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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 :		(11) International Publication Number:
F16L 15/00, 47/00	A1	WO 90/00236
		(43) International Publication Date: 11 January 1990 (11.01.90)

(21) International Application Number: PCT/US89/02790

(22) International Filing Date: 28 June 1989 (28.06.89)

(30) Priority data:
212,599 28 June 1988 (28.06.88) US

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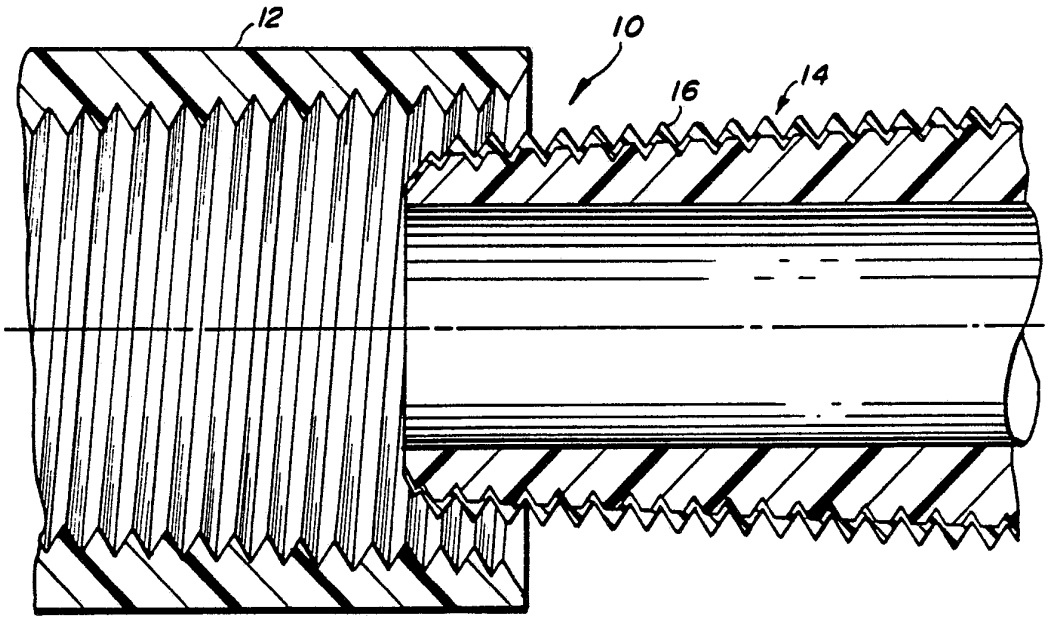
(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), LU (European patent), NL (European patent), SE (European patent).

Published
With international search report.
With amended claims and statement.

(54) Title: COMPOSITE THREAD COUPLING FOR REINFORCED PIPE



(57) Abstract

A joint (10) for fiberglass pipes (12, 14) is provided wherein mating female and male threads are ground or scribed into the ends of the pipes (12, 14) to be joined. At least one of the ground, threaded surfaces has a paste thread (16) contact molded into it so that the root or base of the paste thread is below the crest of the ground thread. Upon mating of the coupled pipe ends, the paste thread surface (16) provides a smooth finish and a relatively low, consistent engagement and disengagement torque. The overlapped projections of the ground male and female threads provide for mechanical interlock and correspondingly enhanced tensile strength in the joint.

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COMPOSITE THREAD COUPLING FOR REINFORCED PIPE

Background Of The Invention

The invention relates to couplings for non-ferrous pipe (or tubing) of plastic or fiberglass, for example. More particularly, the invention relates to glass reinforced resin pipe having premolded or contact molded end portions (male and female threads) for joining the end portions together.

Resin pipe reinforced with glass filamentous material is well known to the art and possesses a number of advantages over metal pipe, e.g., inertness, low weight, corrosive resistance, and high strength. These properties make such pipes particularly suitable for use in the chemical processing industry and in the oil industry for use as line pipe, down hole tubing, etc.

Threaded end portions of glass reinforced resin pipes have been formed by a number of methods. One method employs the use of discrete coupling members (bonded to the pipes) providing threaded adjacent ends to the pipes to be joined. However, since the adjacent ends of such pipes are joined by an interposed connector, the possibility for leakage is doubled. In addition, the time and effort necessary for assembly is increased as well as the possibility for damage during assembly.

The use of threaded pipe end portions is a considerable improvement over the employment of discrete coupling members.

However, the formation of threaded end portions simultaneously with the formation of the pipe by virtue of a threaded coupling-like member over the end portion of a rotatable mandrel, for example, is also subject to some disadvantages. For example, care must be taken to avoid the entrapment of air in the resin in the formation of the threads and to assure uniform and complete filling of the threads. Thus, an extra step is introduced into the formation of the pipe. The application of release agents to the threaded nipple end must also be carefully applied to insure a good release of the thread and further to prevent any damage to the threads when the finished pipe is removed from the mandrel.

