April 27, 1965 L. F. SHEPARD ETAL 3,180,524

TRIGGER DEVICE

Filed July 1, 1960

2 Sheets-Sheet 1

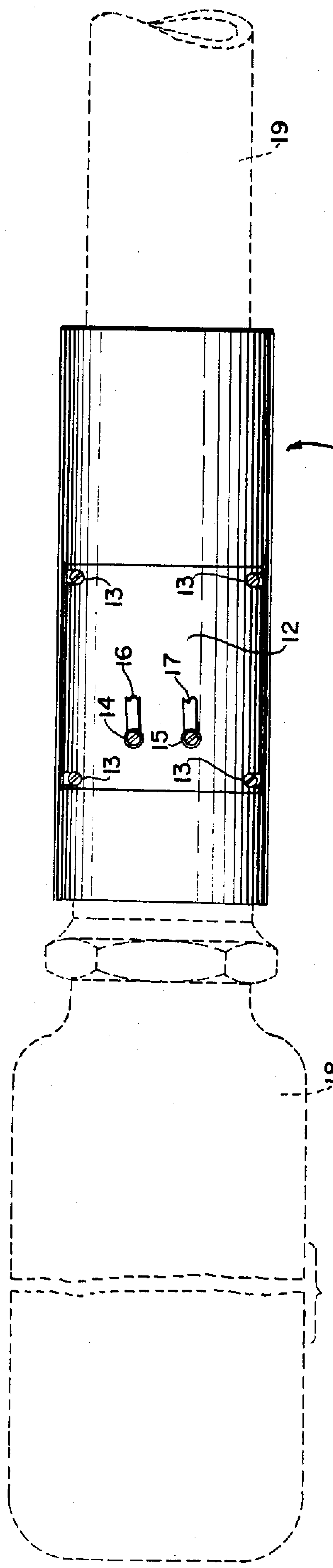

FIG. 1.

