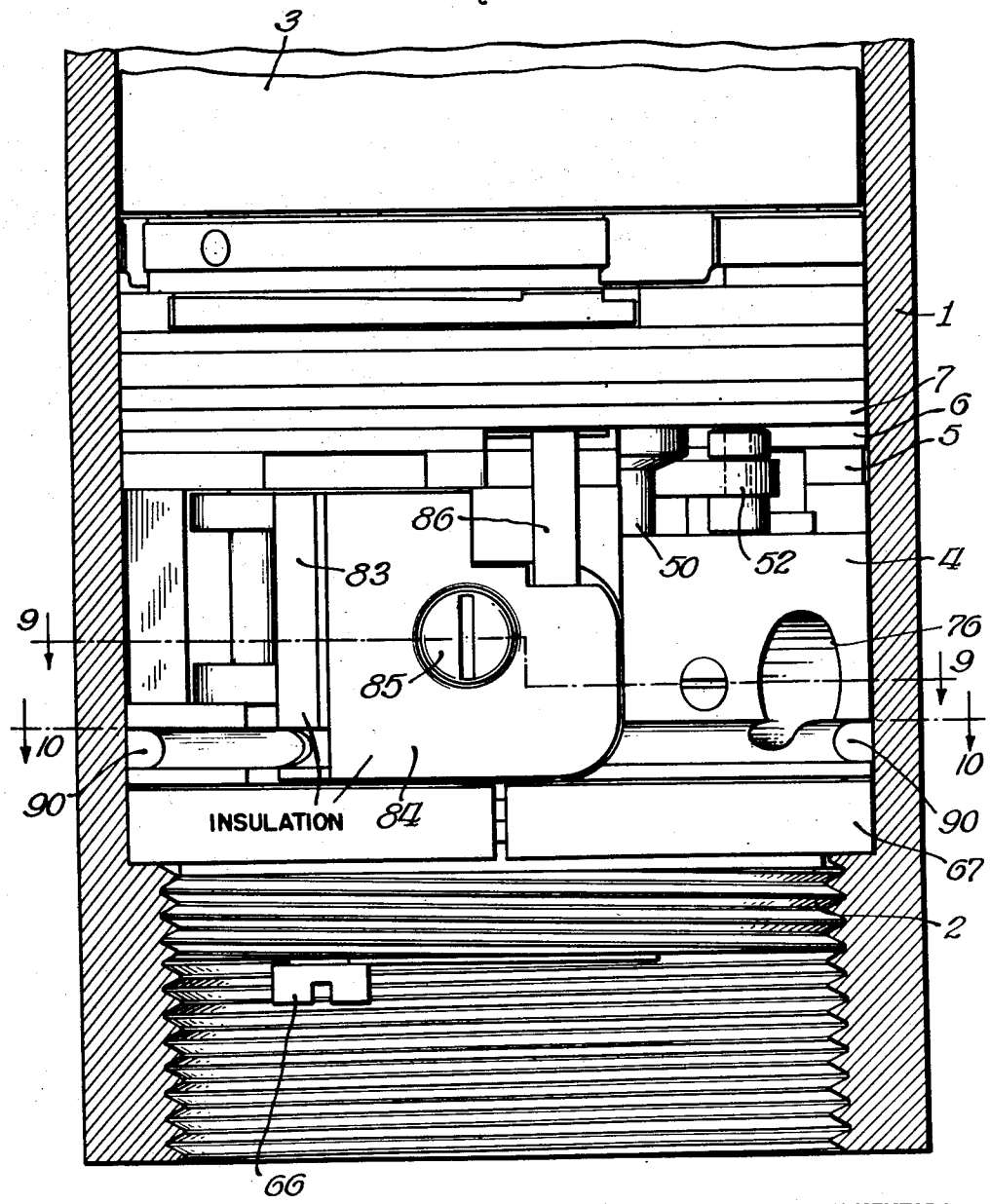
Nov. 7, 1950 J. FINK ET AL 2,528,823

MECHANICAL TIME FUSE

Filed July 3, 1944 6 Sheets-Sheet 1

Fig. 1.



INVENTORS:
Jean Fink and
Louis Hebbeln

BY

Atty.

Nov. 7, 1950 J. FINK ET AL 2,528,823

MECHANICAL TIME FUSE

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Fig. 2.

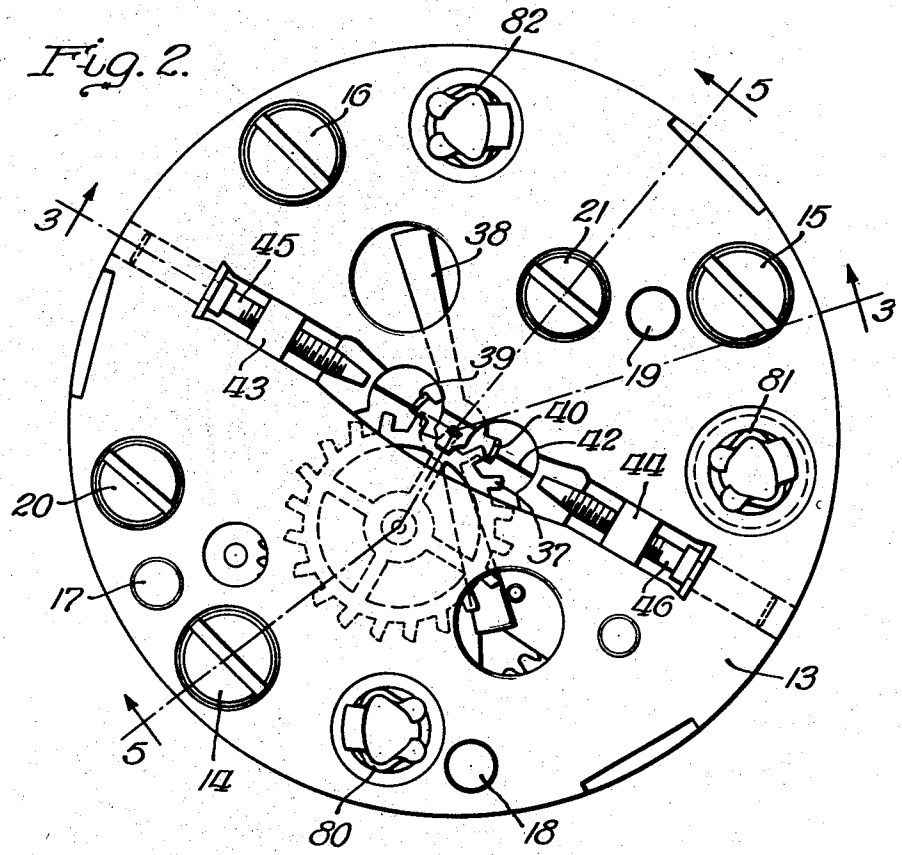
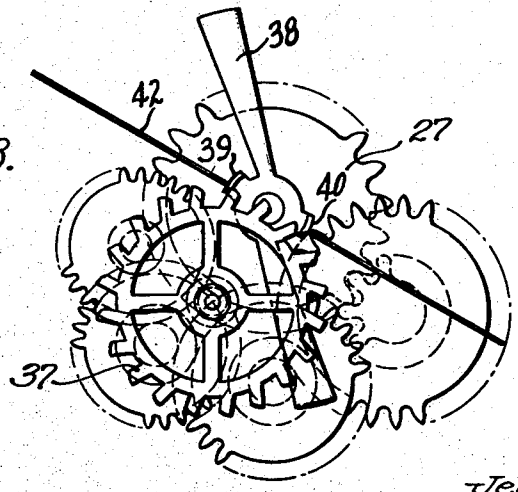


