Feb. 26, 1935. F. ALIQUÒ 1,992,278

MECHANICAL FUSE FOR TIME AND PERCUSSION PROJECTILES

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Fig. 1.

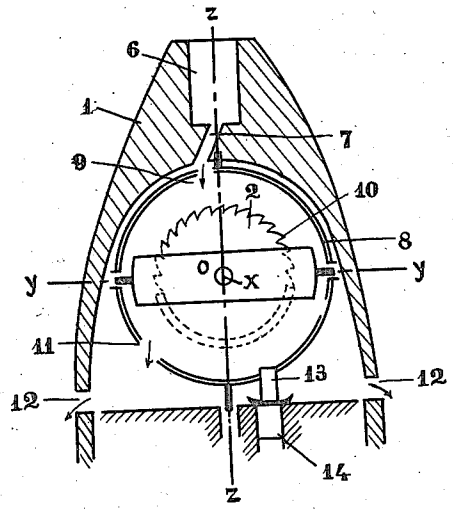


Fig. 2.

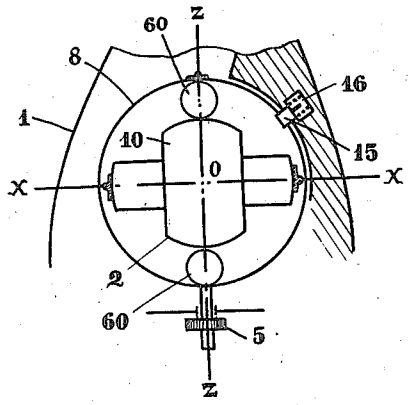


Fig. 3.

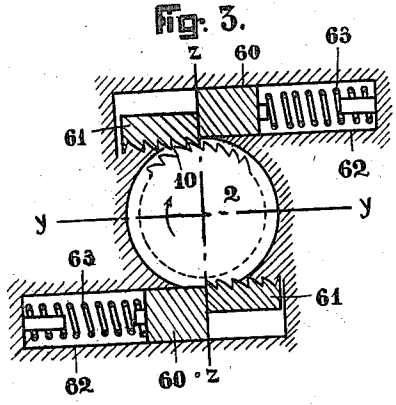


Fig. 5.

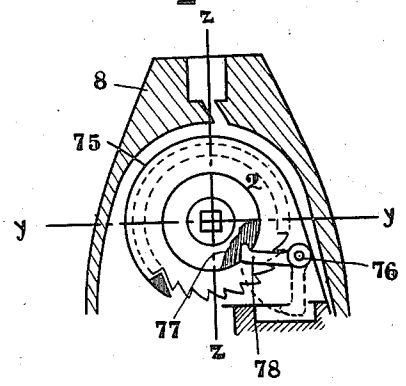


Fig. 8.

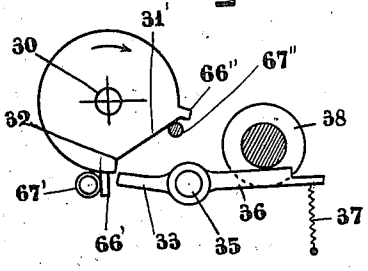
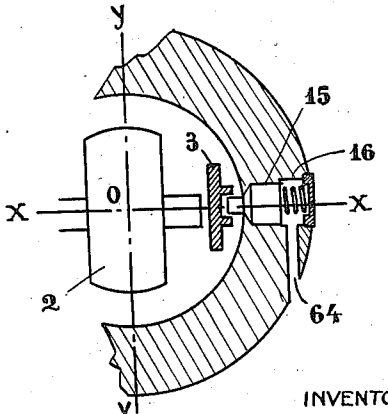


Fig. 4.



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Fig. 6.

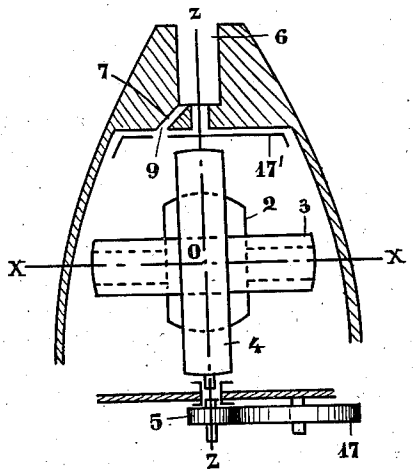


Fig. 7.

