Oct. 7, 1930. F. W. BOLD 1,777,547

MECHANICAL TIME FUSE

Filed Sept. 7, 1926 2 Sheets-Sheet 1

Fig. 5.

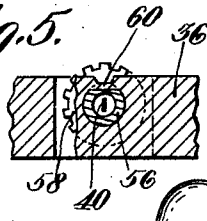


Fig. 9.

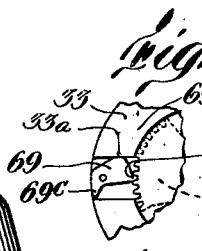


Fig. 2.

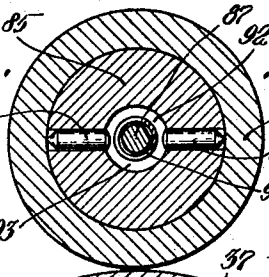


Fig. 4.

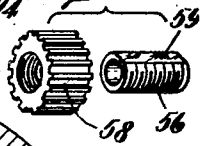


Fig. 1.

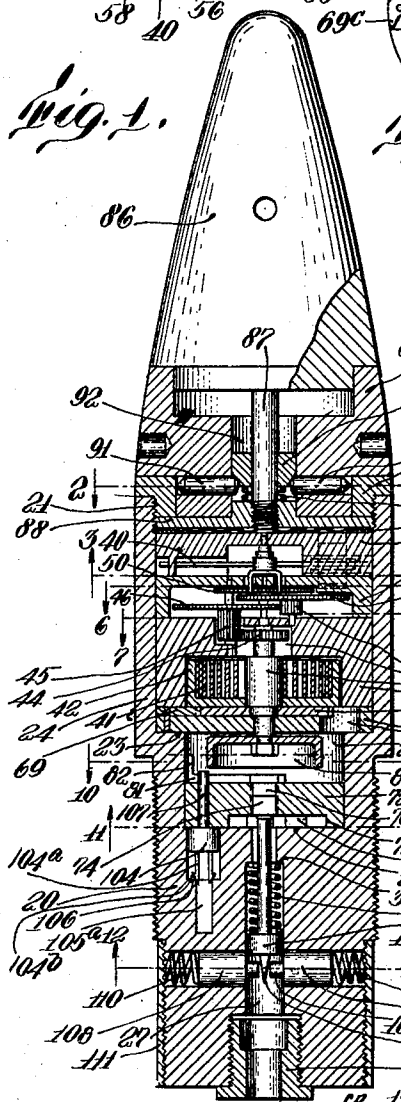


Fig. 3.

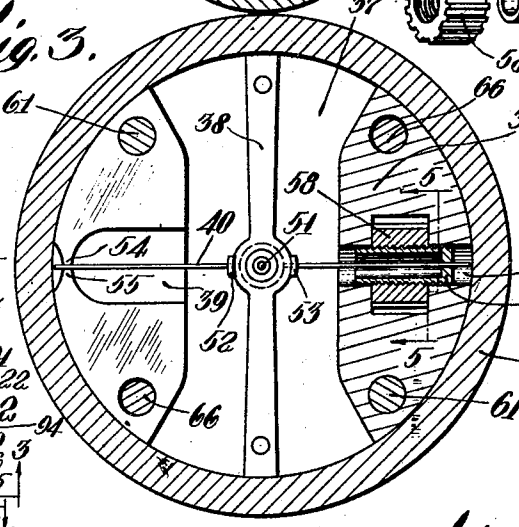


Fig. 6.

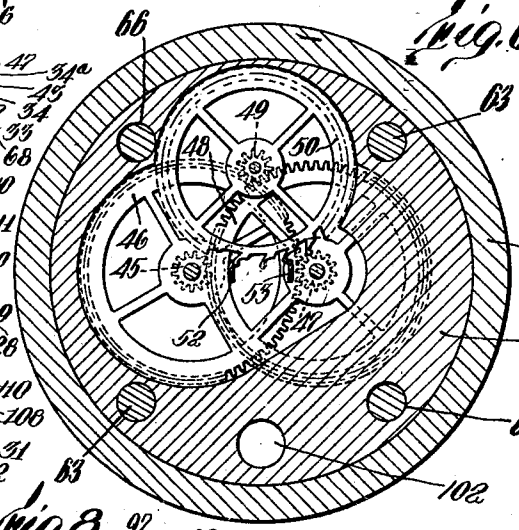


Fig. 7.

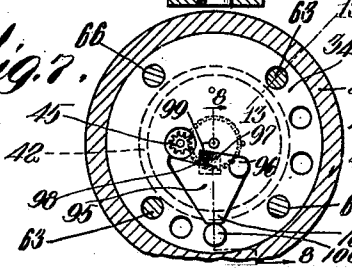
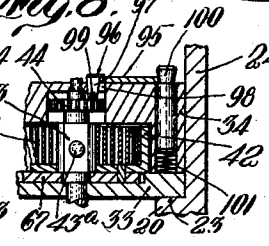


Fig. 8.



Inventor:
F. W. Bold
by Wright, Brown, Quinby & May
Attys.

Oct. 7, 1930. F. W. BOLD 1,777,547

MECHANICAL TIME FUSE

Filed Sept. 7, 1926 2 Sheets-Sheet 2

Fig. 10.

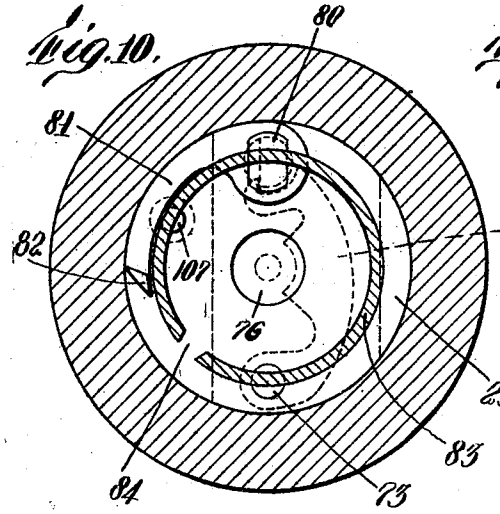


Fig. 11.

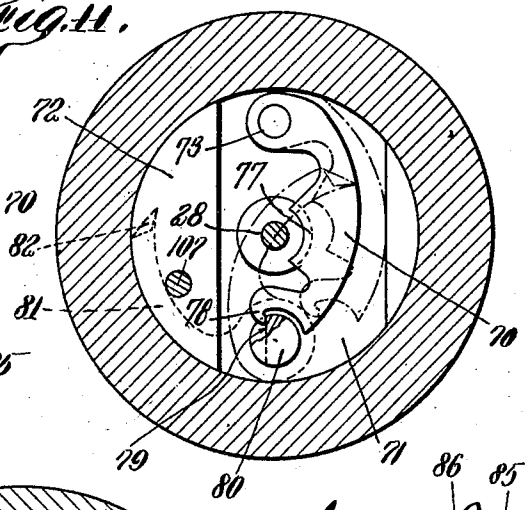


Fig. 20.

