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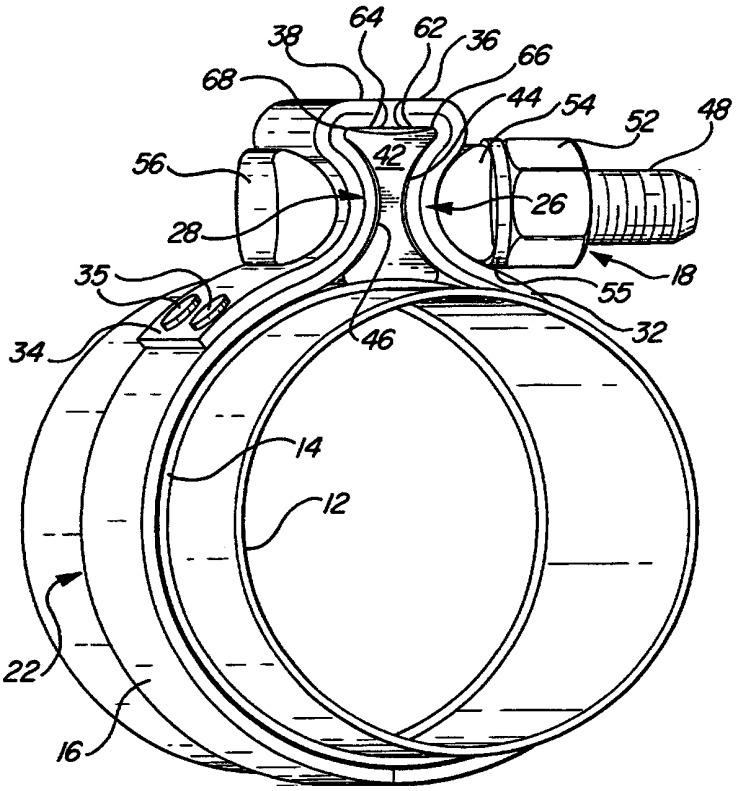

(57) Abstract: A band clamp (10) for pipe joints is disclosed comprising a band (16) with confronting sidewalls (26, 28) when wrapped around pipes to be coupled. The clamping mechanism includes a pair of force bars (54) outboard of the sidewalls and a spline (42) with concave surfaces on opposite sides, the spline (42) being disposed between the end flanges. A bolt (48) extends through bolt holes and draws the flanges against the spline (42) to stretch the band (16) around the pipes when the bolt (48) is tightened against the force bars (54). The sidewalls have lateral flanges (36, 38) which overhang the spline (42) to arrest movement of the sidewalls relative to the spline (42) to obtain alignment of the bolt holes when the clamp is tightened.

WO 00/77436 A1

IMPROVED BAND CLAMP

FIELD OF THE INVENTION

This invention relates to band clamps and more particularly, it relates to band clamps which are useful for pipe joints such as those used in vehicle exhaust systems.

BACKGROUND OF THE INVENTION

In vehicle exhaust systems, it is desirable to provide a pipe joint with high pull-apart strength and with a good fluid seal between the pipes. For both lap joints and butt joints, a band clamp has been provided in the prior art which admirably meets the requirements of pull-apart strength and fluid sealing. However, in some applications of a certain type of high tension band clamps often referred to as the "TORCA™ clamp", there has been a problem in some cases of inadequate force or loading applied by the clamp to pipe joints. In other cases there is a problem of breakage of a clamping bolt during installation or service of the clamp. Applicant has discovered the cause of these problems and has discovered a solution which is realized in accordance with the invention set forth herein.

In the prior art, high tension band clamps of the TORCA™ type are disclosed in Cassel patent 4,312,526 granted January 26, 1982 and Cassel et

al. patent 4,629,226 granted December 16, 1986. Patent 4,312,526 is especially suited for either lap joints or butt joints in vehicle exhaust systems in which the clamp band is made of relatively thin material. The band clamp of patent 4,629,226 is especially adapted for lap joints in vehicle exhaust systems wherein the clamp band is made of relatively thick material.

Both of the high tension band clamps mentioned above are characterized by structure and operation as follows. The clamp comprises a clamp band which is disposed around a member, such as a pipe which is to be joined with another pipe. The clamp band is, for the most part, circular or roundish in cross-section and is adapted to fit around the pipe. The ends of the roundish sector terminate in a channel-shaped sector which comprises a pair of sidewalls extending radially outwardly from the roundish sector. The clamp band is made of a single piece of sheet metal and each free end thereof is folded back on itself to form a double layer. Thus, the sidewalls are of double thickness and terminate at their outer ends in respective loops or bights. The bights serve as retaining members for restricting the movement of the sidewalls when the tightening means is tightened. The clamp band is tightened around the pipe by tightening means which comprises a reaction member or spline which is disposed within the channel-shaped sector and which is adapted to seat upon the pipe. For this purpose, the spline

has an inner surface of arcuate configuration conforming to the pipe. The spline is provided on each side with a laterally facing concave surface. The tightening means further includes a bolt which extends through the sidewalls and the spline. The threaded end of the bolt extends through a spacer or bar which is disposed outside one sidewall and which has a convex surface which is opposite one concave surface of the spline. The bolt has a head with a convex inner surface which is disposed outside the other sidewall opposite the other concave surface on the other side of the spline. Alternatively, a bolt with a conventional head may be used and a separate bar with a convex surface is disposed under the bolt head opposite the other concave surface of the spline. A nut on the threaded end of the bolt is tightened to draw the sidewalls toward engagement with the spline and thus develop high tension in the clamp band.

I have discovered that tightening of the bolt to seat the sidewalls against the spline causes the free ends of the sidewalls to be pulled toward the pipe with slippage relative to the spline which becomes firmly seated on the pipe during the tightening operation. This slippage causes the sidewalls to engage the bolt at the periphery of the bolt holes in the sidewalls and to pull the bolt toward the pipe. As a result, the bolt becomes firmly seated against the periphery of the bolt hole in the spline. Additional tightening of the bolt causes additional downward slippage of

the sidewalls relative to the spline. This causes the two sidewalls to apply a bending moment on the bolt on opposite sides of the spline which acts as a fulcrum for the bolt. The retaining members on the sidewalls are adapted to limit the amount of slippage of the free ends of the sidewalls relative to the spline so that high tension can be developed in the clamp band when the tightening of the bolt is completed. Because of variation of dimensions of the parts within the allowable tolerances of manufacture, there will be some joints in which the bolt is subjected to bending stresses before the retaining members arrest the free ends of the sidewalls. In a pipe joint where the bolt is bent by the downward force of the two sidewalls pulling it into engagement with the spline, the bolt will be placed in tension across the upper part of its cross-section and it will be placed in compression across the lower part of its cross-section. Since only a fraction of the bolt cross-section is in tension the clamping force achieved by the clamp band is significantly less than the full potential. This can result in a joint with reduced pull-apart strength or reduced sealing. Also, with only a fraction of the cross-section of the bolt in tension, the tensile strength of the bolt is significantly reduced and the tensile forces which must be developed to tighten the clamp will exceed the tensile strength of the bolt and cause it to break.

A general object of this invention is to overcome certain disadvantages of the prior art and to provide a high tension band clamp with a reduced incidence of bolt breakage upon tightening of the clamp.

SUMMARY OF THE INVENTION

In accordance with this invention, a band clamp is provided which is capable of providing a pipe joint with good fluid sealing and high pull-apart strength and which can be manufactured at low cost.

Further, in accordance with this invention, means are provided in a clamp of "Torca™" type for preventing the bolt holes in the sidewalls from becoming misaligned with the bolt hole through the spline during tightening of the clamp.

Further, in accordance with this invention, an open sleeve band clamp has a band with a double layer in the sidewalls and in the adjacent portions of the roundish sector, said double layer being provided by folding each free end of the band back on itself to form a flap on the inside of the band for engagement with the workpiece to be clamped, each such flap being referred to herein as an inverted flap. The inverted flap is sufficiently long to extend in a layered disposition with a portion of roundish sector of the band to form a flap-band interface region. In this position, the

inverted flap becomes sandwiched between the outer layer of the band and the workpiece and is thereby held against creeping movement as the clamp is tightened.

Further, in accordance with the invention, a mechanical interlock is provided between the inverted flap and the band in the flap-band interface region.

Further, in accordance with the invention, a rigid stop member is provided on the free end of each sidewall to coact with an abutment on outer end of the spline and arrest movement of the sidewall during tightening of the clamp, with the bolt holes of the sidewalls in alignment with the bolt hole in the spline.