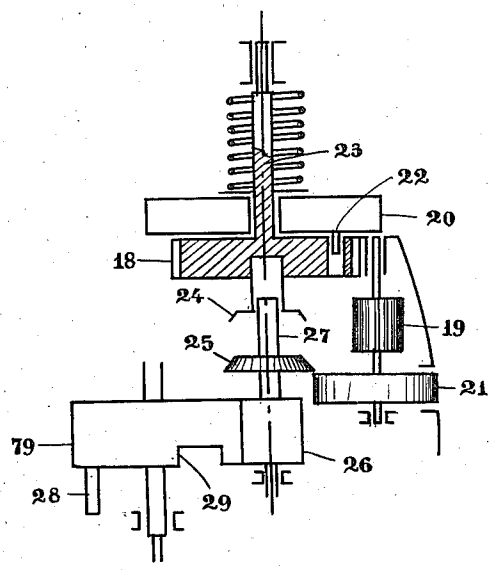


Fig. 9.

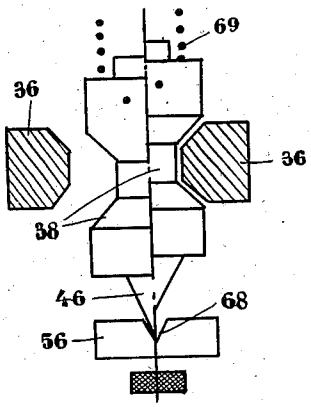
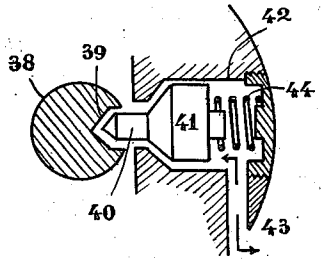


Fig. 10.



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MECHANICAL FUSE FOR TIME AND PERCUSSION PROJECTILES

Francesco Aliquò, Rome, Italy

Application January 15, 1932, Serial No. 586,791
In Hungary January 23, 1931

10 Claims. (Cl. 102—36)

The present invention refers to mechanical fuses for time and percussion projectiles, having a rotating movement when issuing from the fire arms, in which the safety, setting, actuating, and other devices receive their movements and are controlled by the rotating movement of the projectiles, either by itself alone, or in combination with other dynamical forces which develop from the firing of the shot.

The control of the above said devices is obtained, according to the present invention by means of a gyroscope suspended in such a way that its permanent axis of rotation can maintain itself normal to the axis of the projectile, and is moreover conveniently connected to the various devices which are controlled by it in dependence of the number of revolutions made by the projectile.

The invention includes various forms of practical embodiment of the principle above set forth, which refer both to percussion and time fuses and also to fuses intended to act in both manner; some of the said embodiments are described hereinunder and illustrated in the accompanying figures, by way of example, it being understood that the invention is not limited to the embodiments herein described and illustrated, but includes all other forms of embodiments depending on the fundamental principle of the invention and the essential parts as herein set forth.

The accompanying drawings forming part hereof diagrammatically illustrate the essential parts of the fuse made according to the invention and embodying the novel features thereof.

Fig. 1 shows a section through the fore part of the fuse taken through a diametral plane, showing the gyroscopic devices, and relating to a suspension having three degrees of freedom.

Fig. 2 shows another longitudinal section which serves to illustrate a suspension having two degrees of freedom.

Figs. 3, 4 and 5 show various details of the fuses illustrated in Figs. 1 and 2.

Fig. 6 shows also a diametral section of the fuse, with certain variations in its construction.

Fig. 7 is another diametral section of the fuse, developed in a plane, which shows the gearings contained in the time setting device.

Fig. 8 shows a special form of construction of the device, controlled by a time setting device in order to release the percussor and to render possible its action.

Fig. 9 shows a safety device which prevents the action of the percussor when the fuse is not set on the zero mark.

Fig. 10 shows a safety device for holding the percussor in its place while the projectile travels along the boring of the gun.

As shown in Fig. 1, the interior of the fore part 1 of the fuse contains a rotating mass 2, the axis of which xx, (which is assumed to be perpendicular to the plan of the drawings) crosses the axis zz of the projectile at a point O, corresponding to the centre of gravity of the rotating mass 2. The axis xx is supported by a suspension ring 3, which can revolve round a diametral axis yy which also passes through the point O, and which is perpendicular to the other said axes xx and zz. The axis yy is supported by the ring 4 (Fig. 6) which may also consist of a hollow sphere 8 (Fig. 1) which encloses in its interior the whole Cardan suspension, thus enabling the rotating mass to rotate freely around three different axes, or degrees of freedom.