Another method involves scribing grooves in a finished pipe to form threads therein. Although this is a workable arrangement, it is not without drawbacks. The scribing procedure results in broken reinforcement threads and exposed fiberglass strands in the pipe. However, a joint having scribed grooves on the mating male and female members provides the distinct benefit of enhanced tensile strength in the area of the coupling when compared to coupling elements bonded or otherwise molded to the fiberglass pipe. In other words, the scribed grooves of a male/female coupling provide a direct mechanical interlock between the substrates of the joined pipes. Such pipes possess increased tensile strength in the coupling portion which corresponds to the relatively greater interlaminar shear strength of a scribed thread compared to a molded thread.

What emerges from the evolvement to date of fiberglass pipe male/female type couplings is a number of advantages and disadvantages associated with purely scribed grooves in the pipe on the one hand and paste threads contact molded to the pipe laminate on the other hand.

Scribed threads are ground into the pipe laminate and necessarily involve excess resin material (for the amount ground away). The grinding and scribing processes applied may involve broken or cut threads or exposed fiberglass strands and the potential rejection of the thread after the entire pipe has been formed. However, the ground or scribed male and female thread joint provides the distinct advantage of a mechanical interlock tied integrally to the pipe laminate. The interlaminar shear strength of ground threads is recognized to be relatively greater than that of paste or molded threads whereby the corresponding tensile strength of the joint is enhanced.

In regard to paste or contact molded threads formed on the pipe laminate ends to be joined, certain advantages and disadvantages also exist. The primary disadvantage resides in the fact that a paste or molded thread does not provide mechanical interlock between the joined pipe laminates because only an adhesive bond exists between the paste threads and the pipe laminate. However, the paste or molded threads provide a more consistent thread profile with a corresponding relatively smooth finish, resulting in relatively lower engagement, and more

significantly disengagement, torque requirements. Furthermore, the paste or molded thread has less of a tendency to powder during engagement than does the relatively rough surface of a thread scribed into the pipe laminate material. Also, a paste or molded thread includes a more random orientation of reinforcement materials when compared to the reinforcement strands or threads which may be cut in the pipe laminate during grinding of a scribed thread. In other words, a random orientation of reinforcement materials with respect to the shear plane of the scribed threads results in a relatively stronger joint.

The above considerations are important in considering the application and use of the joint. For example, in an oil field situation utilizing a string of fiberglass pipes or tubes, it is obviously important that sufficient interlaminar shear strength exist at a joint. Put another way, it is important that the overall tensile strength of a pipe string not be unduly limited by potential separation of any one joint during use of the string. The tensile strength of the joints is also of significance in a horizontal pipe application. For example, a horizontal pipe typically will have a hydrostatic pressure associated with it which develops an end load on a pipe string which in turn exerts a tensile force on the pipe joints in an axial direction. In short, the tensile or axial force considerations in both a vertical and horizontal pipe string are the same with respect to the present invention.

Summary Of The Invention

The present invention provides for scribed or ground male and female threads on adjacent ends of two fiberglass pipe sections to be joined. At least one of the scribed threaded surfaces has a paste thread contact molded thereon so that the root or base of the paste thread is below the crest of the ground thread to which it is molded. The pitch of the contact molded thread is the same as the ground thread to which it mates. Upon mating of the coupled pipe ends, the paste thread surface provides the advantages enumerated above while also providing a mechanical interlock between the pipe sections. Mechanical interlock results from the overlapped projections of the male and female threads ground into the fiberglass pipes. The paste thread may be provided on either the male or female portion of the coupling. Alternatively, within the scope of the present invention, a paste thread may be formed on both the male and female scribed portions of the coupling. In this embodiment, the root or base of the paste threads on each joint portion are below the crest of the ground threads to which they are molded. As a further alternative embodiment of the present invention, it is comprehended that the aforesaid paste thread on a fiberglass pipe could be directly joined with the mating end of a steel or metallic pipe having integrally ground threads. Although reference has been made throughout to fiberglass reinforced pipe, it is also to be understood that carbon, polyester or other

functionally equivalent fibers, in addition to the more traditional glass fibers could be used to reinforce the pipe resin within the scope of the present invention.

Accordingly, an object of the present invention is to provide an improved coupling for joined fiberglass pipe sections in the sense that the joint will have significantly improved tensile strength in an axial direction when compared to certain prior art couplings.

Another object of the present invention is to provide a fiberglass pipe coupling which includes enhanced tensile strength as referred to above and which further includes the benefits of a paste thread interface on the male/female coupling surfaces.

A still further object of the present invention is to provide the aforesaid coupling in a manner which can be easily made a part of the fabrication process for fiberglass pipe.

With these and other objects in view which will more readily appear as the nature of the invention is better understood, the invention consists in the novel construction, combination and arrangement of parts hereinafter more fully illustrated and claimed.

Description Of The Drawings

FIGURE 1 is a longitudinal view in cross section of two fiber reinforced pipe ends having a male and female portion for coupling the same together. The female portion includes threads ground directly into the pipe laminate. The male portion has

paste threads contact molded onto threads which are also scribed into the pipe laminate.