Fig. 8.



INVENTORS:
Jean Fink and
Louis Hebbeln

BY

R. S. Richardson

Atty

Nov. 7, 1950 J. FINK ET AL 2,528,823

MECHANICAL TIME FUSE

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Fig. 3.

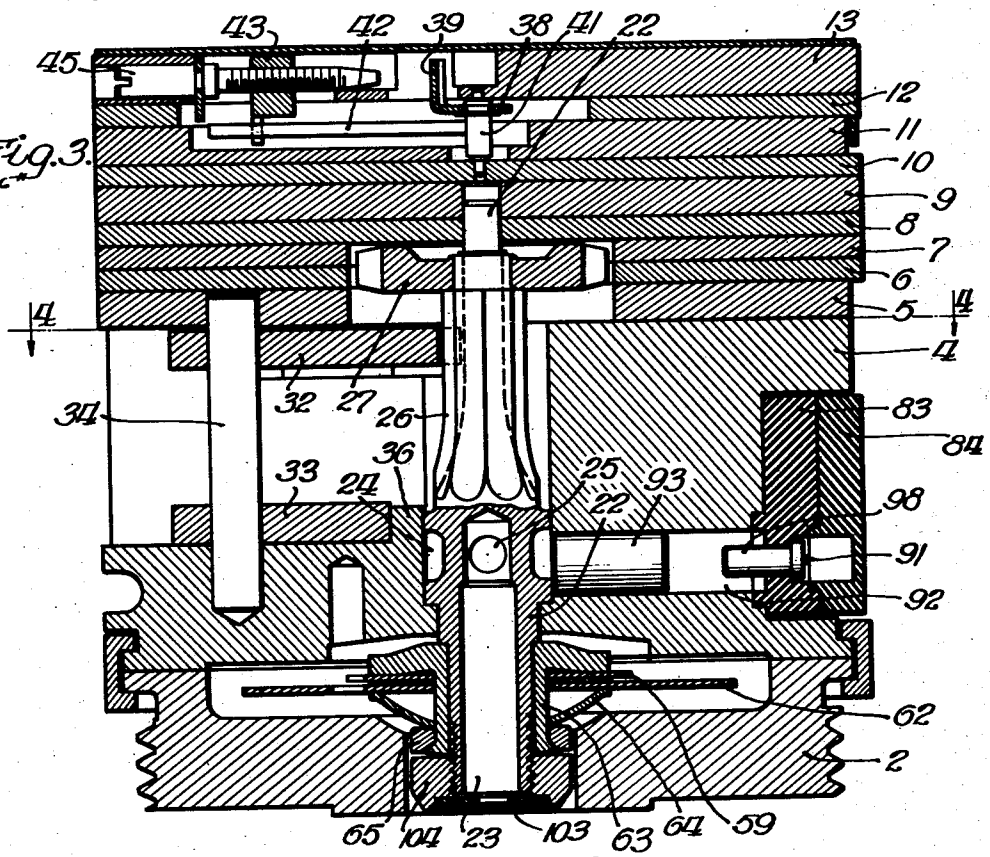
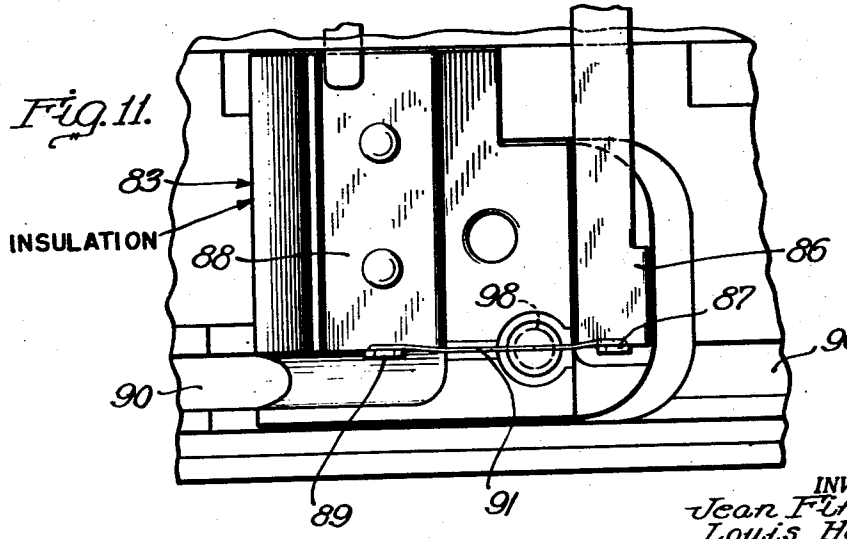


Fig. 11.



INVENTORS:
Jean Fink and
Louis Hebbeln
BY
R. B. Richardson
Atty.

