May 13, 1958 V. VIASMENSKY 2,834,292

INTERMITTENT ACTION BALL CAM ROTOR

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Fig. 1.

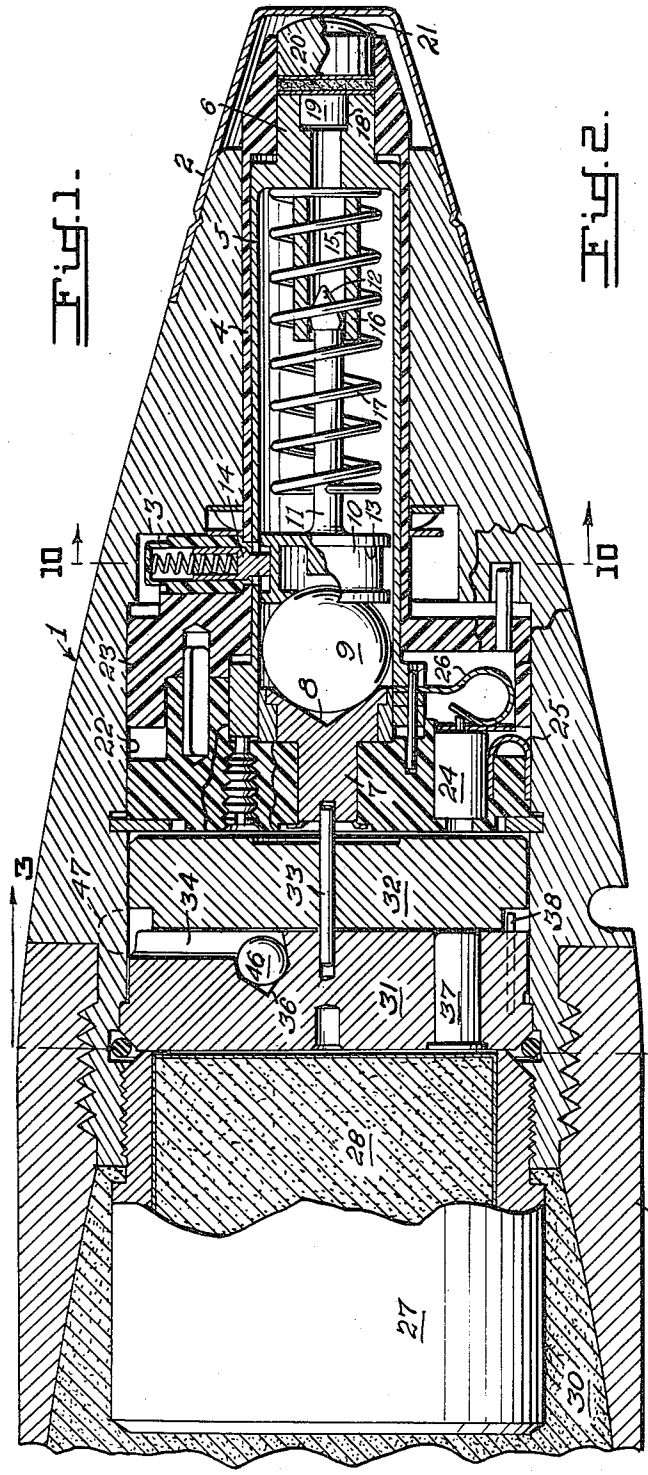


Fig. 2.

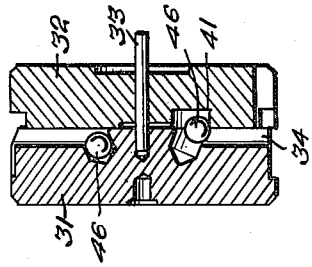


Fig. 9.