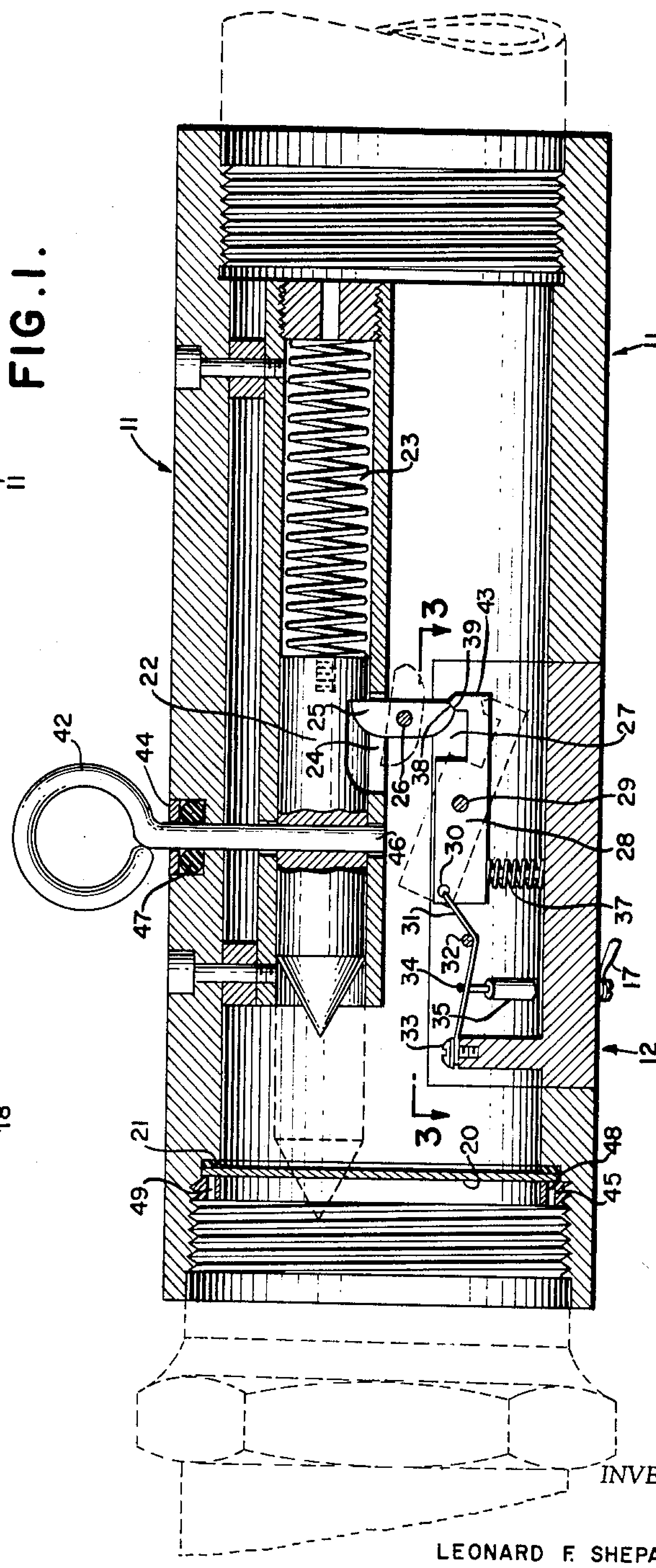

FIG. 2.