A complete understanding of this invention may be obtained from the detailed description that follows taken with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of the band clamp of this invention in a first embodiment;

Figure 2 is a cross-sectional view of the band clamp of Figure 1;

Figure 3 is a view of the clamp band in a flat condition at an intermediate stage of forming;

Figure 4 is a cross-sectional view, for explanatory purposes, of inside and outside pipes to be joined and a spline seated on the outer pipe;

Figure 5 is a cross-sectional view of a portion of the sidewalls of the clamp band of this invention;

Figure 6 is a cross-sectional view of the spline of the clamp;

Figure 7 is a perspective view of the band clamp of this invention in a second embodiment;

Figure 8 is a cross-sectional view of the band clamp of Figure 7;

Figure 9 is an end elevation view of the clamp of Figure 7 before it is applied to pipes which are to be joined together;

Figure 10 is a plan view of the clamp of Figure 8;

Figure 11 is a side elevation view of the clamp of Figure 8;

Figure 12 is an end elevation view of the band clamp of a third embodiment of this invention before it is applied around a pipe;

Figures 13A and 13B show a fourth embodiment of this invention;

Figures 14A and 14B show a fifth embodiment of this invention;

Figures 15A, 15B and 15C show a sixth embodiment of this invention;

Figures 16A, 16B and 16C show a modified sidewall and stop member for the band clamp of Figures 15A, 15B and 15C;

Figure 17A shows additional detail of a structural feature of the band clamp of Figure 16A; and

Figures 17B, 17C and 17D show modifications of the structural feature of Figure 17A.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring now to the drawings, there are shown illustrative embodiments of the invention in a band clamp which is especially adapted for use in vehicle exhaust systems. It will be appreciated as the description proceeds that the

invention is useful in other embodiments and other applications.

First Embodiment of the Invention

The band clamp of this invention in a first embodiment will be described with reference to Figures 1 and 2. As shown in Figures 1 and 2, the band clamp 10 forms a pipe lap joint with inside and outside pipes 12 and 14, respectively, in telescoping relationship. The outside pipe 14 has a lap portion which extends over the inside pipe 12 to provide an overlap region of the pipes under the band clamp 10. In order to provide a fluid seal between the pipes, a collapsible sealing zone (not shown) is provided on the outside pipe 14 in the overlap region. This pipe joint is, for example, of the type shown in the above-mentioned Cassel et al. patent 4,629,226.

The clamp 10 comprises a clamp band 16 which is disposed around the outer pipe 14 over the sealing zone. The clamp band 16 is provided with a tightening means 18. The clamp band 16 is, for the most part, circular or roundish in cross-section. It has a roundish sector 22 adapted to fit around the sealing zone on the pipe 14 and a channel-shaped sector 24 which comprises a pair of flanges or sidewalls 26 and 28 extending radially outwardly from the roundish sector. The clamp band 16 is made of a single piece of sheet metal and each free end thereof is folded back on itself

to form outer layers or flaps 32 and 34 which overlay the inner layer in face-to-face engagement. In this manner, the sidewalls 26 and 28 and a portion of the roundish sector 22 are made of double thickness. This provides a cross-sectional area in the section of the sidewall through the bolt hole which is equal to or greater than that in the single layer portion of the band. The flaps 32 and 34 are secured to the inner layer of the clamp band 16 by respective weldments 33 and 35 which inhibit slippage of the inner layer relative to the flaps. The sidewalls are provided at their outer ends with respective lateral flanges or ears which constitute stop members 36 and 38 which will be described in greater detail below.

The clamp band 16 is tightened around the pipe 14 by the tightening means 18. The tightening means comprises a reaction member or spline 42 which is disposed within the channel-shaped sector 24 and extends outwardly from the pipe 14 with its inner end adapted to seat upon the outer surface of the pipe 14. For this purpose, the spline has an inner surface of arcuate configuration conforming to the pipe. The spline 42 is provided with a pair of oppositely facing concave surfaces 44 and 46. The tightening means 18 includes a bolt 48 and a nut 52. It also includes a spacer or bar 54 and a washer 55 disposed outside the sidewall 26. The bar 54 has a convex surface which is opposite the concave

surface 44 of the spline 42. The bolt 48 has a head in the form of a bar 56 with a convex surface which is disposed outside the sidewall 28 opposite the concave surface 46 on the spline 42. The bolt extends through bolt holes in the sidewalls 26 and 28, the spline 42, washer 55 and the spacer 54.

When the clamp 10 is assembled and the nut 52 is tightened on the bolt 48, the relationship of the parts is as shown in Figures 1 and 2. It will be understood that, before the nut is tightened, the sidewalls 26 and 28 of the channel-shaped sector 24 are not seated against the spline 42. When the nut is tightened, the bolt head 56 and the spacer 54 are drawn together and press the sidewalls 26 and 28 into engagement with the spline 42. Depending upon the degree of tightening, the sidewalls may be only partially seated against the spline. As a result of this tightening action, the roundish sector 22 is stretched around the pipe 14 in tight engagement therewith. This tightening action of the clamp 10 exerts sufficient force on the sealing zone to provide a good fluid seal and high pull-apart strength in the pipe joint.

The relationship of the parts of the clamp 10 when it is in the tightened condition will now be described in greater detail with reference to Figure 2. The stop member 36 has a stop surface 62 on its lower side which is engaged by an abutment surface 66 on the upper end of the spline

42 when the clamp 10 is tightened. Similarly, the stop member 38 has a stop surface 64 on its lower side which is engaged by an abutment surface 68 on the upper end of the spline 42. With the clamp in the tightened condition, the inner end of the spline 42 is firmly seated against the outer pipe 14.

As noted above, the clamp band 16 is made from a single piece of sheet metal and each end thereof is folded back on itself to form an outer layers or flaps 32 and 34 which overlay the inner layer in face-to-face engagement. It should be noted here that the clamp band is preformed to a configuration which is generally similar to that shown in Figure 2 except that the channel-shaped sector 24 is open wider such that either or both sidewalls 26 and 28 may be located outboard of the spline 42. When the clamp is tightened by the nut 52, the sidewalls are drawn toward the spline and the stop members 36 and 38 move into the position over the end of the spline 42, as shown in Figure 2, without substantial interference.

During the fabrication of the clamp band 16 prior to the pre-forming of the sidewalls 26 and 28, the bolt holes 72 and 74 through the sidewalls are punched with the clamp band in a flat condition. The desired spacing between the bolt holes through the sidewalls is that which results in alignment of the centerlines of the bolt holes 72 and 74 through the sidewalls 26 and 28 with

each other and with the centerline of the bolt hole 76 through the spline 42 when the clamp is tightened to the condition shown in Figure 2. This spacing of the bolt holes 72 and 74 from each other is determined in accordance with the diameter of pipe 14, height of the spline 42 and location of the bolt hole 76 through the spline 42 as described below.

The relationship of the parts of the band clamp of this invention will be described in greater detail with respect to Figures 3, 4, 5 and 6. Figure 3 shows the clamp band in a flat condition with the flaps 32 and 34 folded back on the clamp band. The bolt holes 72 and 74 may be punched through the double layer portion of the clamp band 16 formed by the flaps. The length of the clamp band L1 between the centerlines of the bolt holes 72 and 74 is shorter than a length L2 which is equal to the length of an imaginary line 78 (shown in dashed lines in Figure 4) which extends from a starting-point 1 on the centerline 76′ of the bolt hole 76 and extends around the outer pipe 16 to an ending-point 2 at the centerline 76′ on the other side of the spline 42. The imaginary line 78 lies in a plane which contains the centerline 76′ and is perpendicular to the centerline of the outside pipe 14. The imaginary line 78 follows the contour of the spline 42 and the pipe 14. The length of the clamp band L1 between the bolt hole centerlines 72′ and 74′ is shorter, when the clamp band 16 is

unstressed, than the length of the imaginary line 78 by a predetermined length ΔL. The value of ΔL is such that the clamp exerts radially directed forces on the outside pipe 14 when the clamp is fully tightened so that the outside pipe 14 is circumferentially collapsed into close engagement with the inside pipe 12 and exerts a radially compressive force against the inside pipe. This relationship of the parts of the clamp band 16 to the outside and inside pipes is already known in the band clamps of the Torca™ type identified above.

In order to minimize bending stresses in the bolt, the centerlines 72′ and 74′ of the first and second sidewall bolt holes 72 and 74 are positioned, during tightening, into alignment with the centerline 76′ of the spline bolt hole 76 by the structural relationship of the elements of the band clamp and the outer pipe 14. This structural relationship will be described with reference to Figures 5 and 6. The stop surface 62 on the stop member 36 is a distance A from the centerline 72′ of the bolt hole 72 through the sidewall 26 when measured perpendicularly to the centerline 72′. The abutment surface 66 is a distance B from the centerline 76′ of the spline 42 when measured perpendicularly to the centerline 76′. The distance A is equal to the distance B. The stop surface 64 is a distance C from the centerline 74′ of the bolt hole 74 in the sidewall 28 when measured perpendicularly to the centerline 74′.