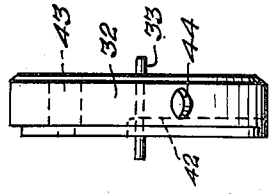
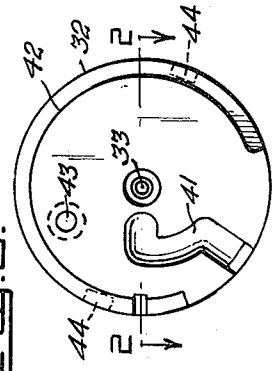


Fig. 8.



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Fig. 3.

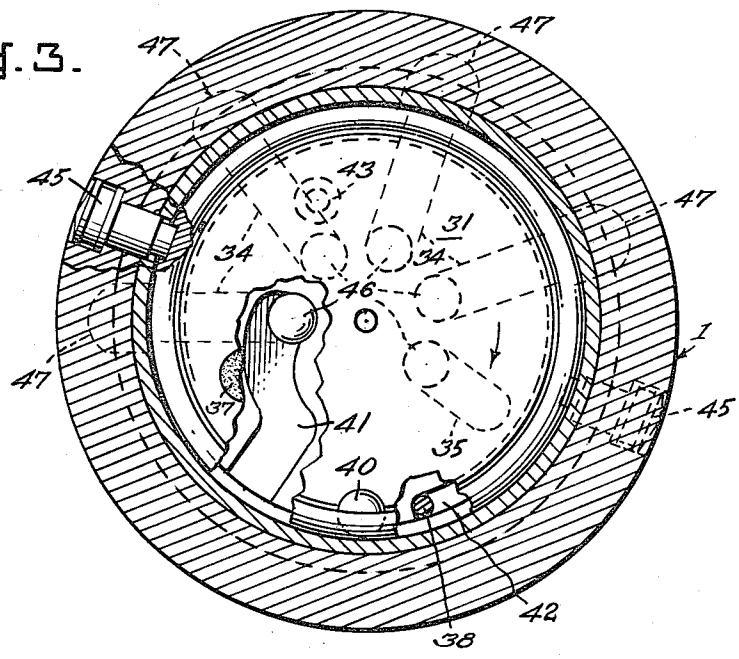


Fig. 4.

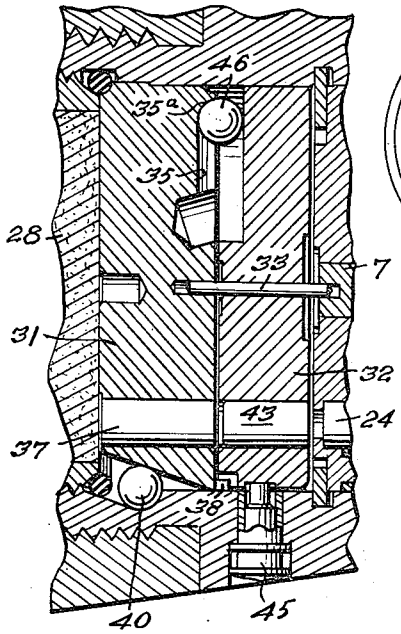


Fig. 5.

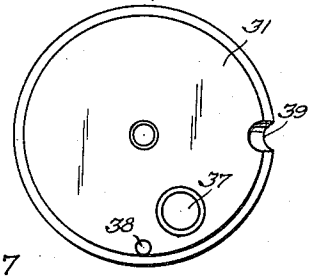


Fig. 6.

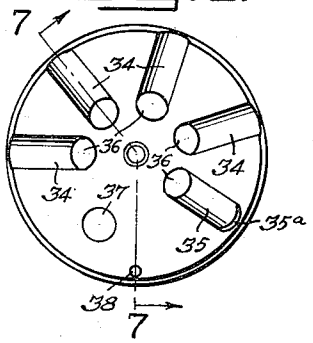


Fig. 7.

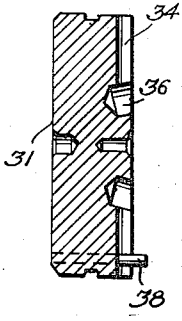
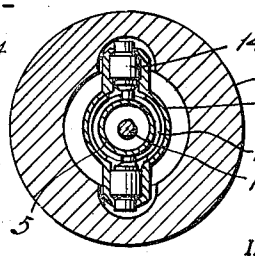


Fig. 10.