INVENTORS

LEONARD F. SHEPARD

ROBERT J. REDDEN

BY

Anthony P. Mentis ATTORNEY

April 27, 1965 L. F. SHEPARD ETAL 3,180,524

TRIGGER DEVICE

Filed July 1, 1960 2 Sheets-Sheet 2

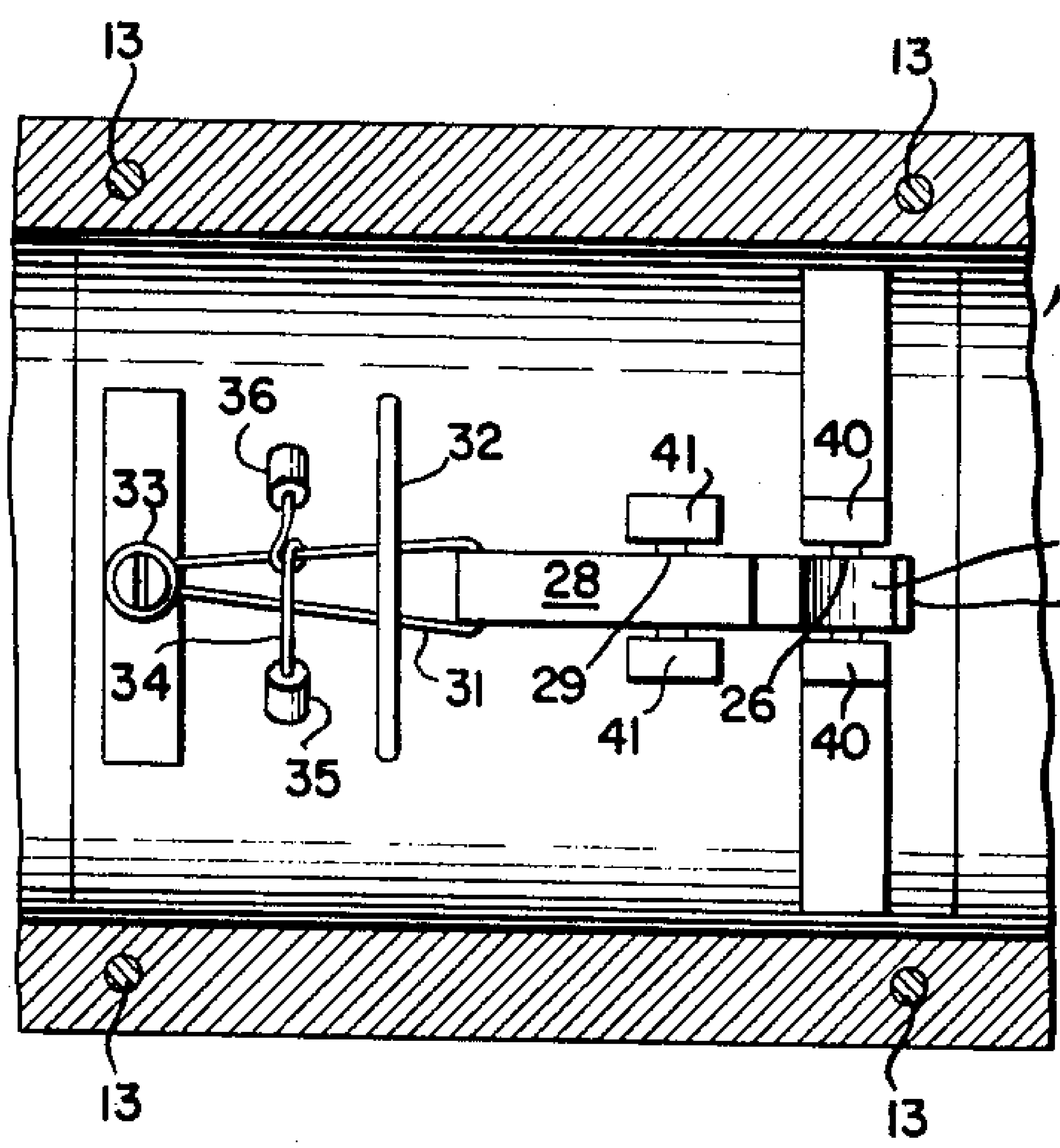

FIG.3.