In the case in which the ring 3 is rigidly connected with the ring 4, or with the sphere 8, a suspension is obtained capable only of two different rotating movements as shown in Fig. 2.

In either of these cases, the suspension can rotate freely round the axis zz, soon after setting in rotation the mass 2, the said suspension is free to rotate.

The gyroscopic axis xx, can either retain fixed in space the direction in which it has been left by the connecting pieces with the body of the fuse, if it possesses three degrees of freedom, or it develops the rotation of precession, disposing itself normally to the plane of the throw if it possesses two degrees of freedom.

In both these cases, after having liberated the rotating mass, the axis xx, which assumes in space the fixed direction of gyroscopic stability, will maintain in space the whole suspension in its unvaried orientation, so that the projectile, by rotating round the common axis zz, will transmit to the gearing or gearings which are connected with the fuse, and placed along the said axis zz, a rotating movement round the bearings connected with the gyroscopic suspension, and which are free to rotate round the said axis zz.

Having thus obtained the relative rotation of the axis xx, the direction of which is fixed in space in respect of the axis zz, common to the fuse and to the mass 2, the axis xx will revolve, relatively to the projectile and in opposite direction to it, thereby performing a number of revolutions equal to the number of revolutions made by the said projectile. If therefore the axis zz is connected with a device, for instance a pinion 5 (Fig. 2) arranged to transmit the said number of revolutions, it will be possible to control in this way, any suitable device, contained into the projectile, that may be made to work after the projectile has completed a certain number of revolutions previously fixed.

The above described device controlled by means of a gyroscope, may consist for example in a safety device designed to prevent the explosion of the projectile during its travel along the bore of the gun and up to a certain distance after

leaving the weapon. It may also consist in freeing a catch device for releasing the firing pin, thus causing the explosion after the projectile has made a pre-determined number of revolutions.

In order that the gyroscope may work in the way described above, it is necessary that its rotating mass may be set in rotation inside the core of the gun, and that for the device having three degrees of freedom, before setting free its axis; it is subsequently necessary that the movement initially transmitted to the rotating mass be maintained along the trajectory of the projectile, and that the number of the revolutions accomplished is communicated to the controlled devices.

For the initial starting of the rotating mass, a spring 75 may be provided, as shown in Fig. 5, previously wound, which can be set free while the projectile runs along the bore of the gun, or under the action of inertia, or by the action of the centrifugal force, or by the action of both said forces.

In the said Fig. 5, a stop catch 76 is shown, which in combination with the slot 77, connects the mass wound by the spring with the rotating mass embodied with it; when the firing occurs, the said stop catch is released by the action of the inertia, and it enters a slot into which it is kept, for example, by means of a spring 78. The stop catch 76 is normally kept into the slot 77 by means of a spring not shown in the drawings. On the other hand, the start of the rotating ring 2 can be produced by the same centrifugal force, by arranging, as shown in Fig. 3, two masses 66, placed eccentrically, each of them being embodied by a toothed rack 61, engaging with a toothed crown provided in the ring 2, and sliding in a cylindrical recess 62 in which an helicoidal spring 63 is provided.

It will be understood that when the projectile leaves the gun, the centrifugal force produces the immediate sliding of the two masses 60 towards the bottom of the cylindrical recess 62, compressing the springs 63, and disengaging the toothed rack 61 of the ring 2, after having impressed to it a very rapid rotating movement.

After the rotating mass has been set in movement, and the gyroscope has been set free, in order to maintain and increase the rotating movement, it may be found convenient and advantageous to utilize the air pressure that develops in front of the projectile during its movement.

As shown in the drawings, the fore part of the projectile is provided for this purpose with an axial hole 6 into which the air enters, said hole giving access to a canal 7 which runs obliquely. The external ring of the gyroscope is shaped as a hollow sphere 8 (Figs. 1 and 2) provided with hole 9 through which the air current issuing from the canal 7 enters. The said hollow sphere can revolve round the axis *zz*, and the hole 9 provided in it, is placed in the diametral plane coinciding with the mean plane of the rotating mass 2.

This latter is provided at its periphery with ribs, or with recesses 10, which act in the manner of turbo-blades, against which impinges the air current entering through the hole 9, whenever during the rotation of the sphere, said hole passes under the canal 7; thus the rotating mass receives an impulse at every revolution of the projectile.

The air which has entered the sphere through the hole 9, leaves through another hole 11, and is discharged outside through the holes 12, provided on the head, and which are suitably disposed and inclined so as to discharge the air in the depression zone which is formed on the surface of the projectile.

