

Nov. 13, 1951

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2,574,830

EXPLOSIVE DEVICE

Filed Nov. 4, 1949

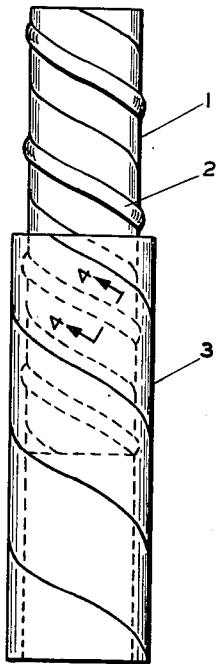


FIG. 1

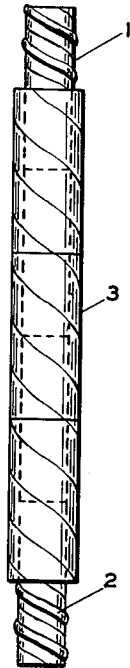


FIG. 2

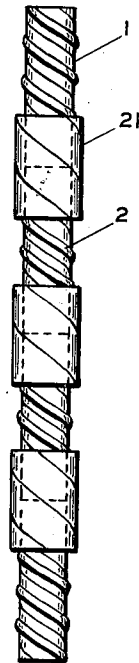


FIG. 3

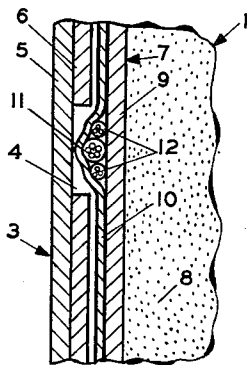


FIG. 4

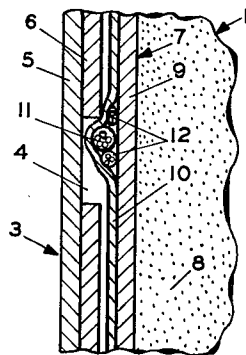


FIG. 5

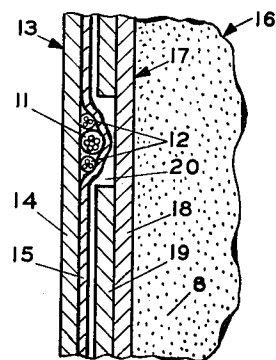


FIG. 6

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2,574,830

EXPLOSIVE DEVICE

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Application November 4, 1949, Serial No. 125,605

16 Claims. (Cl. 102—24)

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This invention relates to an explosive device and more particularly to an explosive device which may be joined together with similar explosive devices to form an explosive column.

In U. S. Patent 2,317,354 to Bennett there is disclosed an explosive cartridge assembly comprising a plurality of explosive cartridges connected in end-to-end abutting relationship by a plurality of connecting sleeves which threadedly engage the cartridges. With such an assembly, the cartridges and sleeves are supplied in a standard unit which may be readily built up in the field by simply screwing the units together to form an explosive column of the length desired. Such explosive assemblies have found wide use in geophysical prospecting and as geophysical prospecting techniques have advanced, explosive columns of increasingly greater length have been employed. As a result, the amount of tensile stress on the entire column, which stress is translated into torsional force due to the pitch of the threaded sleeves and cartridges, has been correspondingly increased. The resultant effect of this increased torsional force is a tendency for a section of the explosive column to rotate. This rotation is highly undesirable since even a slight rotation will cause a corresponding gap between the ends of the explosive cartridges disposed at the point where rotation occurs. Depending on the type of explosive which is being employed, a substantial gap can result in incomplete propagation, or if its width becomes great enough, a total failure of propagation. Furthermore, if the weight of the explosive column is still further increased, the cartridge and sleeve having the least frictional resistance in threaded relationship actually can unspiral to the degree that disengagement takes place and the portion of the assembly therebelow may be dropped during lowering of the column into a vertical borehole.