FIGURE 1A is an enlarged, isolated view of the thread engagement illustrated in Figure 1.

FIGURE 2 is a view similar to Figure 1 with the contact molded paste threads being placed on the female portion of the coupling instead of the male portion.

FIGURE 2A is an enlarged, isolated view of the thread engagement illustrated in Figure 2.

FIGURE 3 is a longitudinal view in cross section of two fiber reinforced pipe ends having a male and female portion for coupling the same together. Each portion includes threads ground directly into the pipe laminate with paste threads contact molded to the threads scribed into the respective pipe laminates.

FIGURE 3A is an enlarged, isolated view of the thread engagement illustrated in Figure 3.

Similar reference characters designate corresponding parts throughout the several figures of the drawings.

Description Of The Invention

Pipe joint 10 in Figure 1 is provided for connecting the ends of a pair of non-ferrous (e.g., fiberglass or plastic) pipe sections 12 and 14. The pipe sections have tapered ends as shown and correspondingly tapered male and female coupling portions. Each pipe section 12 and 14 is formed of resin including embedded strands of glass filaments (for example) for reinforcement

purposes, as is well known in the art. As mentioned above, the reinforcement filaments could also be carbon, polyester or other functionally equivalent materials.

In the Figure 1 embodiment, female threads are ground into the laminate body of pipe 12 and may, for example, have an eight round thread as is widely used in such fiberglass pipe applications. In the male pipe portion 14, threads are also scribed into the laminate body of the pipe and include a pitch corresponding to that on the female pipe coupling portion. The ground threads on pipe portion 14 are in turn provided with an overlying paste thread or contact molded thread 16 which includes the same pitch as the threads scribed into the resin pipe bodies. The contact molded thread 16 is preferably formed of the same resin that is used to fabricate pipe body 14. With the molded thread 16 bonded to pipe body 14, and both being formed of the same resin material, thermal expansion and contraction is easily accommodated since there is no rate differential. The paste thread 16 has filler material in it to control viscosity and chopped fibers to provide further reinforcement to the thread 16. The chopped fibers in the plastic thread 16 are randomly oriented as opposed to the wound reinforcement filaments in the fiberglass pipe bodies.

Upon engagement as illustrated in Figure 1A, the crest of the threads scribed into each of the joined fiberglass pipes overlap one another and provide a mechanical interlock with the

reinforced plastic thread 16 being sandwiched therebetween. This is a distinct advantage over the prior art structures which rely on the adhesion of a molded plastic thread to an underlying pipe body for tensile strength purposes. Preferably the ground threads are relatively shallow in order to minimize the cutting of the wound reinforcement threads or filaments in each of the pipe sections. Of course, in minimizing the cutting of the reinforcement threads in the pipe body, the reduction in reinforcement provided to the pipe body is minimized, and the wasted material of the pipe body due to grinding is minimized. With the engagement arrangement of the joint of the present invention, it is possible, therefore, to have an effective joint of enhanced tensile strength while minimizing the depth of the ground or scribed threads in the pipe body laminates.

In addition to the enhanced tensile strength characteristics of the coupling provided by the present invention, the provision of the contact molded thread surface provides for a more consistent, smooth thread engagement surface. This in turn translates into a relatively lower engagement and disengagement torque than would be the case, for example, if a ground thread were engaged with another ground thread. Of course, with a smoother thread surface, there is also a reduced tendency of the paste thread to powder or abrade when compared to the relatively abrasive surface of the ground thread if it were engaged with another ground thread.

Figures 2 and 2A show another embodiment of the present invention with the female portion 18 of the joint having a contact molded thread surface 20 over the female threads ground into the pipe body 18. Correspondingly, the male pipe portion 22 only has threads ground into the pipe body. All of the same considerations applicable to the embodiment illustrated in Figures 1 and 1A apply to the embodiment illustrated in Figures 2 and 2A.

Figures 3 and 3A illustrate yet another embodiment of the present invention. In this embodiment, both the female pipe coupling portion 24 and the male portion 26 have threads of resin material molded to the threads scribed into the respective pipe bodies. The contact molded threads are designated at 28 on female portion 24 and at 30 on male portion 26.

The embodiment illustrated in Figures 3 and 3A would be used where relatively close thread tolerances are required and in difficult field applications for example where relatively lower engagement and disengagement torques might be desired. In addition, the Figure 3 embodiment could be utilized when it is desired to have increased corrosion resistance since the molded paste thread surface is more effective in resisting corrosion than is the surface provided by threads scribed into the pipe body.

However, the Figure 3 embodiment, as in the Figure 1 and Figure 2 embodiments, has as its principal advantage the

mechanical interlock provided by the overlapping crests on the threads scribed into each of the coupled pipe bodies and the desirable characteristics associated with the contact molded thread surface as considered above.