The abutment surface 68 is a distance D from the spline centerline 76' when measured perpendicularly to that centerline. The distance C is equal to the distance D. With this structural relationship, the bolt holes through the sidewalls and the splines are maintained in substantial alignment during tightening of the clamp and the bending stresses on the bolt are minimized.

When the clamp 10 is tightened around a pipe or other workpiece, the bending stresses in the bolt 48 are minimized because the centerlines 72' and 74' of the first and second bolt holes 72 and 74 are maintained in alignment with the centerline 76' of the spline bolt hole 76 by the coaction of the stop surfaces 62 and 64 with the abutment surfaces 66 and 68, respectively. This result is obtained notwithstanding the stretching of the clamp band 16 around the pipe.

As described above, the length L1 of the clamp band 16 from the centerline 72' of said first sidewall bolt hole 72 to the centerline 74' of said second sidewall bolt hole 74 is shorter, before tightening of the clamp than the length L2 of line 78. This relationship allows for stretching of a clamp band 16 to obtain the desired clamping forces when the bolt 48 is tightened to the specified torque. During tightening, the first and second stop members 36 and 38 are pulled down until stop surfaces 62 and

64 engage abutments 66 and 68, respectively, on spline 42. The stop members 36 and 38 are sufficiently rigid so as to not yield significantly with continued tightening of the clamp to stretch the band 16 around the workpiece. Since the distances A and B are equal to distances C and D, respectively, the bolt holes through the sidewalls and the spline are maintained in alignment during tightening of the clamp.

Second Embodiment of the Invention

The second embodiment of the invention will be described with reference to Figures 7 through 11. This embodiment of the invention differs from that described with reference to Figures 1 through 6 in that the clamp band is formed as a single layer of sheet metal from end-to-end. Other parts remain the same and the same reference characters are applied to such parts and, in the interest of brevity, the description of such parts will not be repeated.

The band clamp as shown in Figures 7 and 8 comprises a clamp band 16′ which is disposed around the outside pipe 14 for joining it to the inside pipe 12. The clamp 10′ comprises the clamp band 16′ which is provided with a tightening means 18. The clamp band 16′ has a roundish sector 22′ adapted to fit around the sealing zone on the pipe 14 and a channel-shaped sector 24′ which comprises a pair of flanges or sidewalls 26′ and 28′

extending radially outwardly from the roundish sector. The clamp band 16′ is made of a single piece of sheet metal and the sidewalls terminate at their outer end in respective stop members 36′ and 38′.

The relationship of the parts of the clamp 10′ in the tightened condition, as shown in Figures 7 and 8, will now be described in greater detail with reference to Figure 8. The stop member 36′ has a stop surface 62′ on its lower side which is engaged by an abutment surface 66′ on the upper end of the spline 42 when the clamp is tightened. Similarly, the stop member 38′ has a stop surface 64′ on its lower side which is engaged by an abutment surface 68′ on the upper end of the spline 42. In this tightened condition, the inner end of the spline 42 is firmly seated against the outer pipe 14.

The stop member 36′ is provided at both ends with a gusset 37′ and similarly, stop member 38′ is provided at both ends with a gusset 39′ as shown in Figure 7 (see also Figures 9, 10 and 11 described below). The gussets 37′ and 39′ are provided to resist bending of the stop members 36′ and 38′ by outward force exerted thereon by the spline 42 during tightening of the clamp. The gussets 37′ are formed by a stamping operation on the ends of the sidewall 26′ and the stop member 36′ to deform the metal at each end so that it forms a bridge, which constitutes the gusset,

between the sidewall and the stop member. The gussets 39' are formed in the same manner on the ends of the sidewall 28' and stop member 38.

Figures 9, 10 and 11 show the second embodiment of the band clamp before it is applied to the pipes 12 and 14. As shown, the parts of the clamp are loosely assembled with the nut 52 screwed onto the end of the bolt 48 sufficiently to hold the parts together. In this condition, the sidewalls 26' and 28' are not seated against the spline 42. Note that the bolt 48 is formed with a splined section 49 which provides an interference fit with the spline 42 to hold the spline captive for convenience of installation of the clamp.

The clamp 10' of Figure 8 functions in the same manner as the clamp 10 of Figure 1 in respect to the coaction of the stop members 36 and 38 with the abutments 66 and 68, respectively to align the bolt holes with each other when the clamp is in the tightened condition.

Third Embodiment of the Invention

A third embodiment of the invention will be described with reference to Figure 12. The band clamp 10b is similar to the clamp 10 of Figures 1-6 except that the clamp band 16b is provided with inner or inverted flaps 32b and 34b which underlay the outer layer in face-to-face engagement.

Additionally, in this embodiment, the flaps 32b and 34b are secured to the outer layer of the clamp band by respective mechanical interlocks 33b and 35b.

The clamp band 16b is made of a single piece of sheet metal and each free end thereof is folded back on itself to form the inverted flaps 32b and 34b. This provides a double thickness and hence greater strength for the sidewalls 26b and 28b and also for adjacent portions of the roundish sector 22. The inverted flaps are sufficiently long to extend into the roundish sector 22 of the clamp band thereby forming an overlap region with the roundish portion. In this region, the inverted flaps 32b and 34b become sandwiched between the roundish portion of the band 16b and the clamped pipe (not shown in Figure 12). When the clamp 10b is tightened on the pipe, the compressive force increases on the inverted flaps in the overlap region. The compressive force on the flaps increases the frictional constraint against creeping movement of the flaps relative to the outer layer of the clamp band 16b when the sidewalls are drawn into engagement with the respective sides of the reaction member.

The mechanical interlocks 33b and 35b in the clamp band 16b provide additional holding force on the respective flaps to increase the constraint against creeping movement of the flaps when the clamp is tightened. Each mechanical interlock

comprises a cup-shaped indentation in the flap which is nested in a cup-shaped indentation in the clamp band 16b. The mechanical interlocks 33b and 35b may be omitted in applications of the clamp 10b where the frictional resistance provides sufficient constraint against creeping movement of the flaps.

The clamp 10b of Figure 12 functions in the same manner as the clamp 10 of Figure 1 in respect to the coaction of the stop members 36 and 38 with the abutments 66 and 68, respectively, to align the bolt holes with each other when the clamp is in the tightened condition.

Fourth Embodiment of the Invention

A fourth embodiment of the invention will now be described with reference to Figures 13A and 13B. This embodiment is similar to that of Figure 12 in that it comprises inverted flaps. In the embodiment of Figure 13A and Figure 13B, the inverted flaps 32c and 34c are secured to the clamp band 16 by mechanical interlocks 33c and 35c which comprise a nesting indentations or dimples. It is noted that the sidewalls 26c and 28c are provided at their free ends with retaining members or bights 41 and 43. These retaining members are disclosed in greater detail in Cassel patent 4,312,526 cited above. The bights 41 and 43 are of a structure different from stop members 36 and 38 of Figure 12 and do not coact with the spline

42 in the same manner, and do not operate to position the bolt holes of the sidewalls and spline in alignment with each other.

Fifth Embodiment of the Invention

A fifth embodiment of this invention is shown in Figures 14A and 14B. The clamp 10d of this embodiment is a wide band clamp of the open loop type. Clamp 10d is especially adapted for a pipe lap joint and the clamp band 16d is provided with an end band 82 and end band 84 which are integrally joined with each other at a narrow circumferentially extending shoulder 86. End band 82 is of larger diameter than end band 84 and is adapted to engage the outer pipe of a lap joint while band 84 engages the inner pipe. This clamp is provided with a pair of bars 54, two sets of bolts 48 and nuts 52. A clamp of this type is disclosed in Cassel patent 4,312,526 the disclosure of which is incorporated herein by reference. The clamp of Figures 14A and 14B differs from the disclosure of the Cassel patent by the provision of inverted flaps 32d and 34d. It is noted that the sidewalls 26d and 28d of this embodiment are provided with retaining members or bights 41 and 43 in the same manner as the fourth embodiment.

Sixth Embodiment of the Invention

A sixth embodiment of this invention will now be described with reference to Figures 15A, 15B and 15C. The clamp 10e of this embodiment is a wide band clamp for use with either pipe butt joints or pipe lap joints; it is a flat band clamp of the type disclosed in Cassel patent 4,813,720, the disclosure of which is incorporated herein by reference.

Figure 15A is a fragmented view of the band clamp in that only one end of the clamp band 16e is shown together with the tightening means 18. The other end of the clamp band 16e is a mirror image of the end which is shown and is adapted to be looped around a pair of pipes pipe joint and connected with the tightening means 18 in the same manner as shown in Figure 14A of the fifth embodiment.