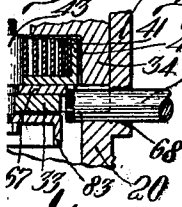


Fig. 12.

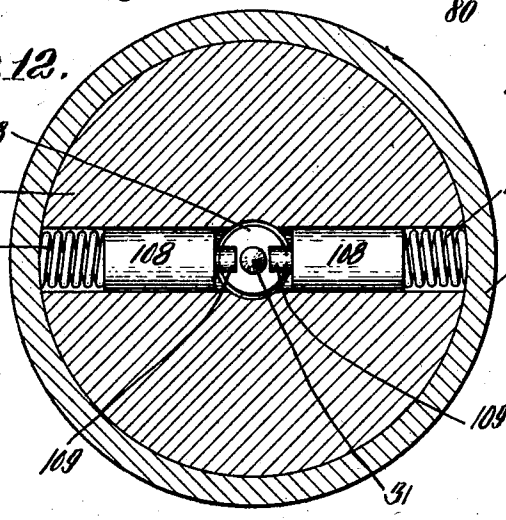


Fig. 13.

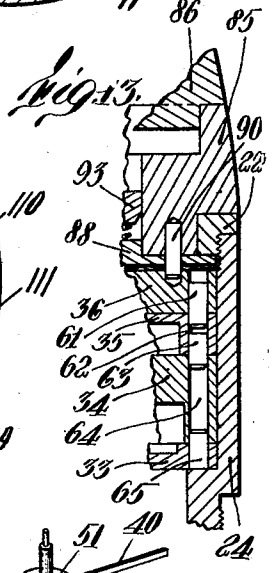


Fig. 14.

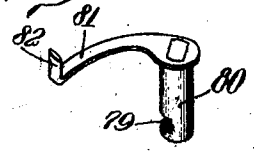
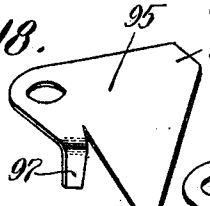


Fig. 18.



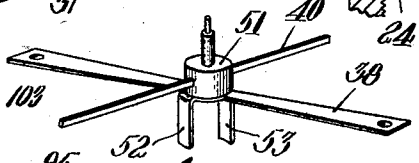


Fig. 15.

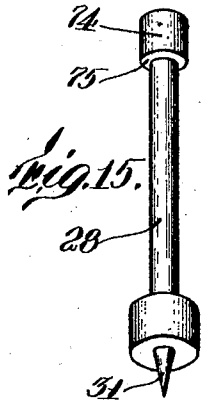


Fig. 16.

Fig. 17.

Fig. 18a.

Fig. 19.

Inventor:
F. W. Bold
by Wright, Brown, Quinby & Huxley
Attys.

Patented Oct. 7, 1930 1,777,547

UNITED STATES PATENT OFFICE

FREDERICK W. BOLD, OF CHELSEA, MASSACHUSETTS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO CHELSEA CLOCK COMPANY, OF CHELSEA, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS

MECHANICAL TIME FUSE

Application filed September 7, 1926. Serial No. 133,794.

This invention relates to time fuses of the mechanical type adapted for use in connection with artillery projectiles, and for analogous purposes. One of the objects of the invention is to produce an especially compact, and at the same time reliable and accurate, mechanism for this purpose, and one which can be made of such small diameter as to be usable with artillery projectiles of the smaller calibers. Another object is to locate the firing pin in the axial center of the fuse and projectile, and to make the structural frame parts of the mechanism of exceptional rigidity and solidity, thereby contributing to the object previously mentioned, namely, that of securing accuracy and reliability in operation under the severest conditions of service. Still further objects are concerned with novel means for regulating the escape mechanism, or time controlling element of the fuse mechanism, for locking the adjustable setting cap or head to the body structure of the fuse, for normally locking the time movement and releasing it at the instant of firing, for controlling the firing pin, and for safeguarding the firing pin against prematurely moving to detonate the primer of the fuse.

The invention consists in the means for accomplishing the foregoing and other objects, hereinafter set forth in this specification, and in the equivalents of such means, within the scope of the appended claims.

In the drawings illustrating the following specification,—

Fig. 1 is a longitudinal central section (as to all except the forward extremity) of a mechanical time fuse embodying this invention;

Figs. 2 and 3 are cross sections of the fuse taken on the lines 2—2 and 3—3, respectively, of Fig. 1, and looking in the directions of the arrows respectively applied to said lines;

Fig. 4 is a perspective detail view of the regulator for governing the rate of movement of the escape mechanism;

Fig. 5 is a cross section taken on line 5—5 of Fig. 3 illustrating such regulator;

Figs. 6 and 7 are cross sections taken on the lines 6—6 and 7—7, respectively, of Fig. 1;

Fig. 8 is a fragmentary sectional view taken on line 8—8 of Fig. 7;

Fig. 9 is a fragmentary plan view of one of the frame plates of the time mechanism, with the click or pawl for holding the main spring in wound up condition;

Figs. 10, 11 and 12 are cross sections taken on lines 10—10, 11—11 and 12—12, respectively, of Fig. 1, looking in the directions of the arrows applied to such lines;

Fig. 13 is a fragmentary longitudinal sectional view taken on a radial plane indicated by the line 13—13 of Fig. 7;

Fig. 14 is a perspective view of the controller arm of the release mechanism;

Fig. 15 is a perspective view of the firing pin;

Fig. 16 is a perspective view of the firing pin locking and releasing lever;

Fig. 17 is an elevation showing the coaction of the firing pin and its locking and releasing lever;

Fig. 18 is a perspective view of the automatically releasable lock for the time mechanism;

Fig. 18[a] is a fragmentary similar view of a modified lock for the same purpose.

Fig. 19 is a perspective view of the balance and hair spring mechanism by which the running rate of the time mechanism is controlled.

Fig. 20 is a fragmentary longitudinal section of the fuse showing provisions for winding up the mainspring of the time mechanism by insertion of a winding key through the side of the base.

Like reference characters designate the same parts wherever they occur in all the figures.