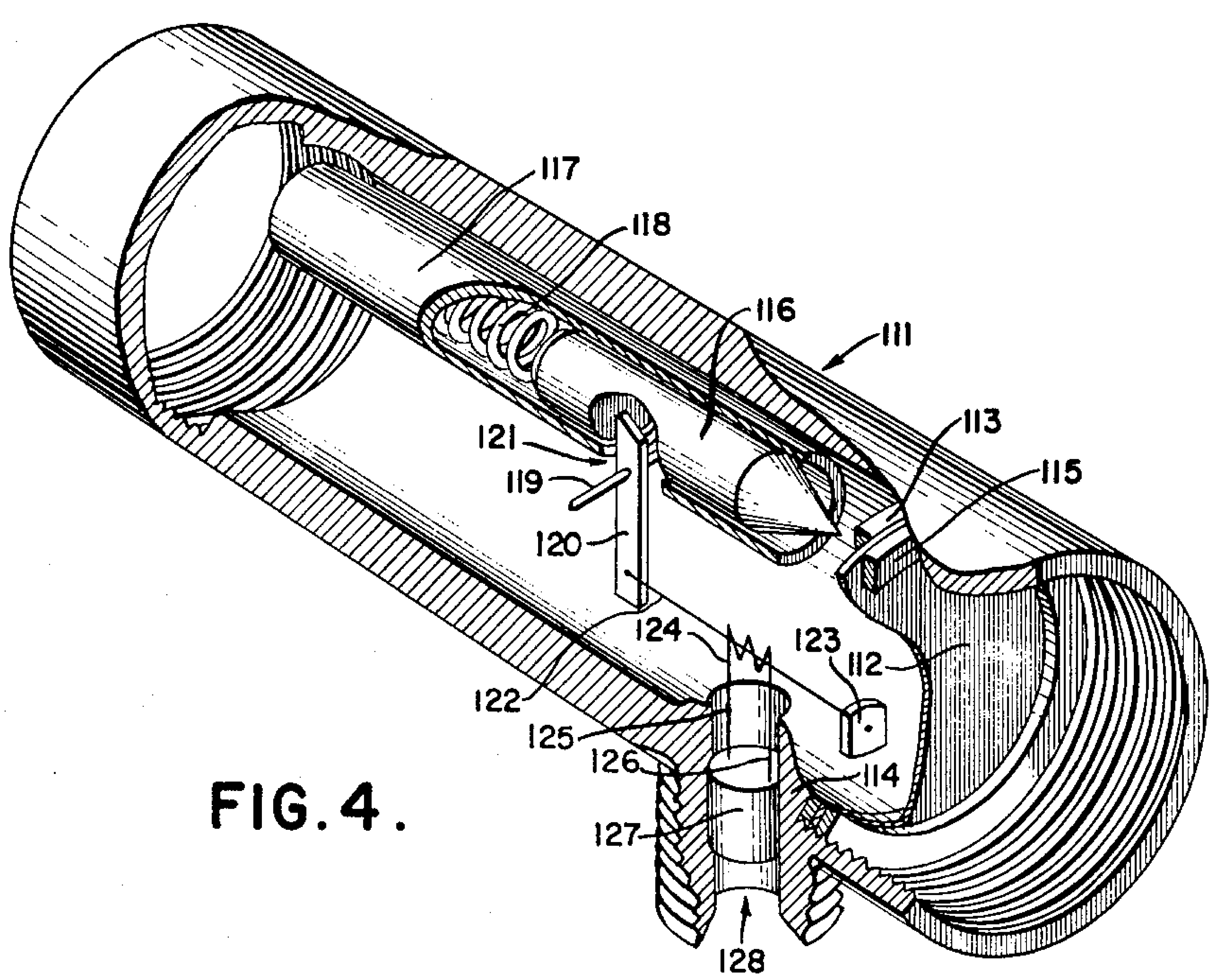

FIG.4.

INVENTORS

LEONARD F. SHEPARD

ROBERT J. REDDEN

BY

Anthony P. Mentis ATTORNEY

3,180,524

United States Patent Office

3,180,524
Patented Apr. 27, 1965

3,180,524

TRIGGER DEVICE

Leonard F. Shepard and Robert J. Redden, Dover, Del., assignors to International Latex Corporation, Dover, Del., a corporation of Delaware

Filed July 1, 1960, Ser. No. 40,415
5 Claims. (Cl. 222—5)

This invention is useful when there is a need for releasing compressed air or other gas from a container into an inflatable bladder at a controllable time. The present invention resides in the trigger device which actuates the release of the compressed gas. The triggering should occur at a precisely controllable time either by the control of an operator or by the action of a suitable timing device. Timing devices with essentially mechanical linkage to the trigger mechanism have been used and found undesirably erratic in their operation.

An electric current is well adapted to carry the actuating effect from a remote operator or from a local timing device. Because the closing of an electric circuit is a simple matter requiring only a rather trivial mechanical force, when an electrical current is used the timer itself can be selected purely on the basis of its own accuracy and reliability.

However, in many applications such as underwater use, it is not desirable that the trigger device require heavy electric current. Such requirement would carry with it the requirement of an undesirably large battery and elaborate electrical mechanism.

It is an object of this invention to devise a trigger assembly having a strong reliable hold against firing until activated, and which at the same time can be actuated with certainty by only a light electric current. Accordingly a small flow of electric current is used to deteriorate or degrade the physical properties of an organic thread or filament so as to reduce its tensile strength to the point where it is no longer able to hold back a biased striker from puncturing the diaphragm of a compressed gas container. The invention comprises a biased striker, means for holding said striker in biased position comprising an organic filament, and means for overcoming the holding action of the said organic filament so that it no longer keeps the striker in biased position. The means for holding the striker in biased position may be a lever combined with an organic filament. Advantageously, more than one lever may be used in conjunction with the organic filament. Embodiments of the invention and an assembly in which it is incorporated are shown in the accompanying drawings in which:

FIGURE 1 is a plan view showing the relationship of the trigger device to a gas container.

FIGURE 2 is a longitudinal section showing the trigger device in a cocked position. The dotted lines show the device after it has been fired.

FIGURE 3 is a view taken along the lines 3—3 of FIGURE 2.

FIGURE 4 is a perspective view of an alternative embodiment.

In the embodiment shown in FIGURES 1–3, the body of the trigger device is indicated generally as 11. A hatch cover 12 is attached to body 11 by means of screws 13, which cover also has terminals 14 and 15 which are connected to lead-in wires 16 and 17. Shown in dotted lines is compressed gas container 18 and outlet connection 19 leading to an inflatable bladder, not shown.

Housing 11 has internal screw threading in its inlet end which allows the attachment of compressed gas container 18. Sealing ring 21 abuts the shoulder of housing 11 and frangible diaphragm 20 is held in place by retaining ring 45 which is screwed into the threading of housing 11.