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MECHANICAL TIME FUSE

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Fig. 4.

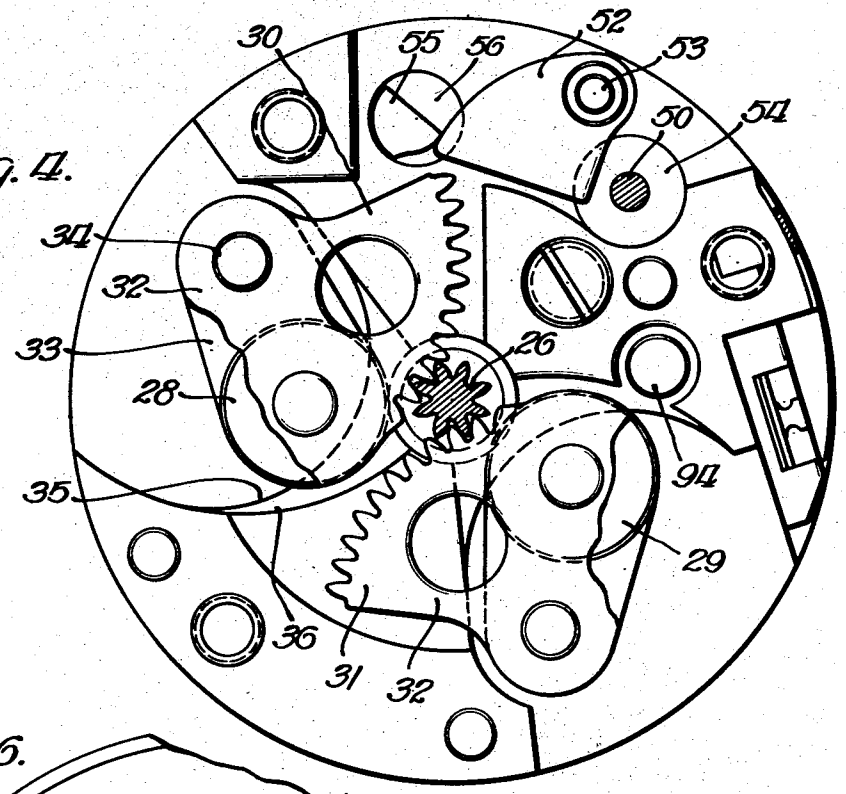
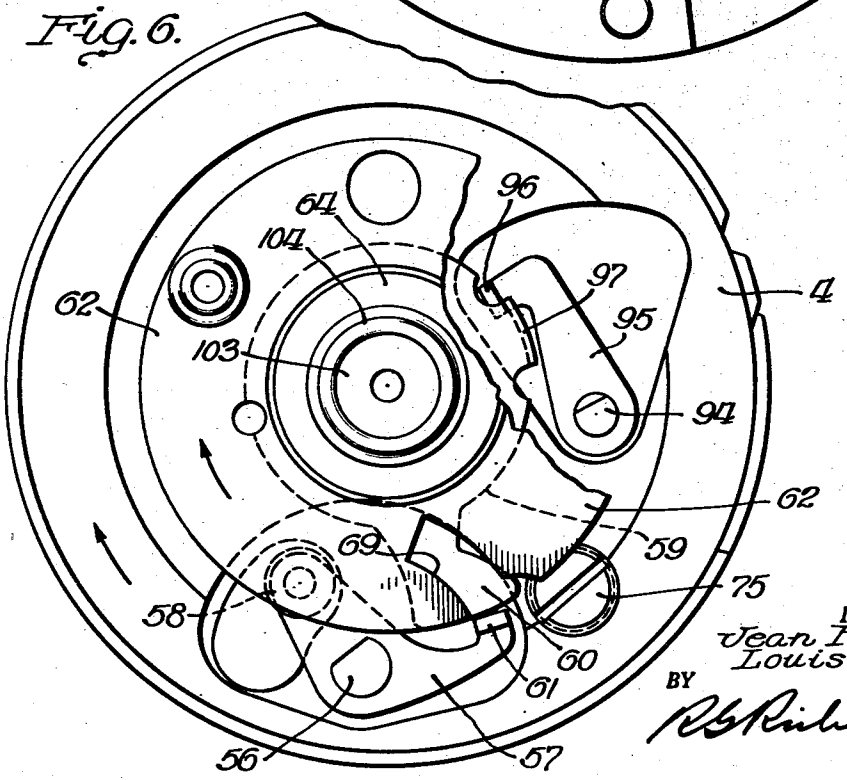


Fig. 6.



INVENTORS:
Jean Fink and
Louis Hebbeln
BY
R. B. Richardson
Atty.

Nov. 7, 1950 J. FINK ET AL 2,528,823

MECHANICAL TIME FUSE

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Fig. 5.