The fuse base 20 is internally recessed to form chambers and passages, preferably substantially as shown in Fig. 1. It is externally threaded at or adjacent to one end, which I may call the bottom end or portion, for mounting in the artillery projectile, and its opposite or head end is open and internally threaded at 21 to receive a retaining ring 22, which holds the interior parts removably in

place. There is an internal shoulder at 23 between which and the retaining ring is confined the time mechanism or movement. That part 24 of the base between the shoulder 23 and the open end may be designated for the purposes of this description as the casing, and the space within such casing may be designated as the main or outer chamber. Below the shoulder 23 is an inner or lower chamber 25 having a bottom 26, from which a passage 27 extends through the lower part of the base to its end. In this passage is fitted movably the firing pin or hammer 28, having a shoulder to receive the impelling pressure of the firing pin spring 29 which surrounds the pin and reacts against the abutment 30 in the base; and on the extremity of the firing pin is a point 31 to detonate the primer. The lower end of the passage 27 is enlarged and internally threaded to receive the primer 32, which holds a cap of fulminating powder and has a passage leading to the bursting charge of the projectile to which the fuse is applied, as usual in this art.

It will be noted that the firing pin is located in the axial center of the fuse. This is a valuable feature, for reasons which will appear later, and its attainment, in connection with other improvements, is one of the objects of the present invention.

Time mechanism or movement.—The moving parts of this mechanism are made light in weight and are located close to the axis of the fuse to minimize the disturbing effects of centrifugal force, but are strong and rugged; while the structural or framing parts which support the movable members are solid and rigid in construction and arrangement. The structural or frame members preferably consist of four parts, formed as shown and herein described, namely, a bottom plate 33 which rests on the shoulder 23 and is recessed in its upper side to receive the mainspring-winding wheel and holding click or pawl therefor, a main plate 34 which is deeply recessed in its under side to contain the mainspring barrel and main wheel, an intermediate plate 35 which is recessed on the under side to accommodate the wheels of the time train, and a top plate 36 recessed on its under side to accommodate the balance and hair spring and the regulator. These plates rest upon one another at their rims, and all except the top plate 36 have substantially complete circumferential engagement with the plate beneath, and with the fuse base, respectively. Moreover, even the top plate is supported over a large proportion of its area, those parts of its area which do not rest directly on the plate 35 beneath being the transverse space 37 which contains the balance 38 and a recess 39 opening from the space 37 to permit flexing of the hair spring 40. Each plate has a top wall or web which is substantially continuous, and sufficiently rigid to prevent its deflection by inertia or setback under even the heaviest possible firing charge. All these plates are of proper external form and dimensions to fit within the fuse casing.

The moving parts of the time movement comprise a spring driven gear train and a spring-controlled oscillative bar-like balance. The main or driving spring 41 is confined in a mainspring barrel 42 which fits freely within the central recess or chamber of the main plate 34 and is rotatable about a main shaft or arbor 43 in the axis of the fuse body, having pivot bearings in this plate and in the end plate 33. The ends of the mainspring are connected to the arbor 43 and barrel 42 by suitable hooks on the arbor and barrel, respectively. The arbor 43 carries a main wheel 44 which meshes with a pinion 45 connected to the first wheel 46 of the movement. An extension chamber 34ª of reduced diameter rises in the main plate from the chamber which contains the spring barrel, to receive the main wheel 44, and is covered by an integral web of the plate which provides the upper bearing for the main arbor. A small recess is formed in the upper side of the plate 34 to receive the pinion 45 and opens into the extension chamber, whereby this pinion is enabled to mesh with the main wheel 44. An integral web left between the spring barrel chamber and the last named recess provides the lower bearings for the first wheel staff. The first wheel 46 drives a pinion 47 mounted on the same staff with the second wheel 48, and the latter wheel drives a pinion 49 mounted on the staff of the third or escape wheel 50. The staffs of these three wheels and their pinions have lower pivot bearings in the plates 34 and 35. The bearings of the first and second wheels are on opposite sides of the fuse axis, and those of the escape wheel are on a third side. Thus the gear train virtually surrounds this axis and is located wholly within a circle of minimum diameter centered in the axis of the fuse.

The balance 38 is a bar mounted on a staff 51 which has pivot bearings in the plates 35 and 36 and in the axis of the fuse. Arms 52 and 53 are connected with the balance and extend downward through openings in the top of the plate 35. They form an escape pallet cooperating with the escape wheel and are suitably spaced and located, on opposite sides of the staff 51, to be oscillated by the teeth of the escape wheel and govern the rate of rotation of this wheel. Preferably the balance and pallet arms are made in one piece; blanked out from a piece of sheet steel, or other suitable material, and the arms bent down from the plane of the blank.

The hair spring 40 is a substantially straight spring secured in the staff 51 and held at one end in a narrow slot between

shoulders 54, 55, at the end of the recess 39. Its opposite end is held by a regulator which consists of an externally threaded tube or thimble 56 and a nut 58 surrounding said thimble and meshing with its threads. The thimble is mounted in a substantially radial passage 57 in the top plate 36, opening into the space 37, and the nut is fitted to rotate in a chamber which intersects the passage 57 and opens through the upper face of the plate; whereby the nut is accessible for adjustment after the movement has been assembled. The outer end of the tube or thimble 56 is closed by an end wall, in which is a slot of suitable dimensions to receive and confine the adjacent end of the hair spring. Rotation of the nut 58 moves the thimble inward or outward with respect to the balance pivot and, by shifting the point at which it confines the hair spring, alters the effective length of the latter and so regulates the running speed of the movement.

This regulator is an important feature of the invention and has the following useful characteristics. Its parts are small in dimensions. The thimble 56 may be made of wire threaded externally and flattened at one side, as shown at 59 in Fig. 4. It is bored internally through part of its length to form the end wall above mentioned and provide an open inner space sufficiently large to permit flexing of the hair spring and limit the confinement thereof to its engagement with such end wall. Such thimbles may be made by automatic machine tools in large quantities at small expense. The slot in the end wall which receives the hair spring may be made by punching or by a transverse saw cut. The flat side 59 is provided in order to prevent rotation of the thimble when the nut is turned; and the key member which cooperates with the flat side to that end is conveniently and economically made in the following manner. The passage 57 in the top plate which receives the regulator is drilled through from the periphery of the plate in a location near to one surface thereof, preferably the surface which comes next to the plate 35. A thin wall is thus left between such surface of the plate and the passage, and this thin wall is offset by a suitable tool, as indicated at 60 in Fig. 5. In practice, this offsetting is preferably done while a mandrel or core of the same form and dimensions as the thimble is held in the passage, whereby the offsetting of the plate is limited to that amount which will fit and cooperate perfectly with the thimble. The regulating nut 58 may be made of a piece cut from a bar or tube and internally threaded; which may be done by automatic machine tools. Its outer surface is longitudinally ribbed to give a purchase for rotating it.