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INTERMITTENT ACTION BALL CAM ROTOR

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Application July 6, 1956, Serial No. 596,367

7 Claims. (Cl. 102—79)

This invention relates to a time delay fuze and more particularly to a periodic acting ball cam rotor arming mechanism for a point detonating fuze of the type disclosed in the application of Brown et al., Serial No. 388,076, filed October 23, 1953, entitled "Fuze for Use on Rotating Artillery Ammunition."

Due to the sensitivity of the fuze disclosed in the Brown application a time delay is necessary to prevent arming of the fuze in the gun barrel, or within a short time after leaving the gun barrel since contact of said fuze with the leaf of a tree or camouflage surrounding the gun position is sufficient to cause the projectile to explode.

It is a primary object of this invention to provide a ball cam rotor intermittent time-delay mechanism possessing superior advantages over previous mechanisms of this type.

It is another object of the invention to provide an intermittent time-delay mechanism having a long arming period whereby premature detonation due to the projectile passing through trees or camouflage adjacent the gun position, and the like is prevented.

A still further object of the invention is to provide an arming mechanism which is reliable in operation but securely held in a "safe" position during handling.

Briefly the arming of the fuze is accomplished by centirfugal force due to projectile spin. When the projectile to which the fuze is assembled is fired centrifugal detents release a rotor which contains an element of the explosive train for the booster charge. The detents may be of the type which ride the gun bore or spring loaded so that they do not open until the projectile is spinning at close to its maximum angular velocity. These detents prevent premature or partial arming of the rotor during normal handling of the projectile and also prevent premature cycling of the rotor in the gun barrel. When the detents pull out, the rotor of the fuze begins to rotate in response to centrifugal force acting on an indexing ball held between the rotor and stator, the stator having a straight radial groove and the rotor having a spiral cam groove, as shown in the application of Brown et al. supra. The improvement over the device shown in the above application is the use of a plurality of indexing balls held between the rotor and stator in which the stator has a plurality of grooves for each ball and the rotor has a single cam groove that aligns itself over each ball successively upon being rotated in response to the centrifugal forces acting on the preceding ball. The last ball locks the rotor in armed position as described hereinafter. Since the rotation of the rotor is stopped every time a ball escapes to the outside and the next ball enters the cam groove of the rotor an intermittent motion is imparted to the rotor and a building up of rotor velocity is prevented. This provides a long arming time.

If the speed of rotation of the projectile is known and the mass of the balls and rotor are known the time required for the rotor to rotate through any angular distance can be calculated and the arming time accurately determined.

The invention accordingly comprises the elements and combination of elements and arrangement of parts hereinafter described.

A preferred embodiment of the invention has been shown in the accompanying drawings in which:

Fig. 1 is a longitudinal sectional view of an assembled fuze in unarmed position and showing a portion of the projectile including the booster charge;

Fig. 2 is a fragmentary sectional view showing a ball entering the cam groove of the rotor and radial groove of the stator from one of the cup shaped pockets in which the balls are normally held;

Fig. 3 is a cross section taken along line 3—3 of Fig. 1;

Fig. 4 is a fragmentary section illustrating the rotor in armed position;

Fig. 5 is a plan view of the front face of the stator;

Fig. 6 is a plan view of the rear face of the stator;

Fig. 7 is a cross section of the stator taken along line 7—7 of Fig. 6 looking in the direction of the arrows;

Fig. 8 is a plan view of the front face of the rotor;

Fig. 9 is a side elevation of the rotor, and

Fig. 10 is a cross section taken along line 10—10 of Fig. 1 and looking in the direction of the arrows.

While the means for initiating the firing of the fuze is not a part of this invention, a description of the same is included herein to correlate the sequence of operation from the impact of the fuze with a target to the explosion of the projectile charge.

