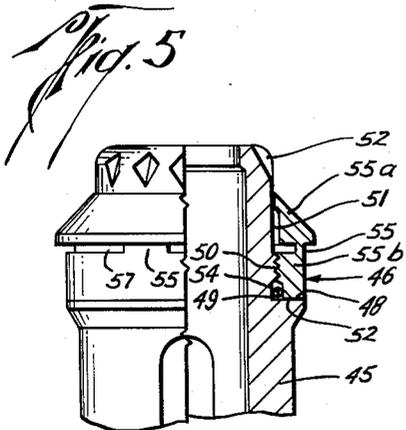
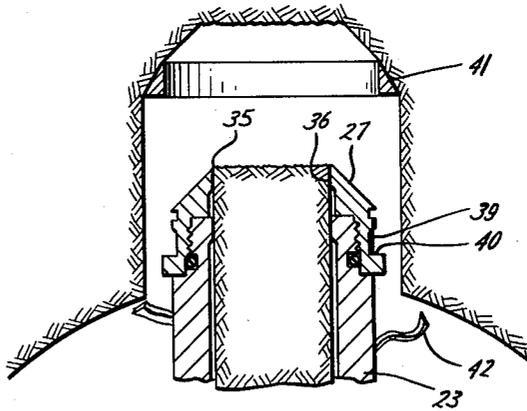
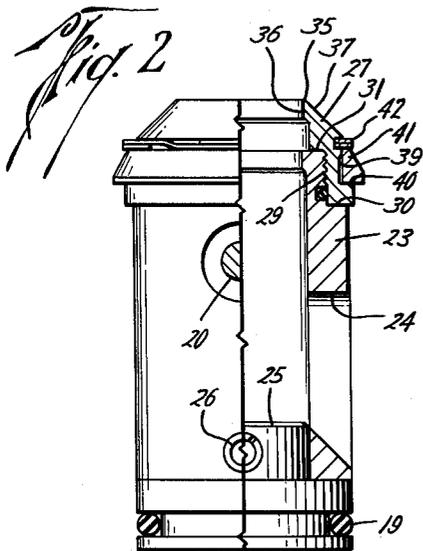
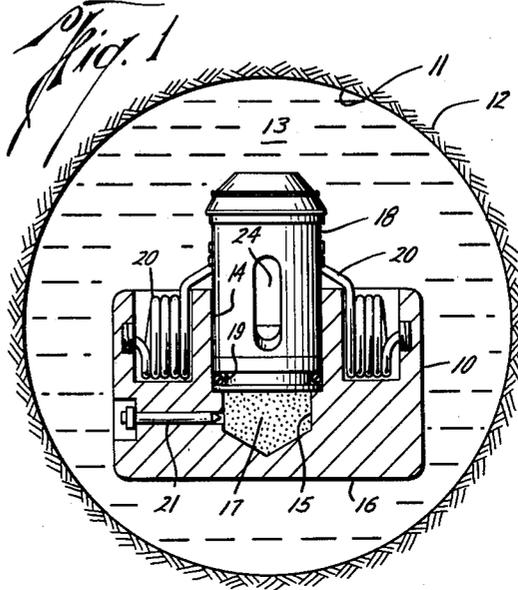
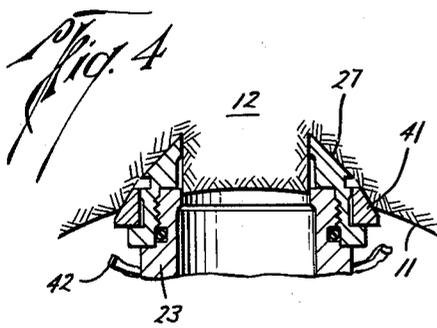


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E. F. BRIEGER
CORE TAKER DEVICES
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3,101,797



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3,101,797

CORE TAKER DEVICES

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8 Claims. (Cl. 175-4)

This invention relates to apparatus for obtaining solid samples of earth formations and, more particularly, pertains to a new and improved core-taking apparatus for obtaining a solid sample of earth formation material.