When the movement is assembled, all the frame plates are keyed together by pins or dowels set into one plate of each pair and entering alined holes in the adjacent plate. Thus, the top plate 36 carries pins 61 which enter holes 62 in the plate 35; and pins 63 are fixed in the holes 62 and enter holes 64 in the plate 34. The latter holes are entered from the opposite end by pins 65 set into the plate 33. In addition, long screws 66 are passed through alined openings in all of the plates and are screwed into the bottom plate, while their heads occupy countersunk recesses in the upper side of the top plate. These pins and screws anchor the plates together in structural unity.

On the head of the mainspring barrel is secured a winding wheel 67 which enters a chamber or recess in the top side of the bottom plate 33. The winding wheel has peripheral teeth adapted to be engaged for winding the spring by a winding pinion inserted through a hole 68 in the bottom plate before the movement is placed in the base. The wound up condition of the spring is maintained by a click or pawl 69 pivoted to the bottom plate in an extension of the recess therein. The click has a tooth 69^a to enter between the teeth of the winding wheel, and a shoulder 69^b arranged to bear on an abutment 33^a of the plate to prevent the spring from unwinding. It has also a finger 69^c which swings outside of the circumference of the plate when displaced by the rotation of the wheel in winding up, and is prevented from so moving by the surrounding fuse casing when the movement is placed therein. Thus the mainspring is positively locked.

Winding of the mainspring after placement of the time movement in the base is made possible by a slight modification of this fuse, however, and suitable provisions for so winding it are illustrated in Fig. 20. A hole 68^a in the side of the base is adapted to receive, and preferably provide a bearing for, a winding key 68^b having teeth on its end capable of meshing with the teeth of the winding wheel 67 in the manner of a crown gear and pinion couple, and the hole is located at a suitable position to permit such engagement. A notch is formed in the edge part of the bottom plate 33 to permit insertion of the key into engagement with the winding wheel, and may be registered with the hole 68^a by correct placement of the movement on insertion, or by turning the movement afterwards by the setting means, later described. The click 69 is, in this case, made resiliently yielding to permit travel of the teeth of the wheel past its tooth 69^a, and to prevent unwinding of the spring, either by making the finger 69^c springy, or by omitting the finger and applying a pawl spring of ordinary character. After winding, and withdrawal of the key, the hole 68^a is closed by a screw or other plug, the inner end of which terminates clear of the movement frame, so that it will not interfere

with the subsequent setting of the movement.

Firing-pin lock.—The firing pin is held in its retracted or armed position, shown in Fig. 1, by a locking and releasing arm or lever 70, which, for the purposes of this description, I will call the release lever. Said release lever is contained in a recess 71 in the under side of a plate 72 which is contained in the chamber 25 and rests on the bottom 26 thereof, and has a pivot stud 73 about which the release lever is adapted to turn. The latter also rests on the surface 26 and extends across the chamber 25 beside the upper end of the passage 27 which contains the firing pin. Said pin has on its upper end a head 74 formed at its under side with a beveled shoulder 75, which head, when the pin is in its armed position, enters a central opening 76 in the plate 72. The release lever has on its central part a protuberance 77 adapted to extend partly across the entrance to passage 27, as indicated in Figs. 10 and 11, underlying and supporting the head 74 of the firing pin, and the surface of this protuberance which thus engages the firing pin is beveled, or preferably so, whereby the pressure exerted by the firing pin tends to crowd the release lever out of the way of the head. On the free end of the release lever is a hook 78, or equivalent abutment, adapted to engage an abutment shoulder or arm 79, preferably formed by cutting away one side of a pin 80 which passes through the plate 72 and has a rotative bearing therein. The point at which the hook 78 engages the shoulder 79 is eccentric to the axis of the pin 80, and the line of force application by the hook is at one side of such axis, whereby the pressure exerted thereon by the release lever tends to rotate the stud. In effect, this part of the stud constitutes a short lever arm on which the release lever presses.

The stud 80 carries fixed upon its upper end, and resting on the upper surface of the plate 72, an arm or lever 81 which I may call, for the purposes of this description, a control arm. It is provided with an upstanding finger 82. The finger 82 normally resides in the annular space between the wall of chamber 25 and the circumference of a control or timing disk 83 which has a gateway 84 at one point adapted to admit the finger 82. This control or timing disk is secured to the end of the mainspring arbor 43, protruding below the bottom movement frame plate 33, and is rotatable with the arbor in the upper part of chamber 25. In the present instance, it is made as a shallow drum having a cylindrical flange in which the gateway 84 is cut, but it may be otherwise constructed, provided it has a circumference adapted to restrain movement of the control arm and a slot, or equivalent opening, adapted to permit movement of the control arm when the control disk is in a certain position.

The spring-pressed firing pin, acting on the beveled part 77 of the release lever, tends to move the latter outwardly and exerts force through the hook 79 on stud 80, tending to move the control arm and its finger inwardly toward the center of chamber 25. After the projectile carrying the fuse has been fired from a gun, and so set in rotation, the pressure thus applied is greatly increased by centrifugal force acting on the release lever and tending to swing the same from the full line position shown in Fig. 11 to the adjacent position thereof shown by broken lines. The force thus applied through the stud 80 to the control arm 81 is greater than the centrifugal force acting in the opposite direction on the control arm, whereby the resultant of the forces then acting on the control arm causes the finger 82 of the latter to bear on the outside of the control disk and to enter the gateway therein when such gateway arrives beside the finger in the course of rotation of the disk. I have insured that the resultant force will be as above stated, by making the release lever 70 relatively heavy and massive and the control arm relatively light and small in mass.

It is possible also to insure the same effect in other ways, all of which are within my contemplation; as by providing the control arm 81 with a second and counter balancing arm at the opposite side of a line radial to the fuse and passing through its pivot, or by applying an additional spring to the lever 70 so as to exert force tending to throw it outward, or by applying a spring to the control arm 81 or its pivot 80, tending to move the control arm inward; all as well known to those skilled in this art. The release lever and control arm, with their interengaging abutments, form the hammer lock mechanism of the fuse, controlled by the time mechanism.

While the beveled construction of that part of the release lever on which the firing pin bears is of advantage, because it not only relieves the release lever of any frictional resistance to its outward movement, due to the pressure exerted by the firing pin, but also applies this pressure usefully to displace the release lever, (wherefore I claim it as a valuable feature of the invention), yet I may, without departure from the general principles of the invention and within the scope of the protection which I claim, dispense with this feature and rely on centrifugal force or other means alone to displace the control lever in the manner indicated.

