Feb. 23, 1965 W. R. DICKIE 3,170,363

EXPLOSIVE SEPARABLE NUT

Filed Nov. 6, 1961

FIG. 1

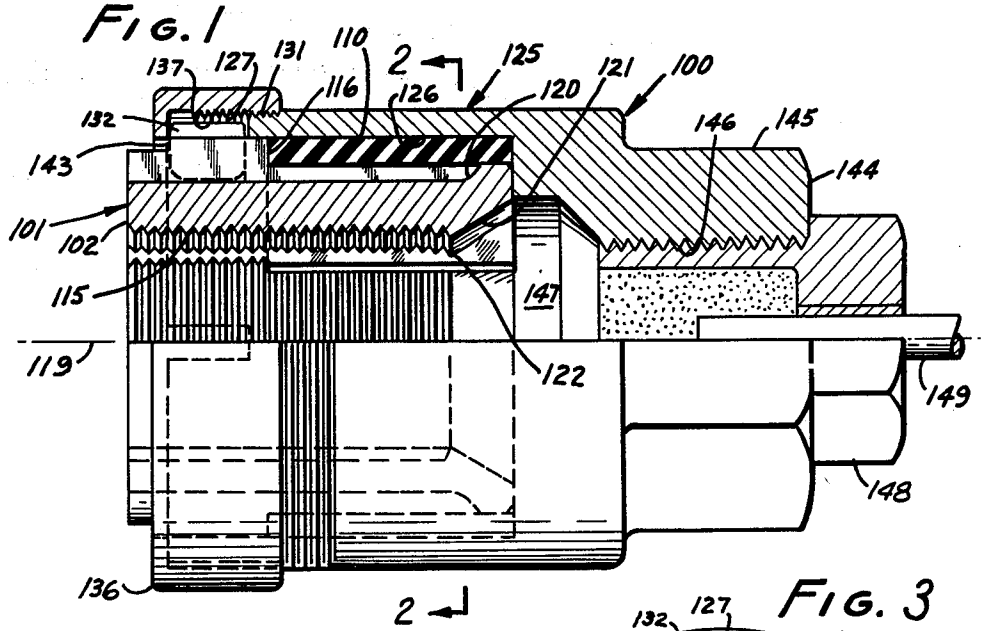


FIG. 2

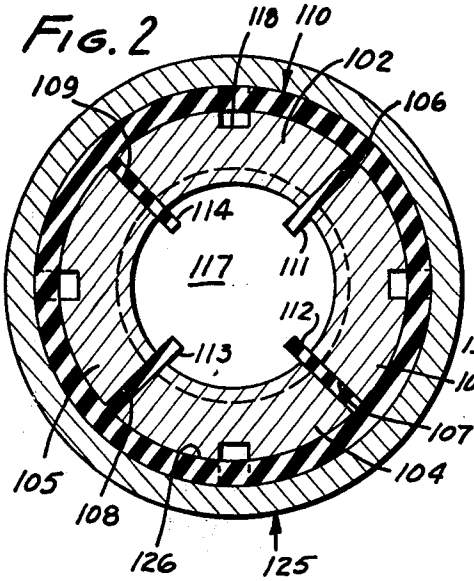
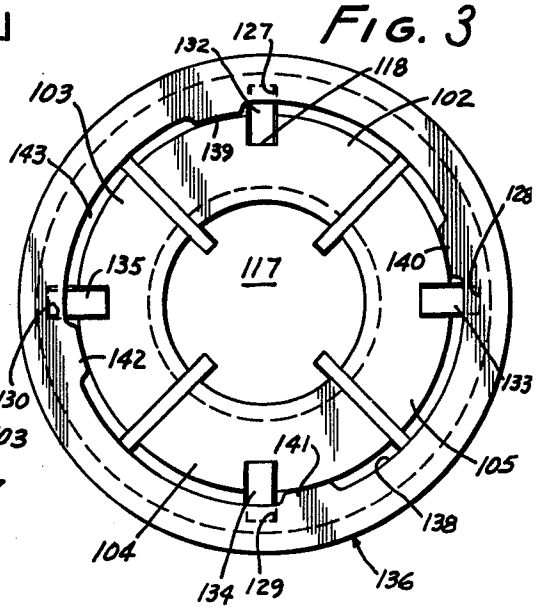


FIG. 3



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EXPLOSIVE SEPARABLE NUT

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This invention relates to a separable nut of the explosive type.