Generally, cores or samples of earth formation material are obtained by lowering a side wall sample taker assembly into the borehole to the level of the formation to be investigated. The sample taker assembly includes a gun body which receives a number of hollow core-taking bullets together with explosive means which are selectively operable so that the bullets may be impelled towards and into a formation, with the hollow interior of the bullets thereby receiving the formation material. Usually, the core bullet is secured to the gun body by one or more flexible retrieving connections so that a pull, as by raising the gun body, serves to withdraw the core bullet with a formation sample from the earth formations. Thus, a formation core sample can be retrieved to the surface of the earth for examination and testing.

However, many problems are presented by the variety of formations which are encountered in sampling operations. For example, the types of formations may be generally classified as (1) soft, (2) medium (3) firm, (4) hard, and (5) extra hard. Thus, the problems may vary from the difficulty in getting the bullet into the extra hard formations without damage to the difficulty encountered in soft formations in the withdrawal of the core bullet from the formation. To obtain core samples from the various types of formations, different types of core bullets have been designed to meet the various conditions arising. Aside from the problem of retrieving the core bullets, it is, of course, necessary to obtain a core sample which is representative of the formation tested.

Particularly in the soft to firm formations, recovery of core bullets has been facilitated by providing the core bullet with a separable forward portion in the form of an annular cutting ring which generally has a slightly greater outer diameter than the core barrel. Thus, the ring forms an enlarged hole relative to the body of the bullet to alleviate "sticking" of the bullet body in the formation. When a pull is exerted on the body of the bullet, it should separate from the cutting ring thereby to leave the cutting ring in the formation. It will be appreciated that a considerable problem arises in attaching the cutting ring to the bullet body so that it will remain attached until the bullet is in the formation and thereafter be easily separable from the bullet body. For example, the explosive blast and recoil resulting from the firing of one bullet of previous types sometimes displaces the ring from an adjacent bullet. Hence, the bullet, when fired without a cutting ring, typically remains "stuck" in the formation and therefore lost or, if recovered, the bullet is both damaged and empty.

In the Patent No. 2,923,530, granted to Roger Q. Fields, a solution to the problem of retaining the cutting ring to the bullet body is provided in the form of a rubber retainer ring to resiliently secure the cutting ring to the bullet body. However, it has been found that high temperatures or low hydrostatic pressures may sometimes affect the efficiency of this type of retainer and thus it is still possible, under certain conditions, to dislodge a cutting ring prior to its trip into the formation.

Another solution proposed for this problem is a shear pin connection between the cutting ring and bullet body,

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but this has been found unsatisfactory because the cutting rings too often either separate from the bullet body prior to firing or are inseparable when in the formation. Hence, a shear pin connection gives rise to considerable uncertainty as to the reliability of the core sampling operation. Moreover, a shear pin connection is difficult and time consuming in assembly.

As the firmness of the formation increases, for example, from soft to firm, the outer diameter of the cutting ring generally decreases. For firm to very hard formations, the cutting ring has generally the same outer diameter as the bullet body and is integral or solidly connected with the bullet body. Also, for formations extending from firm to hard, the compaction of the core sample, as it is received by the bullet body, increases so that the core sample often cracks or fragments so as to shatter easily when it is removed from the bullet body. A shattered or cracked core sample may also be lost while retrieving the apparatus from the well bore. It is, of course, desirable to obtain an intact core sample from the retrieved bullet.

An invention disclosed in my co-pending application S.N. 13,945, filed March 9, 1960, alleviates the foregoing problems presented by various types of formations where the type of formation is known prior to running a core taker apparatus in the well. This invention permits the use of any desired cutting ring by the provision of a universal bullet body which will receive interchangeable cutting rings at any time.

However, in many instances, such as "wildcat" wells or the like, it is completely unpredictable what the type of formations may be. Obviously, a wrong selection of the type of core-taking bullet proves expensive since the wall may be damaged, and repeated runs of the tool with various types of cutting rings may be necessary to obtain core samples for testing. To further illustrate the problem, the type of cutting ring as employed for soft formations, when used in hard formations, either fails to penetrate the formation to any extent or fails to recover a sample if it does penetrate a short distance because the formations cut will not enter the bullet body, but will remain with the cutting ring. Also, such an operation generally damages the core bullet beyond reuse and requires a replacement. On the other hand, a cutting ring integral with the bullet body and with a diameter similar to the diameter of the bullet body, as employed for hard formations, will generally become "stuck" when fired into soft formations and thus remain there after the gun body is retrieved so that no sample is recovered.