Setting means for the timing mechanism—In order to regulate the length of time which will elapse after the timing mechanism has started to run before the gateway 84 will be brought into position to admit the control

lever finger 82, I provide a setting cap or head on the fuse for rotating the entire time mechanism and therewith the timing disk 83. The setting head is constructed preferably of a ring 85 which rests on the retaining ring 22 previously mentioned, and has a central boss projecting into the interior of the retaining ring, and an outer head or terminal 86 which fits on the outer end of the ring 85 and carries a stem 87 projecting through such ring. The inner end of the stem 87 is threaded and is detachably screwed into a locking plate or disk 88 which underlies the central boss on ring 85 and the circumference of which extends outward under the retaining ring 22. The disk or plate 88 may be drawn up by the screw stem 87 far enough to take up looseness between the setting head and the retaining ring. A space is left between the head locking plate and the top frame plate of the time mechanism, in which is placed a spring washer 89 for the double purpose of holding this mechanism yieldingly but firmly against the bottom of its chamber in the fuse body, and of creating a limited friction between the locking plate and the retaining ring. The friction effect so caused permits the setting head to be easily turned and insures that it will not turn so freely as to be liable to accidental displacement after having been set. There are fixed in the boss of the ring 85 two (more or less) dowel pins 90 which pass through holes in the plate 88 and enter sockets in the movement frame plate 36, for transmitting rotational movement from the setting head to the timing mechanism and timing disk 83.

Setting lock.—The setting of the time mechanism last described is effected before the projectile equipped with the fuse has been loaded in the gun. Derangement of the setting by forces acting upon and after firing of the gun is prevented by a lock, of which the embodiment shown here consists of two sharp pointed pins 91 located in radial passages in the boss of the ring 85 with their outer pointed ends next to the inner surface of the retaining ring 22, and their inner beveled ends protruding into the central passageway 92 in the ring 85. This passageway is substantially larger than the stem 87 and contains a wedge block or displacer 93 which surrounds the stem 87 and is adapted to slide endwise in the passage. The part of the wedge block contiguous to the locking pins 91 is beveled so that, under its inertia setback, when the gun is fired, it will wedge and crowd the pins outward, causing their sharp pointed outer ends to indent the retaining ring 22 which, as before stated, is tightly screwed into the base or body part of the fuse, and effectually preventing any rotary movement of the setting cap or time mechanism relatively to the fuse body. A spring 94 normally relieves the locking pins of the weight of the displacer 93, leaving the latter free of the retaining ring when the fuse is set. A single pin arranged and operated as is the pin 91 may be used, or there may be more than two. The duplicate arrangement allows the pins to balance each other; and when more than two are used, they are distributed about the fuse axis for balance.

Lock for the timing mechanism.—The time movement is locked and prevented from running prior to discharge of the projectile from the gun. The means for that purpose is shown in Figs. 7, 8 and 18. A plate 95 is pivoted by a pivot pin 96 to the upper side of the movement frame plate 34 so that it may swing in a plane perpendicular to the axis of the fuse, and is provided with a bent down lug 97 which passes through an opening 98 in the plate 34 into the path of a pin 99 which rises from the main wheel 44. This lug is inclined to the path in which the pin 99 travels in such manner, as shown in Fig. 7, that the pin tends to push it out of the way, and is able to do so and pass by it when the lug is not prevented from being so displaced. Broadly, the lug is a displaceable detent or obstruction for a moving part of the time mechanism, various equivalents for which may be made within the scope of my invention. Normally, it is obstructed and locked in the path of the projection 99 by a locking or stop pin 100, which occupies a hole in the plate 34 and is supported by a spring 101 in said hole resting on the plate 33, and protrudes into an alined hole 102 in the plate 35. Said pin extends and is movable lengthwise of the fuse, and may be withdrawn by setback below or back from the plane in which the plate 95 moves. The plate 95 is provided with an angular part or shoulder 103 besides the pin 100 and so close thereto that it is prevented thereby from moving outwardly far enough to permit release of the pin 99. The plate 95 is also formed in such manner that its center of mass is at one side of its pivot 96, and at one side of the radius of the fuse passing through said pivot, whereby centrifugal force is effective to throw it outward when the projectile is rotating in flight and the locking pin 100 has been retracted by setback. The angular projection or shoulder 103 is so formed that, after passing the locking or stop pin 100 when the latter is retracted, it leaves the latter free to move forward again under the impulse of its spring 101 after having acquired momentum. But in being again projected, the pin 100 passes at the left of the angular projection 103, (with reference to Fig. 7), and restrains the locking plate from again assuming a position which would obstruct the running of the time mechanism.

Control arm safety lock.—The control arm 81 is locked and prevented from bearing against the timing control disk or entering

the gateway therein, prior to firing of the projectile from the gun, by a lock consisting of a pin 104 set into a socket 105 in the base part of the fuse body. The pin has a projecting extremity 107 of reduced diameter which passes through a complemental hole in the plate 72, between the arm and the axis of the fuse, and in a location where it normally holds the finger 82 of the control arm wholly out of contact with the timing disk, and a short distance away from the disk, as shown in Fig. 10. On the lower end of this pin are two separated projections or legs 104[a] of resilient character having external wedge surfaces 104[b] at or near their lower ends. There is an extension 105[a] of reduced diameter from the bottom of the socket 105, and a shoulder 106 is formed between the bottom of the socket proper and this extension. In the normal unstressed condition of the legs 104[a], their beveled faces 104[b] rest on the shoulder 106, whereby the pin is supported so as to lock the control arm 81, as above described. By virtue of this feature, the timing disk may be turned in either direction and through any angle in being set, even though in so doing the gateway is brought beside the finger 82, without danger of prematurely releasing the firing pin. The lower extremities of the legs 104[a] and their outer surfaces above the wedge portions thereof are near enough together to enter the socket extension when the pin is acted upon by setback. Therefore, when the gun is fired, the legs are wedged together by the shoulder 106 and enter the socket extension where their resilience causes them to exert friction against the sides of the extension, preventing rebound of the pin into a position where it could again lock the control arm prior to release thereof by the timing disk.

Locking pins of this description may be made automatically in large quantities and at small expense by automatic machine tools of the screw machine type, the outer surfaces and wedge faces of the legs being formed by a turning operation, and the legs being separated by a subsequent slotting or sawing operation, being thereby made springy and resilient enough for action in the manner described.

