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The field of the present invention is that of safety devices intended for locking a firing pin for a fuse of a spin-stabilised projectile.

Projectiles, notably medium calibre shells, are fitted with safety devices intended to prevent initiation of the pyrotechnic circuit before firing and during the first few tens of metres of their trajectory.

A known safety device consists of a lock, for example a split sleeve, which immobilises the projectile firing pin in translation, and which is surrounded by a spiral spring consisting of an elastic strip wound upon itself.

Patent DE1197786 describes such a safety device for a medium calibre projectile fuse.

The lock consists of a strip folded back upon itself so as to form a sleeve with a hexagonal profile. The sleeve acts as a stop for a shoulder on the firing pin thus preventing the said pin from striking a detonator.

Because of its split structure, the lock is able to open under the action of the centrifugal force exerted upon it during firing. The opening of the lock allows the firing pin to move in translation, for example at impact on a target.

A spiral spring is wound around the lock. The function of the spiral spring is to delay the time at which the lock opens. Since this opening occurs only after a few tens of metres of trajectory the gun crew is protected.

The centrifugal force which acts on the spring during firing thus causes it progressively to unwind and to wind up against the wall of a cylindrical housing in the fuse. Once the spring is completely unwound, the lock can then open and release the firing pin.

Such a device has disadvantages. For example misfires have been observed owing to the fact that the

spring can form unwanted loops which interfere with the firing pin and prevent it from moving freely.

The purpose of the invention is to propose a safety device not suffering from such drawbacks.

5 The safety device according to the invention ensures that, during firing, the spiral spring remains properly wound against its cylindrical casing without forming unwanted loops that are liable to prevent the firing pin from striking the detonator.

10 Thus the purpose of the invention is a safety device intended to lock a firing pin for a spin-stabilised projectile fuse, the said device comprising a spiral spring consisting of an elastic strip wound upon itself and held by its own elasticity around a
15 locking device which maintains the firing pin in the safety position, this device being characterised by the fact that the locking device consists of a flexible strip wound around the firing pin the material and geometry of which are such that it exerts no elastic
20 return force towards the firing pin, the length of the strip being such that, when it is unwound during firing following the spiral spring and applied against the said spiral spring by the action of the centrifugal force, its ends overlap.

25 According to one embodiment of the invention, the flexible strip comprises grooves, which are preferably orientated towards the firing pin.

The firing pin may then be cylindrical or have a polygonal section, preferably hexagonal.

30 The grooves may have a variable pitch allowing the strip to wind around the firing pin to form a polygonal shape.

If the firing pin has a polygonal section, the grooves of the strip will then be positioned, as it
35 unwinds, at the corners of the polygon.

According to another characteristic of the invention, the strip is such that, once it has unwound

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following the spiral spring, its ends overlap on an arc of between 60 and 180 .

Another purpose of the invention is a process for producing such a device, the process being
5 characterised by the fact that it comprises a stage of manufacturing the grooves in the strip by knurling a smooth strip between a knurling wheel and a backing pulley.

10 Knurling can be done using a variable pitch knurling wheel.

In a variant, the strip may be pulled between the knurling wheel and the backing pulley by the rotation of a polygonal shaft on which the knurled strip winds up, this polygonal shaft consisting of the
15 firing pin.

The invention will be better understood from the following description of particular embodiments with reference to the attached drawings on which:

- figure 1 is a schematic axial section of a
20 safety device according to a first embodiment of the invention, the device being shown in the safe position;

- figure 2 is a transverse section of this device through the plane shown by the line AA on figure 1;

25 - figure 3 is a similar view to figure 2, the device being shown in the unlocked position;

- figure 4 is a transverse section of a variant embodiment of the invention in the safe position;

30 - figure 5 shows this variant with the device shown in the unlocked position;

- figure 6 is a transverse section of a second embodiment of the invention in the safe position;

35 - figure 7 shows one stage in the production of the flexible strip used in the first embodiment of the invention;

- figure 8 shows one stage in the production of the flexible strip used in the second embodiment of the invention.

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With reference to figures 1 and 2, a safety device 1 according to a first embodiment of the invention is intended to lock a firing pin 2 in a safe position in which it is unable to strike a detonator (not shown).