This application is a continuation-in-part of applicant's co-pending patent application, Serial No. 829,674, filed July 27, 1959, now Patent No. 3,120,149, entitled "Separable Nut," which is assigned to the same assignee as the present application.

An object of this invention is to provide a nut which can be turned onto a threaded shank to reliably and strongly engage therewith, and which can be relied on to become disengaged from the shank upon the firing of an explosive charge.

A related object is to attain the above reliability with a minimal explosive charge. In conventional explosively-separated fasteners, separation of the fastener ordinarily requires that some portion of the fastener be fractured. The force required to fracture a section is determined by many factors, many of which are not susceptible of close control in mass-production manufacture. The various properties contributing to the strength of the material, and the variation in cross-section area inherent in dimensional variations, even when close-tolerance work is done, are but two examples of such factors. Accordingly, it has been customary to make the explosive charge sufficiently large that the force it generates will fracture the least-advantageous fastener, even though so large a charge is not needed for the particular specimen, or even for the greater proportion of like fasteners. It is undesirable to have these charges any larger than absolutely necessary, because of their effect on adjoining structure and equipment.

In the instant invention, only a small amount of material needs to be displaced, and none needs to be fractured. Only force adequate to accomplish a small unstaking action plus some frictional resistance to movement is required. The total force needed to separate this fastener is appreciably smaller than the force produced by the smallest practical explosive charge. Therefore the charge is minimal. This is in sharp contrast to conventional fasteners, wherein the fracture section is often load-bearing, and therefore strong, in which the forces required for fracture are of the same order as those produced by a practical charge, and in which the charge must be further increased to provide a safety factor so that the fastener will separate regardless of variatons in the physical properties and dimensions of the fastener.

A nut according to this invention includes a plurality of nut segments which, when assembled in abutting relationship, form an internally threaded passage for receiving and engaging the threads on a shank. The segments are held assembled together by being fitted into a recess in the end of a retainer in torque transmitting engagement with the retainer. Yieldable retaining means hold the segments in the recess. An explosive charge is provided in the recess for removing the retainer from the segments by overcoming the retaining means, and firing the retainer away from the segments.

The invention will be fully understood from the following detailed description and the accompanying drawings, in which:

FIG. 1 is a side elevation, partly in cutaway cross-section showing the presently preferred embodiment of the invention;

FIG. 2 is a cross-section taken at line 2—2 of FIG. 1; and

FIG. 3 is a left-hand end view of FIG. 1.

FIG. 1 shows the presently preferred embodiment of a separable nut **100** according to the invention. It includes a nut **101** made up of four segments **102, 103, 104, 105**. Each of these segments is arcuate in cross-section and together they can be assembled as shown in FIGS. 2 and 3 to make up the major portion of a continuous peripheral structure. They are spaced apart by gaps **106, 107, 108, 109** and are held together by a band **110** which has four fins **111, 112, 113, 114**, which fit respectively in gaps **106–109**. The band and its fins thereby hold the segments together, facilitating the assembly of the device.

Each of the segments has an internal thread, such as thread **115** on segment **102**. The threads, while discontinuous across the gaps, are aligned so that a threaded shank member can be threaded thereinto. It is evident that best manufacturing technique is to form the thread and all other shapes on the nut as a single piece, and then form the segments by slitting it. The segments are not interchangeable among each other, and the band serves the additional purpose of keeping the segments in their proper order. An alignment shoulder, such as shoulder **116** on segment **102**, is provided for abutting against one end of the band, thereby establishing the relative axial position of all of the segments.

As best shown in FIG. 1, the fins extend inwardly into the passage **117** formed by the nut segments, and it is evident that the fins will have to be cut by the shank member which is to be threaded into the nut segments. Accordingly, the band is preferably made of an easily cut plastic-composition such as nylon. The fin members also serve as thread locks to resist unthreading of the separable nut from the device by virtue of their frictional drag on the shank member.