Referring now to Fig. 1, reference character 1 indicates generally a fuze body having a windshield 2, such body being of external ogive form and through which is formed a central axial opening. At a substantially central point, the opening has a shoulder 3 defining a reduced diameter portion of the opening forward of such shoulder. A cylindrical liner 4 of electrical insulating material is received in the opening and embraces a metallic hammer receiving cylinder 5 provided with a forwardly disposed axial boss 6 and a closure element 7 adapted to close the rearward end of the cylinder 5. A hammer ball 9 is received within the rearward portion of the cylinder 5 and normally is nestled in cup 8 formed by the forward face of the closure 7 and a cup 10 formed in the rearward face of a plunger 11. A firing pin 12 is defined by the forward end of plunger 11. An annular channel 13 is formed about the periphery of the cup portion of plunger 11 and receives a pair of spring-biased plunger detents 14 only one of which appears in Fig. 1 and disposed radially in liner 4, and prevents axial displacement of the plunger 11 within cylinder 5. The firing pin portion 12 of plunger 11 is normally received in an axial bore 15 in an axially disposed, inwardly extending boss 16 integral with the cylinder 5 and boss 6. A coil spring 17 is disposed around the boss 16 and normally prevents plunger 11 from moving forward in event of failure of detents 14, but will not prevent the plunger from forward movement upon impact of the projectile with a target. Forwardly of the bore 15 in boss 6 is a counter bore 18 to receive a detonating element 19. A piezoelectric crystal 20 is also mounted in counterbore 18 between detonator element 19 and an anvil 21 positioned in front of the crystal 20 and retained by the windshield 2.

Rearwardly disposed of the shoulder 3 is an enlarged chamber 22 of the central axial opening to receive a housing 23 of electrical insulating material. The housing 23 serves to receive the rearward portion of cylinders 4 and 5, closure member 7, an electrically responsive detonating squib 24 and electrical conductors 25 and 26, and the components of the time-delay elements of this invention. Booster cup 27 containing charge 28 and a pro-

jectile **29** containing charge **30** are threadably engaged to the rearward end of the fuze body **1**. The time delay mechanism is disposed between the closure member **7** and booster **28** and comprises a stator **31** and a rotor **32**. The rotor is mounted upon an axially disposed shaft **33** journaled at its ends to closure **7** and stator **31**. The structure of the stator can best be viewed from Figs. 5, 6 and 7 and consists of a disc having substantial thickness. Its forward face is provided with a series of semicircular radial grooves **34** and **35** (there being five grooves shown in the drawing). These grooves radiate inwardly towards the axis of the disc and terminate in a series of pockets **36** bored therein at an angle of approximately 150° to the longitudinal axis of the disc and at points equally distant from the axis of the stator. It will be noted that groove **35** of the stator **31** has an inclined surface **35***a* adjacent the periphery of the stator as best seen in Fig. 4. The purpose of groove **35** and incline **35***a* is to lock the rotor in armed position. Stop pin **38** insures that the rotor will be in a position to align the powder train element **37** carried by the rotor with powder train element **43** of the stator and electric detonating squib **24** as best seen in Fig. 4.

An angularly disposed, semi-circular notch **39** is cut in the rearward edge of the stator **31** to receive a doweling ball **40** to anchor the stator against rotation within the fuze body **1**.

The rotor element **32**, as clearly shown in Figs. 8 and 9, consists of a disc of approximately the same thickness as the stator. Its rearward face, best seen in Fig. 8, is provided with a substantially spiral semicircular shaped cam groove **41** extending from the periphery of the rotor to a point registering with pockets **36** in the stator when the elements are in their assembled relation within the fuze. The rotor **32** is provided with a marginal groove **42** cut in the rearward edge through an angle of 270°. This groove receives stop pin **38** in stator **31** and limits rotor movement in armed position. A power train element **43** is carried by the rotor **32** to register with powder train element **37** in the stator **31** when the time-delay elements **31** and **32** are in armed relation. The rotor **32** is provided with a pair of cups **44**, best seen in Fig. 8, bored in its outer peripheral surface to receive spring-biased detents **45** housed in fuze body **1** and adapted to be withdrawn from the pockets **44** by centrifugal force when the projectile is spinning. The rotor indexing balls **46** (there being five shown on the drawing) are normally held within the pockets **36** when the delay elements **31** and **32** are in unarmed position.