Even though the selection of the bullet is exercised with considerable care, there is the element of chance involved if the information available relative to the formations is insufficient and the results may or may not be as desired.

Accordingly, it is an object of the present invention to provide new and improved core-taking apparatus for universal use in core-sampling operations where the character of the formations to be encountered is in doubt, to optimize the possibilities of obtaining a core sample.

Another object of the present invention is to provide new and improved core-taking bullets in which the possibility of obtaining a core sample is maximized irrespective of the formation characteristics.

Yet another object of the present invention is to provide new and improved core-taking bullets operable in a wide variety of types of formations.

A further object of the present invention is to provide new and improved core-taking bullets which are simple and inexpensive in arrangement as well as versatile, efficient, and reliable under a variety of field operations.

In apparatus for investigating earth formations, according to the present invention, a gun body receives a plurality of core-sampling bullets disposed adjacent one another lengthwise of the gun body which are adapted to

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be impelled toward and into the formation by explosive means. The bullets have a bullet body or body member which is tubular with a forward cutting end. Releasably secured to the body member at a location rearwardly of the forward cutting end is a release ring for enlarging the diameter of the penetration. Thus, if the formation is hard, the body member having the forward cutting end will penetrate the formations prior to the release ring contacting the formations so that a core sample is obtained by the body member. On the other hand, if the formation is soft, the separable release ring will enter the formations developing an enlarged hole and the body member with a core sample can be pulled free of the release ring which remains in the formation.

The novel features of the present invention are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation, together with further objects and advantages thereof, may best be understood by references to the following description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a view in cross section of apparatus for investigating earth formations embodying the present invention taken in a plane perpendicular to the axis of a borehole in which the apparatus is disposed, and illustrating the apparatus in one condition of operation;

FIG. 2 is a view in partial cross section of a bullet assembly embodying the present invention;

FIG. 3 is a partial view in cross section of an annular release ring and the forward end of a bullet body, as located relative to formation wherein a bullet body is being withdrawn from a soft formation;

FIG. 4 is a partial view in cross section of an annular release ring and the forward end of a bullet body when impacted in a hard formation; and

FIG. 5 is a view in partial cross section of a modified form of the present invention.

In FIG. 1 of the drawing, there is shown a gun block or body 10 disposed in a borehole 11 opposite a formation 12 of interest. Usually, borehole 11 contains a drilling mud 13; however, the present invention may be employed in either dry or fluid-filled boreholes.

Gun block 10 has a cylindrical bore 14 adjoining a bore 15 of smaller diameter, the bore 15 forming a powder chamber which terminates short of the rear surface 16 of the gun block. Chamber 15 contains an appropriate and conventional explosive propellant 17 while bore 14 receives a generally cylindrical core-taking device or bullet assembly 18 constructed in accordance with the present invention. Although not illustrated, gun block 10 generally contains additional bullet assemblies in respective bores distributed along a vertical axis for the gun block.

Bullet assembly or bullet 18, near its rearward end, has an annular groove 19 which receives an O-ring to provide a fluid-tight seal for the bullet assembly 18 in the bore 14, and flexible retrieving wires 20 are secured in a conventional manner between the bullet assembly and gun block 10 to permit the bullet body of the assembly to be retrieved. A conventional igniter 21 suitably mounted in the block 10 may be employed to detonate the explosive propellant 17 and thereby propel the bullet 18 towards and into the formation.

Referring now to FIG. 2, bullet 18 is comprised of a substantially cylindrical, hollow, bullet body or body section 23 and provided with ports 24 in its side walls, a rear end or bottom closure 25 connected to the body by a connecting pin 26, and a forward cutting end section or ring 27 which is solidly connected to the forward end of body section 23 by a threaded connection 29.

The forward end of the bullet body 23 is described in full in my aforesaid co-pending application and reference may be made thereto for a more specific description. In general, however, the forward end of the bullet body 23 includes a forward, outer, annular, relieved portion ex-

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tending between a shoulder 30 and a forward end surface 31, the shoulder and end surface being arranged substantially parallel to one another and perpendicular to the central axis of body 23. Intermediate of the annular shoulder 30 and the forward end surface 31 and beginning from the annular shoulder 30 are an O-ring receiving groove, a threaded section and a cylindrical surface.