In U. S. Patent 2,403,488 to Bennett there is disclosed a threaded explosive assembly composed of threaded cartridges and threaded sleeves provided with an additional friction thread spirally disposed on each cartridge intermediate the male thread in frictional engagement with the inner surface of its respective sleeve. This friction thread is of a size which permits screwing of the sleeves upon the cartridges to form an explosive assembly and assists in the prevention of the sections of the assembly from becoming unscrewed as a result of the torsional forces created by the weight of a vertically suspended assembly or column. The use of such a friction thread does raise the permissible limit of the over-all weight of such a threaded explosive assembly and is thus a valuable improvement over the assembly of U. S. 2,317,354. However, as the lengths of the columns used in geophysical

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prospecting have increased still further, even this improved assembly will unspiral as a result of the torsional force created by the weight of the vertically suspended column. The answer to this problem cannot be found in increasing the size of the friction thread to effect a correspondingly increased resistance to the resultant torsional force, since a point is reached where it becomes too difficult or impossible to assemble the cartridges and sleeves to form the column.

The object of the present invention, therefore, is a device which is adapted to be connected with similar devices to form an elongated column which will not unspiral as a result of the torsional force created by tensile stress.

The further object of the invention is an explosive device which is adapted to be connected with similar explosive devices to form an explosive column which will not unspiral as a result of the torsional force created by the tensile stress of a threaded explosive column of any practical length.

Generally described, the present invention is a device adapted to be connected with similar devices to form a column comprising an internally threaded sleeve having an externally threaded tubular member disposed therein by engagement of male and female threads; the male thread comprising at least three spirally disposed, substantially contiguous, flexible, substantially cylindrical members, the center member having a greater diameter than the outer members and each successive outer member having a lesser diameter than each preceding member; and the female thread being a substantially rectilinear groove having a width and depth sufficient to receive the entire male thread in threaded engagement.

A further embodiment of the present invention is a threaded assembly having a plurality of externally threaded tubular members held in substantially end-to-end abutting relationship by at least one internally threaded sleeve by engagement of male and female threads; the male thread comprising at least three spirally disposed, substantially contiguous, flexible, substantially cylindrical members, the center member having a greater diameter than the outer members and each successive outer member having a lesser diameter than each preceding member, and the female thread being a substantially rectilinear groove having a width and a depth sufficient to receive the entire male thread in threaded engagement. In the preferred embodiment which constitutes the particular object of this invention, the inner tubular member is an externally threaded explosive cartridge. While the female thread may be carried by either the sleeve or the inner tubular member, it is preferred that the

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female thread be carried by the sleeve and the male thread be carried by the cartridge.

Having generally described the invention, further and more specific illustration is given with reference to the accompanying drawing in which like symbols refer to like parts wherever they occur. Fig. 1 represents an elevational view of a threaded cartridge and sleeve. Fig. 2 is an elevational view of an explosive assembly in accordance with the invention. Fig. 3 is an elevational view of a further embodiment of an explosive assembly in accordance with the invention. Fig. 4 is a fragmentary, sectional view taken on line 4-4 of Fig. 1. Fig. 5 is a fragmentary, sectional view showing the male and female threads of Fig. 4 in locked relationship. Fig. 6 is a fragmentary, sectional view of an alternative embodiment of the invention.

Referring now to Figs. 1, 2 and 4, an explosive cartridge 1 is provided throughout its length with an external, spirally disposed male thread 2. The cartridge 1 threadedly engages the tubular sleeve 3 which is substantially the same length as the cartridge. The sleeve 3 is provided with an internal, longitudinally continuous female thread 4 which is a substantially rectilinear groove defined by a strip of cellulosic material spirally disposed about the inner periphery of the sleeve 3 in spaced relationship.

With particular reference to Figs. 4 and 5, the sleeve 3 comprises an outer wrapping 5 adhesively affixed to an inner wrapping 6 which has been wrapped in spaced relationship to form the female thread 4. The cartridge 1 is formed from a shell 7 filled with explosive material 8. The shell 7 is formed from an inner wrapping 9 consisting of a plurality of plies of glued paper and an outer wrapping 10 consisting of a single ply of glued paper. Spirally disposed about the shell between the wrappings 9 and 10 are three contiguous, cellulosic cords. The center cord 11 is of greater diameter than the outer cords 12. The center cord 11 and the contiguous cords 12, together with the outer paper wrapping 10, form the male thread. The female thread 4 is of sufficient width and depth that it receives the entire male thread 2 in threaded engagement.