Firing pin safety lock.—As an additional safeguard, I provide a further lock to prevent release of the firing pin if the normal control mechanism should be accidentally tripped and released prior to firing from the gun. This safety lock comprises bolts 108 set into transverse passages in the fuse base and each having a projection 109 lying in the path of the lower head on the firing pin. These bolts are pressed inward by springs 110, which react against a sleeve 111 (Fig. 12) mounted externally on the base of the fuse or against the passage in the shell into which the fuse is set. As here shown, there are two locking bolts disposed in positions to balance each other, but there may be more than two, or only one. They effectually prevent such release of the firing pin as would explode the primer before the projectile has actually been fired from the gun and set into rotation so rapidly as to generate centrifugal force sufficient to retract the lock.

It will be understood that when a projectile equipped with the fuse is fired from a gun, the first effects are those due to the inertia or setback of the axially movable parts. The displacer 93 is actuated to lock the setting cap by the pins 91; the pin 100 is displaced, leaving the detent lug 97 of the timing mechanism lock free to be shifted out of the way of the pin 99; and the controller locking pin 107 is withdrawn, leaving the firing pin lock mechanism free to act when permitted by the timing mechanism. Then, as the projectile and fuse are set into rotation by the rifling of the gun, the timing mechanism detent is forcibly displaced by centrifugal force, carrying the shoulder 103 across the end of the locking pin 100 and to the other side thereof; and the firing pin safety lock 108 is also retracted. The timing mechanism now runs continuously at the rate predetermined by the qualities of the balance and hairspring, and by the adjustment of the hairspring, until the gateway in the timing disk, after a lapse of time determined by the preliminary setting of the timing mechanism, is brought beside the finger 82, which finger, having been previously pressed lightly against the timing disk by the force exerted through the release lever 70, then swings through the gateway from near the position shown by dotted lines in Fig. 11 to that shown by dot-and-dash lines, and releases the firing pin.

The fuse made as hereinbefore described comprises new inventive characteristics of construction and arrangement, by virtue of which the factors heretofore acting in connection with devices of this nature to impair the accuracy of running have been eliminated. The location of the firing pin in the axis of the fuse relieves the firing pin of all application of centrifugal force and thus eliminates the frictional resistance to its movement due to lateral pressure on its guides. The wheels of the time train are small and light in weight and are all located at the least possible distances from the axis of the fuse, having regard to the necessary diameters of the several wheels, whereby the disturbing effects of centrifugal force on these members are reduced to the minimum. The frame plates in which the various parts of the time mechanism are mounted are rigid in construction and rigidly supported on one another and on the base of the fuse, wherefore they are not displaced or distorted by setback and centrifugal force, and do not apply any increased friction to the moving

parts. On this account there is no appreciable variation in the rate of running of the time mechanism on acount of differences in velocity of the projectile or differences in the firing charge. The same fuse can be used with projectiles of all calibers, from the smallest to the largest, and is adapted for projectiles as small as one inch in diameter. The exceptionally small diametral dimension of the fuse is made possible by the location of the firing pin in the axial position, by the novel construction and arrangement of the firing pin lock mechanism, by the location of the train wheels close to and surrounding the axis of the fuse and by their small diameters, and by the small diameter of the main wheel 44.

The time train herein described may be set up to run in either direction by making reversals or substitutions of certain parts. Assuming that this train as thus far shown and described runs counter-clockwise, it may be made to run clockwise by reversing the escape wheel on its staff, reversing the mainspring, or substituting an oppositely coiled mainspring, and making other changes, as follows. To permit of reversal or substitution of the mainspring, the hooks or studs provided on the arbor 43 and in the barrel 42 are preferably made to take a spring coiled in either a lefthand or a righthand spiral. Such stud may be formed integrally on the arbor by turning down one side thereof about an axis perpendicular to the axis of the arbor itself so as to leave an undercut stud 43ª, as shown in Fig. 8, surrounded by a flat surface on the side of the arbor. Or an arbor having a hook facing in one way only may be used for driving in one direction, and an arbor with a hook facing the opposite way may be substituted to drive in the opposite direction. The hook or stud of the barrel is generally a separate stud applied to the otherwise complete barrel, and is preferably headed or undercut to take springs of opposite wind. To permit winding of the reversed mainspring and to hold it in wound up condition, the click 69 is reversed so as to yield in the opposite direction to that indicated in the foregoing description and to cooperate with the opposite side of the notch in the plate 33 in preventing unwinding. The firing mechanism lock is replaced by a similar lock to that shown in Figs. 7 and 18, but differing only in the detail that the lug 97 is given an opposite inclination or bevel, as shown in Fig. 18ª. The pallet arms 52 and 53 are, or may be, beveled at the edges which coact with the escape wheel appropriately with the wheel according to the direction in which the latter runs and the angles of its tooth faces. The difference between clockwise running and counter-clockwise running mechanisms embodying this invention involves only those features just described, and any such mechanism may be changed over as to its direction of running by making these simple reversals or substitutions of equivalent parts. This capability of the mechanism is of importance in that it enables essentially the same fuse to be used in guns having rifling of either righthand or lefthand pitch, with the minimum of alterations and substitutions.

The parts of the fuse are all of simple character, capable of being rapidly and cheaply made by automatic machinery. Any suitable materials may be used, preferably brass or bronze for the structural parts and such moving parts as are subject to the least pressure and wear, on account of the ease with which this material may be worked, and steel for the parts in which special hardness or special strength with light weight are required.

In the foregoing description, the relations between the various parts of the fuse have been described for convenience on the assumption that the fuse is vertical, with the advancing end uppermost, when in position for examination and comparison, wherefore such terms as "top", "bottom", "above", "below", and other terms indicating relative height, have the same significance as "forward" and "rear", etc., considered with reference to the fuse in position for horizontal flight. The descriptive terms applied to the several parts of the fuse have been selected for convenience and as apt to the particular design of these parts here disclosed; but such terms are not to be narrowly construed as limiting my protection to the particular structures and forms of the several parts designated thereby. Evidently many of these parts may be otherwise formed than as shown herein, while still functioning and cooperating in essentially the same manner and to the same end as herein described, and all such equivalent forms and constructions of corresponding parts are intended to be included within the scope of the protection hereinafter claimed, whether or not they are within the ordinary definitions of such descriptive terms.

What I claim and desire to secure by Letters Patent is:

1. In a mechanical time fuse having a firing hammer, locking mechanism for holding said hammer in cocked position, and an adjustable timing mechanism for controlling the said locking mechanism, a setting member rotatably mounted on the fuse base in connection with the timing mechanism for setting the latter, a locking device carried by the setting member adapted to indent a fixed part of the fuse base, and a displacer arranged to be moved by its inertia upon firing and engageable with said locking device for impelling the latter into locking position.

