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(54) PIPE FLANGE ASSEMBLY

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Related U.S. Application Data

(63) Continuation of application No. 09/385,902, filed on Aug. 30, 1999, now Pat. No. 6,543,811, which is a continuation-in-part of application No. 08/759,272, filed on Dec. 2, 1996, now Pat. No. 5,947,528.

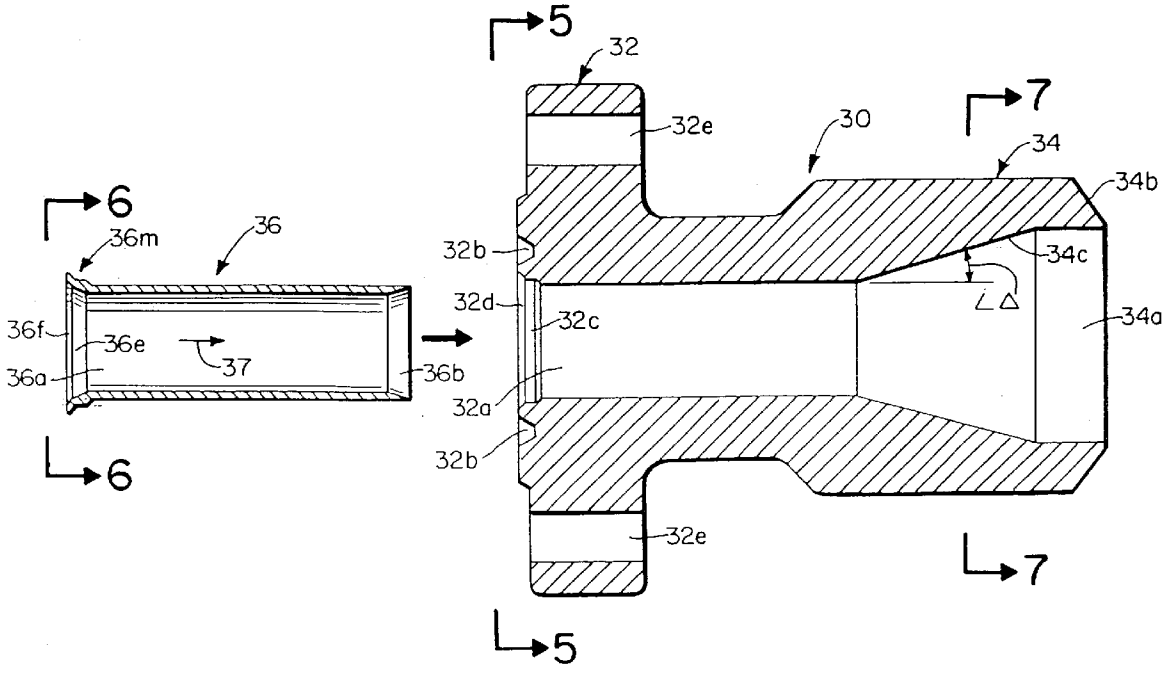
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(57) ABSTRACT

An erosion resistant pipe flange assembly for preventing erosion of metal pipe flanges connecting two joints of pipe. The erosion resistant pipe flange assembly includes a flange section, a reducer section integrally formed with said flange section, and a replaceable liner for preventing erosion and abrasion of the interior of said pipe flange assembly.