As will hereinafter become more apparent, other types of cutting rings, as disclosed in my aforesaid co-pending application, may be easily interchanged on the bullet body 23. The cutting end section or ring 27, however, as shown in FIG. 2, is a universal type to be employed in formations of unknown character to obtain a solid core sample.

Cutting ring 27 has a cutting edge 35 formed between a straight cylindrical bore 36 and an outwardly, conically tapered surface 37. Mouth bore 36 has a short length and adjoins a rearward bore of greater diameter thereby providing a relieved portion in which the core sample is subjected to a minimum amount of compaction or rearrangement of sand grains. The bullet body 23 is similarly provided with different bore portions and, hence, the two relieved sections, i.e. the one in the cutting ring 27 and the one in the bullet body 23, serve to minimize the core damage. At the same time, removal of the core from the bullet body is facilitated since only a short section of the formation core is held securely by the body.

The ring member 27 has an internal, threaded portion compatible with a threaded portion on the bullet body and a rearwardly facing shoulder arranged to abut the end surface 31 of the bullet body as well as an end surface to abut shoulder 30 of the bullet body. To accommodate for manufacturing tolerances, ring 27 may be slightly spaced from shoulder 30.

To secure the cutting ring 27 to the bullet body, an O ring is inserted in the O ring receiving groove in the bullet body 23 and placed under compression between a cylindrical surface on the cutting ring 27 and O ring groove to frictionally secure the cutting ring 27 against rotation relative to the bullet body 23. Standard dimensions of O ring groove and clearance may suitably be employed.

Rearwardly from the forward cutting edge 35, the cutting ring 27 is provided with a cylindrical surface 39 which extends between the outer tapered surface 37 and an outer, forwardly facing shoulder 40. Slidably received by the cylindrical surface is an annular release ring member 41, which abuts the shoulder 40 and has an outer tapered surface. The release ring 41 is secured to the cutting ring 27 by means of a retainer ring member 42 received in an annular groove in the cutting ring 27, the release ring 41 thereby being releasably secured between the shoulder 40 and retainer ring 42. The retaining ring consists of a thin band of metal spirally arranged to fit in the groove of the cutting ring and, for example, may be a ring of the type sold under the trademark "Spirolox" by the Ramsey Corporation of St. Louis, Missouri.

The general principles which enable the separation of the release ring member from the bullet body are as follows. Upon impact of the bullet 18 with the borehole wall, cutting edge 35 cuts into the formations with the cutting ring 27 entering the formation. At some distance into the formation, the retainer ring 42 contacts the formation and is torn or stripped from the ring groove in the bullet body and the release ring 41 passes into the formation, the retainer ring 42 being left in the borehole as shown in FIG. 3. Thereafter, a pull on the bullet body 23 permits the cutting ring 27 attached to the bullet body 23 to slide freely through the release ring 41 bringing with it, of course, a formation sample.

Should the formation be hard, then, of course, only the forward end 27 on the bullet body 23 will enter the formation, as shown in FIG. 4, and, by the time the release ring 41 reaches the formation, an adequate sample is in

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the bullet body. Thus, even though no further penetration occurs, a reasonable sample is obtained.

From the foregoing description, it will be appreciated that the cutting ring or forward, formation cutting end 37 and bullet body or body section 23 are an essentially integral body member. Thus, it will be obvious that a bullet body can be made in an integral one piece unit which would, of course, eliminate the separate pieces. Also, in an integral unit, the bores of different diameters in the bullet body 23 would not be necessary. These features will hereinafter become more apparent. Also, the preferred type of retaining ring 42 is illustrated; however, it will be obvious that a resilient O ring may be used though it would not be as satisfactory in operation as a metal ring.

Turning now to FIG. 5, a form of an integral body member 45 is illustrated in conjunction with another form of release ring 46. In FIG. 5, the bullet body 45 is tubular with a forward portion which is externally reduced in diameter to form an annular shoulder 48. Adjacent to the shoulder 48 is an O ring groove 49 and threaded portion 50 and a cylindrical surface 51 which extends to the forward cutting end 51. The cutting end may be notched or serrated to facilitate cutting action.