Lastly, it is comprehended that a fiber reinforced pipe having a scribed thread end with a contact molded paste thread thereover (as described above) could be directly joined to a steel or metallic pipe end. The metallic pipe would have mating integrally ground threads whereby the mechanical overlap and associated benefits described above would exist.

WHAT IS CLAIMED IS:

1. A fiber reinforced resin pipe comprising cured resin and strands of filaments embedded in said cured resin;

said pipe having an end portion with threads scribed into said pipe resin and said filaments; and

resin molded threads bonded over said scribed threads so that the valleys of said molded threads lie below the crests of said scribed threads wherein said pipe end portion is adapted to be threadably mated with an end portion of another pipe having scribed threads in the body thereof so that the crests of said scribed threads project over one another.

2. A reinforced resin pipe comprising cured resin and strands of filaments embedded in said cured resins;

said pipe having an end portion with threads scribed into said resin and said filaments; and

resin molded threads bonded over said scribed threads so that the valleys of said molded threads lie below the crests of said scribed threads wherein said pipe end portion is adapted to be coupled with an end portion of another reinforced resin pipe having mating threads which extend below the crests of said scribed threads underlying said molded threads.

3. A reinforced resin pipe comprising cured resin and strands of filaments embedded in said cured resin;

said pipe having an end portion with female coupling threads scribed into said resin and said filaments; and

resin molded female threads bonded over said scribed female threads so that the valleys of said molded threads lie below the crests of said scribed threads whereby said pipe end portion is adapted to be threadably mated with an end portion of another reinforced resin pipe having male threads scribed into the resin and filaments thereof so that the crests of said scribed female threads project over the crests of the scribed male threads on the end portion of the mated pipe.

4. A reinforced resin pipe as defined in claim 3 wherein said scribed female threads provide a mechanical interlock with the scribed male threads of the joined resin pipe end portion.

5. A reinforced resin pipe as defined in claim 4 wherein the pitch on said molded threads is the same as the pitch on the mating scribed threads.

6. A reinforced resin pipe as defined in claim 5 wherein the pitch on said scribed threads underlying said molded threads is the same as the pitch of said molded threads.

7. A reinforced resin pipe as defined in claim 5 wherein the resin of said molded threads is the same as the resin comprising the pipe body to which it is bonded whereby said molded threads and underlying pipe body have the same thermal expansion characteristics.

8. A reinforced resin pipe as defined in claim 7 wherein the resin of said molded threads has fibers to provide reinforcement.

9. A reinforced resin pipe as defined in claim 8 wherein said fibers in said molded thread resin are randomly oriented.

10. A reinforced resin pipe comprising cured resin and strands of filaments embedded in said cured resin;

said pipe having an end portion with male coupling threads scribed into said resin and said filaments; and

resin molded male threads bonded over said scribed male threads so that the valleys of said molded threads lie below the crests of said scribed threads whereby said pipe end portion is adapted to be threadably mated with an end portion of another reinforced resin pipe having female threads scribed into the resin and filaments thereof so that the crests of said scribed male threads project over the crests of the scribed female threads on the end portion of the mated pipe.

11. A reinforced resin pipe as defined in claim 10 wherein said scribed male threads provide a mechanical interlock with the scribed female threads of the joined resin pipe end portion.

12. A reinforced resin pipe as defined in claim 11 wherein the pitch on said molded threads is the same as the pitch on the mating scribed threads.

13. A reinforced resin pipe as defined in claim 12 wherein

the pitch on said scribed threads underlying said molded threads is the same as the pitch of said molded threads.

14. A reinforced resin pipe as defined in claim 13 wherein the resin of said molded threads is the same as the resin comprising the pipe body to which it is bonded whereby said molded threads and underlying pipe body have the same thermal expansion characteristics.

15. A reinforced resin pipe as defined in claim 14 wherein the resin of said molded threads has fibers to provide reinforcement.

16. A reinforced resin pipe as defined in claim 15 wherein said fibers in said molded thread resin are randomly oriented.

17. A pair of reinforced resin pipes coupled to one another and each comprising cured resin and strands of filaments embedded in said cured resin;

one of said pipes having an end portion with male threads scribed into said resin and said filaments and resin molded male threads bonded over said scribed male threads so that the valleys of said molded male threads lie below the crests of said scribed male threads;

the other of said pipes having an end portion with female threads scribed into said resin and said filaments thereof and resin molded female threads bonded over said scribed female threads so that the valleys of said molded female threads lie below the crests of said scribed female threads wherein said pipe

end portions are threadably mated with one another so that the crests of said scribed male and female threads underlying said molded male and female threads project over one another to provide a mechanical interlock between the pipe bodies.

18. A pair of reinforced resin pipes coupled to one another as defined in claim 17 wherein the pitch on said scribed threads and said molded threads is the same.

19. A pair of reinforced resin pipes coupled to one another as defined in claim 17 wherein the resin of said molded threads is the same as the resin comprising the respective pipe bodies to which they are bonded whereby said molded threads and respectively underlying pipe bodies have the same thermal expansion characteristics.