In normal conditions the sphere 8 is kept stationary, for example, by a small pivot 13 (Fig. 1) which may be sunk by inertia into a corresponding recess 14 when the projectile is fired, thus releasing the sphere and the gyroscope.

In order to set free the sphere and the gyroscope, the centrifugal force may also be used, as shown by way of example in Fig. 2, which shows that the blockage of the sphere is obtained by a small pivot 15, the centrifugal force acting upon it causes it to re-enter into a cavity 16, against the action of a spring which normally keeps it in engagement into a hole or recess provided in the sphere.

It is also to be understood that instead of a whole hollow sphere, a single disc 17', as shown in Fig. 6, can be used, said disc may be fitted on the axis *zz*, and it can also be provided with a hole 9, in such a way that at every revolution of the projectile, said hole comes in correspondence with the outlet of the small channel 7.

It is to be understood however, that the method already adopted in gyroscopes may also be used, said method consisting in maintaining the rotating mass in movement by a constant flow of air upon its periphery, the driving air issuing from a channel inserted into and embodied with the suspension supporting the gyroscope axis; said flow being fixed relatively to space, which condition prevents the formation of any disturbing couple that may be caused by the action of the flow, and which ought to be conveniently balanced.

The time setting mechanism, one part of which is shown in Fig. 7, comprises a train of gearings fitted with normal or differential teeth connecting the pinion 5 (Fig. 6) carried by the axis *zz*, to the wheel 17 which regulates the movement of the firing pin when the projectile has completed the pre-determined number of revolutions assigned to it. The said train of gearings (Fig. 7) comprises also, according to the present invention, two wheels 18 and 19 which are endowed with two degrees of freedom when the fuse is unarmed, which engage only at the moment of firing.

These two wheels are each connected with one of the two graduation wheels 20, and 21, acting relatively to the number of revolutions, their peripheries being corrugated and projecting slightly through two openings provided on the head of the projectile.

The use of these two free wheels serves to facilitate and accelerate the graduation during the firing against the same target, of a series of shots which must be corrected successively; in fact from the time setting machine a projectile may be loaded directly into the gun without waiting to know the result of the preceding shot the distance of the explosion of which, which is revealed by the observer appointed for this purpose, must serve for correcting the graduation of the following shot. Such correction being small, it can be immediately effected by rotating by hand the wheels 20 and 21.

When the firing occurs, the inertia produces the backward movement of the wheel 18, which consequently engages with the wheel 19 from which it receives its movement, and at the same time disengages itself from the connection with the wheel 20 with which it was previously connected, for the rotating movement, by means of

a small pivot 22 for example, or by any other equivalent means.

In this working position, the wheel 18 is locked by means of lock-snapping device acting on the spindle 23 which carries it and is movable with it, and at the same time forms the connection by means of the coupling 24—25 with the pinion 26, the spindle 27 of which penetrates into the shaft 23. The pinion 26 engages with the last wheel 79 of the gearing which must produce the release of the firing pin, for example, by means of a pivot 28, or by a recess 29, or by means of a cam connected with it.

The device for releasing the firing pin by means of a cam is shown in detail in Fig. 8. This figure shows the shaft 30 carrying the wheel 79, carries also mounted on it a cam 31, the outline of which shows a stop 32 suitably disposed. On the periphery of the cam 31 is made to rest an arm 33 of a lever, the lever being pivoted on the pivot 35, the other arm 36 of the lever being under the action of a pull spring 37. This device is suitably disposed so that its working is not disturbed by the action of the centrifugal force. While the outer end of the arm 33 rests on the periphery of the cam 30, the other arm is thereby kept into a wedge or recess 38 provided in the firing pin which consequently remains locked.

When the step 32 reaches under the end of the lever arm 33, the spring 37 pulls back the arm 36 thus leaving free the percussor to snap.

It is however necessary in order to prevent that, during the time setting, the tooth 32 when passing under the end of the arm 33, may allow it to drop, thus releasing the firing pin. In order to prevent this occurrence, the extension 66'' is provided which, during the setting of the graduation, impinges against a retractile stop tooth 67'', thus preventing the dropping of the arm 33 and the consequent release of the firing pin. The stop tooth 67'' is subsequently removed when the projectile is fired from the gun either by the effect of the axial or tangential inertia, or by the centrifugal force developed, thus leaving the wheel 31 free to work. With this arrangement it is possible to obtain the working of the projectile with the time graduation set to zero, causing the end of the arm 33 to rest within the distance of a few turns from the step 32, or else by setting free the firing pin after having released the safety devices.