When tensile stress occurs between the cartridge 1 and the sleeve 3, one of the cords 12 rides up over the edge of the female thread 4 in locking relationship, as shown in Fig. 5. In the embodiment shown in Fig. 5, the upper thread 12 is crushed out of round between the edge of the female thread 4 and the outer wrapping 10 on one side and the inner wrapping 9 of the cartridge shell 7 on the other side.

In Fig. 6 is shown an alternate embodiment of the invention wherein the male thread is carried by the sleeve and the female thread is carried by the cartridge. The sleeve 13 is formed from an outer wrapping 14 composed of a plurality of layers of paper and an inner wrapping 15 composed of a single layer of paper. Spirally disposed between the wrappings 14 and 15 are three contiguous, cellulosic cords. The center cord 11 is of greater diameter than the outer cords 12. The center cord and the contiguous cords 12, together with the inner wrapping 15, form the male thread. The cartridge 16 is formed from a shell 17 filled with explosive material 8. The shell 17 is formed from an inner wrapping 18 composed of a plurality of plies of paper and an outer wrapping 19 consisting of a strip of cellulosic material spirally disposed in spaced relationship to form a female thread 20. The female

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thread 20 is of sufficient width and depth to receive the entire male thread in threaded engagement. When tensile stress occurs between the cartridge 16 and the sleeve 13, one of the cords 12 enters into locking relationship with the edge of the female thread 20, as illustrated in Fig. 5.

In Fig. 3, a still further embodiment of the invention is shown in which the internally threaded sleeves 21 are substantially shorter than the externally threaded cartridges 1. However, the short sleeves 21 and the cartridges 1 are locked together just as in the assembly shown in Fig. 2.

The following examples are given to more specifically illustrate the invention.

Example 1

Spirally wound sleeves were made which were 2.34 inches in inner diameter and 21½ inches long and which comprised 5 plies of 104-lb. manila paper and a strip of 0.040 point chipboard spirally disposed about their inner periphery in spaced relationship to form the female thread. Spirally wound shells were also made which were 2.31 inches in outer diameter, exclusive of the thread, and 21½ inches long and which comprised 5 inner plies of 104-lb. manila and 3 outer plies of 68½ lb. manila. A male thread was spirally disposed beneath the outer layer of paper at the same inclination as the female thread of the sleeves and comprised a central 0.065-inch kraft cord and two abutting 0.045-inch, two-ply, 16-lb. jute cords. Two of the cartridge shells were screwed into the opposite ends of one of the sleeves until the ends of the shells were in abutting relationship at approximately the midpoint of the sleeve. Additional torsional force was applied to lock the resulting column together. Five such columns were assembled. These columns were then individually suspended by the end of one extending shell and weight was applied to the end of the shell extending from the lower end of the sleeve. The weight was gradually increased with the following results:

Test No.	Weight at Which Column Held Without Separation	Maximum Weight Applied	Results
1.....	135	-----	Support broke with additional weight.
2.....	175	175	Column held.
3.....	160	175	Lower shell stripped through sleeve without unspringing.
4.....	100	125	Do.
5.....	140	180	Do.

Example 2

The tests of Example 1 were repeated. The sleeves were identical but the cartridge shells were formed from 6 plies of 104-lb. manila and 2 plies of 68½ lb. manila. The following results were obtained:

Test No.	Weight at Which Column Held Without Separation	Maximum Weight Applied	Results
1.....	55	65	Unspiraled at 65 lbs.
2.....	120	140	Unspiraled at 140 lbs.
3.....	155	165	Unspiraled at 165 lbs.
4.....	150	160	Unspiraled at 160 lbs.
5.....	160	165	Unspiraled at 165 lbs.

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Example 3

The tests of Examples 1 and 2 were repeated. The sleeves were identical to those used but the shells were formed from 7 plies of 104-lb. manila and 1 ply of 68½ lb. manila. The following results were obtained:

Test No.	Weight at Which Column Held Without Separation	Maximum Weight Applied	Results
1.....	80	105	Unspiraled at 105 lbs.
2.....	80	90	Unspiraled at 90 lbs.
3.....	80	90	Unspiraled at 90 lbs.
4.....	80	85	Unspiraled at 85 lbs.
5.....	80	85	Unspiraled at 85 lbs.