In the center of the outside of each of the segments, there is an axial-extending spline **118** which extends parallel to axis **119** of the separable nut. This spline is the same shape as splines **77–79**, each of them having an arcuate surface concave outwardly, such as surface **120** on segment **102**.

Part of a counterbore **121** is formed in each of the segments, the assembled counterbore section preferably being frusto conical, thereby providing relief at the inner end of the segments.

Junction **122** of the segments and their counterbore section represents a pivot point for a purpose to be discussed below.

A retainer **125** includes a cylindrical walled recess **126** within which the nut is fitted. The outer wall of the band is also cylndrical so that, in effect, the assembled nut **101** and the inside wall of the recess, and thereby the retainer, are disposed together in piston-cylinder relationship. Four key slots **127, 128, 129, 130** are milled in the left-hand end of the retainer as shown in FIG. 1, and an external thread **131** is also formed adjacent to that end. Four keys **132, 133, 134, 135** are fitted in splines **118** and extend into the respective key slots, where they serve to key the retainer and the nut rotationally together while still permitting relative axial movement of these two bodies.

A cap **136** is threaded onto thread **131** by means of an internal thread **137**. It has an interior collar **138** and the collar overlaps the radially outermost end of each of the keys. Four tabs **139, 140, 141, 142** are integral with the collar and each overhangs a shoulder **143** on a respective segment. The tabs are the only axial restraint between the segments and the retainer, while the remainder of the collar is a continuing restraint on all four of the keys. However, in the use of this device there are no

important axial forces until the separation occurs. For this reason, the tabs are light, so as to be easily "unstaked."

End **144** of the retainer has a wrench-engaging section **145** which is shown in the drawings as hexagonal. This shape is arbitrary and may be slotted, recessed or of any other desired torque-tool engaging configuration instead of a hexagon.

An internally threaded port **146** passes through end **144** of the retainer and opens into an expansion chamber means **147** between the retainer and the nut **101**. Passage **117** is closed by a shank member when it is threaded in it so that the expansion chamber is closed, at least in part, by the retainer. A squib **148** is threaded into the port. The squib includes an explosive charge which will fire gases under pressure into the expansion chamber means **147** toward and against the end of a shank member. An electrode is buried in the explosive charge to act as one terminal for the squib, and the metal body can be used as the other electrode, thereby enabling a firing current to be sent through the charge to detonate the same. Conductor **149** illustrates an electric connection for igniting the squib.

When the squib is fired, gases under pressure are shot into expansion chamber means **147**, which tends to move the retainer to the right and the nut to the left in FIG. 1. Initially, tabs **139–142** are bent out of the way of shoulder **143** and there is then no further impediment directly connected to the retainer which tends to hold the retainer and nut together. The keys, however, are well backed up by collar **138** and soon after they begin moving, they strike the band and cut through it. It is found that nylon material not only cuts easily but actually serves to lubricate and facilitate the cutting action and reduce friction between the band and the wall of the cylindrical wall recess **126**, thereby minimizing the friction drag between the nut and the retainer. Furthermore, the band and its fins act as a gas seal to keep gases from leaking past the segments, thereby further improving the operation of the device by increasing the efficiency of the squib.

No part of the band is initially disposed in the splines. Instead, the fins extend only between the adjacent segments.

When the keys and arcuate surfaces **120** strike them, the right-hand end of the segments will be cammed downwardly around junction **122** as a fulcrum. The counterbores **121** are smooth and in the event that threads of the shank member extend to the right beyond junction **122** in FIG. 1, there will be no binding between the surfaces forming the counterbores **121** and these threads so that the segments will cam free and the shank member can slip away. At this time, it is immaterial whether the keys are further restrained by collar **138**, and they may or may not be.

The inner wall of the recess and the outer surface of the band are essentially cylindrical. It will be understood that they could instead form pyramidal or tapered shapes, tapering toward a smaller end at the head of the retainer than at the retainer recess opening. This would avoid substantial sliding friction between the cylindrical surfaces of the recesses and the exterior peripheral surfaces of the nut segments, but would give up the advantage of the complete enclosure of the explosion products until the retainer is completely removed which is obtained when the prismatic shapes shown in the drawings are used.