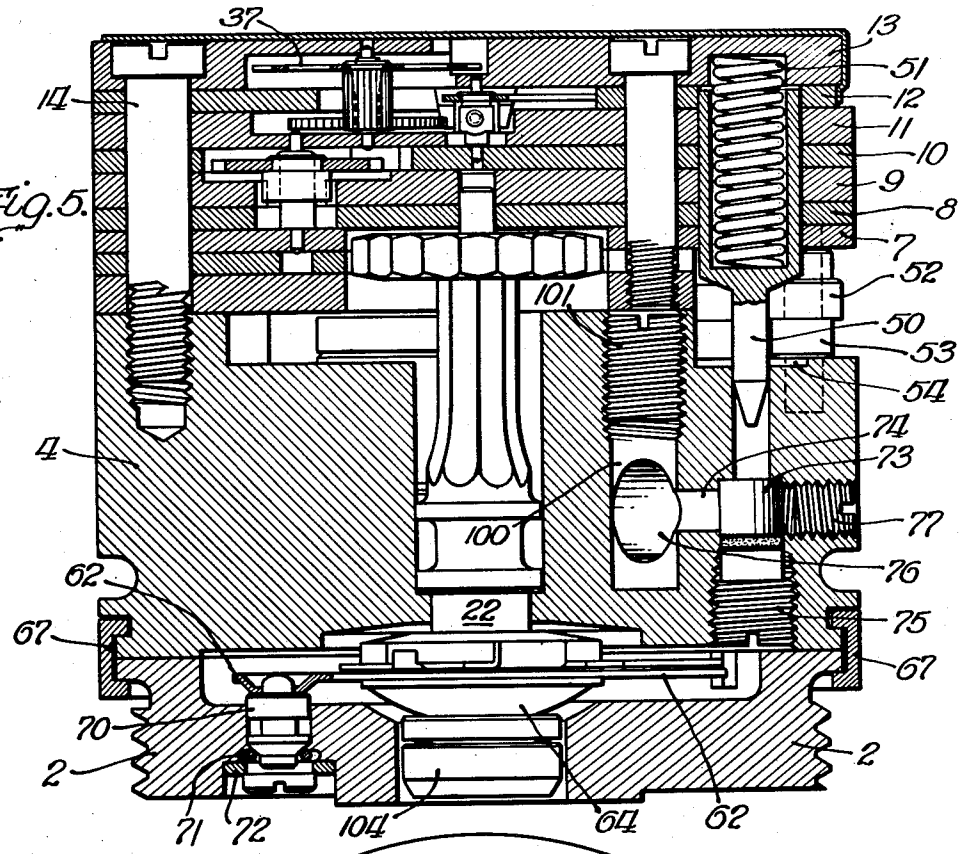
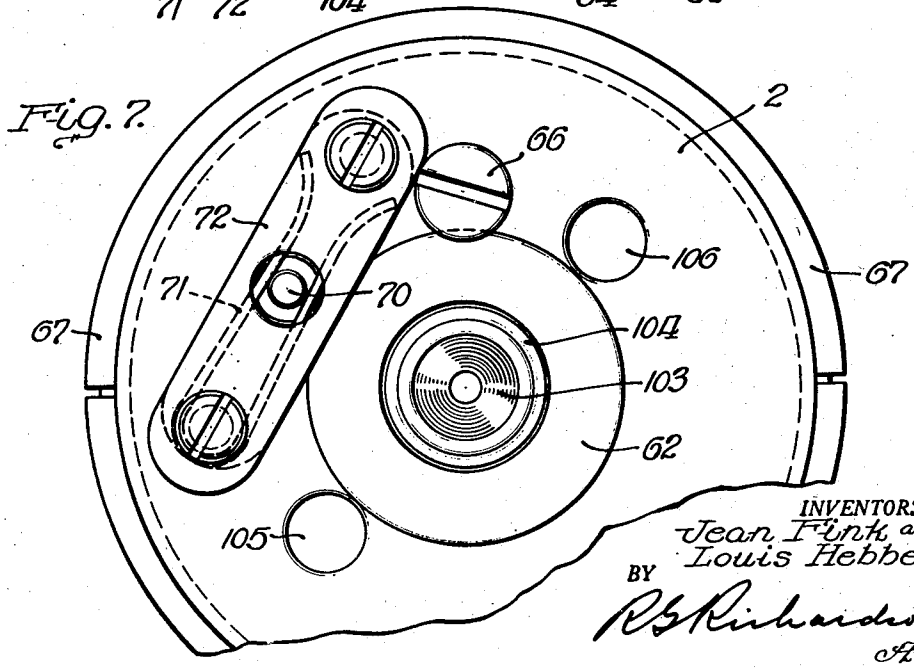


Fig. 7.



INVENTORS:
Jean Fink and
Louis Hebbeln
BY
R. S. Richardson
Atty.

Nov. 7, 1950 J. FINK ET AL 2,528,823

MECHANICAL TIME FUSE

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Fig. 9.

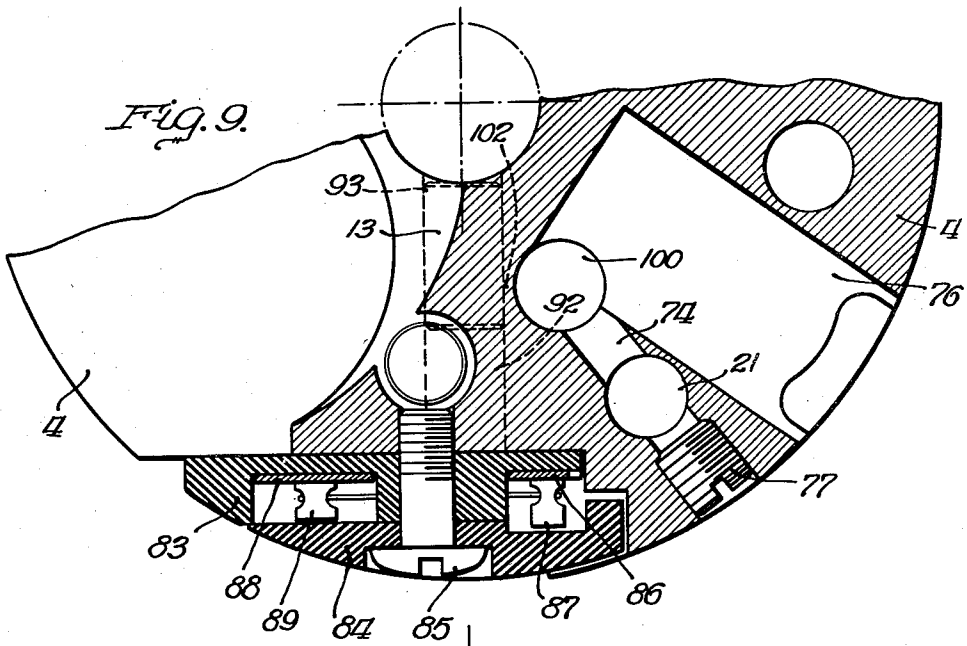
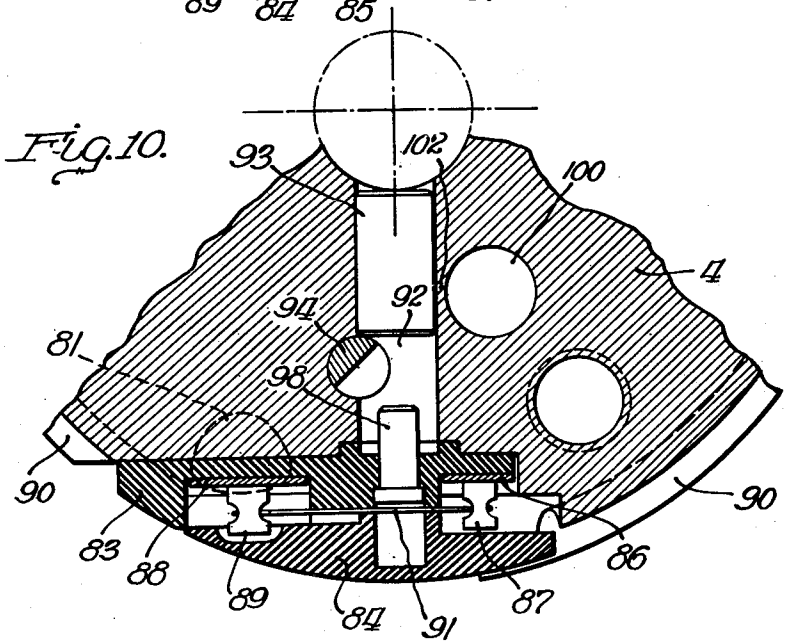