Holes 48 and 49 in retaining ring 45 allow it to be screwed into the threading as by the use of a suitable pronged instrument. Striker pin or hammer 22 is fitted with a heavy spring 23 and has a restraining means such as a cocking notch 24 into which fits one end of lever or cam 25. Cam 25 rotates on shaft 26. The other end of cam 25 fits into a notch 27 of a second lever or cam 28. Cam 28 rotates on shaft 29 and has a hole 30 through which is threaded an organic thread 31 made of a material such as nylon. Thread 31 passes under hold-down bar 32 and is attached to supporting element 33. A thin electrical resistance wire 34 is wrapped around thread 31 and is connected to terminals 35 and 36 which are in turn connected by wires 16 and 17 to a source of electric energy such as a battery, not shown. Thread 31 is under a slight tension and causes the end of cam 28 to compress light spring 37. Faces 38 and 39 of cams 25 and 28 are chamfered slightly in the direction wherein a force exerted by spring 23 would tend to make the cams disengage. This chamfering or beveling, shown in exaggerated form in FIG. 2, causes a small part of the force of spring 23 to equal, or balance, the frictional forces existing between faces 38 and 39. None of the force of spring 23 is transmitted to thread 31 or spring 37 so that thread 31 opposes only the force exerted by light spring 37. Thread 31 therefore immobilizes and holds the system in static equilibrium. The outlet end of housing 11 is also provided with internal screw threading which allows the attachment of a connection leading to a bladder to be inflated. Although it has been indicated that a separate diaphragm 20 is used, high pressure gas containers are available which are sealed with a rupturable diaphragm and which have no valve. Containers of this type may be simply screwed into the housing 11 whereupon the diaphragm 20 and retaining ring 45 may be omitted.

FIGURE 3 shows the hatch cover removed and the arrangement of the parts carried by the cover. Bearings 40 and 41 support shafts 26 and 29 respectively.

To assemble the mechanism, hatch cover 12 and its related parts are removed from the housing 11. Cams 25 and 28 are set into firing position and thread 31 inserted through hole 30 and tied down at support 33. The resistance wire is secured to one terminal 35, wrapped around the thread 31 and attached to the other terminal 36. Pressure is applied by any suitable means to the front of the striker pin 22, as by a rod, to force it back and compress spring 23, whereupon safety pin 42 is inserted into the bore 46 of striker pin 22. The loading rod is removed and cover 12 with its parts set in firing position is fitted into housing 11 with the top end of cam 25 being inserted into notch 24. Cover 12 is secured by means such as screws 13. O-ring 47 and its associated press fit retaining washer 44 seals the passageway in which the safety pin is located. Lead-in wires 16 and 17 are connected to the external terminals 14 and 15, and sealing ring 21, diaphragm 20, and retaining ring 45 are inserted. A suitable gas container is connected to one end of housing 11 and an outlet connection 19 leading to the bladder is attached at the other end.

When it is desired to set off the trigger device, safety pin 42 is pulled up out of the bore 46, current from a battery or other source is allowed to flow through the lead-in wires 16 and 17 to the resistance wire 34 which becomes heated. The heat of the wire degrades the thread 31 and causes it to sever at the point where it is in contact with the wire. The severing of thread 31 permits spring 37 to act on cam 28. Cam 28, under the urging of spring 37 rotates on shaft 29 and drops its end 43, thus freeing the lower end of cam 25. Under the force of spring 23, cam 25 rotates on shaft 26 and disengages from notch 24 of the striker pin 22. Striker pin 22 is forced by spring 23 to rupture diaphragm 20. Gas from the container flows through the rupture diaphragm and into the connection leading to the bladder which becomes inflated.

The organic filament is a poor conductor of heat and electricity and undergoes a reduction of its physical strength at relatively low temperatures. Consequently only a small amount of heat energy is needed to degrade the physical properties of the filament. This is in contrast to fusible metal links used by the prior art, which are good conductors of heat and electricity, fuse at relatively high temperatures after a relatively long time, and require proportionately large amounts of power. Organic materials suitable for the practice of this invention are natural and synthetic organic fibers such as cotton, linen, wool, rayon, silk and the like. In the instant invention energy losses due to conduction and radiation, etc. are so small that under the influence of only a small amount of heat, filaments of these materials will quickly deteriorate and burn through, becoming severed at the point where the heat is applied. Particularly advantageous are thermoplastic fibers. Nylon, Dacron and Orlon are examples of such. Nylon is well known in the art to be a linear polyamide. Dacron is a linear polyester and Orlon is a linear polyacrylonitrile, all three being sold by the DuPont Company. For the purposes of this invention, thermoplastic fibers are operable even when the amount of applied heat is insufficient to oxidize and burn the thread through completely. As the name "thermoplastic" implies, thermoplastic threads such as nylon soften and tend to become plastic when heated. When in such softened condition, the tensile strength is lowered so that the thread can be pulled asunder with a minimum of force. In the instant invention the organic filament is under a slight tension since it provides the margin of force which keeps the biased striker in static equilibrium. Even though an amount of heat may be applied which is insufficient to completely oxidize the thread, it nevertheless will be sufficient to soften the thread and reduce its tensile strength so that the small tension which is present will pull the thread apart at the weakened spot and thus sever it. A small quantity of heat in such an arrangement therefore initiates a physical degradation process which culminates in the severing of the thread. It can be appreciated that the amount of energy needed to soften a spot in a thermoplastic thread is extremely minute. As a result, very low energies are needed to make the instant invention work. The thread may be quite thin because it is not necessary for it to have a great deal of tensile strength since it does not have to oppose the the force of main spring 23.