The release ring 46 is annular and releasably secured to the body by means including internal threads engageable with the threaded portion 50 of the body 45, with a rearwardly facing end surface 52 arranged to abut the shoulder 48 on the body. Preferably, the securing means include an O ring 54 received between the release ring and the body to prevent accidental unthreading.

The release ring 46 includes breakable retainer portions 55 interconnecting a forward ring member 55a and a rearwardly threaded ring member 55b, which maintain them in essentially fixed spatial relation to one another, but are adapted upon impact of the forward ring 55a with the formation to disjoint or crush so that the forward ring 55a is releasable from the threaded ring 55b. Thus, the bullet body 45 can be withdrawn from the formation while the forward ring 55a remains embedded therein.

The retainer portions 55 are connecting segments formed by cutting an internal, annular, rectangularly shaped groove in the release ring 46 and thereafter milling or cutting away portions of the remaining wall thickness to form opening 57 thereby minimizing the amount of metal actually interconnecting the forward ring 55a to the rearward ring 55b. In practice, the segments are three in number and equally spaced. The width of the groove need only be sufficient to permit breaking of the segments.

For the type of cutting ring, as disclosed in FIG. 5, when the impelled bullet impacts the formation, the cutting end 52 of the bullet body 45 enters the formation. After the cutting end of bullet is some distance into the formation, the forward ring 55a contacts the formation so that the retainer portions 55 are broken or crushed generally at their weakest point. Thereafter, the forward ring 55a is carried into the formation by the rearward ring 55b on the bullet body 45 until the impelling force is expended. Subsequently, a pull on the bullet body 45 permits the body to slide through the forward ring member 55a and be retrieved. After retrieving the apparatus, the core sample is removed.

While particular embodiments of the present invention have been shown and described, it is apparent that further changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. A formation core taking device adapted to be fired from a gun body into earth formations about a well bore and comprising: a tubular body member having a forward, formation cutting end formed between an internal bore and an outer surface, said body member having an

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external, forwardly facing, annular shoulder spaced rearwardly of said forward cutting end; a ring member slidably received by the forward cutting end of said body member to abut said shoulder and be spaced rearwardly of said forward cutting end, said ring member having an outer diameter greater than the diameter of said body member; and means releasably coupling said ring member to said tubular body member, said coupling means being responsive to forces developed within the well bore after the firing of said tubular body member to uncouple said ring member from said tubular body member thereby permitting said body member to be retrieved from the formations independently of said ring member.

2. A formation core taking device adapted to be fired from a gun body into earth formations about a well bore and comprising: a tubular body member having a forward, formation cutting end formed between an internal bore and an outer, conically sloped surface terminating at a cylindrical outer surface, said cylindrical outer surface terminating at an external, forwardly facing, annular shoulder; a ring member slidably received by the cylindrical surface of said body member to abut said shoulder and be spaced rearwardly of said sloping surface, said ring member having an outer diameter greater than the diameter of said body member; and means releasably coupling said ring member to said tubular body member, said coupling means being responsive to forces developed within the well bore after the firing of a tubular body member to uncouple said ring member from said tubular body member thereby permitting said body member to be retrieved from the formations independently of said ring member.

3. A formation core taking device adapted to be fired from a gun body into earth formations about a well bore and comprising: a tubular body member having a forward, formation cutting end formed between an internal bore and an outer surface, said body member having an external, forwardly facing, annular shoulder spaced rearwardly of said forward cutting end; a ring member slidably received by the forward cutting end of said body member to abut said shoulder and be spaced rearwardly of said forward cutting end, said ring member having an outer diameter greater than the diameter of said body member; and means releasably coupling said ring member to said tubular member including an annular groove in said body member and a retainer member in said groove, said retainer member being responsive to forces developed within the well bore after the firing of a tubular body member to uncouple said ring member from said tubular body member thereby permitting said body member to be retrieved from the formations independently of said ring member.