Example 4

The tests of Example 1 were repeated with sleeves prepared as in Example 1. The shells employed were formed from 6 plies of 104-lb. manila and 2 plies of 68½ lb. manila. In tests 1 through 9, however, only a single 0.065-inch kraft cord was spirally disposed beneath the outer layer of 68½ lb. manila to form the male thread. In tests 10 through 12, a 0.040-inch friction thread was spirally disposed midway between the single 0.065-inch male threads. The fit of the cartridges and sleeve was classified as loose, average, fairly tight, and tight depending upon the amount of effort necessary to screw them together. The results were as follows:

Test No.	Fit of Shell and Sleeve	Weight Causing Unspiraling
		Lbs.
1.....	Fairly tight.....	26
2.....	do.....	32
3.....	Average.....	24
4.....	Loose.....	18
5.....	Fairly tight.....	28
6.....	do.....	40
7.....	Average.....	22
8.....	Loose.....	16
9.....	do.....	12
10.....	Tight.....	65
11.....	do.....	45
12 ¹	do.....	71

¹ The cartridges were screwed into the sleeve only with extreme difficulty.

Example 5

Cartridge shells similar to those of Example 1 (5 plies 104-lb. manila and 3 plies 68½ lb. manila) were loaded with a commercial blasting gelatin. A locked 50-lb. explosive column was formed from 10 of these cartridges and 10 of the sleeves similar to those of Example 1. This column was vertically suspended by the extending end of the top cartridge and was subjected to severe shaking and jarring action. No unspiraling occurred and the maximum separation between any of the cartridges was .25 inch.

Example 6

Cartridge shells similar to those of Example 1 were loaded with a commercial blasting gelatin. A locked explosive column was formed from 9 of these cartridges and 9 sleeves which were similar to those used in Examples 2 and 5 except that they were 1½ inches shorter than the cartridges. This column was vertically suspended from the extending end of the top cartridge and subjected to severe shaking and jarring action as in Example 5. No unspiraling occurred and the maxi-

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mum separation between any of the cartridges was .25 inch.

Although cellulosic materials are the preferred materials of construction for the components of the invention, the invention is not so restricted. The cartridges and sleeves may, if desired, be formed from metal, metal foil, or combinations of metal foil and cellulosic materials. The cartridges and shells may also be made from various types of plastic or plastic sheeting. The male thread may also be formed from plastic strips or cord or from soft metal wire such as aluminum or copper. It is preferred, however, to make the cartridges and sleeves from a plurality of plies of paper, to form the female thread from a strip of chipboard spirally disposed about the outer surface of the cartridge or the inner surface of the sleeve in spaced relationship, and to form the male thread from kraft, jute, hemp, cotton or paper cord, or twine. According to the preferred embodiment of the invention, the cords forming the male thread are disposed beneath the outer ply of the paper cartridge shell or beneath the inner ply of the paper sleeve depending upon whether the male thread is carried by the cartridge or the sleeve.

The preferred method of manufacturing the carriage wrappers and sleeves of the present invention is by spiral winding. This method of manufacturing is economical and permits formation of the necessary threads on the sleeves and cartridge wrappers in a facile manner, since these threads may be wound on the respective parts at the same pitch used for the spiral winding. However, this method of manufacture requires the use of strip, flat material such as paper or other cellulosic material and easily worked metal foil. Materials of this kind have a considerable range of dimensional stability. Moreover, spiral wrapping machines and convolution wrapping machines, particularly when adhesives are employed, are incapable of manufacturing paper or other cellulosic tubes or tubes formed from metal foil within close tolerances. The range of dimensional stability inherent in these materials, plus the best tolerance limit obtainable in machines of the class described, does not permit a really close fit between the sleeve thread and the cartridge sleeve, male or female as the case may be. When a close fit is attempted, it is impossible, in a large percentage of cases, to manually screw the cartridges and sleeves together. As a result of this fact, it has heretofore been found necessary to provide a relatively loose fit between the sleeve thread and the cartridge thread. Normally, when the cartridges and sleeves are made so that they can be readily screwed together to form an explosive column, the amount of unspiraling is the greatest. By employing the multiple cord male thread of the invention, however, best results are actually obtained when the sleeves and cartridges are made with a tolerance which permits the components to be easily assembled. This fact will be readily seen by comparing the results obtained in Examples 1, 2 and 3. It will be noted that as the total over-all diameter of the shell was increased by increasing the number of plies of 104-lb. paper and correspondingly decreasing the number of plies of 68½-lb. paper, the holding strength of the column was reduced. This is due to the fact that the locking relationship between the sleeve and cartridge is greatest when the outer cord of the male thread is able to ride completely over the edge of the female thread to form an extremely tight locking rela-