20. A pair of reinforced resin pipes coupled to one another as defined in claim 19 wherein the resin of said molded threads has fibers to provide reinforcement.

21. A pair of reinforced resin pipes coupled to one another as defined in claim 20 wherein said fibers in said molded thread resin are randomly oriented.

22. A reinforced resin pipe as defined in claim 7 wherein the resin of said molded threads has filler to control viscosity.

23. A reinforced resin pipe as defined in claim 14 wherein the resin of said molded threads has filler to control viscosity.

24. A pair of reinforced pipes coupled to one another as defined in claim 19 wherein the resin of said molded threads includes filler to control viscosity.

AMENDED CLAIMS
[received by the International Bureau on 27 November 1989 (27.11.89)
original claims 1-24 replaced by new claims 1-27 (5 pages)]

1. A pipe having an end portion suitable for making a connection exhibiting superior tensile strength to a female threaded member, comprising:

male scribed threads cut into the exterior surface of said end portion of said pipe and having approximately the same pitch as the threads of said female threaded member;

smooth contact molded threads made of resin overlying said scribed threads and having approximately the same pitch as said scribed threads, wherein said contact molded threads have a consistent and controlled thickness, such that the valleys of said contact molded threads extend below the crests of said scribed threads.

2. The pipe of claim 1 wherein the crests of said threads on said female member extend below said crests of said male scribed threads after said pipe has been threadably attached to said female member.

3. The pipe of claim 2 wherein said contact molded threads contain chopped fibers to provide reinforcement.

4. The pipe of claim 3 wherein said chopped fibers are randomly oriented.

5. The pipe of claim 1, 2, 3 or 4 wherein said contact molded threads contain a filler to control viscosity.

6. The pipe of claim 1, 2, 3 or 4 wherein said pipe is made of resin reinforced with wound filaments.

7. The pipe of claim 6 wherein said scribed threads are cut more shallowly than normal, whereby cutting of said wound filaments is minimized and the strength of the body of said pipe is maintained.

8. The pipe of claim 6 wherein the resin of said molded threads is the same as the resin of said pipe, whereby said molded threads and said pipe have the same thermal expansion characteristics.

9. A pipe having an end portion suitable for making a connection exhibiting superior tensile strength to a male

threaded member, comprising:

female scribed threads cut into the interior surface of said end portion of said pipe and having approximately the same pitch as the threads of said male threaded member;

smooth contact molded threads made of resin overlying said scribed threads and having approximately the same pitch as said scribed threads, wherein said contact molded threads have a consistent and controlled thickness, such that the valleys of said contact molded threads extend below the crests of said scribed threads.

10. The pipe of claim 9 wherein the crests of said threads on said male member extend below said crests of said female scribed threads after said pipe has been threadably attached to said male member.

11. The pipe of claim 10 wherein said contact molded threads contain chopped fibers to provide reinforcement.

12. The pipe of claim 11 wherein said chopped fibers are randomly oriented.

13. The pipe of claim 9, 10, 11 or 12 wherein said contact molded threads contain a filler to control viscosity.

14. The pipe of claim 9, 10, 11 or 12 wherein said pipe is made of resin reinforced with wound filaments.

15. The pipe of claim 14 wherein said scribed threads are cut more shallowly than normal, whereby cutting of said wound filaments is minimized and the strength of the body of said pipe is maintained.

16. The pipe of claim 14 wherein the resin of said molded threads is the same as the resin of said pipe, whereby said molded threads and said pipe have the same thermal expansion characteristics.

17. First and second pipes having mating end portions suitable for making a connection exhibiting superior tensile strength, comprising:

male scribed threads cut into the exterior surface of said end portion of said first pipe;

mating female scribed threads cut into the interior surface

of said end portion of said second pipe and having approximately the same pitch as the scribed threads of said first pipe;

smooth contact molded threads made of resin overlying said scribed threads on both said first and second pipes and having approximately the same pitch as said scribed threads on said first and second pipes, wherein said contact molded threads have a consistent and controlled thicknesses, such that the valleys of said male and female contact molded threads extend below the crests of said male and female scribed threads, respectively.

18. The pipes of claim 17 wherein the crests of said female scribed threads overlap the crests of said male scribed threads after said first and second pipes have been threadably attached to each other.

19. The pipes of claim 18 wherein said contact molded threads contain chopped fibers to provide reinforcement.

20. The pipes of claim 19 wherein said chopped fibers are randomly oriented.

21. The pipes of claim 17, 18, 19 or 20 wherein said contact molded threads contain a filler to control viscosity.

22. The pipes of claim 17, 18, 19 or 20 wherein said pipes are made of resin reinforced with wound filaments.

23. The pipes of claim 22 wherein said scribed threads are cut more shallowly than normal, whereby cutting of said wound filaments is minimized and the strength of the bodies of said pipes is maintained.