The safety device consists of a cylindrical casing 3 closed by a cover 4 which is attached to the casing for example by screws (not shown).

The casing encloses an internal cylindrical space 14.

The casing is intended to be placed in a projectile fuse (not shown). It will be attached to the fuse by means of an external thread 5.

A hole 6 is drilled in the casing 3 to allow the point 2a of the firing pin 2 to penetrate and fire the detonator. The cover has an opening 7 through which the firing pin 2 penetrates the casing 3.

The firing pin 2 has a shoulder 8 which bears against a locking device 9. As can be seen particularly clearly on figure 2, the locking device 9 consists of a flexible strip spirally wound around a shank 2b integral with the firing pin 2. The strip 9 has grooves 10 parallel to one another and to the centre line 11 of the device.

The strip 9 may be made of brass, beryllium copper, stainless or other steel, nickel, or plastics material reinforced or otherwise. The material will be chosen according to the desired rigidity for retaining the firing pin 2 and the amplitude of the centrifugal forces developed when the projectile considered is fired.

The function of the grooves 10 is to give a degree of flexibility to the strip 9, allowing it to be wound around the shank 2b of the firing pin 2 and facilitating its unwinding by using the minimum energy.

In this way it is possible to define a locking device that is both very strong (owing to the

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substantial thickness of the strip) and very flexible owing to the presence of the grooves.

The strip will also be defined in such a way that it exerts no elastic return force towards the firing pin both when wound as shown in figures 1 and 2 and when unwound after firing, as will be described below.

The strip 9 is maintained in the firing pin locking position by a spiral spring 12 of known type.

This spring is formed by an elastic brass strip wound upon itself and kept wound upon the strip 9 by its own elasticity. Other materials could be used for making the spiral: nickel, stainless steel, copper/beryllium, and so on. An elastic clip 13 made of steel or brass maintains the spiral spring 12 in its safe position shown on figures 1 and 2, which prevents any accidental unwinding of the spiral when the projectile is exposed to vibration, for example during transport.

In the embodiment described here, the strip 9 is wound on the shank 2b of the firing pin 2 in such a way that the grooves 10 face outwards, i.e., towards the spiral spring 12.

Such an arrangement facilitates the winding of the strip on the firing pin, and in fact it is then the smooth surface of the strip which is in contact with the firing pin shank.

In a known manner, when the round is fired, the centrifugal inertial force first causes the opening of the clip 13, which is pressed against the inner cylindrical surface 15 of the space 14.

The spiral spring 12 then unwinds progressively and winds up in a spiral against the inner cylindrical surface 16.

When the spiral spring 12 has completely unwound, the strip 9 unwinds in its turn and winds up against the spiral spring.

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The unwinding of the strip is facilitated by the presence of grooves which give flexibility even to a relatively thick strip.

5 The device is then in the unlocked position shown on figure 3.

The diameter of the shoulder 8 of the firing pin is shown by the dotted circle 16. It can thus be seen that the strip 9 and the spiral 12 in the unlocked position show a winding diameter greater than the diameter of the shoulder 8. The shank of the firing pin 2 is then free to move into the hole 6.

Figure 3 also shows that the length of the strip 9 is such that in the unlocked position its ends 9a and 9b partially overlap over an arc subtending an angle α at the centre.

This essential feature of the invention ensures that the spiral spring 12 is maintained in an arc of 260° by the unwound strip 9.

In this way the formation of unwanted loops on the spiral spring 12 is avoided. The formation of such loops is usually caused by friction on the spiral spring of a lock of the type described in DE1197786.

As a result of the invention, the overlapping of the ends of the strip ensures that the spring is maintained with a centrifugal force substantially equal in all radial directions. Hence there is no relative slip between the strip and the spring and no formation of unwanted loops.

The strip 9 may be given a length such that the arc of overlap subtends an angle at the centre of between 60° and 180° , the preferred angle being of the order of 120° .

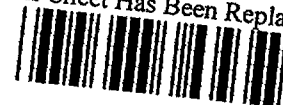
One end of the strip 9 giving an overlap over 180° has been shown as a dotted line 17.