Fig. 10.



INVENTORS:
Jean Fink and
Louis Hebbeln

BY

Atty.

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UNITED STATES PATENT OFFICE

2,528,823

MECHANICAL TIME FUSE

Jean Fink and Louis Hebbeln, Delavan, Wis., assignors, by mesne assignments, to United States of America as represented by the Secretary of the Navy

Application July 3, 1944, Serial No. 543,302

7 Claims. (Cl. 102—71)

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The present invention relates in general to time fuses for projectiles, and more in particular to time fuses of the mechanical type employing clockwork mechanism driven by centrifugal force and functioning to explode the charge in the projectile a predetermined time after the projectile is fired.

A special feature of the invention is a mechanical time fuse of the foregoing type which is adapted for use in anti-aircraft shells which are equipped with electrical detonators. Such a shell becomes a hazard to the defense forces and to civilians if the electrical detonator fails to act; and it is desirable, therefore, to provide for self destruction in the air after a sufficient time has elapsed for the electrical detonator to operate. This object is satisfactorily attained by the inclusion of a time fuse in accordance with the invention.

When used for the purpose of self destruction the time fuse is set for a relatively long time interval, usually slightly longer than the time required for the shell to reach its maximum altitude. The fuses keep accurate time, however, and may be set for any desired time interval, which makes it possible to use ammunition in which they are installed in regular anti-aircraft fire.

The invention includes a number of features of improvement which will be described in detail hereinafter, reference being had to the accompanying drawings, in which—

Fig. 1 is a view of the new fuse in elevation, complete with closing screw, the drawing also showing in section a part of the can in which the fuse and the electrical detonator are enclosed;

Fig. 2 is a plan view of the fuse with the dust cover removed;

Fig. 3 is a section on the line 3—3, Fig. 2;

Fig. 4 is a section on the line 4—4, Fig. 3;

Fig. 5 is a section on the line 5—5, Fig. 2.

Fig. 6 is a bottom view of the fuse, with the closing screw removed;

Fig. 7 is a bottom view of the closing screw, showing the set back pin and spring;

Fig. 8 is a layout of the gear train;

Fig. 9 is a section on the line 9—9, Fig. 1;

Fig. 10 is a section on the line 10—10, Fig. 1; and

Fig. 11 is a view of the terminal block with the cover removed.

Referring to Fig. 1, the reference numeral 1 indicates a so-called fuse can, which is about 1⅞ inches in outside diameter and about 7 inches long. It may be machined from a section of

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seamless steel tubing. Only the lower end of the can is shown in the drawing. At the other end the can is slightly larger in diameter and is provided with external threads by means of which it is held in the shell and internal threads for attaching the nose of the shell by means of a sleeve or the like. The time fuse is contained at the lower end of the can, where it is held by means of the closing screw 2 which is threaded into the can as shown. The electrical detonator, the lower end of which is indicated at 3, goes into the can on top of the fuse, that is, it is located forward of the fuse toward the nose of the shell.

The frame of the fuse comprises a so-called squib block 4, preferably machined from a block of steel, and a stack of circular brass plates 5 to 13, inclusive. These plates are properly located relative to each other and to the squib block by means of three dowel pins 17, 18 and 19, and are clamped to the squib block by three machine screws 14, 15 and 16. There are two additional screws 20 and 21 which are threaded into the lower plate 5 and hold the plates together as a unit, which permits the plate assembly to be removed from the squib block without disturbing the position of the plates relative to each other.

The clockwork mechanism is supported in the plate assembly and is generally similar in mounting and construction to clockwork mechanisms which have been used in fuses before. It will be described briefly, however.

The main shaft is indicated at 22, and can be seen clearly in Figs. 3 and 5. It has two bearings, an upper bearing in the plates 8 and 9 and a lower bearing in the squib block. The lower part of the shaft is hollow, being provided with a central bore or firing passage 23, which is connected by means of a cross bore 25 with an annular passage 24 formed by a groove in the shaft. Toward the other end of the shaft teeth are cut to form the pinion 26 and just below the plate 8 the shaft carries the gear wheel 27. This gear wheel is fixed to the shaft and is the first wheel of the gear train.

The shaft 22 is driven by means of two weights 28 and 29 which move outward by centrifugal force when the shell containing the fuse is fired and rotate the shaft by means of two toothed sectors 30 and 31 which are in engagement with the pinion 26. The construction may be explained in connection with Figs. 3 and 4. The weight 28 is a short section of brass rod and is rigidly secured to two links 32 and 33, which are pivoted on the pin 34 supported between the

squib block 4 and the plate 5. The upper link 32 carries the integrally formed sector 30. The lower link 33 has a rounded end where it is attached to the weight 28, which engages the curved inner wall 35 of a ledge 36 when the fuse is fully wound up. This ledge 36, therefore, acts as a positive winding stop. This arrangement is an improvement on the arrangement formerly used in which winding was stopped by a tooth on the shaft pinion engaging the driving segment beyond the last tooth. The construction of the other weight 29 and associated parts is the same as described.

The gear train layout is shown in Fig. 8 and will not require any extended description. The gears and associated pinions are located in openings or recesses formed in the plates 5—13 and are supported on arbors which have bearings in the plates. The arrangement will be understood clearly from Fig. 5.