The thinner the resistance wire 34, the more localized is the heat area where the wire contacts thread 31. Wires made of nickel or copper, etc. are suitable and may have a diameter of .003". As a general rule it may be said that the total amount of energy needed to raise the temperature of the thread 31 to degrade it must be greater than the amount of energy lost by radiation by the resistance wire and through conduction by the thread. This represents the minimum amount of electric current which may be used and may range in the neighborhood of 100 milliwatts or lower. By virtue of these characteristics a very small amount of current generates an amount of heat sufficient to cause effect degradation of the thread when applied to a small pin point area of the thread. Since the trigger device is operable at very low wattage levels, the size and weight of the power source may be kept very small. This is an important advantage in those applications where space and weight are at a premium. The low energy requirements of the invention also permit the use of any desired source of energy, including the newer exotic sources of electric energy such as atomic batteries, solar cells, and the like.

In the arrangement described above, faces 38 and 39 have been chamfered slightly so that a part of the force of spring 23 is made to balance the frictional forces existing between, and tending to hold, the two faces together. As noted, thread 31 then need be only strong enough to overcome the force of spring 37, since none of the force of spring 23 is transmitted to thread 31 or spring 37. Any change in the tension of spring 23 by reason of rust or corrosion, etc. will not effect the reliability of the device since these changes in tension will not change the balance of the system. A wide range of tensions in spring 23 is therefore accommodated and this gives the trigger device of this invention a very great degree of reliability, since any tendencies toward premature firing or delayed firing are reduced. By carefully changing somewhat further the angle of faces 38 and 39, however, as by additional chamfering, an additional part of the force of spring 23 may be utilized to give the cams 25 and 28 a definite tendency to disengage themselves so that spring 37 may be omitted. This force is so small however that the thread is able to successfully oppose it and keep the system in static equilibrium, i.e. prevent the striker from puncturing the diaphragm. In this arrangement, when thread 31 is severed, cams 25 and 28 will disengage themselves due to this camming action, and the spring 23 will be released. An even more positive action may be obtained by including the light spring 37 in the latter arrangement so that its force may be added to the aforementioned camming action.

The trigger of this invention may be used for many purposes in many environments including high altitudes. With only minor modifications to make it waterproof, it may be used in underwater operations. The flow of current to activate it may be turned on by a manually operated switch or by timing mechanisms well known in the art. The source of the current may be in close proximity to, or situated remotely from the trigger device.

FIGURE 4 shows a different embodiment of the invention. Housing 111 is internally threaded at its rear end to connect to an inflatable bladder, not shown, and similarly threaded at the other end to connect to a cylinder of compressed gas. Gasket 113 abuts against shoulder 114 of the housing. Rupturable diaphragm 112 is held against the gasket by retaining ring 115. The externally threaded neck of a compressed gas container is screwed into the housing next to the retaining ring. Striker 116 is carried in sleeve 117 and abuts spring 118. Shaft 119 carries lever 120, the upper end of which fits into notch 121 of striker 116. Nylon thread 122 is secured to the bottom end of lever 120 and to anchor 123. Resistance wire 124 makes contact with thread 122 and ends in terminals 125 and 126 which extend through plug 127 located in port 128. When a small amount of electric current is led from a current source through the resistance wire 124, the resultant heat deteriorates the tensile strength of the nylon thread to the extent that it separates into two pieces. Lever 120, no longer held, rotates on shaft 119 to release striker 116 which punctures diaphragm 112. Gas from the compressed gas container flows through the housing, out the back end and into the bladder to be inflated. It should be noted that the lever arm of the thread 122 is greater than the lever arm of the striker 116, resulting in a substantial reduction in the restraining force necessary to restrain the striker.

