which tends to rotate the bell crank lever 85 in the direction of the arrow shown in Fig. 9. The body 10, top, middle, and lower plates, and the disc 46 are drilled to provide a longitudinal circular hole 88 that lies parallel to the axis of the body 10 and the outer or upper end of this hole is bevelled, as indicated at 89, this hole being adapted to have

slidably mounted therein a plunger 90, the upper end 91 of which is tapered to correspond with the taper 89 and the extreme upper end is enlarged at 92, the under surface of this enlargement 92 being engaged normally by the member 14 at the bottom of said screw plug, and passing into the body 10 is a headless screw 94, the inner end of which lies adjacent the reduced portion 93, this construction preventing the removal of the plunger 90, but allowing a limited longitudinal movement thereof. The lower portion of the plunger 90 is cut away to form a shoulder 95 that lies adjacent one arm of the bell crank lever 85 and normally has said bell crank lever in the position shown in Fig. 10. With the parts of the device in the position shown in Figs. 1 and 10, it will be obvious that, one arm of the bell crank lever engaging with the radially extending arm 84 and such arm 84 being attached to the hub 40 of the driving spring 37, the timing mechanism will be prevented from operating, but if there is a vertical longitudinal movement of the plunger 90 in the hole 88 sufficient for the shoulder 95 to move out of engagement with the other arm of the bell crank lever 85, the spring 87 will rotate the bell crank lever 85 about its pivot in the direction of the arrow shown, releasing the arm 84 and allowing the timing mechanism to start in operation. The spring 87, once having rotated the bell crank lever 85 in the direction of the arrow shown, will retain it in such rotated position so that it is possible for the plunger 90 to be given a vertical lowering movement back into the position shown in Fig. 1 without affecting the operation of the timing train.

The operation of my improved device is as follows, it being assumed that the body 10 with all attached parts, as above described, is secured to the head of an aerial bomb and that the bomb is to be dropped preferably from an airplane or the like into a designated place or spot, the object being to plant the bomb and have the charge therein detonated a predetermined length of time after such planting, the elapsed time between the planting of the bomb and the detonating of the charge being variable within extremely wide limits from fifteen minutes to two, three, or even more days. Before attaching the mechanism to the aerial bomb, the main spring 37 of the timing train is first wound in the usual manner and then inserted in the body 10, the plunger 90 being placed in the hole 89 until the shoulder 95 engages with the arm 85 which thus effectually prevents premature starting of the timing train. In this position, the non-circular projection 42 on the end of the slidable shaft 41 is so located with respect to the non-circular recess 76 on the under face of the worm wheel 73 that, if the timing train were allowed to rotate, a period of fifteen minutes ordinarily would elapse before such non-circular projection 42 came into alinement with the noncircular recess 76. This normal setting is for the purpose of safety and after the body 10 with attached parts is placed in position on the aerial bomb and before the said bomb is to be dropped from any desired height, the cover plate 84 is removed and by means of the pinion 83 the gears 79 and 80, and therefore the worm 77, are rotated until the indicating hand 81 on the end of the worm 77 is brought into the desired position relative to the proper graduation on the face of the gear 79, this action also rotating the worm 73 so as to vary the relative position of the recess 76 with respect to the projection 42. After the proper setting of the device, the cover plate 84 is restored to its original position and just prior to the time the aerial bomb is to be dropped, the cotter pins 24 are removed to allow free rotation of the hub 16 and attached blades 20. When at the desired height and in the vertical position over the desired place, the aerial bomb with attached mechanism is dropped. The resistance of the air during the dropping of the bomb rotates the blades 20, and therefore the hub 16, causing the plug 13 to unscrew from the end of the body 10 and the member 14 on such screw plug, engaging with the enlargement 92 on the end of the plunger 90, moves such plunger outward longitudinally of the body 10 a sufficient distance to free the shoulder 95 from the arm of the bell crank lever 85 which is rotated in the direction of the arrow shown in Fig. 10 by means of the spring 87. This allows the timing train to start operating and causing a movement of the slidable shaft 41 with respect to the recess 76 in the under face of the worm wheel 73. When the plug 13 is completely unscrewed from the end of the body 10, the hub 16 and all attached members flies off in any direction and no further direction need be given same. The outer movement of the plunger 90 is limited by means of the headless screw 94 and the reduced portion or groove 95 in the plunger 90. When the plunger 90 has reached its outer limit of movement, the lower end thereof is moved out of the path of movement of the catch 72, on the safety device 69, which is thereupon rotated to bring the primer 50, carried thereon, into alignment with the end of the firing pin 65.