35 Owing to the fact that the strip exerts no elastic return force towards the firing pin in the unlocked position, it has no unwanted curvature at its ends.

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Since the strip does not exert an elastic return force towards the firing pin in the wound-up position, it is therefore able to turn freely on the firing pin which facilitates the unwinding of the spiral and makes it possible to define a fuse whose firing pin is fixed in rotation.

Figures 4 and 5 show a variant of construction which differs from the method described with reference to figures 2 and 3 only in the orientation of the strip 9.

In this variant the strip 9 is wound on the shank 2b of the firing pin 2 with its grooves 10 facing inwards, i.e., towards the firing pin.

Such an arrangement improves the contact between the strip and the spiral spring when the strip winds on the said spring during firing. In fact it is then the smooth face of the strip 9 which comes into contact with the spiral spring. In this way the spiral spring is better held against the inside cylindrical surface 15.

As a variant it is possible to define a strip without grooves. The material will be chosen in such a way as to produce a strip exerting no elastic return force towards the firing pin but having nevertheless a certain rigidity along the direction of the centre line 11 of the device, in order to ensure locking of the firing pin.

For example it is possible to define a brass strip 0.4 mm in thickness.

The material of the strip may with advantage be chosen such that under the action of the centrifugal force it undergoes plastic deformation enabling it to be held in the unlocking position shown in figures 3 and 5.

Figure 6 shows a transverse section of a second embodiment of the invention in the safe position.

In this method of construction, the shank 2b of the firing pin 2 has a hexagonal section. The strip 9

has grooves 10 which face inwards, i.e., towards the shank 2b of the firing pin, and which are positioned at the corners of the hexagon.

5 The different grooves 10 on the strip 9 are made with a variable pitch which allows the strip 9 to be wound around the shank 2b.

10 Thus the groove separation is constant for the first six grooves, allowing a first layer of the strip to be wound around the six sides of the firing pin shank. The pitch then increases for the next six grooves by an amount proportional to the thickness of the strip 9, allowing a second layer of the strip 9 to be wound around the hexagon formed by the first layer. The pitch then increases for the following layers.

15 The total length of the strip is chosen as before so as to ensure overlap of its ends when after firing it is wound over the spiral spring by the action of centrifugal force.

20 Such a method of construction allows, as before, the spiral spring to be satisfactorily retained owing to the contact of the smooth surface of the strip upon it.

25 It also enables the strip to be wound satisfactorily upon the firing pin shank and angular integrity of these two elements which improves the device's ability to withstand vibration.

In this case however the firing pin will be fitted so that it is free to rotate in the fuse so as to facilitate the unwinding of the spiral.

30 Correct winding also makes it possible to avoid the strip and firing pin from being out of true which would be likely to cause out-of-balance forces which have an adverse effect on the correct operation of the fuse.

35 The winding of the spiral during assembly of the device is also facilitated by the angular link between the strip and the firing pin.

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As an example for a projectile of calibre 30 mm it is possible to adopt a brass strip 3 mm wide and 0.4 mm thick with grooves 0.3 mm deep.

Four turns of this strip are wound on a hexagonal firing pin shank (width of each face: 1.6 mm) and receives a spiral spring 1 m long.

When, after firing, the spiral is pressed against the cylindrical wall of the recess (diameter 14 mm), the ends of the strip overlap by an amount subtending an angle of 10° at the centre.

As a variant it is of course possible to define a firing pin with polygonal section on which will be wound a strip for which the variable pitch of the grooves will be selected according to the polygon's number of faces.

Figure 7 is a schematic illustration of one stage in the production of the flexible strip which is used in the embodiments shown in figures 2-5.

The basic strip 91 is unwound from a coil not shown. It passes between a knurling wheel 18 and a backing pulley 19. The knurled wheel is made of steel, and is driven in the direction Z by a motor 20 and not only pulls the basic strip 91 but also produces on it the grooves 10.

For this purpose the wheel 18 has teeth 21 of triangular profile, the length of which is greater than or equal to the width of the strip 9 and whose separation determines the pitch of the grooves 10.

The backing pulley spins free on the bearings 22, the gap between the backing pulley and the knurled wheel can be varied in order to adjust the depth of the grooves 10.