Attention is called to a safety feature of this invention. In contrast to fasteners which rely on fracturing sections of nuts and shanks, wherein the charge is ordinarily buried in the device, the device being always armed, this invention provides a nut which can be installed unarmed, and the charge attached the last thing. Explosive ordnance is preferably not handled in a factory building. It is preferred to handle it only in protected installations.

The convenience of this device is evident: it can be installed without any precautions whatever, and can be armed whenever it is safe and convenient to do so.

This nut provides a simple construction for a separable nut which is inexpensive to manufacture and reliable in operation.

The term "yielding" as used herein in connection with the retaining means, is intended in its broadest sense. While in the preferred embodiment of the invention it is only necessary to deflect a lip, it is to be understood that "yielding" is not limited merely to bending of a lip shape, but comprehends any retaining means which can be overcome by the explosive charge of the squib. This includes fracture of the retainer or cap, or their plastic deformation, or spring retainer means, or any other means which allows the retainer to move axially away from the retainer after a force of sufficient magnitude is exerted on the retainer. Thus, the term "yielding" as used herein, comprehends any means whatever used to hold the retainer and segments against axial separation which can be overcome by the explosive charge of the squib.

In all embodiments, only a small force is needed to unstake, or bend, a collar or shoulder out of the way to let the retainer move along the segments. Thereafter, the force of friction developed between the segments and the retainer needs to be overcome, but this is small. There is also an additional force needed to cam the segments off the respective shank means. This additional force comes into play when the keys strike the arcuate surfaces. By this time, the devices are substantially separated, and the amount of force required to carry out this light camming action is quite small. It is small enough that it does not require any modification of a basic small charge. In all embodiments, the total force required is well within that provided by a small charge on the order of two grains of gunpowder from a ½ inch diameter fastener of the type shown in FIG. 1, still providing and adequate factor of safety. Furthermore, the only variable which needs to be controlled is the force needed to overcome the yielding means. This is susceptible of reasonably close control, at least close enough to keep the force required well within that provided by a minimal charge.

This invention is not to be limited by the embodiment shown in the drawings and described in the description, which is given by way of example and not of limitation, but only in accordance with the scope of the appended claims.

I claim:

1. A separable nut with an axis, comprising: a plurality of nut segments shaped to fit in spaced adjacency with each other to form an interrupted exterior surface with axially-extending gaps between the segments, and an interrupted internally-threaded passage; a peripheral band having an internal, axially-extending fin in each gap, and an internal interrupted surface in full surface-to-surface engagement with the interrupted exterior surfaces of the nut segments, the fins filling the gaps and thereby holding the segments in alignment and making a fluid seal therebetween, and a continuous surface of revolution on the outside of the band, the band being made of a readily-cut, fluid-impermeable material; a retainer having a recess opening at one end thereof, and having an inner cylindrical wall within which the band and segments are fitted, the surface of revolution making full peripheral contact with said cylindrical wall, the band thereby making a fluid-sealing fit between the retainer and the segments and making sliding fit between itself and the retainer; key and spline means keying the retainer and segments together in torque-transmitting and axially-slidable relationship with each other; a yieldable collar attached to the retainer which laterally overhangs at least a part of ech key and each segment; and an explosive in fluid communication with said recess and adapted to fire gaseous products of explosion between the retainer and the segments for overcoming that part of the collar which

overhangs the segments, and firing the retainer off the segments so that they can separate from each other when the threads of said internally-threaded passage are threaded onto a shank and form a fluid seal therewith, the collar forcing the key along the spline so as to cut the band and release the segments.

2. A separable nut according to claim 1 in which the fins extend into the threaded passage thereby to engage a shank threaded thereinto and act as a thread lock.

3. A sparable nut according to claim 1 in which the key and spline means comprises a key engaged in a slot in the retainer and in a spline in the segments, the splines diminishing in depth toward the inner end of the recess so as to have a tapered bottom, and in which a counterbore is provided in the assembled segments to form a fulcrum axially adjacent to the tapered bottom, whereby the keys tend to force the segment threads away from the shank when the retainer is fired off of the segments.

4. A separable nut according to claim 3 in which a port extends through the retainer in fluid communication with the space in the recess between the retainer and segments for receiving the explosive.

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