2. In a time fuse, a base, an adjustable

timing means, a setting member rotatably mounted on the base in connection with said timing means, and a lock comprising an outwardly movable pointed pin carried by the setting member with its outer pointed end adjacent to a surrounding fixed part of the fuse base and adapted to indent the same when forced outwardly, and a longitudinally movable weight having a wedging portion operable by setback to crowd the locking pin outwardly.

3. In a time fuse having a base, a timing means adjustably mounted in said base, a setting member rotatably mounted on the base and coupled with said timing means for adjusting the latter, and a setting lock comprising pins radially mounted in the setting member with provision for movement outwardly from the axis thereof and having terminal indenting points adjacent to a surrounding part of the base, and a centrally located weight movable by inertia under the shock of firing having a beveled portion arranged to bear on the inner ends of said locking pins and crowd them outwardly.

4. In a time fuse having a base, an adjustable timing means, and a rotatable setting member mounted on the base coaxially therewith, a lock for securing the setting member in adjusted position consisting of a pin mounted in one of the members constituting the base and setting member with provision for inward and outward movement with relation to the axis thereof and having an indenting portion adjacent to the other of said members, and a weight arranged with provision for movement endwise of the fuse under setback, said weight being arranged to engage the locking pin, and said pin and weight being formed with mutually coacting provisions for crowding the pin into locking position when the weight is moved by setback.

5. In a time fuse, a recessed base, timing means contained in said recessed base and adjustably rotatable therein, a retaining ring secured to said base overlapping the timing means, a setting member supported on said retaining ring, a holding plate secured to said setting member and underlapping the retaining ring, and a resilient presser between the timing means and the said plate pressing the latter against the retaining ring with yielding friction-causing force.

6. In a time fuse, a recessed base, timing means contained in said recessed base and adjustably rotatable therein, a retaining ring secured to said base overlapping the timing means, a setting member supported on said retaining ring, a holding plate secured to said setting member and underlapping the retaining ring, a resilient presser between the timing means and the said plate pressing the latter against the retaining ring with yielding friction-causing force, and means operated by force acting upon firing for securing the setting member immovably with respect to the base.

7. In a mechanical time fuse, a series of frame plates supported one upon another at their peripheral parts and recessed within such peripheral parts for reception of the parts of the timing mechanism, the end portions of said plates being substantially continuous across their recessed portions and providing rigid bearings for the pivots of the rotatable parts of the timing mechanism.

8. In a mechanical time fuse, a movement frame composed of superposed plates having surface contact with one another at their circumferential parts and being internally recessed to receive the parts of the movement, one of said plates having a transverse recess for the reception of a bar-like balance member and having a lateral recess opening therefrom to receive one arm of a hair spring attached to said balance, and a regulator mounted in the body of the plate at the opposite side of the transverse recess.

9. In a mechanical time fuse, a movement frame composed of superposed plates having surface contact with one another at their circumferential parts and being internally recessed to receive the parts of the movement, one of said plates having a transverse recess for the reception of a bar-like balance member and having a lateral recess opening therefrom to receive one arm of a hair spring attached to said balance, and a regulator mounted in the body of the plate at the opposite side of the transverse recess, said regulator comprising an externally threaded thimble mounted in the plate with provision for movement endwise and prevention of rotatable movement therein, said thimble having an end wall with an opening to receive the hair spring, and a nut seated in a recess in the plate surrounding said thimble and meshing with the threads thereof.

10. In a time fuse, a time mechanism comprising recessed frame plates and moving parts mounted in said frame plates, one of said frame plates having a transverse central recess opening from one end face of the plate and covered by the opposite end portion thereof, and having also a lateral recess opening from one side of said transverse recess, and a passage opening transversely from the opposite side of said transverse recess, the plate having a hair spring receiving slot at the outer end of said before mentioned lateral recess, a thimble mounted in said passage with provision for movement endwise therein and having in its end wall a hair spring receiving slot, said thimble and the passage having complemental key portions to prevent rotation of the thimble, and a nut surrounding the thimble and in threaded engagement with the exterior thereof, said nut being rotatably mounted in the plate and confined against endwise movement.

11. In a mechanical time fuse, a balance and regulator for controlling the rate of running of the timing mechanism, comprising a frame having bearings, a balance having pivots mounted in said bearings, a hair spring secured to said balance extending to opposite sides thereof, means in the frame for confining one arm of the hair spring at an invariable distance from the pivot axis, and an adjustable abutment for the opposite arm of the hair spring consisting of an externally threaded member mounted for movement in the frame lengthwise of the hair spring and having a confining portion embracing the hair spring, and a nut surrounding and meshing with the thimble and mounted rotatably in the frame.

12. In a time fuse, a frame plate having a passage and a chamber intersecting said passage, a regulator comprising an externally threaded thimble mounted and movable endwise in said passage and having a flattened side complemental to one side of the passage to prevent rotation, and a nut fitting rotatably in said chamber and surrounding the thimble in mesh with the threads thereof.

13. In a timing mechanism, a frame plate having a substantially cylindrical passage extending substantially parallel to one face of the plate, a regulator thimble fitted to move in said passage and having a flat side toward the before mentioned face of the plate, the material of the plate between such face and the passage being offset inwardly to modify the circularity of the passage into the substantial complement of the form of the regulator, and a nut surrounding and meshing with the regulator and confined in a chamber in the plate.

14. In a mechanical time fuse, a timing movement comprising a frame composed of superposed plates, one of said plates having a chamber in its lower side for a mainspring barrel and mainspring, and an upper extension chamber for a wheel, said plate having an integral web portion overlying said extension chamber, providing a pivot bearing, said plate having also a recess extending inwardly from its upper side intersecting said extension chamber and terminating above the top wall of the first named chamber, there being an integral part of the plate between said chamber and recess having a bearing for a staff pivot, a second plate supported at its outer parts on the first named plate and recessed in its under side to receive the wheels of a gear train, the top side of the second named plate extending over such recess and having pivot bearings and slots at each side of its central point to admit the pallet arms of an escape mechanism, and a third plate supported on said second named plate and recessed in its under side for reception of a balance, hair spring and hair spring regulator, the top of said third plate extending over such recesses and having a central pivot bearing; and a spring driven time mechanism having staffs, wheels, a balance and a mainspring located in the bearings, chambers and recesses.