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tionship when the column is subjected to tensile stress. The optimum amount of tolerance in a particular cartridge and sleeve will, therefore, depend upon the diameter of the outer cord of the multiple cord male thread.

Although the invention has been particularly described and illustrated with reference to its application in the explosives field, its use is not so limited. The individual units of tubular member and sleeve, or an assembly made therefrom, may be employed in many uses. The units and assemblies of the invention are particularly useful in building up shipping containers of any desired length which can be locked into an integral unit, thus eliminating the necessity of stocking containers of many different lengths.

Furthermore, the invention is not limited in the explosives field to the popular 2¼ inch cartridge with which specific illustration has been given since the invention is operable with cartridges of any desired diameter and length. In addition, the number of plies which are employed to make the sleeves and tubular members or cartridge shells, in accordance with the invention, will naturally vary with the size of the cartridge employed and the type of material contained therein, whether the devices of the invention are used to build up an explosive column, a shipping container, or are employed in any of their possible uses. In like manner, the size and strength of the cords or similar members forming the male threads and the strips of spirally wound material forming the female thread will vary in accordance with the structural demands of the particular application.

When the invention is employed to form explosive units or assemblies, such units or assemblies may be utilized in any type of blasting work where a column of explosive is desired. Any type of blasting explosive, such as gelatinous explosives, ammonium nitrate explosives, various types of dynamite, and black powder, may constitute the cartridge charge, and the use of any of these explosives in conjunction with the present invention is contemplated regardless of their particular field of use.

Since additional advantages and applications of the invention, other than those heretofore set forth, will be apparent to those skilled in the art, the invention is limited only by the scope of the appended claims.

What I claim and desire to protect by Letters Patent is:

1. An explosive device adapted to be connected coaxially with similar devices to form an explosive column, comprising a multi-ply paper sleeve carrying an internally disposed female thread having disposed therein in threaded engagement an explosive cartridge having a multi-ply paper shell and carrying an externally disposed male thread; the female thread being a substantially rectilinear groove formed by a flat strip of chipboard spirally disposed about the inner surface of the sleeve in spaced relationship, and the male thread comprising three spirally disposed, substantially contiguous cellulosic cords, the center cord having a substantially greater diameter than the outer cords.

2. A device according to claim 1 in which the cords are spirally disposed beneath the outer ply of the cartridge shell.

3. A threaded explosive assembly having a plurality of explosive cartridges carrying a spirally disposed male thread and each comprising a multiple ply paper shell containing explosive mate-

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rial, held in substantially end-to-end abutting relationship by at least one multiple ply paper sleeve carrying an internally disposed female thread by engagement of the male and female threads; the male thread comprising three spirally disposed, substantially contiguous cellulosic cords, the center cord having a substantially greater diameter than the outer cords; and the female thread being a substantially rectilinear groove formed by a flat strip of chipboard spirally disposed about the inner surface of the sleeve in spaced relationship, said female thread engaging said male thread in locked relationship when tensile stress is applied to the assembly.

4. An assembly according to claim 3 in which the cords are spirally disposed beneath the outer ply of the cartridge shell.

5. A device adapted to be connected coaxially with similar devices to form a column which comprises a sleeve carrying an internal thread and a tubular member carrying an external thread and connected to the sleeve by engagement of said threads; one of said threads being a male thread which comprises at least three spirally disposed, substantially contiguous, flexible, substantially cylindrical members; one of said members being of larger diameter than any of the other members and each member which is disposed outwardly on either side of the larger member having a progressively lesser diameter; and the other of said threads being a female thread which is a substantially rectilinear groove having a width and depth sufficient to receive the entire male thread in threaded engagement.