The first wheel of the gear train is the wheel 27, mounted on the shaft 22, as already mentioned. The last wheel is the escape wheel 37, seen in Figs. 8 and 5, and also shown in Fig. 2, partly by dotted lines. The escape wheel and associated pinion are mounted on an arbor which has bearings in plates 11 and 13 and drives the oscillatable pallet arm 38 by means of the two pallets 39 and 40 formed integrally therewith. The pallet arm is mounted on a member 41 which has shafts or arbors formed at its opposite ends which have bearings in the plates 13 and 10. The member 41 has a transverse perforation through which the hairspring 42 extends and in which it is fixed by a wedge. The ends of the hairspring 42 are located in slots cut in downwardly extending projections on the two blocks 43 and 44 which are slidable in recesses cut in the plate 13. The blocks may be moved along these recesses in either direction by means of the adjusting screws 45 and 46 to adjust the effective length of the hairspring and thus regulate the rate of the clockwork mechanism.

The primary function of the clockwork mechanism is to release the firing pin and fire the shell at the expiration of a predetermined time. The arrangement by which this is accomplished will now be described briefly.

The firing pin is shown in Fig. 5 and is indicated by the reference character 50. It comprises a lower pointed rod section which is slidable in a hole in the squib block and an upper cylindrical section which is slidable in a passage formed by aligned openings in the plates 7—12. The cylindrical portion of the firing pin contains a helical spring 51. When the firing pin is cocked, as it is shown in Fig. 5, this spring is compressed between the firing pin and the plate 13. The firing pin is held in cocked position by the engagement of the shoulder at the bottom of the cylindrical section with the centrifugally operated member 52 which is mounted on a short relatively heavy shaft 53 having bearings in the plate 7 and in the squib block 4. As can be seen from Fig. 4 the edge of member 52 normally overlaps the recess 54 formed in the top of the squib block to receive the cylindrical section of the firing pin, from which it will be understood that with member 52 in this position it is engaged by the shoulder on the firing pin, as stated. The shoulder is slightly inclined to enable it to easily slip off member 52 when the latter is rotated.

The member 52 is normally locked by a cam 55 on the end of the cam shaft 56. The shaft 56 extends longitudinally through the squib block and is rotatable therein. At the upper end it has an enlarged head on which the cam 55 is formed. At the lower end the shaft is of slightly reduced diameter, forming a shoulder against which the lever 57 rests and where it is secured by upsetting the end of shaft. The lever 57 is provided with a weight 58 at one end whereby the lever is adapted to rotate shaft 56 when the weight moves outwardly by centrifugal force. The lever and weight are received in suitable recesses formed at the bottom of the squib block, as shown in Fig. 6.

Movement of lever 57 and rotation of the cam shaft 56 are normally prevented by means of a so-called safety disc 59 on the main shaft 22. This disc has an arm 60 which is in the path of a projection 61 on the lever 57, when the fuse is in unset condition, as it is shown in the bottom view Fig. 6. There is also a timing disc 62 on the main shaft which prevents movement of lever 57 after the fuse is set and until the clockwork mechanism has measured off the time interval determined by the setting operation. The construction of these parts can be explained in connection with Fig. 3.

There is a flanged sleeve 63 which has a press fit on the shaft 22, the shaft being knurled axially at this point in order to avoid any chance of the sleeve rotating. The safety disc 59 is assembled on sleeve 63 next to the flange and has a couple of projecting ears (not shown) which enter holes in the flange and prevent any angular motion of the disc relative to the sleeve. The sleeve and safety disc are thus fixed on the main shaft 22 and rotate with it. The timing disc 62 is assembled on the sleeve 63 below the safety disc 60, there being a washer interposed between the two discs, and is held in place by means of a conical spring washer 64 and a ring 65. The end of the sleeve is expanded by a spinning operation to secure the ring 65. The timing disc 62 is thus frictionally secured to the main shaft and will rotate with it unless prevented from doing so.

Prior to the firing of the shell in which the fuse is assembled the timing disc 62 is locked against rotation by means of a set back pin in the closing screw 2. These parts will now be described.

The closing screw may be machined from a steel disc and has a flange at the upper end. Below the flange the closing screw is threaded, whereby it may be attached to the can 1 as shown in Fig. 1.

The closing screw is secured to the bottom of the fuse by a screw 66 before the parts are assembled in the can. This screw is removed after assembly is completed, leaving the closing screw attached to the fuse by means of a so-called split ring coupling. The split ring is indicated at 67, is in two parts, and has an internal groove for receiving the flange at the upper end of the closing screw and a corresponding flange at the lower end of the squib block. After the parts are assembled in the can the outside wall of the split ring is engaged by the inside wall of the can, which prevents the two halves of the ring from separating. Thus the fuse is rotatably coupled to the closing screw.

The set back pin is indicated at 70, Fig. 5, and is located in an opening in the closing screw, in which opening it is longitudinally movable. The pin is normally held in the position shown by means of a spring 71, the shape of which can be best seen in Fig. 7. This spring is retained in a recess in the bottom of the closing screw by a

plate 72 and a couple of machine screws. The end of the set back pin projects through a hole at the bottom of a conical depression in the timing disc 62 and thus locks the disc against rotation. When the shell is fired the set back pin moves to the rear, releasing the timing disc, and is held in this position by the spring 71. The two arms of the spring 71 are forced apart by the conical shoulder at the lower end of the pin and drop into the straight walled groove in the pin as soon as this groove comes into alignment with the spring.

The primer which is detonated by the firing pin 50 is indicated at 73, Fig. 5, and is located in a longitudinal bore which is concentric with the bore in which the firing pin is located. The primer is inserted from the bottom of the squib block and the bore is closed by a screw 75.

The squib, which is fired by the electrical detonator, is located in a relatively large radial bore 76, Figs. 1 and 5. The squib bore 76 is connected with the primer bore by a radial bore 74, which is closed by the screw 77. The relation between these bores is shown clearly in the horizontal sectional view, Fig. 9.

Provisions are made for connecting the electrical detonator with the squib, comprising plug and jack connections between the electrical detonator and the fuse and suitable terminals on the squib block. These parts will now be described.