Operation

As installed in an unarmed position in the fuze **1** the spiral cam groove **41** of the rotor fits directly over the first radial groove in the stator. One of the index balls **46** is positioned at the innermost end of the radial groove in the stator and the spiral cam groove of the rotor. The four other balls will be held by the flat face of the rotor in their pockets **36**, the rotor face being flush with the stator face and spaced therefrom. The rotor will not rotate due to detents **45** resting in cups **44**. In this relation of the parts, the explosive train elements are not in alignment and the fuze is "safe." In order to reach "armed" position, i. e. for powder train elements to line up, it is necessary for the rotor to rotate through an arc of 270°.

Upon firing of the projectile, detents **45** will move out of cups **44** in the rotor due to spin of the projectile and release the rotor for rotation. Movement of the rotor is accomplished by the centrifugal force of the balls **46** acting on the rotor cam groove **41**. The rotor arming travel starts when centrifugal force causes the ball nestling in grooves **34** and **41** to bear against the outer surface of the rotor cam groove with a torque greater than the resisting torques. As the rotor is turned, the ball moves outwardly in the radial groove in the stator until the rotor

is turned to allow the ball to escape through the now coincident radial grooves in stator and rotor. As the ball escapes, the rotor is stopped momentarily until the ball nestles in receptacle **47** cut in the fuze body **1** (see Fig. 3) this receptacle provides adequate clearance so that the ball is in effect thrown out. The next ball in the stator cup now enters the rotor cam groove and radial stator groove exactly as the first ball did. The rotor arming travel starts again and the ball movements are repeated. Thus four balls enter the rotor cam groove, supply driving torque and are "thrown out" by entering the recesses **47** in the body of the fuze. The last ball is used as a lock to hold the rotor in its final position, i. e. ball in groove **35**, whereby the explosive train elements **37** and **43** are aligned and the fuze armed. This last ball can either recess half a diameter in the fuze body, thereby locking the rotor (not shown) or it can jam in a partially completed stator radial groove as shown, i. e. groove **35**.

Since the rotation of the rotor is stopped every time a ball escapes to a receptacle **47**, an intermittent motion of the rotor is produced, and the rotor velocity is not allowed to build up. This provides for a long arming delay.

If the speed of rotation of the main structure is known, and if the mass of the balls and rotor is known, then the time required for the rotor to rotate through any angular distance can be calculated. This time can be made approximately inversely proportional to the rotational speed of the projectile.

While many changes will be obvious to one skilled in the art the above description and accompanying drawing shall be interpreted as illustrative and not in a limiting sense beyond the scope of the appended claims.

I claim:

1. A periodic time-delay arming mechanism for a point detonating fuze comprising within a fuze body, a stator fixedly mounted within said body coaxially with the longitudinal axis of said body, a rotor journaled for rotation within said body about an axis coaxial with said longitudinal axis, powder train elements carried by said rotor and said stator, said stator having a plurality of semicircular radial grooves, said grooves radiating inwardly to terminate in a series of cup shaped recesses in one face thereof, said rotor having a single semi-circular spiral cam groove in one face and extending from the circumference of said rotor to a point near the axis of rotation thereof, the grooved faces of said rotor and said stator being adjacent each other, a plurality of indexing balls seated within said cup shaped recesses, and spring biased detent means to releasably hold said rotor in unarmed position.