The embodiment of Figure 15A is provided with an inverted flap 32e on the clamp band 16e, as shown, and a corresponding inverted flap on the other end which is not shown. It is also provided with a set of mechanical interlocks 33e, as shown, and corresponding set of interlocks on the other end of the band which is not shown. The embodiment of 15A differs from the embodiment of Figure 14A and 14B by use of a stop member or ear 36e, as shown, on the free end of the sidewall 28. A corresponding stop member or ear is provided on

the sidewall at the other end of the clamp band which is not shown.

Figure 15B is a cross-sectional view of a mechanical interlock 33e. Figure 15C is a cross-sectional view of the stop member 36e.

The clamp 10e of Figure 15A functions in the same manner as the clamp 10 of Figure 1 in respect to the coaction of the stop members with the abutments.

Figures 16A, 16B and 16C show a modified sidewall 28 for clamp band 16e of Figure 15A. Figure 16A is a plan view of a sidewall 28 on one end of the clamp band 16e. The fragmented view of Figure 16A shows the sidewall in a flat condition before it is preformed to the configuration shown in Figure 15A. The sidewall 28 comprises an inverted flap 32f which is folded back from the clamp band 16f. The sidewall has a pair of elongated bolt holes 92 as described in the Cassel patent 4,813,720 cited above. The flap 32f is secured to the clamp band 16f by a set of mechanical interlocks 33f. Figure 16B shows a cross-sectional view of the interlock structure. The sidewall 28 is provided at its free end with a stop member 36f. The stop member 36f extends from edge-to-edge of the double layered sidewall 28 which is crimped at equally spaced locations to form stiffener elements 94 each having a cross-sectional configuration as shown in Figure 16C.

Figure 17A shows a stiffener element 94 in detail. Figures 17B, 17C and 17D show stiffener elements 94', 94'' and 94''' in different configurations.

Although the description of this invention has been given with reference to particular embodiments it is not to be construed in a limiting sense. Many variations and modifications will now occur to those skilled in the art.

What is claimed is:

1. In a band clamp for applying radial compression force against a roundish workpiece such as a pipe, said clamp comprising a clamp band adapted to be disposed around said workpiece, said clamp band having a cross-section including a roundish sector and a radially projecting channel-shaped sector,

said channel-shaped sector comprising a first and second sidewalls extending outwardly from the roundish sector and being circumferentially separated from each other to form an opening in the band, said first and second sidewalls having a first sidewall bolt hole and a second sidewall bolt hole with first and second centerlines, respectively,

a spline disposed between the sidewalls and having a concave surface disposed opposite each sidewall, said spline having a spline bolt hole with a third centerline, said spline being adapted to be seated on said workpiece when said clamp band is disposed around said workpiece,

a pair of bars each having a convex surface, one bar being disposed against one sidewall opposite one concave surface of the spline and the other bar being disposed against the other sidewall opposite the other concave surface of the spline,

tightening means including a bolt and nut with the bolt extending laterally through bolt holes in the said bars, sidewalls and spline and being adapted, when the nut is tightened on the bolt, to force the sidewalls toward the respective spline surfaces, whereby the clamp band is stretched around said workpiece,

the improvement comprising:

abutment means on said spline, and

a stop member on each of said sidewalls for engaging said abutment means and for arresting movement, during tightening of said clamp, of said sidewalls relative to said spline with said first and second sidewall bolt holes in alignment with said spline bolt hole.

2. The invention as defined in Claim 1 wherein:

said clamp band comprises a first layer of sheet material extending from the outer end of the first sidewall to the outer end of the second sidewall and comprising first and second flaps,

said first flap comprising a second layer of sheet material disposed in lapping relation with said first layer in said first sidewall and in lapping relation with a portion of said first layer material in said roundish sector,

said second flap comprising a third layer of sheet material disposed in lapping relation with said first layer in the second sidewall and in lapping relation with a portion of said first layer in said roundish sector,

said first and second layers being joined together at the outer end of said first sidewall and said first and third layers of being joined together at the outer end of said second sidewall.

3. The invention as defined in Claim 2 wherein:

said first, second and third layers are of unitary structure and said flaps are disposed on the outside of said first layer of sheet material.

4. The invention as defined in Claim 2 wherein:

said first, second and third layers are of unitary structure and said flaps are disposed inside said first layer of sheet material.

5. The invention as defined in Claim 4 wherein:

each of said first and second flaps is secured at its free end to said first layer by a mechanical interlock.

6. The invention as defined in Claim 1 wherein:

the stop member on said first sidewall comprises a lateral flange on said sidewall and the stop member on the second sidewall comprises a lateral flange on said second sidewall, each of said lateral flanges overhanging said abutment means.

7. The invention as defined in Claim 6 wherein:

each of said sidewalls has a double layer and said lateral flange includes stiffening elements.

8. The invention as defined in Claim 7 wherein:

each stiffening element comprises deformations of the double layer of said lateral flange.

9. In a band clamp for applying radial compression force against a roundish workpiece such as a pipe, said clamp comprising a clamp band adapted to be disposed around said workpiece, said clamp band having a cross-section including a roundish sector and a radially projecting channel-shaped sector,

said channel-shaped sector comprising a first and second sidewalls extending outwardly from the roundish sector and being circumferentially separated from each other to form an opening in the band, said first and second sidewalls having a first sidewall bolt hole and a second sidewall bolt hole with first and second centerlines, respectively,

a spline disposed between the sidewalls and having a concave surface disposed opposite each sidewall, said spline having a spline bolt hole with a third centerline, said spline being adapted to be seated on said workpiece when said clamp band is disposed around said workpiece,

a pair of bars each having a convex surface, one bar being disposed against one sidewall opposite one concave surface of the spline and the other bar being disposed against the other sidewall opposite the other concave surface of the spline,

tightening means including at least one bolt and nut with the bolt extending laterally through bolt holes in the said bar, sidewalls and spline and being adapted, when the nut is tightened on the bolt, to force the sidewalls against the respective spline surfaces, whereby the clamp band is stretched around said workpiece,

the improvement wherein:

the length of the clamp band from the centerline of said first sidewall bolt hole to the centerline of said second sidewall bolt hole is shorter, before said tightening, than the length of a line traced on the surface of the spline and the workpiece with the spline seated on the workpiece, said line extending from a starting-point at the centerline of the spline bolt hole on one side of the spline around the workpiece to an ending-point at the centerline of the spline bolt hole on the other side of the spline,

said first and second sidewalls having first and second stop members, respectively, connected therewith, said first and second stop members having first and second stop surfaces, respectively, thereon,

said spline having first and second abutment surfaces for engagement with said first and second stop surfaces, respectively, when the

sidewalls are pulled toward said workpiece during tightening of the clamp,

a first distance measured from and extending perpendicularly to the centerline of the first sidewall bolt hole to said first stop surface being substantially equal to a second distance measured from and extending perpendicularly to the centerline of the spline bolt hole to the first abutment surface, and a third distance measured from and extending perpendicularly to the centerline of the second sidewall bolt hole to said second stop surface being substantially equal to a fourth distance measured from and extending perpendicularly to the centerline of the spline bolt hole to the second abutment surface, whereby the bolt holes through the sidewalls and the spline are positioned in alignment with each other when the clamp is in a tightened condition.

10. In a band clamp for applying radial compression force against a roundish workpiece such as a pipe, said clamp comprising a clamp band adapted to be disposed around said workpiece, said clamp band having a cross-section including a roundish sector and a radially projecting channel-shaped sector,

said channel-shaped sector comprising a first and second sidewalls extending outwardly from the roundish sector and being

circumferentially separated from each other to form an opening in the band, said first and second sidewalls having a first sidewall bolt hole and a second sidewall bolt hole with first and second centerlines, respectively,

a spline disposed between the sidewalls and having a concave surface disposed opposite each sidewall, said spline having a spline bolt hole with a third centerline, said spline being adapted to be seated on said workpiece when said clamp band is disposed around said workpiece,

a pair of bars each having a convex surface, one bar being disposed against one sidewall opposite one concave surface of the spline and the other bar being disposed against the other sidewall opposite the other concave surface of the spline,

tightening means including a bolt and nut with the bolt extending laterally through bolt holes in the said bars, sidewalls and spline and being adapted, when the nut is tightened on the bolt, to force the sidewalls toward the respective spline surfaces, whereby the clamp band is stretched around said workpiece,

the improvement comprising:

said clamp band comprises a first layer of sheet material extending from the outer end of

the first sidewall to the outer end of the second sidewall and comprising first and second flaps,

said first flap comprising a second layer of sheet material disposed in lapping relation with said first layer in said first sidewall and in lapping relation with a portion of said first layer material in said roundish sector,

said second flap comprising a third layer of sheet material disposed in lapping relation with said first layer in the second sidewall and in lapping relation with a portion of said first layer in said roundish sector,

said first and second layers being joined together at the outer end of said first sidewall and said first and third layers of being joined together at the outer end of said second sidewall,

each of said flaps is disposed inside said first layer of sheet material.