The spring jacks on the fuse can be seen in Fig. 2, where they are indicated by reference numerals 80, 81 and 82. The jacks are of known construction and are set in holes drilled through the plates 5—13. The jacks 80 and 82 are in electrical contact with the plates while the jack 81 is insulated from the plates by a suitable bushing. The electrical detonator is provided with properly located plugs which enter the jacks on the fuse when the parts are assembled in the can.

The terminal block 83, Figs. 9, 10 and 11, is made of suitable insulating material and is located in a recess cut in the side of the squib block. 84 is the terminal block cover, also made of suitable insulating material. The block and cover are clamped to the squib block by a machine screw 85.

A metal strip 86 has one end clamped between the plates 6 and 7, the former plate having a shallow recess to admit the end of the strip, as shown in Fig. 1. The strip 86 passes downward in a shallow recess in the side of the squib block and is bent to the rear at the point where it passes beneath the cover 84, the rest of the strip being located in a recess formed in the terminal block 83. The end of strip 86 is bent forward at right angles to form the terminal 87. This is the grounded terminal and is connected to the jacks 80 and 82 through the plates 5—13. The terminal strip 88 is located in another recess in the terminal block 83, where it is secured in any suitable manner. At its upper end the terminal strip 88 is conductively connected to the jack 81, the latter being provided with a downwardly extending tab which is soldered to the strip 88. At its lower end the terminal strip 88 has the integrally formed terminal 89, which is bent forward at a right angle. The terminals 87 and 89 can be seen clearly in Figs. 9 and 10.

The reference character 90 indicates an annular groove which is provided to carry the squib conductors. As previously mentioned, the squib is located in the squib bore 76. One conductor

from the squib is bent to the left, Fig 1, and extends along the groove 90 and beneath the cover 84 to the terminal 87, where it is secured by soldering. The other conductor from the squib is bent to the right, extends around the squib block in groove 90, and passes beneath the cover to terminal 89 where it is secured by soldering. The squib and connecting conductors are not shown, but the arrangement will be readily understood from the above explanation.

The squib is normally incapable of being fired, due to a short circuiting conductor 91, which extends between the terminals 87 and 89. The fuse is armed, so far as the electrical detonator is concerned, by severing conductor 91 at the proper time, preferably about one-half second after the shell is fired. The arrangement for arming the electrical detonator also arms the fuse as regards the primer and the squib.

Referring to Figs. 3 and 10, it will be seen that there is a radial bore 92 in the squib block extending clear through to the main shaft bearing and communicating with the annular passage 24. The gate 93 is located in bore 92 and comprises a section of steel rod which is slidable in the bore. The gate is normally locked by means of a shaft 94, Figs. 4, 6 and 10, which is rotatable in a longitudinal bearing hole in the squib block which intersects the radial bore 92, as seen in Fig. 10. The shaft 94 is cut away on one side where it passes the bore 92, so that when the shaft is rotated about 20 degrees it will clear the bore 92 and release the gate 93.

Shaft 94 is rotated by centrifugal force acting on a lever 95 which is attached to the lower end of the shaft, as shown in Fig. 6. The end of lever 95 extends beneath the safety disc 59 and is bent at a right angle to form a hook 96 which engages an oppositely formed hook 97 at the edge of the safety disc. The lever 95 is thus normally locked and cannot rotate the shaft 94.

The arrangement for severing the wire 91 comprises a light pin 98 which is located in an opening in the terminal block 83, said opening being in alignment with the bore 92. The parts are shown clearly in Fig. 10, from which it will be seen that there is a recess in the cover 84 just large enough to admit the head of pin 98. When the gate 93 is released by shaft 94 it strikes the pin 98 a smart blow and the head of the pin shears off the wire 91 at two points where it crosses the edge of the opening in the cover.

The firing of either the primer or the squib will fire the other due to the fact that the primer bore and the squib bore are connected by the radial bore 74. The primer and squib will not fire the shell, however, unless the gate 93 has been released, as will now be explained.

By reference to Figs. 5 and 9 it will be seen that there is a longitudinal bore 100 which is drilled from the top of the squib block and closed by the screw 101. The bore 100 intersects the radial bores 76 and 74, as shown clearly in Fig. 9, and passes close to the radial gate bore 92, as shown in Fig. 10, there being a relatively thin wall 102 between the bores 100 and 92 where they pass each other. When the gate is in normal position this wall is supported by the gate and cannot be broken down by the firing of the primer and squib. After the gate is released the wall 102 is unsupported and is easily ruptured when the primer and squib fire. The rupture of wall 102 establishes communication from the primer and squib bores to the central bore 23 in the main shaft by way of bore 100, the gate bore 92, annu-

lar passage 24, and cross bore 25. A capsule containing a booster charge is usually inserted in bore 23 and is retained by the perforated washer 103 which is secured at the end of nut 104. The latter is threaded onto the end of the main shaft 22 and serves to hold the flanged sleeve 63 firmly in place. The nut 104 also affords means for attaching a wrench to the shaft to wind the fuse.

The operation of the fuse will probably be clear enough from the previous description, but may nevertheless be explained briefly.

Assuming that the fuse is wound and cocked, the parts being in the positions in which they are shown in the several figures of the drawings, the closing screw may be secured to the fuse by means of screw 66. The electrical detonator may then be assembled to the fuse by inserting the plugs with which it is provided into the jacks 80, 81 and 82. The split ring 67 may now be applied and the assembly lowered into the can 1, whereupon the closing screw may be turned up tight by means of a wrench inserted in the holes 105 and 106, Fig. 7, in the bottom of the closing screw. The screw 66 is now removed, leaving the fuse coupled to the closing screw by means of the split ring 67. A container with a booster charge may now be screwed into the lower end of the can.

The can is assembled into the shell as described near the beginning of the specification, with the booster charge toward the base of the shell and the electrical detonator toward the nose. A suitable connection is provided between the nose of the shell and the electrical detonator so that rotation of the nose will rotate the electrical detonator.