2. A periodic time delay arming mechanism for a point detonating fuze comprising within a fuze body a stator fixedly mounted within said body and coaxial therewith, a rotor journaled for rotation within said body about an axis coaxial with the longitudinal axis of said stator, a bore through said rotor and said stator, powder train elements carried by said rotor and said stator within said bores and normally held in safe position, said stator having a plurality of straight radial grooves cut in the face adjacent said rotor terminating inwardly in cup shaped recesses, a plurality of indexing balls loosely fitting within said recesses, said rotor having a single semi-circular spiral cam groove cut in the face adjacent said stator and extending from the circumference of said rotor to a point near the axis of rotation thereof, the inner end of said cam groove being aligned with the first of said plurality of radial grooves and adapted to receive an indexing ball within the bore formed by said cam groove and said radial groove communicating therewith.

3. A periodic time delay arming mechanism for a point detonating fuze comprising within a fuze body, a rotor journaled for rotation about the longitudinal axis of said body, a stator coaxial with and parallel to said rotor, said

stator having a plurality of straight radial grooves cut in the face adjacent said rotor, said radial grooves terminating in cup shaped recesses at the inner end of said radial grooves, said rotor having a single semi-circular spiral cam groove cut in the face of said rotor adjacent said stator and extending from the circumference of said rotor to a point near the axis of rotation thereof, a plurality of indexing balls loosely fitting within said cup shaped recesses between said rotor and said stator, said cam groove normally overlying the first of said plurality of radial grooves, powder train elements carried within said rotor and said stator, spring biased detents operatively associated with said rotor to releasably hold said elements in safe position, said powder train element within said rotor periodically indexed to armed position by rotation of said rotor in response to centrifugal force acting on said balls.

4. A periodic time-delay arming mechanism for a detonator fuze comprising within a fuze body, a stator having a portion of a powder train therein, a rotor having another portion of said powder train therein, a plurality of radial grooves cut in the face of said stator, said grooves terminating in cup shaped recesses adjacent the longitudinal axis of said stator, a plurality of balls loosely seated in said recesses, a spiral cam groove cut in one face of said rotor adjacent the grooved face of said stator, said balls acting upon centrifugal force to periodically and sequentially enter said cam groove to impart rotation to said rotor, centrifugal detents operatively associated with said rotor to lock said rotor in safe position and release said rotor upon said body reaching a predetermined angular velocity, and means to lock said rotor in armed position.

5. A periodic time-delay arming mechanism as in claim 4 in which said means to lock said rotor in armed position comprises a semi-circular radial groove cut in said stator having its outer end terminating in an outwardly inclined surface inwardly of the periphery of said rotor.

6. A periodic time-delay arming mechanism as in claim 4 in which said fuze body has a plurality of pockets cut in the inner wall thereof adapted to receive said balls as they pass the peripheral circumference of said rotor and said stator as said rotor is indexed to armed position.

7. The combination in a point detonator fuze of the type disclosed comprising a fuze body having a booster charge at the rear end thereof, impact responsive means at the forward end thereof and a periodic time-delay arming mechanism within said body disposed between said impact means and said booster charge, said mechanism including a stator fixedly attached to said fuze body, a rotor parallel to and spaced from said stator, said rotor journaled for rotation within said housing about an axis coincident with the longitudinal axis of said stator, normally angular spaced powder train elements carried within a bore in said stator and said rotor, spring biased detents coacting with detent pockets formed in said rotor to lock said rotor in unarmed position, said detents releasing said rotor in response to predetermined angular acceleration of said fuze body, a plurality of semi-circular straight radial grooves cut in one face of said stator from the outer edge of said stator and terminating in cup shaped recesses adjacent the longitudinal axis of said stator, said rotor having a single spiral cam groove cut in the face adjacent said stator and extending from the circumference of said rotor to a point adjacent the axis of rotation of said rotor, a plurality of steel indexing balls loosely fitting within said cup shaped recesses for successively and periodically rotating said rotor in response to centrifugal forces acting on said balls to index said rotor to align said powder train elements to armed position, said balls successively and periodically received in a plurality of pockets formed inwardly in the body of said fuze as said balls pass from the semi-circular grooves in said stator and said rotor, and means to lock said rotor in armed position, said means including a semi-circular radial groove cut in said stator and having its outer end terminating in an outwardly inclined surface inwardly of the periphery of said rotor.

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