11. The invention as defined in Claim 10 wherein:

each of said first and second flaps is secured at its free end to said first layer by a mechanical interlock.

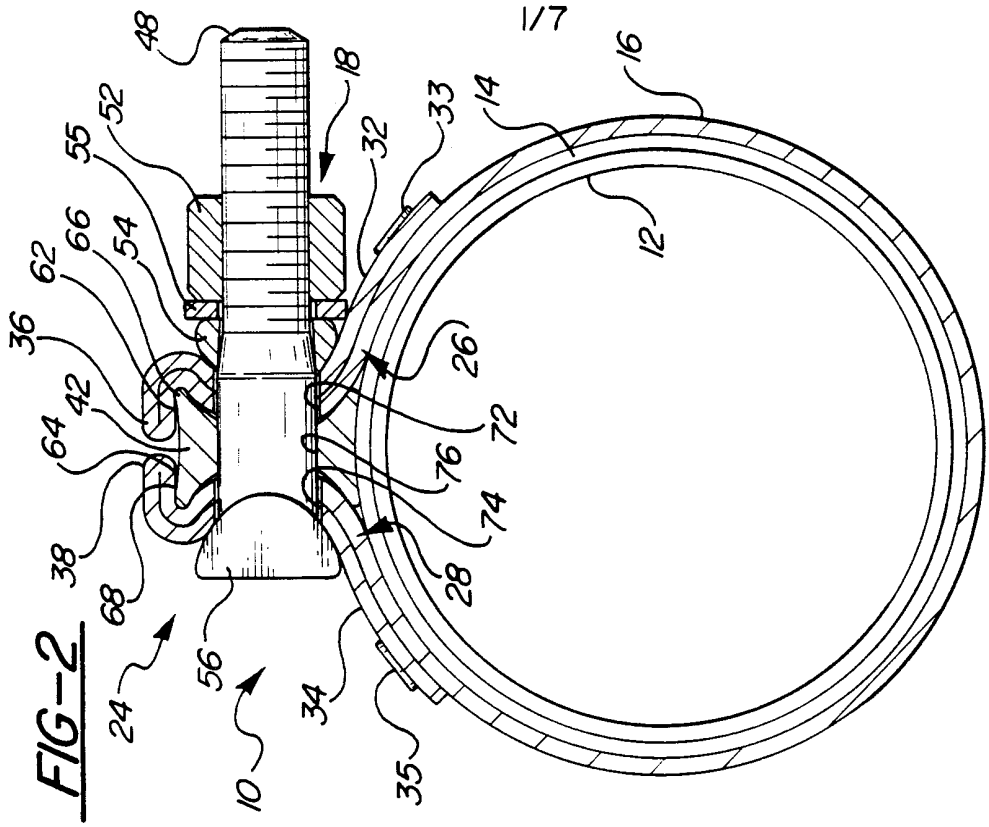
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FIG-2

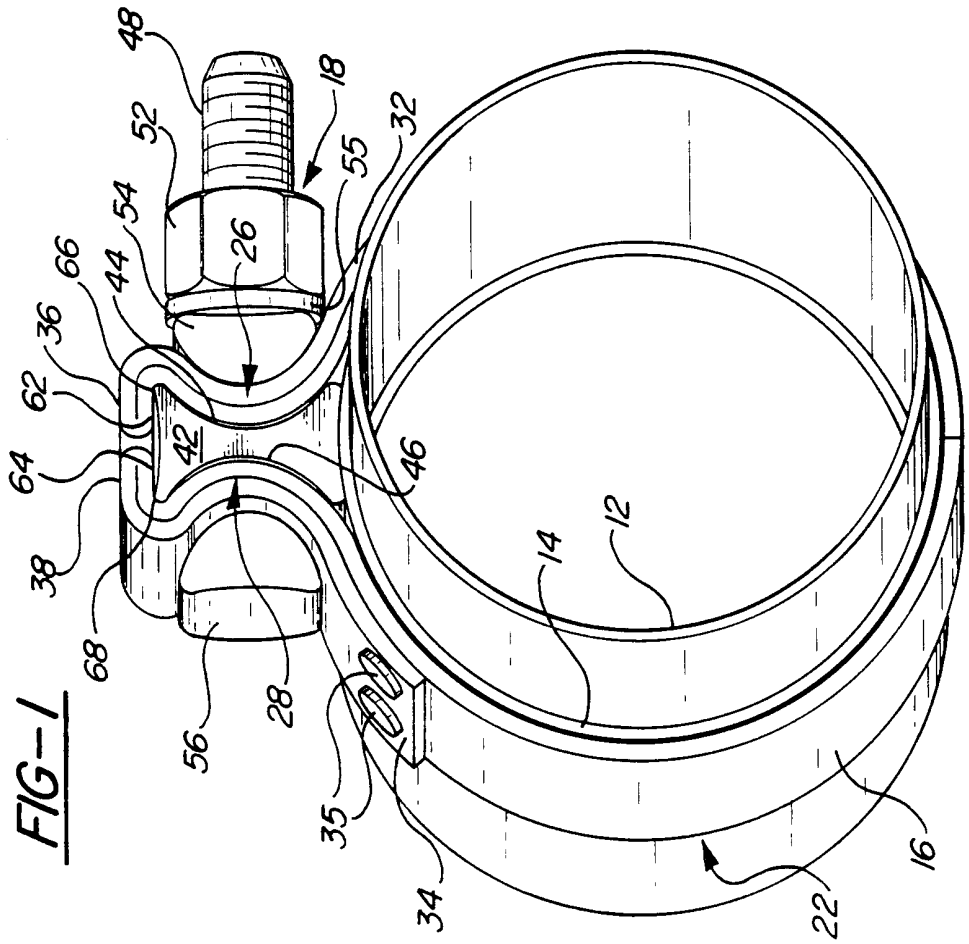
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FIG-1