We claim:

1. A compressed gas container inflating device comprising a housing having a fluid passageway therethrough with inlet and outlet means, the inlet end of the housing adapted to receive the neck of a compressed gas container, a frangible diaphragm in said inlet means sealing said gas in the container, a biased diaphragm-puncturing member movable in a direction to rupture said diaphragm, pivotable cam means restraining said puncturing member from moving in said direction, an organic filament under slight tension which is a poor conductor of heat and electricity locking said pivotable cam means in restraining position, and an electrical heat element in point contact with said filament and in communication with a

source of electrical energy, said filament being degradable by the heat generated in the electrical heat element when electrical energy flows through said element and said cam means constituting mechanism affording a mechanical advantage whereby the forces exerted by said cam means substantially resist the bias of the diaphragm-puncturing member and said filament does not directly oppose the bias of the diaphragm-puncturing member and provides the margin of force which maintains the diaphragm-puncturing member in biased position.

2. A compressed gas container inflating device comprising a housing having a fluid passageway therethrough with inlet and outlet means, the inlet end of the housing passage threaded to receive a gas container with an externally threaded neck, a portion of the housing passage of reduced diameter forming a shoulder, a sealing member abutting against the outward side of the shoulder and compressed against said shoulder by a frangible diaphragm and a retaining ring member, a spring-loaded diaphragm-puncturing member held in cocked position by a first cam, one end of which engages a cocking notch in the diaphragm-puncturing member and the other end of which engages a notch in one end of a second cam, the other end of said second cam under tension of a thread of nylon, said thread in point contact with a resistance wire which is connected to a source of electrical energy, a spring abutting the said other end of said second cam and opposing the tension of said thread and said second cam with said thread being disposed out of alignment with respect to said diaphragm-puncturing member, whereby when the tension of the nylon thread is removed as a result of its heat degradation occasioned by the flow of electrical energy through the resistance wire, the said abutting spring will cause the said cams to pivot and release the bias puncturing member to rupture the frangible diaphragm and release gas from the container, the forces exerted by the said cams substantially resisting the force of the cocked diaphragm-puncturing member and wherein the said filament does not directly oppose the force of the diaphragm-puncturing member and provides the margin of force which maintains the diaphragm-puncturing member in cocked position.

3. A trigger device in static equilibrium comprising a biased striker having a cocking means and held in biased position by a first pivoted cam, one end of which engages said cocking means and the other end of which engages one end of a second pivoted cam, the other end of said second cam secured to an organic filament under slight tension which is a poor conductor of heat and electricity and which immobilizes the two cams, and an electrical resistance wire in point contact with the filament and in communication with a source of electrical energy, said filament being degradable by the heat generated in the resistance wire when electrical energy flows through said wire and said second cam with said filament being disposed out of alignment with respect to said striker, whereby the forces exerted by the said cams substantially resist the force of the striker and the said filament does not directly oppose the bias of the striker and provides the margin of force which maintains the trigger device in static equilibrium.

4. The trigger device of claim 1 in which the organic filament is thermoplastic.

5. A trigger device in static equilibrium comprising a biased striker held in biased position by locked cam means, said cam means being locked in position by an organic filament under slight tension which is a poor conductor of heat and electricity, an electrical resistance wire in point contact with the filament and in communication with a source of electrical energy, said filament being degradable by the heat generated in the resistance wire when electrical energy flows through said wire, said filament not directly opposing the bias of the striker and said cam means constituting a mechanism affording a mechanical advantage such that the slight tension of the filament maintains the device in static equilibrium.

References Cited by the Examiner

UNITED STATES PATENTS

1,329,990	2/20	Muller	222—5
2,306,384	12/42	Freygang	200—142 X
2,374,200	4/45	Heigis	222—3
2,527,605	10/50	Walk	222—5
2,615,107	10/52	Zito.	
2,946,484	7/60	Stoner	222—5
3,008,479	11/61	Mancusi	137—8

RAPHAEL M. LUPO, *Primary Examiner.*

LOUIS J. DEMBO, LAVERNE D. GEIGER, *Examiners.*