6. An explosive device adapted to be connected coaxially with similar devices to form an explosive column which comprises a sleeve carrying an internal thread and a tubular explosive cartridge carrying an external thread and connected to the sleeve by engagement of said threads; one of said threads being a male thread which comprises at least three spirally disposed, substantially contiguous, flexible, substantially cylindrical members; one of said members being of larger diameter than any of the other members and each member which is disposed outwardly on either side of the larger member having a progressively lesser diameter; and the other of said threads being a female thread which is a substantially rectilinear groove having a width and depth sufficient to receive the entire male thread in threaded engagement.

7. A device according to claim 5 in which the cartridge shell, the sleeve, and threads are formed from cellulosic materials.

8. An explosive device adapted to be connected coaxially with similar devices to form an explosive column which comprises a paper sleeve carrying an internal thread and a tubular explosive cartridge carrying an external thread and connected to the sleeve by engagement of said threads; said cartridge comprising a tubular paper shell containing explosive material; one of said threads being a male thread comprising at least three spirally disposed, substantially contiguous, flexible, substantially cylindrical members; one of said members being of larger diameter than any of the other members and each member which is disposed outwardly on either side of the larger member having a progressively lesser diameter; and the other of said threads being a female thread which defines a substantially rectilinear groove having a width and depth sufficient to receive the entire male thread in threaded engagement and formed by a flat,

substantially rectilinear strip of cellulosic material spirally disposed in spaced relationship.

9. A device according to claim 8 in which the male thread is carried by the cartridge and the female thread is carried by the sleeve.

10. A device according to claim 8 in which the male thread is carried by the sleeve and the female thread is carried by the cartridge.

11. A threaded assembly having a plurality of tubular members carrying an external thread held in substantially end-to-end abutting relationship by at least one sleeve carrying an internal thread and engaging the external thread of the tubular members; one of said threads being a male thread which comprises at least three spirally disposed, substantially contiguous, flexible, substantially cylindrical members; one of said members being of larger diameter than any of the other members and each member which is disposed outwardly on either side of the larger member having a progressively lesser diameter; and the other of said threads being a female thread which is a substantially rectilinear groove having a width and depth sufficient to receive the entire male thread in threaded engagement; said female thread engaging said male thread in locked relationship when tensile stress is applied to the assembly.

12. A threaded explosive assembly having a plurality of tubular explosive cartridges carrying an external thread held in substantially end-to-end abutting relationship by at least one sleeve carrying an internal thread and engaging the external thread of the tubular members; one of said threads being a male thread which comprises at least three spirally disposed, substantially contiguous, flexible, substantially cylindrical members; one of said members being of larger diameter than any of the other members and each member which is disposed outwardly on either side of the larger member having a progressively lesser diameter; and the other of said threads being a female thread which is a substantially rectilinear groove having a width and depth sufficient to receive the entire male thread in threaded engagement; said female thread engaging said male thread in locked relationship when tensile stress is applied to the assembly.

13. A threaded assembly according to claim 12 in which the cartridge shells, the sleeves, and the threads are formed from cellulosic materials.

14. A threaded explosive assembly having a plurality of explosive cartridges carrying an external thread, each cartridge comprising a tubular paper shell containing explosive material; said cartridges being held in substantially end-to-end abutting relationship by at least one sleeve carrying an internal thread and engaging the external thread of the cartridges; one of said threads being a male thread which comprises at least three spirally disposed, substantially contiguous, flexible, substantially cylindrical members; one of said members being of larger diameter than any of the other members and each member which is disposed outwardly on either side of the larger member having a progressively lesser diameter; and the other of said threads being a female thread which is a substantially rectilinear groove having a width and depth sufficient to receive the entire male thread in threaded engagement; said female thread engaging said male thread in locked relationship when tensile stress is applied to the assembly.

15. A threaded assembly according to claim 14 in which the male thread is carried by the cartridge and the female thread is carried by the sleeve.

16. A threaded assembly according to claim 14 in which the male thread is carried by the sleeve and the female thread is carried by the cartridge.

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