FIG-3

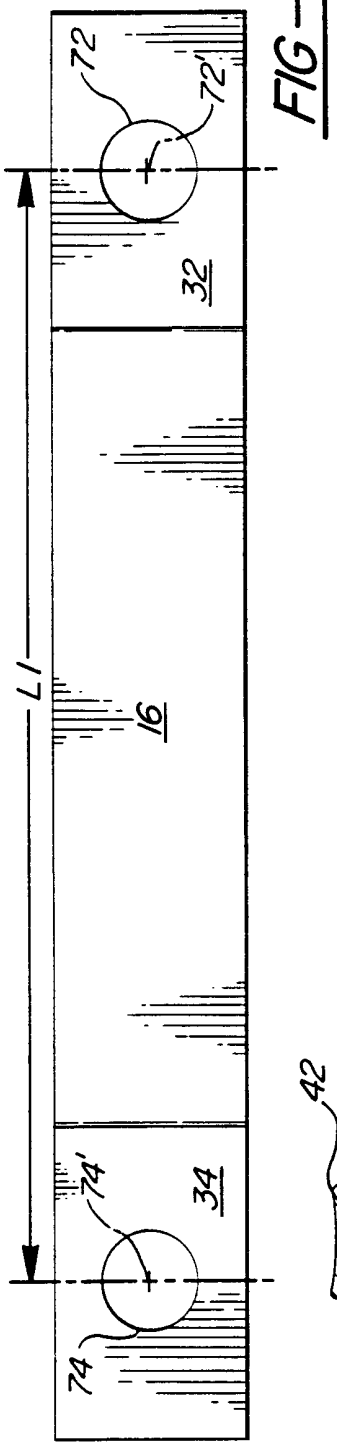

FIG-4

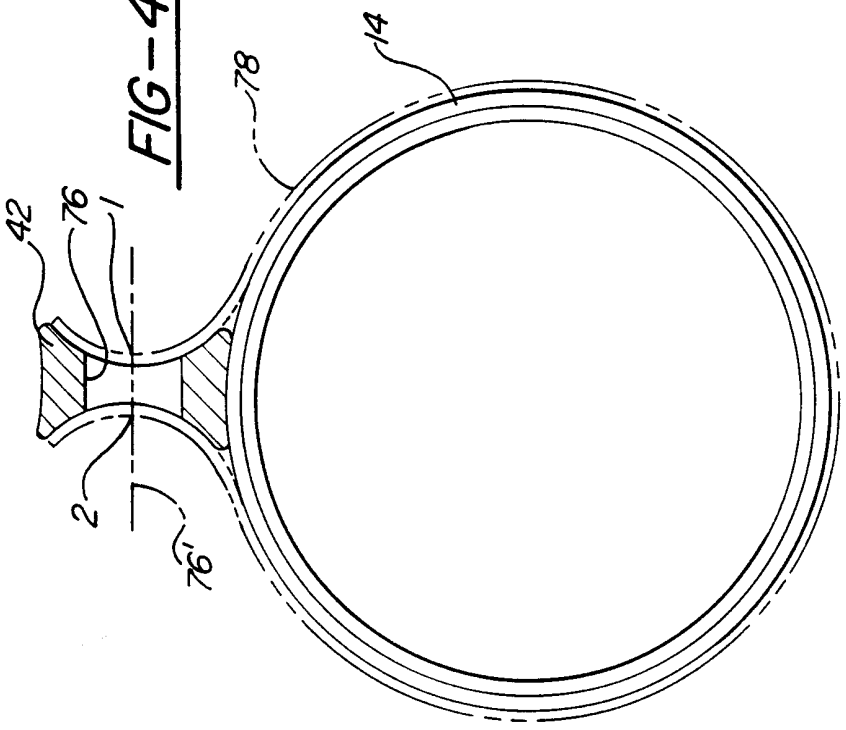

FIG-5

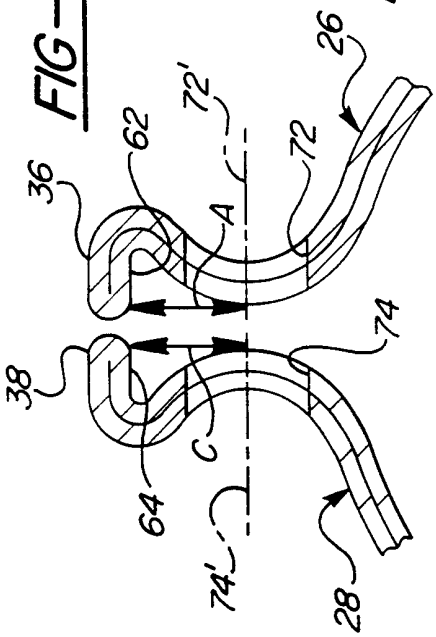

FIG-6

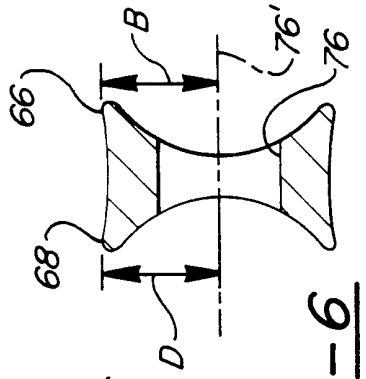

FIG-8

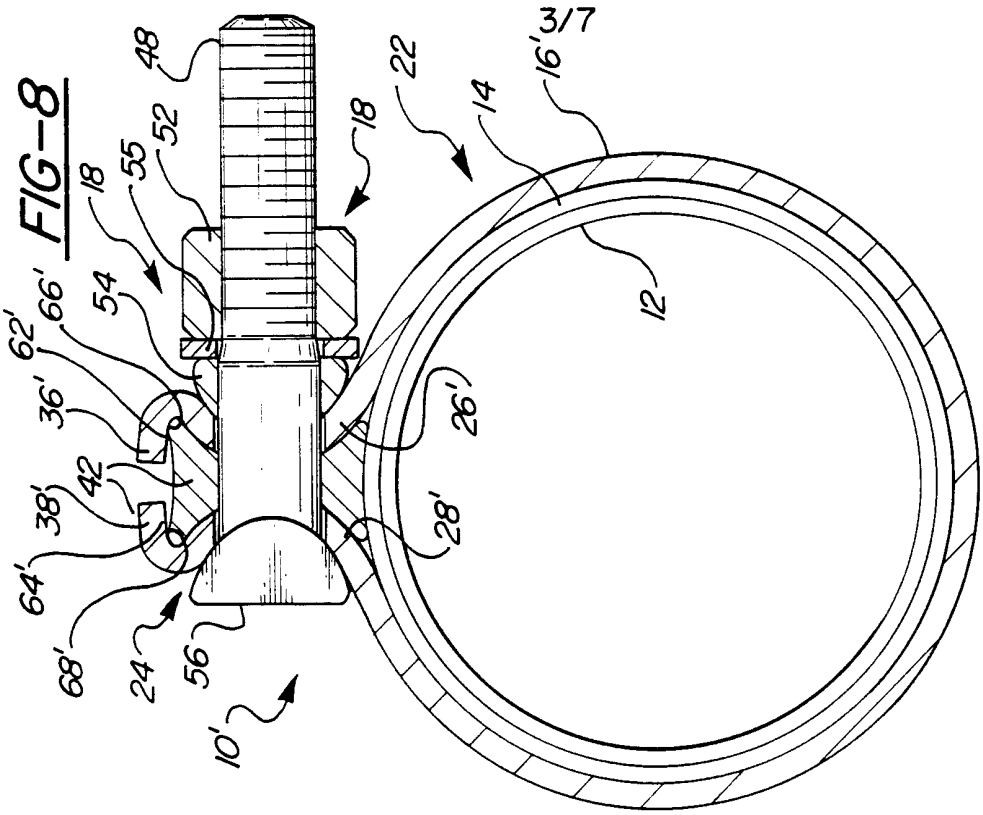
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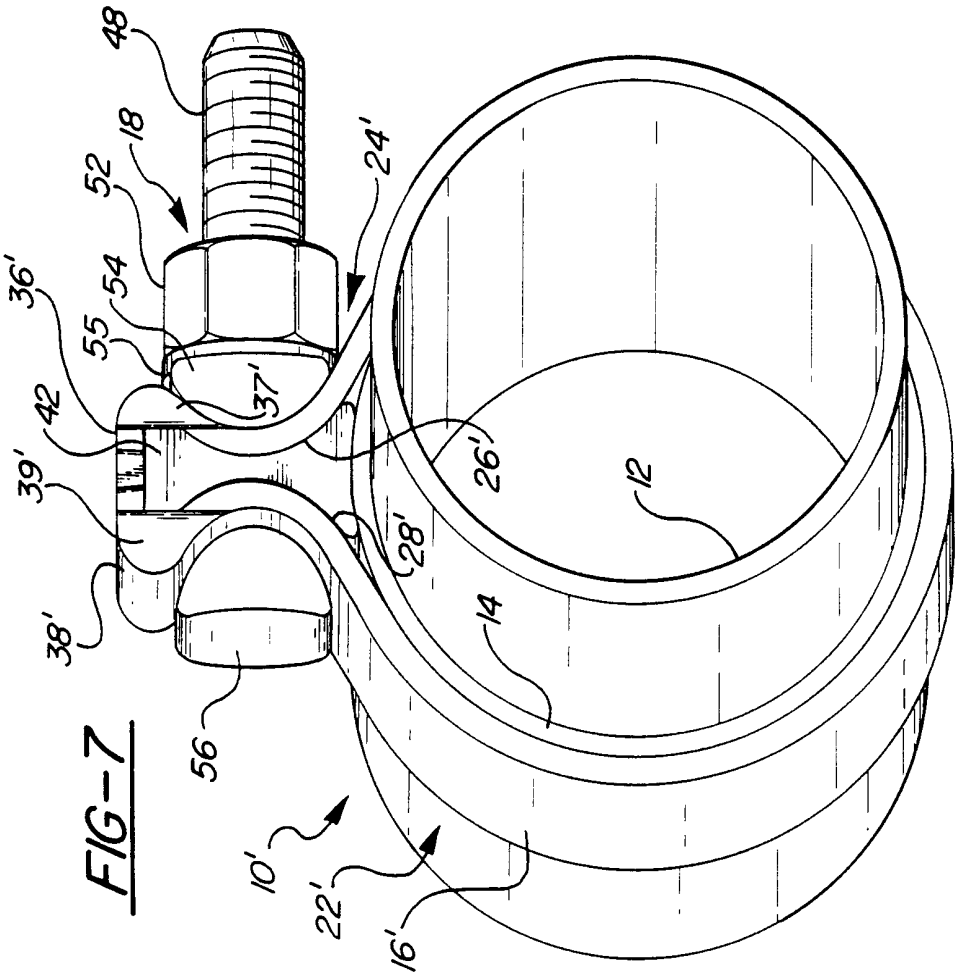
FIG-7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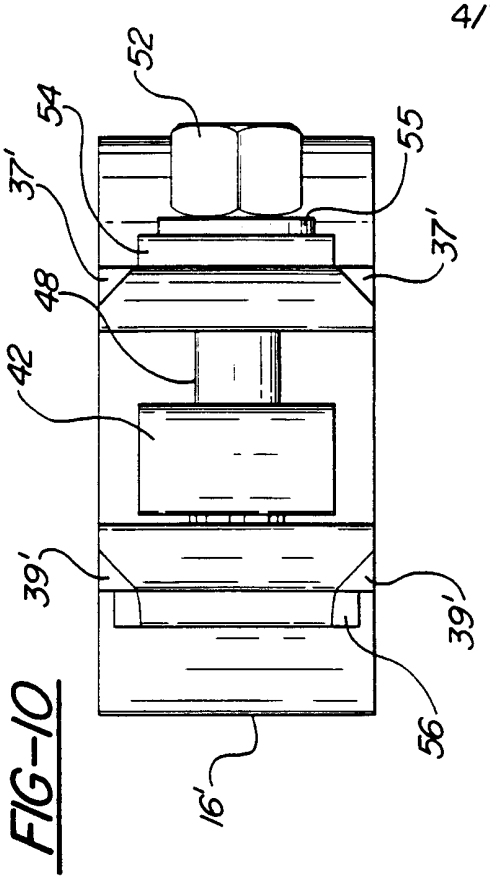