It may also be required that the fuse may not work in case it should have been forgotten to graduate it, when it is supposed that the mounting position is that corresponding to the extension 33 resting against the tooth 32, at the beginning of the profile indicated at 31', with the setting to zero, and that the arc that can be utilized for the graduation is 66'—66''. In this case the arrangement that can be adopted is shown in Fig. 9, the left half side of which shows the position of the point of the firing pin after it has been unlocked from the lock 36, which occurs when the tooth 32 has passed under the end of the arm 33, letting it drop. In this position, the point 46 of the firing pin rests against the sliding bar 56, which acts like a shutter and holds it, as it penetrates into the recess 68 provided in it. In this position the centrifugal force has no effect and the fuse remains in the safety position. If however it is desired, when the fuse has been inadvertently left to the zero graduation in the inoperative position, to prevent the gyroscope to transmit its rotation to the cam 31, thus recharging it in error, a stop notch formed by an extension 66'' joined to the cam 31 can be provided as shown in Fig. 8, said extension 66'' meeting in its movement a stop notch 67'', in such a way that the working of these two parts does not hamper the regular working of the other two parts 66' and 67', a result which can be obtained, for example, by arranging the two pairs at various heights.

When on the other hand the fuse has been set and the arm has been brought in the raised position as shown in Fig. 8, the arm 36 enters the wedge 38 which is provided with sloping planes, the firing pin is thereby raised charging the snapping spring 69, the point 46 is withdrawn from the recess 68, thus leaving free the small bar 56 to operate as hereinafter described.

It will be clear that also in this case it is possible to obtain the working of the fuse set to zero, by disposing the arm 33 to rest on the cam 31 within a few turns in addition to those prearranged for the unlocking of the safety device.

It is however also necessary to prevent that the firing pin or the movable portion of the two elements, percussor and detonator, which by their impact produce the lighting of the exploding charge, in case of a percussion fuse, or such part of percussion added to the automatic devices provided for pre-arranged distance, may explode prematurely before the delivery of the shot, or while the projectile traverses the bore of the cannon or at a small distance after leaving its mouth.

The safety mechanism shown in Fig. 10 provides against this contingency.

As shown in figure, the firing pin 38 is maintained into a fixed position by an extension 40 which enters into a cylindro-conical notch 39. The said appendix 40 is carried by a piston 41 which can slide in a radial direction inside a cylinder 42, which communicates with the outside through an opening 43.

A spring 44 keeps the piston 41 in the position shown in Fig. 10, in which the percussor is shown to be blocked.

When the shell leaves the gun the centrifugal force produced by the rotation of the projectile would have a tendency to shift the piston 41 outward, thus unlocking the firing pin. According to the present invention however, advantage is taken of the difference of air pressure on the head of the projectile, occurring while the projectile is traversing the bore of the gun, and after leaving its mouth, in order to ensure the projectile from the danger of exploding while it is still inside the gun.

In fact it is known that while the projectile is inside the gun traversing its bore, the air pressure on the head of the projectile which is of a static nature, and consequently propagates in all directions, is very high, reaching or surpassing a pressure of 20 kilos per square centimetre; after the projectile has left the mouth of the gun however, the stream lines of the air current are formed which take place after the projectile has already traversed a certain distance of its trajectory depending on the value of its initial velocity, during which it still maintains a positive acceleration, the pressure, which has become dynamical pressure, becomes considerably lower on its head, while on its sides, no-pressure zones are formed as well as under-pressure zones.

Consequently if the hole 43 is suitably placed, and by conveniently proportioning the diameter of the cylinder 42, the weight of the piston 41, and the strength of the spring 44, it can be obtained

that the effect of the air pressure is greater than that obtained by the centrifugal force, thus keeping blocked the piston 41, while the projectile is still inside the gun and until, after it has left the mouth of the gun, the normal flux of the air stream lines has been established. In this way the explosion of the projectile while it is inside the gun or soon after leaving it, is prevented.

From the foregoing it is apparent that the spring need not to be very strong; it is sufficient that it may hold the firing pin before the firing, and then, in case that for any reason the projectile should drop unexploded, it is sufficient that the spring may bring the extension 40 into the recess 39 of the firing pin for the conical coupling thus re-establishing the safety position and rendering the projectile inoffensive.

The effect due to the difference of pressure inside and outside the bore of the gun, can also be made use of for retarding the initial working of the gyroscope as a turn recorder.