The backing pulley 19 has a width greater than or equal to that of the strip, and is covered with rubber in order to entrain the strip and prevent any relative slip.

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The strip 9 on which the grooves 10 are made is then cut to the desired length by means of the blades 23 whose known means of operation are not shown.

This method of construction also makes it possible to give the strip a bow orientated towards the knurled wheel, which facilitates its subsequent winding on the firing pin.

Figure 8 shows schematically one stage in the production of the flexible strip which is used in the method of construction of figure 6.

The basic strip 91 passes between the knurled wheel 18 and the backing pulley 19. The knurled wheel is again driven in the direction Z by a motor 20 which pulls the basic strip 91 and produces the grooves 10.

The backing pulley 19 spins free on the bearings 22, the gap between the backing pulley and the knurled wheel is again adjustable.

In this embodiment, the knurled wheel has teeth 21 of varying pitch. Thus it has 6 first teeth 21a, relatively close to one another and separated at a constant first pitch.

These first teeth are followed by 6 second teeth 21b, a little farther apart from one another at a constant second pitch.

The second teeth are then followed by 6 third teeth 21c, again farther apart from one another at a constant third pitch.

The set of teeth 21a, 21b and 21c makes it possible to produce on the basic strip 91 grooves whose variable pitch allows the strip 9 to be wound on a hexagonal shank as previously described. The strip 9 is then cut to the desired length by means of the blades 23.

According to a variant of this process, the strip 9 can be pulled by means of a hexagonal shaft on which the formed strip is wound.

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This hexagonal shaft will preferably consist of the shank 2b of the firing pin 2, driven in rotation in the direction Z' by a motor not shown.

5 There is then no need to provide a motor to drive the knurled wheel.

The advantage of this process is that it produces directly a firing pin 2 fitted with its locking strip 9 with the strip wound on the firing pin to a well determined tightness.

10 To adjust the tightness it will be sufficient to modify the tension of the strip 9 by varying the torque of the motor driving the firing pin and the resisting torque of the backing pulley or the knurled wheel (fitted with adjustable brakes).

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CLAIMS

1. Safety device intended for locking a firing pin for a spin-stabilised projectile fuse, device comprising a spiral spring (12) consisting of an elastic strip wound upon itself and pulled back by its elasticity around a locking device which maintains the firing pin (2) in the safe position, device characterised by the fact that the locking device consist of a flexible strip (9) wound around the firing pin (2) and the material and geometry of which are such that it exerts no elastic return force towards the firing pin (2), the strip having a length such that when during firing it is unwound following the spiral spring (12) and pressed against the said spiral spring by the action of centrifugal force, its ends (9a, 9b) overlap.

2. Device according to claim 1, characterised by the fact that the flexible strip contains grooves (10).

3. Device according to claim 2, characterised by the fact that the grooves (10) are orientated towards the firing pin (2).

4. Device according to any of the claims 1-3, characterised by the fact that the firing pin is cylindrical.

5. Device according to claim 3, characterised by the fact that the grooves (10) have a variable pitch allowing the strip (9) to be wound on the firing pin to give a polygonal shape.

6. Device according to claim 5, characterised by the fact that the firing pin (2b) has a polygonal section, preferably hexagonal, the grooves (10) of the strip being located as it winds on at the corners of the polygon.

7. Device according to any of the claims 1-6, characterised by the fact that, once the strip has

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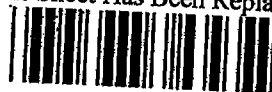
unwound following the spiral spring, its ends overlap along an arc of between 60 and 180 .

5 8. Process for producing a device according to any of the claims 2-7, characterised by the fact that it comprises a stage of producing the grooves (10) in the strip by knurling a smooth strip between a knurling wheel (18) and a backing pulley (19).

10 9. Process according to claim 8, characterised by the fact that the knurling is done with a knurling wheel (18) of variable pitch.

15 10. Process according to either of the claims 8 or 9, characterised by the fact that the strip is pulled between the knurling wheel and the backing pulley by the rotation of a polygonal shaft on which the knurled strip (9) winds, this polygonal shaft consisting of the firing pin (2b).

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