FIG-10

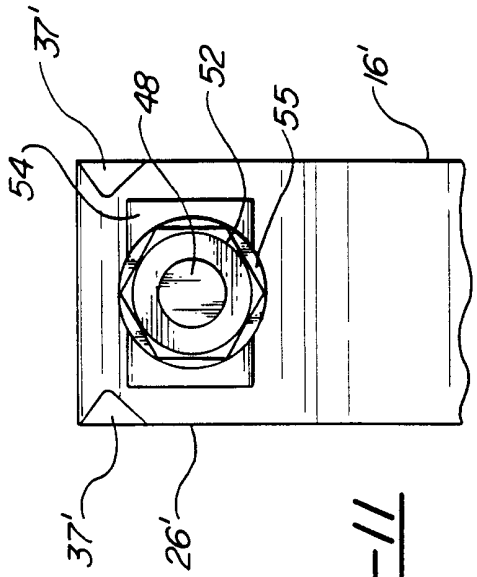


FIG-11

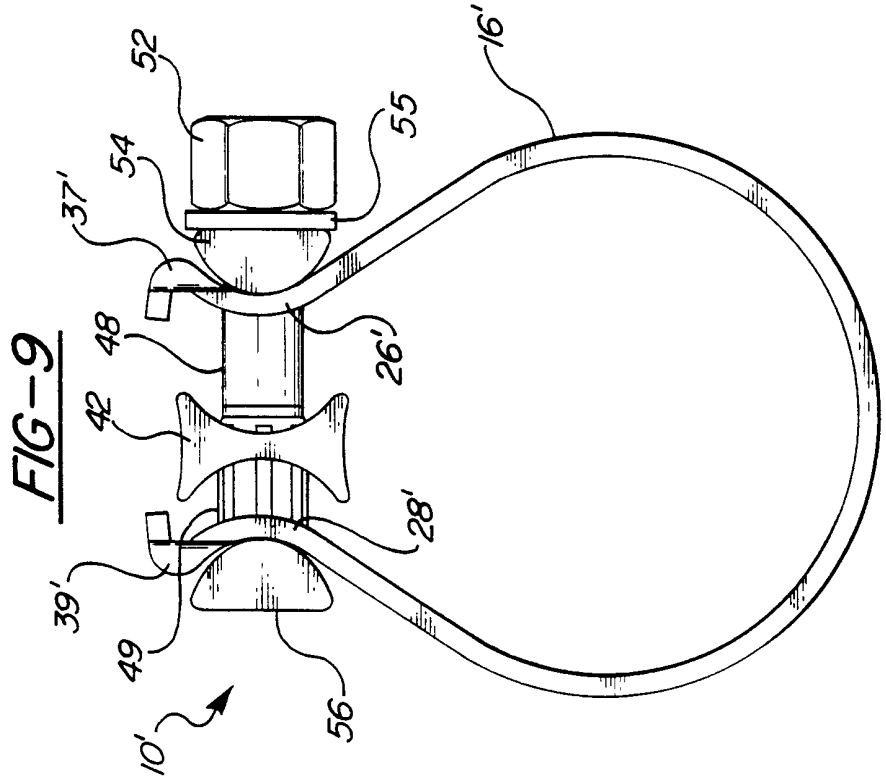


FIG-9

FIG-12

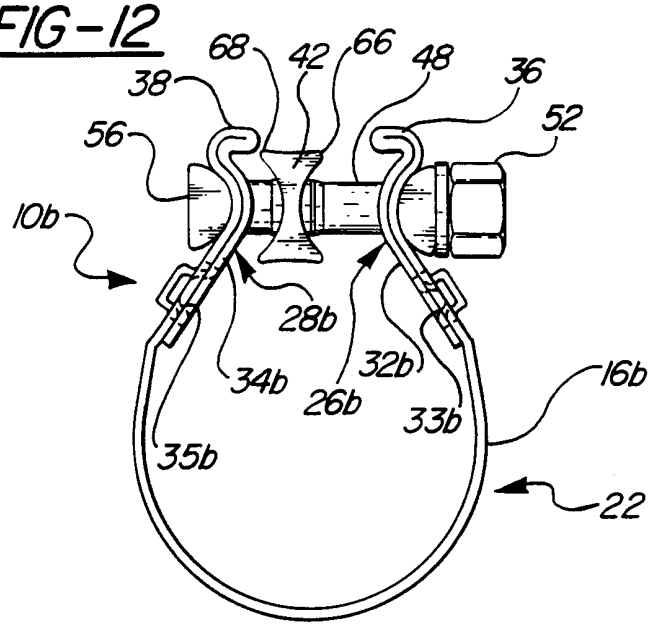


FIG-13A

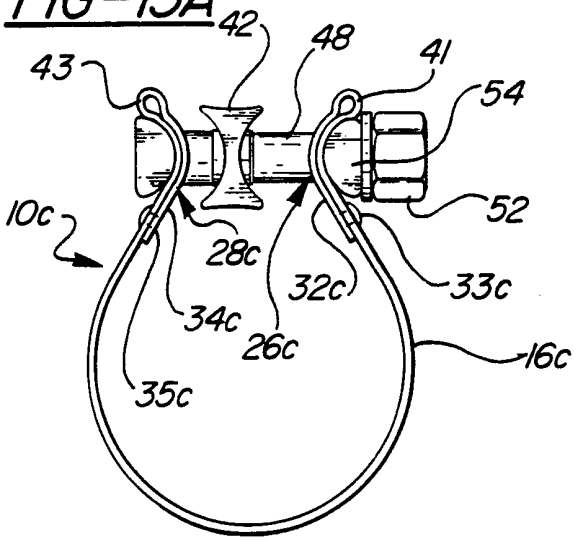


FIG-13B

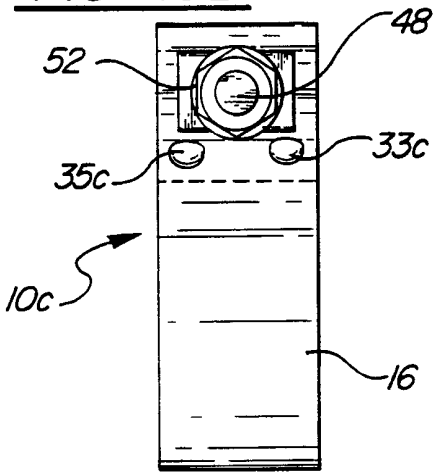


FIG-14A

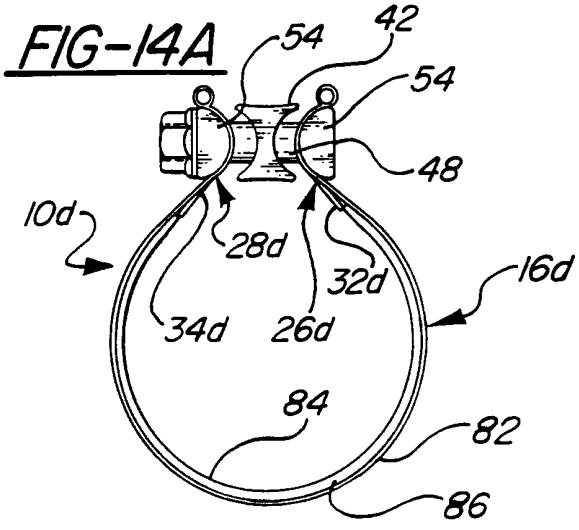
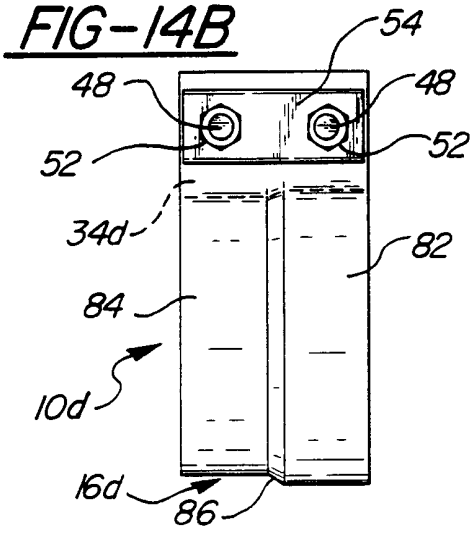