When the aerial bomb with attached fuse strikes the desired spot, the plunger 90 is forced into the passage 89 and the taper end 91 insures a tight joint between such plunger and body and prevents absolutely the entrance of moisture or dirt of any description along the hole 89 and thereby preventing derangement of the timing train mechanism. Entrance of moisture or dirt is also prevented by means of the plate 84. When the

timing train has rotated the non-circular shaft 41 into alinement with the noncircular recess 76 on the under face of the worm wheel 73, the compression spring 63 forces the slidable shaft 41 upward until the upper end of the projection 42 engages with the bottom of the recess 76, the spring 63 also moving the cup-shaped member 43 upward to expose the diametrically arranged holes in the cup-shaped member 44 and allowing the escape of the balls 67 from the V-shaped groove 68 in the firing pin 65 whereupon the compression spring 66 forces the firing pin 65 against the primer 50, detonating the charge in the aerial bomb.

My improved setting device, while adapted and originally designed for use in connection with the aerial bomb fuse herein described and claimed, is also adapted for use in other types of fuses and I do not, therefore, limit myself to the particular use herein shown and described.

While I have necessarily shown and described the preferred embodiment of my invention somewhat in detail, it is to be understood that I may vary the size, shape, and arrangement of parts within wide limits without departing from the spirit of the invention.

Having thus described my invention, what I claim as new is:

1. In a fuse, the combination of a firing pin, a timing train controlling the operation thereof, a starting mechanism associated with the timing train, and means movable longitudinally of the fuse and operable automatically and only during the flight of the fuse for controlling the starting of the timing train.

2. In a fuse, the combination of a body, a timing train located therein, starting mechanism for the timing train, and means associated with the timing train and operable automatically and only during the flight of the fuse for controlling the starting of the timing train and means for locking said last named means normally in inoperative position.

3. In a fuse, the combination of a body, a firing pin, a timing train for controlling the operation of the firing pin and located within said body, a plunger for controlling the starting of the timing train extending to the exterior of the body, and means operable only during the flight of the fuse for moving said plunger longitudinally of the body for controlling the starting of the timing train.

4. In a fuse, the combination of a body provided with a chamber, a timing train located within said chamber, and means extending through said body and into said chamber for starting the timing train in operation and for preventing access of moisture or dirt to the timing train and means rotatably mounted on the exterior of the fuse and operable only during the flight of the fuse for controlling the timing train starting means.

5. In a fuse, the combination of a cup-shaped member provided with diametrically arranged perforations, a firing pin slidably mounted within said cup-shaped member, a firing spring acting to force the firing pin outward with respect to said cup-shaped member, a cup-shaped member enclosing said first named cup-shaped member and of sufficient length to cover said alined perforations, a groove in said firing pin, balls in said diametrically arranged perforations fitting into said groove and prevented from moving outward thereof by said second cup-shaped member, a compression spring located between the upper end of the first cup-shaped member and the under face of the second cup-shaped member, a slidable shaft engaging the top of the first cup-shaped member, a non-circular projection formed on the upper end of the slidable shaft, a rotatably mounted member provided with a non-circular recess associated with the non-circular projection, means for varying the relative position of said recess and non-circular projection, means for rotating the slidable shaft to bring the non-circular projection thereof into alinement with the non-circular recess whereby the compression spring forces the projection into the recess and moves the end of said second cup-shaped member from the diametrically arranged holes to permit escape of the balls from the groove in the firing pin and allows the firing spring to actuate the firing pin.

In testimony whereof, I have signed my name to this specification.

FREDERICK W. BOLD.