15. In a mechanical time fuse, a timing mechanism comprising a frame built up of superposed recessed plates having integral peripheral engaging portions, a balance located in a recess of the top plate of the series and having pivots rotatably mounted axially in the two upper plates, pallet arms connected to the balance and extending through openings in the second plate on opposite sides of a diameter through the pivot bearing therein, a gear train composed of wheels and pinions having staff pivots journaled in the second and third plates from the top, said train including an escape wheel cooperating with said pallet arms, a main arbor journaled in the third and fourth plates, a main wheel on said arbor and a mainspring and mainspring barrel surrounding the arbor and contained within the third plate, said last named plate having a chamber opening from its under side containing said barrel and an extension chamber containing the main wheel, and having a recess opening from its top side containing a pinion of the gear train in mesh with said main wheel.

16. A mechanical time fuse comprising a recessed body, a movement frame comprised by superposed plates in said body in direct contact with one another at their peripheral portions, a spring driven time movement located in and between said plates and having pivot bearings therein, said movement including a balance pivoted in the upper part of the frame and having pallets, a gear train pivoted at a lower stage in the frame and having an escape wheel complemental to said pallets, and a mainspring barrel, mainspring, and main arbor pivoted at a still lower stage in the frame, said arbor protruding below the bottom plate of the frame, a timing control disk secured to the protruding end of said arbor, a spring pressed firing hammer located in the bottom portion of the fuse base, and a releasable locking mechanism for holding said hammer in armed position and including a control arm coacting with said control disk to permit release of the hammer at a predetermined time.

17. In a time fuse, a base casing and a time movement in said casing including a mainspring, a winding wheel for said mainspring, a holding click for said winding wheel, and a frame member to which said click is pivoted; the click having a tooth projection engaging the winding wheel and a finger adjacent to the base casing and constrained thereby to exert force tending to hold the tooth of the click in locking connection with the winding wheel.

18. In a time fuse, a base casing and a

time mechanism, including a mainspring, a toothed winding wheel in connection with the mainspring and rotatable to wind up the same, a frame for said mechanism structurally separate from the casing and insertible therein, and a click pivoted to the frame having a projection arranged to enter between the teeth of the winding wheel for locking the wheel and being displaceable outward by said teeth when the wheel is turned in the spring-winding direction; the frame having an abutment arranged to arrest the click in wheel-locking position under the pressure of the mainspring, and the click having a finger arranged to be projected beyond the frame when the click is displaced in the manner set forth, which finger is constrained by the fuse casing when the time mechanism is placed therein, to oppose such displacement of the click.

19. In a mechanical time fuse, a recessed base, a spring impelled firing pin located axially in said base and having a head, a release lever pivoted within the base at one side of the axis thereof and extending across the central part of the base, having a part adapted to underlie one side of the firing pin head for locking the firing pin in armed position, being so disposed that centrifugal force tends to displace it from locking position, said lever having a hook, a stud pivotally mounted in the base and having a lever arm engageable with said hook to hold the release lever in locking position, a control arm secured to said stud, and means for releasably holding said control arm in a position wherein the lever arm of said stud holds the release lever in its locking position.

20. In a time fuse, a spring impelled firing pin, a displaceable locking and releasing member for holding said firing pin in armed position, said member being displaceable from its holding position by centrifugal force when the projectile carrying the fuse is in flight, a control member for holding said locking and releasing member in locking position, and a timing member for maintaining said control member in holding position and constructed to release the control member from such position at a predetermined time.

21. In a mechanical time fuse, a rotatable timing disk, a pivotally mounted control arm having a portion arranged to engage said disk and having a locking shoulder, a release lever constructed to be engaged with said locking shoulder and being movable from its engaged position by centrifugal force, the release lever and locking shoulder being so arranged that the force so acting presses the control lever against the timing disk, and the latter having an opening formed to permit passage of the control lever when the timing disk is in a certain position.

22. In a mechanical time fuse, a spring impelled firing pin, a pivoted control arm having an associated lever arm, a release lever having a shoulder engageable with said lever arm, a rotatable timing disk arranged to hold said control arm and lever arm in position for locking the release lever, said timing disk having an opening arranged to permit movement of the control arm sufficiently to release the release lever when the timing disk is in a certain position; the release lever being constructed to lock the firing pin in armed position when locked by the control lever arm and being displaceable by centrifugal force into position for releasing the firing pin.

23. In a time fuse, a spring impelled firing pin, a release lever for locking said firing pin in armed position, said release lever being displaceable by centrifugal force and the pressure of the firing pin out of its locking position, a control arm having means for engaging the release lever and holding said lever in locking position, and a time mechanism for releasably locking said control arm, said release lever being constructed and arranged to apply force tending to displace the control arm from its locked position.

24. In a mechanical time fuse having a firing pin, a release lever pivoted at one of its ends to the fuse at one side of the axis thereof and having a locking projection at the other end and constructed intermediate its ends to lock the firing pin in armed position, a control arm pivoted in the fuse base adjacent to the second named end of the release lever and having an eccentric projection engageable with the locking projection of the release lever to secure the same in its pin-locking position and disengageable therefrom by rotation, said release lever being movable by centrifugal force to rotate the control arm and disengage its locking projection from the projection of the latter, and a timing member normally preventing movement of the control arm and having an opening formed to permit such movement when the timing member is in a certain position.

25. In a time fuse, a timing mechanism having a projection movable in a given path, a lock member pivoted to swing in a plane transverse to the axis of the fuse, having a lug arranged to move into and out of the path of said projection with the swinging of the lock, a stop pin mounted with provision for movement axially of the fuse, and a spring supporting the pin normally holding it across the plane in which the lock is movable and tending to project the pin after retraction thereof across such plane, said lock having a shoulder engaging said pin and being held thereby with its lug in the path of the before named projection, the pin being retractable by setback to clear the lock and the lock being movable by centrifugal force to withdraw its lug from said projection and carry said shoulder past the location of the stop pin.

26. A mechanical time fuse comprising a

base having a central passage opening from one end and being chambered from the opposite end to form a casing, a passage from the first named end entering the chamber, a plate mounted in the base of the chamber and having a passage alined with the previously named passage, a spring impelled firing pin located in the first named passage and having a head adapted to enter the passage in said plate when the firing pin is armed, a release lever resting on the bottom of said chamber and pivoted to the under side of said plate, having a portion adapted to underlie the armed firing pin head, a stud pivoted in and passing through the plate, having a shoulder at the under side of the plate and a control arm at the top of the plate, said shoulder when in normal locking position being engaged with a part of the release lever and holding said lever in position to lock the firing pin, a time mechanism contained in the casing portion of said base, and a time disk connected to the time mechanism located adjacent to said control arm in position to hold the latter in the normal locking position, said disk having an opening formed to permit movement of the control arm into unlocking position when the disk has turned through a predetermined angle.

In testimony whereof I have affixed my signature.

FREDERICK W. BOLD.