To obtain this object, it is sufficient, as shown in Fig. 4, to provide a channel 64 between the cavity 16 into which slides the piston 15 which serves to block the gyroscope, with the outside. In the figure the movement of ring 3 is supposed to be blocked.

I claim:

1. Fuse mechanism for projectiles having a rotating movement round their longitudinal axis simultaneous with their movement of advance, comprising in combination safety, firing and snapping devices, a gyroscope, the permanent axis of which can be set and maintained perpendicular to the axis of the trajectory of the projectile, means for starting the movement of the rotating mass of the gyroscope when the shot is fired, means for maintaining the movement of rotation of the gyroscope, means for connecting the axis of the gyroscope to the said safety, firing and snapping devices in order to control the same in accordance with the number of rotations made by the projectile.

2. Fuse mechanism according to claim 1, provided with relatively inert masses which are movable radially and operate by their inertia by means of the centrifugal force developed by the rotative movement impressed upon the projectile when the shot is fired and effect unlocking of the rotating mass and of the gyroscope.

3. Fuse mechanism according to claim 1, provided with relatively inert masses which are movable in the axial direction by their inertia, which movement is caused by the longitudinal acceleration produced when the shot is fired, and effects the unlocking of the rotating mass and of the gyroscope.

4. Fuse mechanism according to claim 1, provided with relatively inert masses subjected to the combined action of inertia due to the centrifugal force of rotation of the projectile and to the inertia due to the longitudinal and angular acceleration of the projectile produced when the shot is fired and providing a resultant force causing a displacement of the said masses, said masses then operating to effect unlocking of the rotating mass and of the gyroscope.

5. Fuse mechanism according to claim 1, provided with springs which are adapted to act when the shot is fired and effect starting of the rotating mass of the gyroscope after said rotating mass has been released.

6. Fuse mechanism according to claim 1 having means for maintaining the rotation of the gyroscope including an air channel provided on the head of the projectile, a hollow sphere enclosing the gyroscope and provided with a hole which at every turn of the projectile comes in coincidence with said air channel allowing a current of air to impinge against the periphery of the rotating mass of the gyroscope, and blades on said rotating mass adapted to receive an air current impulse at every revolution of the projectile.

7. Fuse mechanism for projectiles having a rotating movement round their longitudinal axis simultaneously with their movement of advance, comprising safety devices and a firing pin, a gyroscope adapted to effect operation of the safety devices and setting of the firing pin in the firing position, a gear train associated with the gyroscope axis and operated thereby, a stop lever, a locked suspension for the gyroscope, means for unlocking said suspension so as to effect the setting of the firing pin in said firing position, said stop lever being mounted on the last element of said gear train, said locked suspension including a cam disposed adjacent to and adapted to act on said stop lever, the said unlocking device being operated by the aerodynamical pressure acting on the projectile when it leaves the mouth of the gun, at which point the initial acceleration has come to an end and the air current lines have been established.

8. Fuse mechanism according to claim 1, provided with blades or ribs associated with the rotating mass of the gyroscope, and when in flight also provided with means for maintaining the movement of rotation of the projectile during such flight comprising an air current entering into the fuse from the point of its head and acting on said blades or ribs, and means causing said air current to operate intermittently on said blades or ribs.

9. Fuse mechanism for projectiles having a rotating movement round their longitudinal axes simultaneously with their advance movement, which fuse mechanism is provided with a gyroscope of which the permanent axis is capable of being set and maintained perpendicular to the axis of the trajectory of the projectile, means for releasing the rotating mass of the gyroscope, means for maintaining the rotation of said rotating mass during flight comprising blades or ribs associated with the rotating mass and in flight comprising an air current entering the fuse from a point upon its head and impinging intermittently on said blades or ribs, a firing pin, means for predetermining by adjustment from the exterior of the fuse the intended number of revolutions to be made by the projectile before detonation thereof occurs, comprising a regulating wheel, there being an oscillating stop lever which is retracted from the firing pin upon the projectile having made said intended number of revolutions, which regulating wheel acts upon said oscillating stop lever in its retracted position, and means preventing the release of the firing pin during adjustment of the fuse.

10. Fuse mechanism according to claim 9, provided with means preventing the operation of the fuse in case adjustment thereof has been omitted, comprising a radially movable slide bar adapted to make contact with the firing pin of the fuse, there being a recess in said slide bar for receiving the point of the firing pin in order to prevent movement of the slide bar from the effect of centrifugal force.

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