24. The pipes of claim 22 wherein the resin of said molded threads is the same as the resin of said pipes, whereby said molded hreads and said pipes have the same thermal expansion characteristics.

25. A pipe made of resin reinforced with wound filaments having an end portion suitable for making a connection exhibiting superior tensile strength to a female threaded member, comprising:

male scribed threads cut shallowly into the exterior surface of said end portion of said pipe and having approximately the same pitch as the threads of said female threaded member, whereby

cutting of said wound filaments is minimized and the strength of the body of said pipe is maintained;

smooth contact molded threads made of the same resin as said pipe and reinforced with randomly-oriented chopped fibers, and containing a filler to control viscosity, overlying said scribed threads and having approximately the same pitch as said scribed threads, wherein said contact molded threads have the same thermal expansion characteristics as said pipe, as well as a consistent and controlled thickness, such that the valleys of said contact molded threads extend below the crests of said scribed threads and the crests of said threads on said female member extend below said crests of said male scribed threads after said pipe has been threadably attached to said female member.

26. A pipe made of resin reinforced with wound filaments having an end portion suitable for making a connection exhibiting superior tensile strength to a male threaded member, comprising:

female scribed threads cut shallowly into the interior surface of said end portion of said pipe and having approximately the same pitch as the threads of said male threaded member, whereby cutting of said wound filaments is minimized and the strength of the body of said pipe is maintained;

smooth contact molded threads made of the same resin as said pipe and reinforced with randomly-oriented chopped fibers, and containing a filler to control viscosity, overlying said scribed threads and having approximately the same pitch as said scribed threads, wherein said contact molded threads have the same thermal expansion characteristics as said pipe, as well as a consistent and controlled thickness, such that the valleys of said contact molded threads extend below the crests of said scribed threads and the crests of said threads on said male member extend below said crests of said female scribed threads after said pipe has been threadably attached to said male member.

27. First and second pipes made of resin reinforced with wound filaments having end portions suitable for making a connection exhibiting superior tensile strength, comprising:

male scribed threads cut shallowly into the exterior surface of said end portion of said first pipe, whereby cutting of said wound filaments is minimized and the strength of the body of said first pipe is maintained;

female scribed threads cut shallowly into the interior surface of said end portion of said second pipe, and having approximately the same pitch as the scribed threads of said first pipe, whereby cutting of said wound filaments is minimized and the strength of the body of said second pipe is maintained;

smooth contact molded threads made of the same resin as said pipe and reinforced with randomly-oriented chopped fibers, and containing a filler to control viscosity, overlying said scribed threads on both said first and second pipes and having approximately the same pitch as said scribed threads, wherein said contact molded threads have the same thermal expansion characteristics as said pipes, as well as a consistent and controlled thickness, such that the valleys of said contact molded male and female threads extend below the crests of said male and female scribed threads, respectively, and the crests of said female scribed threads overlap the crests of said male scribed threads after said pipes have been threadably connected together.

STATEMENT UNDER ARTICLE 19

The amendments to the disclosure and to the claims were made to bring this application into conformance with the concurrent application now pending before the United States Patent and Trademark Office.