FIG-14B



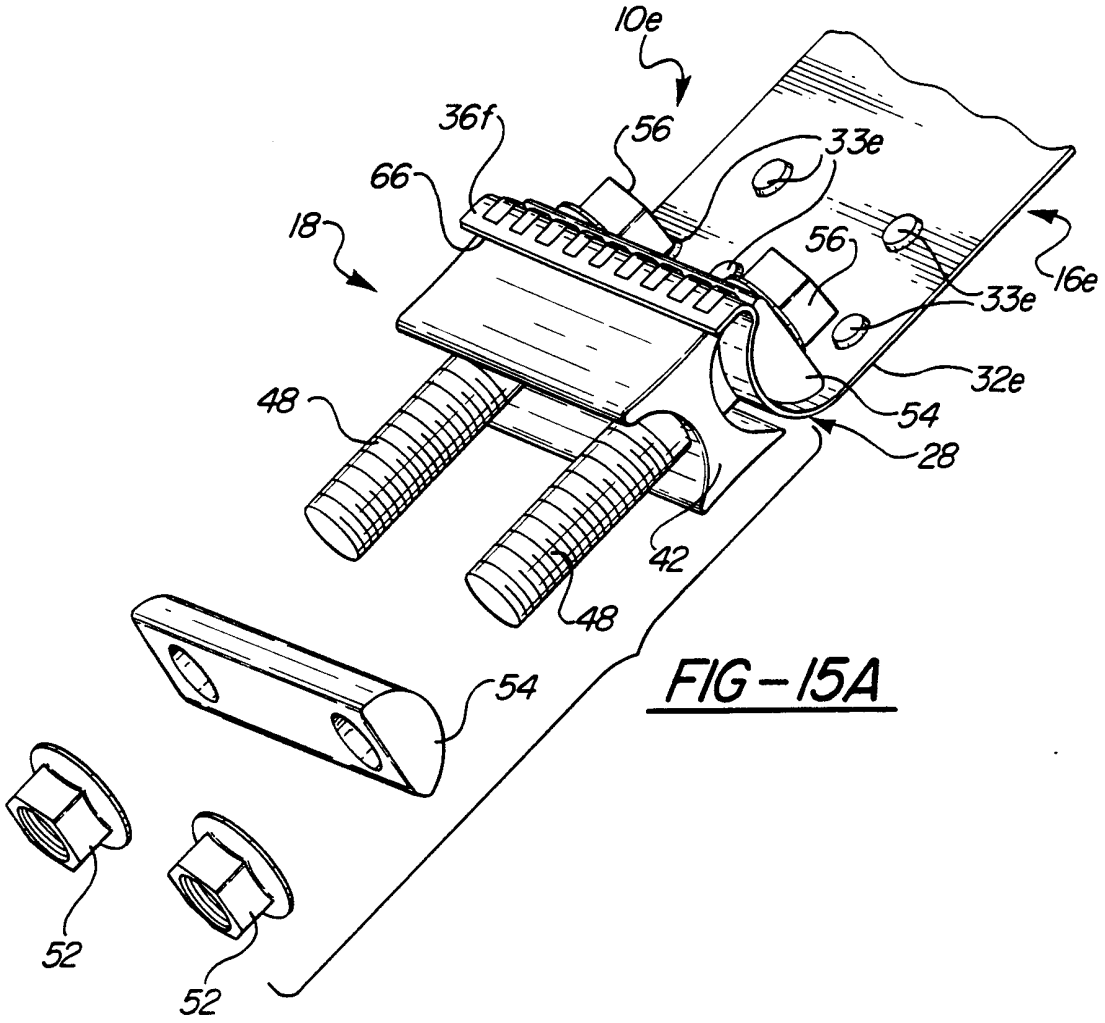


FIG-15A

FIG-15B

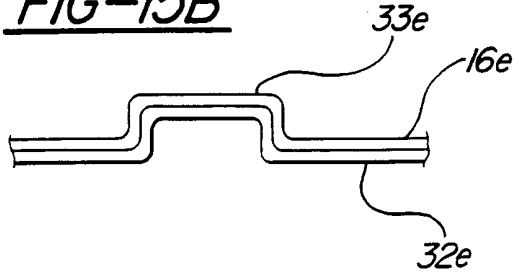


FIG-15C

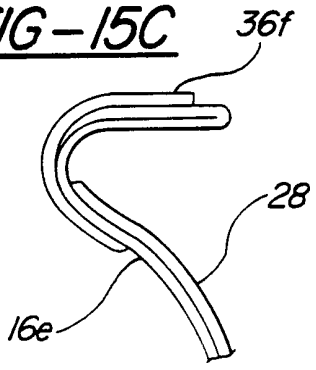


FIG-16A

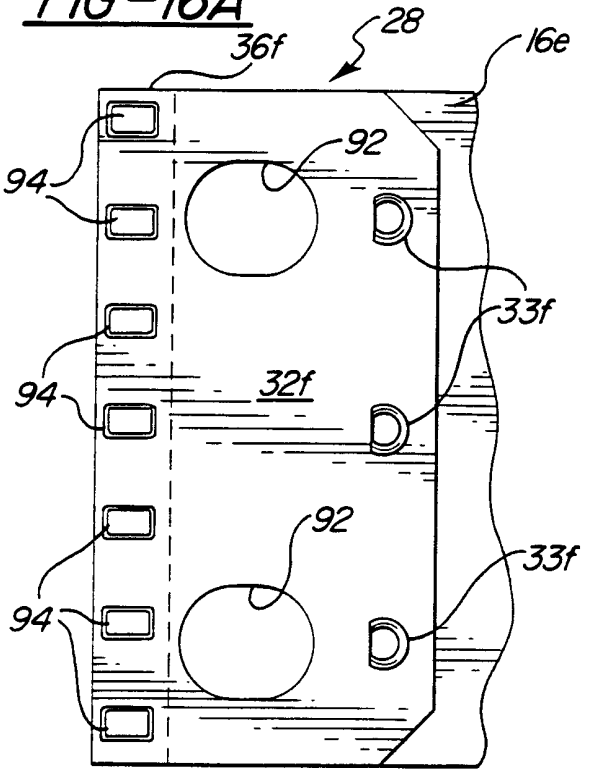


FIG-16B

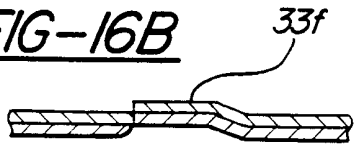


FIG-16C

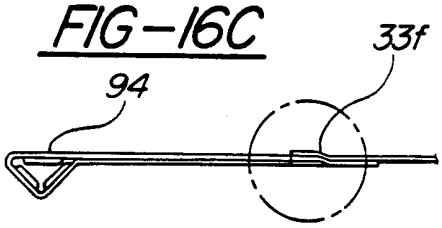


FIG-17A

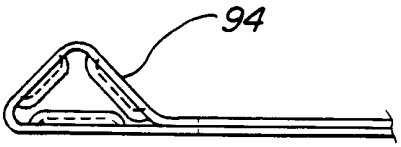


FIG-17B

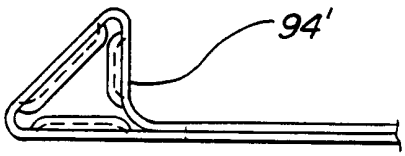


FIG-17C

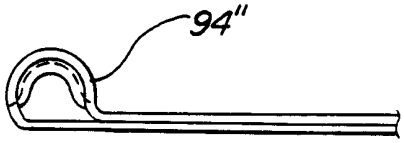
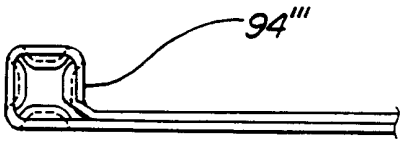


FIG-17D



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/29732

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : F16L 33/04
US CL : 24/279

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 24/279, 19, 20LS, 284-286

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y --- A	US 4,312,526 A (CASSEL) 26 January 1982 (26-01-1982), see fig. 1 and 3.	1-3, 9 ------ 6 ------ 4,5,7,8,10,11
Y	US 4,364,588 A (THOMPSON) 21 December 1982 (21-12-1982), see figures 1-2c).	6
A	US 3,905,623 A (CASSEL) 16 September 1975 (16-09-1975), see figure 4.	1-11
A	US 4,660,862 A (CASSEL et al) 28 April 1987 (28-04-1987), see figure 3.	1-11
A	US 5,310,158 A (CASSEL) 10 May 1994 (10-05-1994), see figure 4.	1-11

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"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
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"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
"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)	"&"	document member of the same patent family
"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		

Date of the actual completion of the international search 23 FEBRUARY 2000	Date of mailing of the international search report 17 MAR 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer JAMES R. BRITTAIN Telephone No. (703) 308-2168

Form PCT/ISA/210 (second sheet)(July 1992)*