The fuse is set in the usual manner, that is, by rotating the nose of the shell a certain number of degrees depending on the time interval desired. The scale on the shell may be calibrated in seconds. The rotation of the nose rotates the electrical detonator and the latter rotates the fuse, being fixed thereto by the plug and jack connections previously described. The closing screw does not rotate as it is tightly screwed into the can. The direction of rotation of the fuse in the setting operation is shown by an arrow in Fig. 6. All parts of the fuse rotate as a unit except the timing disc 62, which is prevented from rotating by the set back pin 70 in the closing screw. When the setting operation is completed, therefore, the timing disc will be in its original position while the fuse and other parts thereof, including the safety disc, will have been rotated a certain angular distance in a clockwise direction as seen in Fig. 6. The essential result of the setting operation is the angular displacement of the projection 61 on lever 57 relative to the notch 69 in the timing disc.

When the shell is fired, the sudden forward impulse given to the shell causes a relative movement between the closing screw and the set back pin 70, the latter dropping behind, so to speak, due to its inertia, and releasing the timing disc 62. The set back pin is locked in its new position by the spring 71, as previously explained.

As the shell begins to rotate centrifugal force is developed, which causes the weights 28 and 29 to apply driving torque to the main shaft 22 by means of the toothed sectors 30 and 31 and the pinion 26. The timing disc 62 having been released by the set back pin the clock mechanism now begins to run. This means that the main shaft, the safety disc and the timing disc are slowly rotated in a clockwise direction, Fig. 6, relative to the rest of the fuse.

The centrifugal force produced by rotation of the shell also tends to operate other parts of the fuse, as will be understood, but these parts are locked against operation for the time being.

The rotation of the safety disc 59 causes the hook 97 to move relative to the hook 96 on lever 95 and after about one-half second the hooks become disengaged, thus releasing lever 95. The lever is instantly operated by centrifugal force to rotate shaft 94, thereby releasing the gate 93. The gate is also under the influence of centrifugal force and moving outward in the bore 92 strikes the pin 98 a blow which causes it to sever the wire 91.

The fuse is now armed. That is, the wire 91 has been severed so as to place the squib under the control of the electrical detonator and the gate has moved out of its normal supporting position relative to the frangible wall 102. The arming interval can be made as long or short as desired within reasonable limits by varying the location of the hook 97 on the safety disc. The interval should be long enough to insure that the fuse does not become armed until the shell is well beyond the muzzle of the gun.

If the electrical detonator presently fires the squib, the shell will be exploded independent of the time fuse, as will be understood. Assuming, however, that the electrical detonator fails to operate, the clockwise mechanism will continue to run and the timing disc will continue to rotate, moving its notch 69 gradually toward the projection 61, on the lever 57. The arm 60 on the safety disc has already moved out from under the projection 61, leaving the lever 57 under the sole control of the timing disc. Eventually, that is, upon the expiration of the time interval for which the fuse was set, the notch 69 will become aligned with the projection 61, thus releasing the lever 57. Centrifugal force acting on the weight 58 now rotates the lever 57 and the shaft 56, and the latter releases the pivoted member 52. This pivoted member is also acted on by centrifugal force and rotates on its pivot to release the firing pin 50. Upon the release of the firing pin, it strikes the primer 73 a blow which detonates the primer and the latter fires the squib, as previously mentioned. These explosions blow out the frangible wall 102 and the booster charge in the bore 23 of the shaft is set off, firing the booster charge at the end of the can which in turn explodes the main charge in the shell.

It should be mentioned that either the primer or the squib will rupture the wall 102 and fire the shell. The location of the primer and squib close together, however, is of advantage, in that each will fire the other, and additional assurance is thus afforded as to breaking down of the wall and explosion of the shell.

The invention having been described that which is believed to be new and for which the protection of Letters Patent is desired will be pointed out in the appended claims.

What is claimed is:

1. The combination, with a time fuse having a clockwork mechanism and a timing disc frictionally driven thereby, of a member rotatably coupled to said fuse and fixed to the shell in which the fuse is assembled, a set back pin in said member for locking said timing disc, and means responsive to rotation of the nose of the shell for rotating the fuse relative to said disc to set the fuse.

2. The combination, with a mechanical time fuse having a flange, of a cylindrical container for said fuse, a flanged member secured inside said container adjacent to said fuse, means for rotatably coupling said fuse to said member comprising a split ring retained in position by engagement with the interior wall of the container and having an internal groove for receiving the flange on said member and the flange on the fuse, and means for rotating said fuse relative to said member.

3. The combination, with a mechanical time fuse having a clockwork mechanism and a timing disc driven thereby through a friction coupling, of means for rotatably mounting said fuse in a shell with the disc toward the base of the shell, means for rotating said fuse in the shell by turning the nose of the shell, and means for preventing rotation of said timing disc during said rotation of the fuse, whereby the fuse is rotated relative to the timing disc and the fuse is set.

4. In a mechanical time fuse adapted for self destruction of a shell containing an electrical detonator, said fuse having clockwork mechanism driven by centrifugal force when the shell in which the fuse is used is fired, a primer, a squib adapted to be fired by said electrical detonator, a shorting conductor for said squib, said primer and squib being located in communcating chambers whereby firing of one will fire the other, means controlled by said mechanism for arming said squib by severing said conductor, means controlled by said mechanism for detonating said primer if the squib is not fired within a predetermined time after the shell is fired, and a firing passage leading from said chambers to the exterior of the fuse.

5. In a mechanical time fuse, clockwork mechanism including a hollow main shaft driven by centrifugal force when the shell in which the fuse is used is fired, an explosive charge in the fuse, means controlled by said mechanism for firing said charge, and a firing passage extending through said shaft for transmitting the effect of the explosion of said charge to the exterior of the fuse.

6. In a mechanical time fuse, clockwork mechanism including a main shaft driven by centrifugal force when the shell in which the fuse is used is fired, said shaft having a coaxial bore adapted to contain a booster charge, a chamber in the fuse containing a primer, means controlled by said mechanism for detonating said primer, and a passageway completed in part by the explosion of said primer for transmitting the force of the explosion to said bore to fire the booster charge therein.

7. In a mechanical fuse, a clockwork mechanism including a main shaft, a pinion on said shaft, two driving weights, two pairs of pivoted links for supporting said weights, respectively, one link of each pair including an integrally formed toothed sector engaging said pinion, and abutments in the fuse body adapted to be engaged by the other links of said pairs to stop the winding when the fuse is being wound by rotating said main shaft.

JEAN FINK.
LOUIS HEBBELN.

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