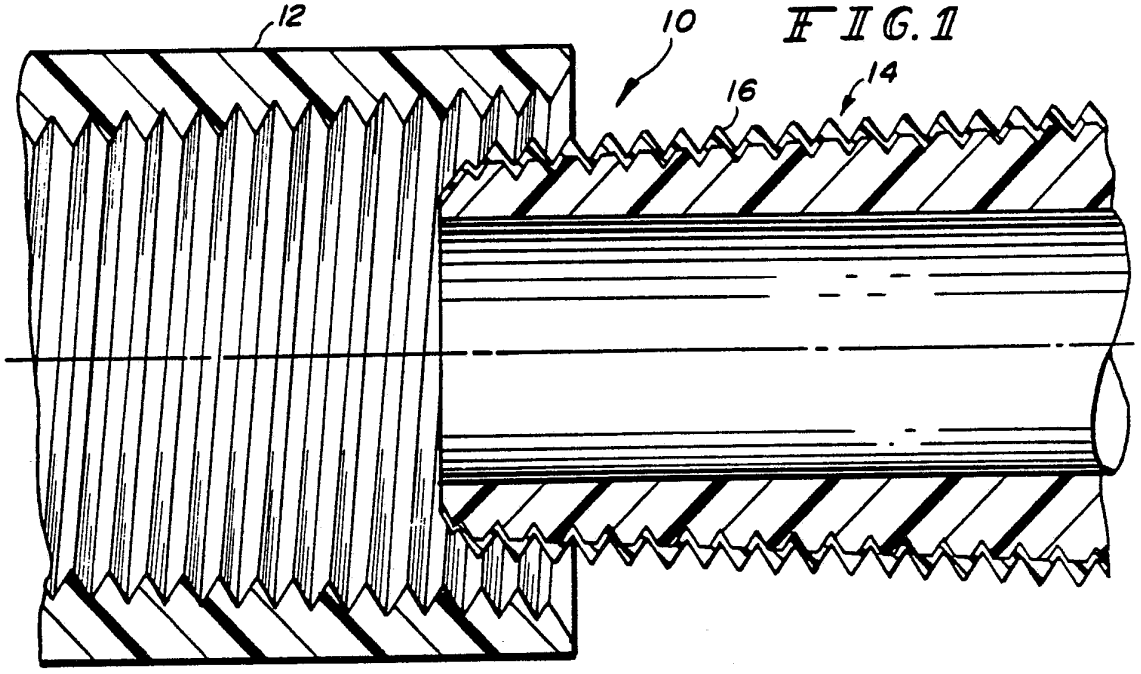


FIG. 1

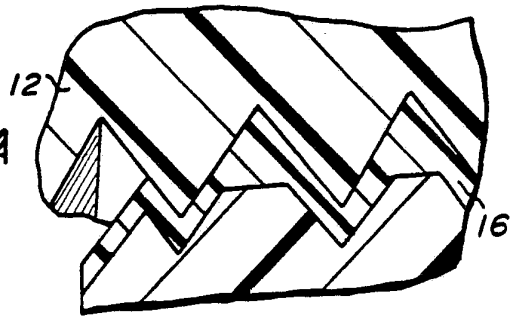


FIG. 1A

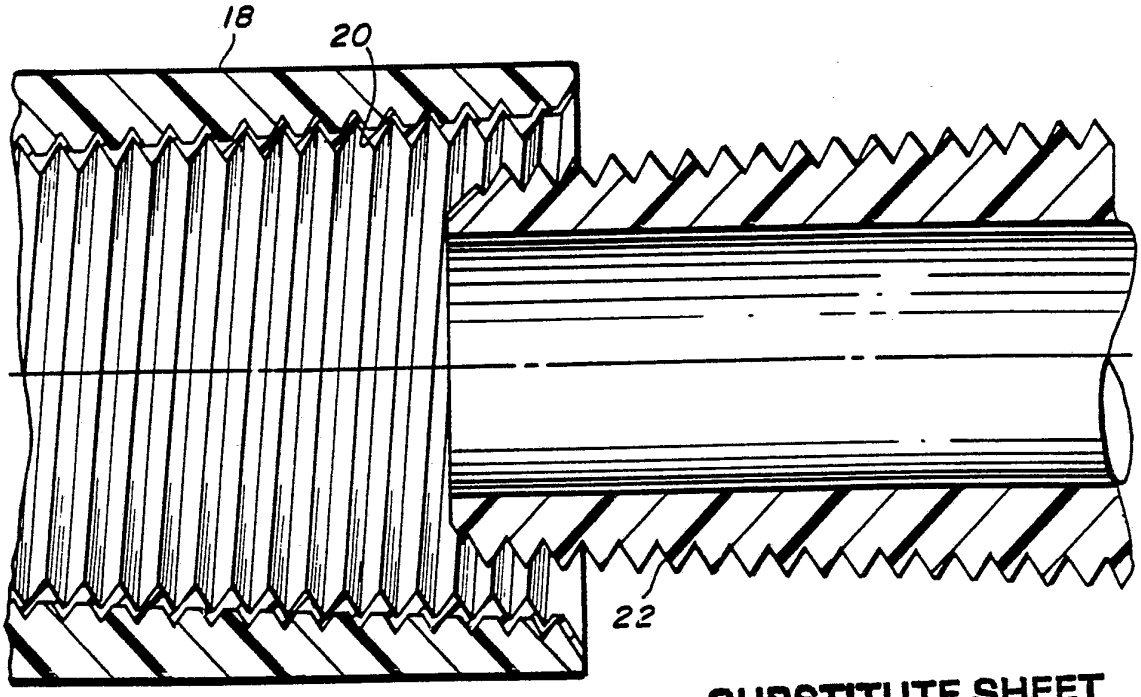


FIG. 2

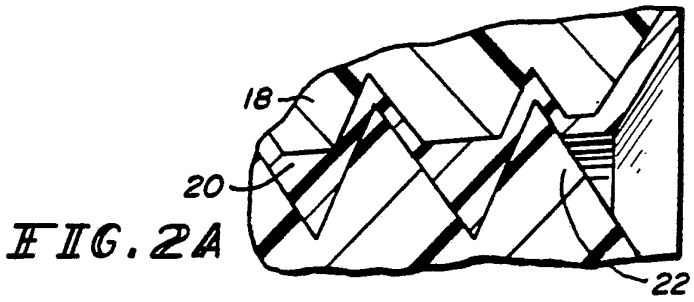
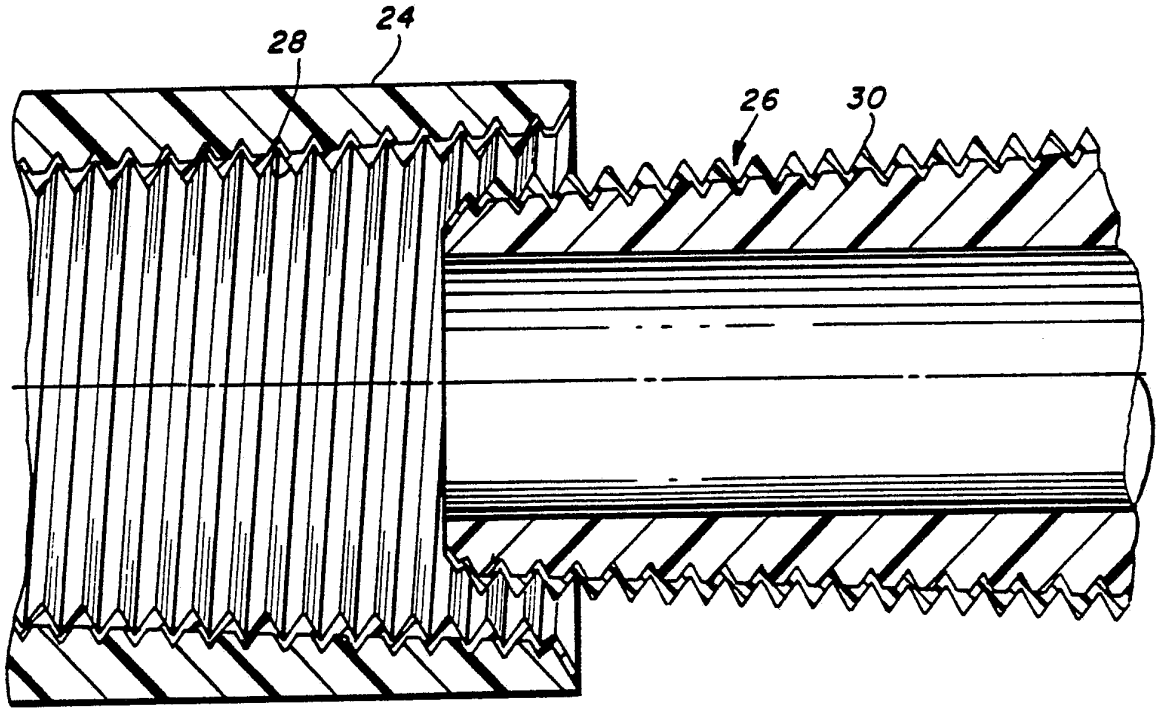


FIG. 2A

FIG. 3



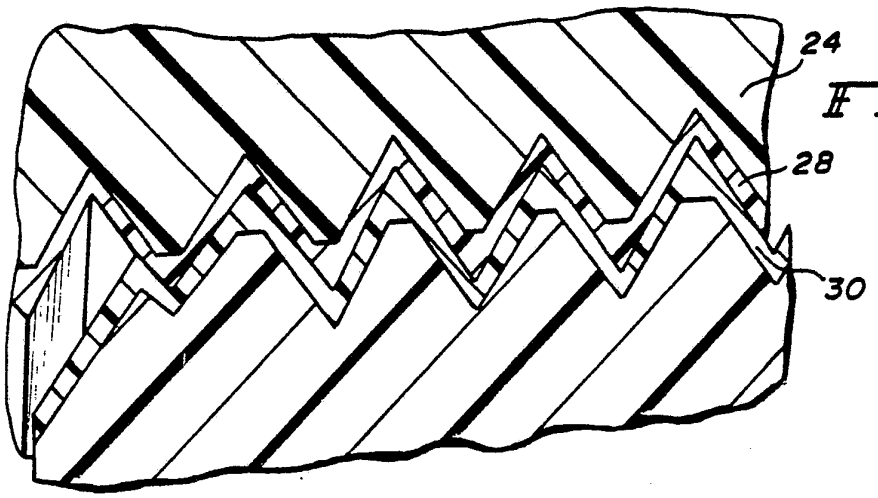


FIG. 3A

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US 89/02790

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (4): F16L 15/00, 47/00
U.S. CL. 285/355, 423, 334

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	285/355,423,333,334,390,909,919,923

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X Y	US, A, 3,101,207 (PAVEL ET AL.) 20 August 1963; (see the entire document).	1-6,10-13,17, 18 7-9,14-16, 19-24
A	US, A, 4,537,426 (CARTER, SR.) 27 August 1985.	1
A	US, A, 4,154,466 (SIMMONS) 15 May 1979.	1
A	US, A, 2,900,435 (CURTISS) 18 August 1959.	1
A	US, A, 4,033,167 (PHILIBERT) 05 July 1977.	1
A	US, A, 658,085 (HIGBEE) 18 September 1900.	1
Y	US, A, 3,366,504 (HULTERSTRUM) 30 January 1968; (see Col. 1, lines 15-32 and Col. 2, lines 4-33).	7-9,14-16, 19-24

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
05 September 1989	26 SEP 1989
International Searching Authority	**Signature of Authorized Officer**
ISA/US	Anthony Knight