4. A formation core taking device adapted to be fired from a gun body into earth formations about a well bore and comprising: a tubular body member having a forward, formation cutting end formed between an internal bore and an outer surface, said body member having an external, forwardly facing, annular shoulder spaced rearwardly of said forward cutting end; a ring member received by the forward cutting end of said body member to abut said shoulder and be spaced rearwardly of said forward cutting end, said ring member having an outer diameter greater than the diameter of said body member; and means releasably coupling a forward portion of said ring member to said tubular member including a breakable section responsive to forces developed within the well bore subsequent to the firing of a tubular body member to uncouple said forward portion of said ring member from said tubular body member thereby permitting said body member to be retrieved from the formations independently of said forward portion of said ring member.

5. A formation core taking device adapted to be fired from a gun body into earth formations about a well bore and comprising: a tubular body member having a for-

ward, formation cutting end formed between an internal bore and an outer surface, said body member having an external, forwardly facing, annular shoulder spaced rearwardly of said forward cutting end; a ring member slidably received by the forward cutting end of said body member to abut said shoulder and be spaced rearwardly of said forward cutting end, said ring member having an outer diameter greater than the diameter of said body member; and means releasably coupling said ring member to said tubular member including an annular groove in said body member and a locking ring in said groove with unconstructed ends to permit radial extension of the locking ring, said locking ring being responsive to forces developed within the well bore after the firing of a tubular body member to uncouple said ring member from said tubular body member thereby permitting said body member to be retrieved from the formations independently of said ring member.

6. A formation core taking device adapted to be fired from a gun body into earth formations about a well bore and comprising; a tubular body member including a tubular body section having an outer, annular shoulder therealong and a threaded surface portion offset at said shoulder and extending towards the forward end of said body section, and a forward, formation cutting end section formed between a forward, internal bore and a forward, outer surface, said section having an external, forwardly facing, annular shoulder spaced rearwardly of said forward cutting end and having a rearward internal threaded counterbore for engagement with the threaded portion of said body section to provide an integral connection of said sections; a ring member slidably received by the forward cutting end of said cutting end section to abut said shoulder and be spaced rearwardly of said forward cutting end section, said ring member having an outer diameter greater than the diameter of said body member; and means releasably coupling said ring member to said end section and responsive to forces developed within the well bore after the firing of a tubular body member to uncouple said ring member from said tubular body member thereby permitting said end section to be retrieved from the formations independently of said ring member.

7. A formation core taking device adapted to be fired from a gun body into earth formations about a well bore and comprising; a tubular body member including a tubular body section having an outer, annular shoulder therealong and a threaded surface portion offset at said shoulder and extending towards the forward end of said body section, and a forward, formation cutting end section formed between a forward, internal bore and a forward, outer surface, said section

having an external, forwardly facing, annular shoulder spaced rearwardly of said forward cutting end and having a rearward internal threaded counterbore for engagement with the threaded portion of said body section to provide an integral connection of said sections; a ring member received by the forward cutting end of said cutting end section to abut said shoulder and be spaced rearwardly of said forward cutting end section, said ring member having an outer diameter greater than the diameter of said body member, and means releasably coupling a forward portion of said ring member to said end section including a breakable portion responsive to forces developed within the well bore after the firing of a tubular body member to uncouple said forward portion of said ring member from said end section thereby permitting said end section to be retrieved from the formations independently of said forward portion of said ring member.

8. A formation core taking device adapted to be fired from a gun body into earth formations about a well bore and comprising; a tubular body member including a tubular body section having an outer, annular shoulder therealong and a threaded surface portion offset at said shoulder and extending towards the forward end of said body section, and a forward, formation cutting end section formed between a forward, internal bore and a forward, outer surface, said section having an external, forwardly facing, annular shoulder spaced rearwardly of said forward cutting end and having a rearward internal threaded counterbore for engagement with the threaded portion of said body section to provide an integral connection of said sections; a ring member slidably received by the forward cutting end of said cutting end section to abut said shoulder and be spaced rearwardly of said forward cutting end section, said ring member having an outer diameter greater than the diameter of said body member; and means releasably coupling said ring member to said end section including an annular groove in said end section and a retainer member in said groove responsive to forces developed within the well bore subsequent to the firing of a tubular body member to uncouple said end section from said tubular body member thereby permitting said end section to be retrieved from the formations independently of said ring member.

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