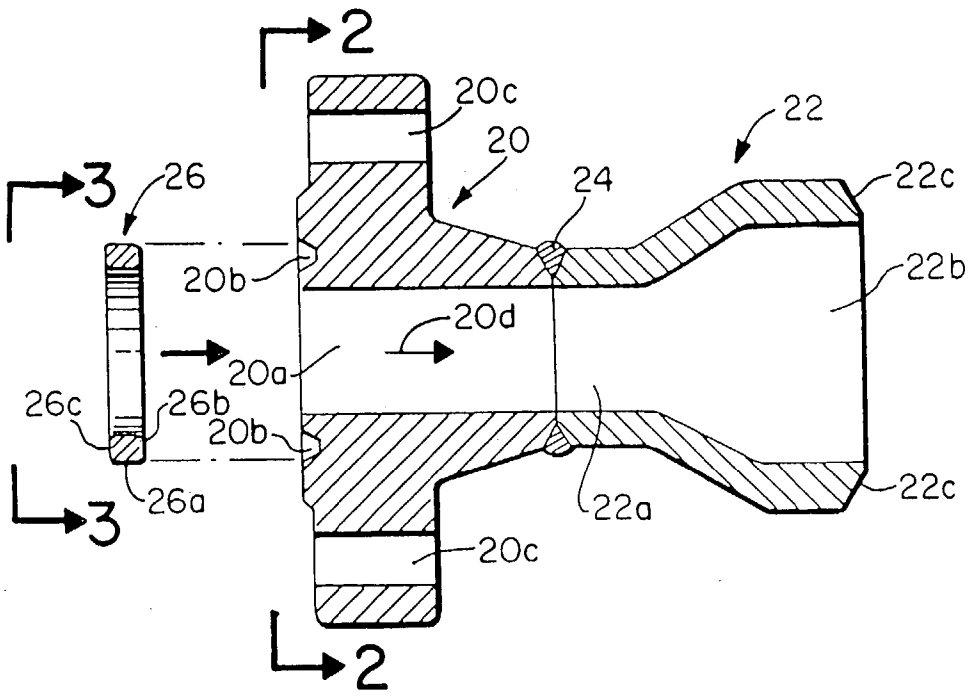


FIG. 1.
PRIOR ART

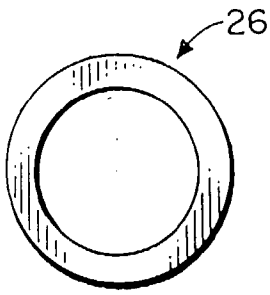


FIG. 3.
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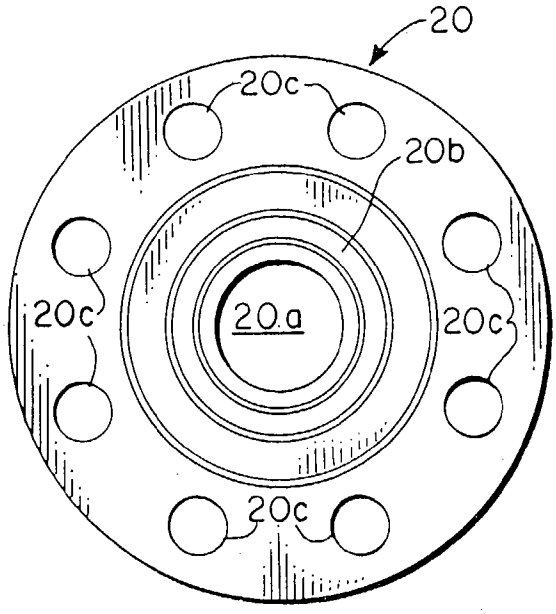


FIG. 2.
PRIOR ART

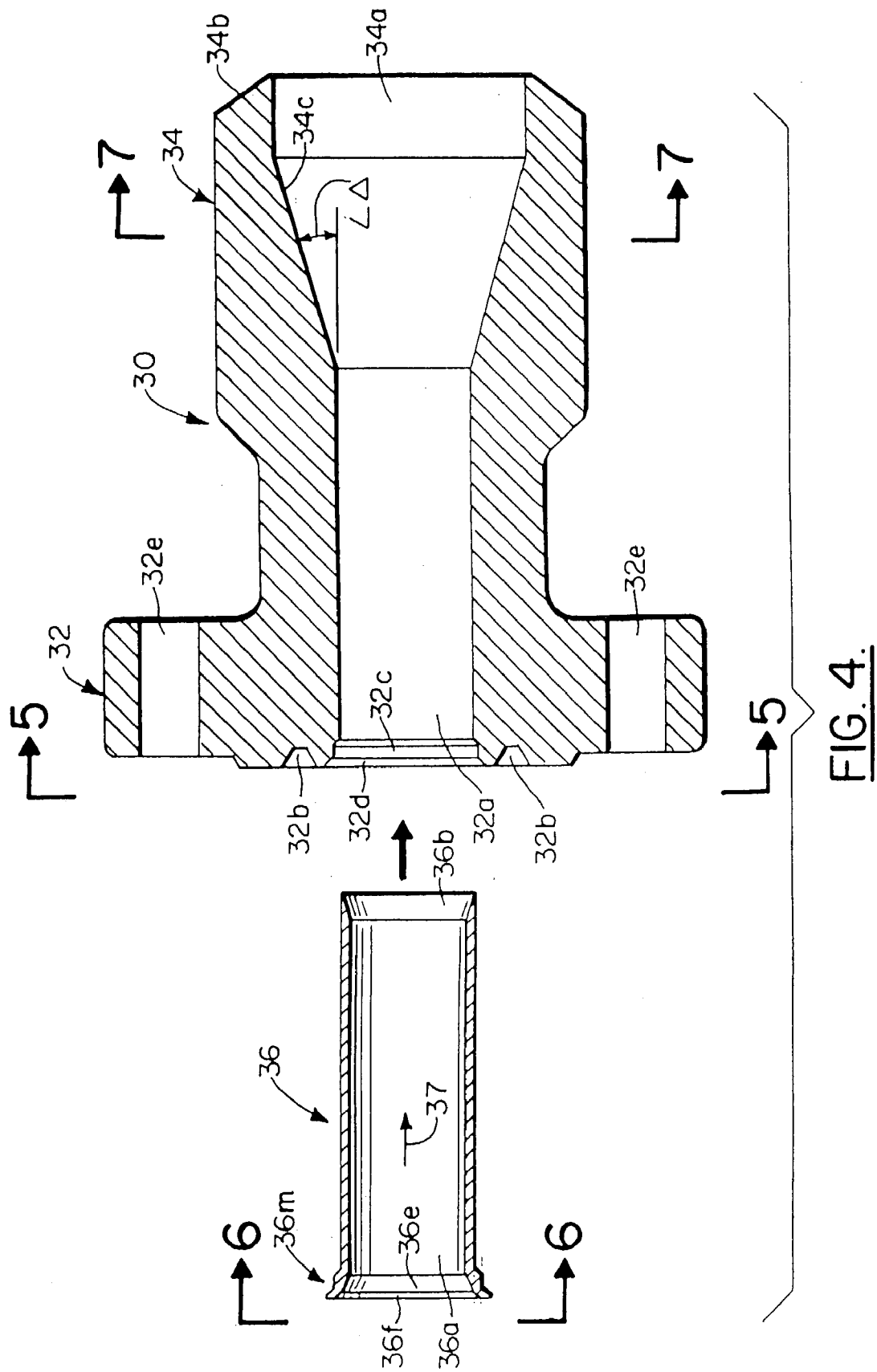

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FIG. 4.

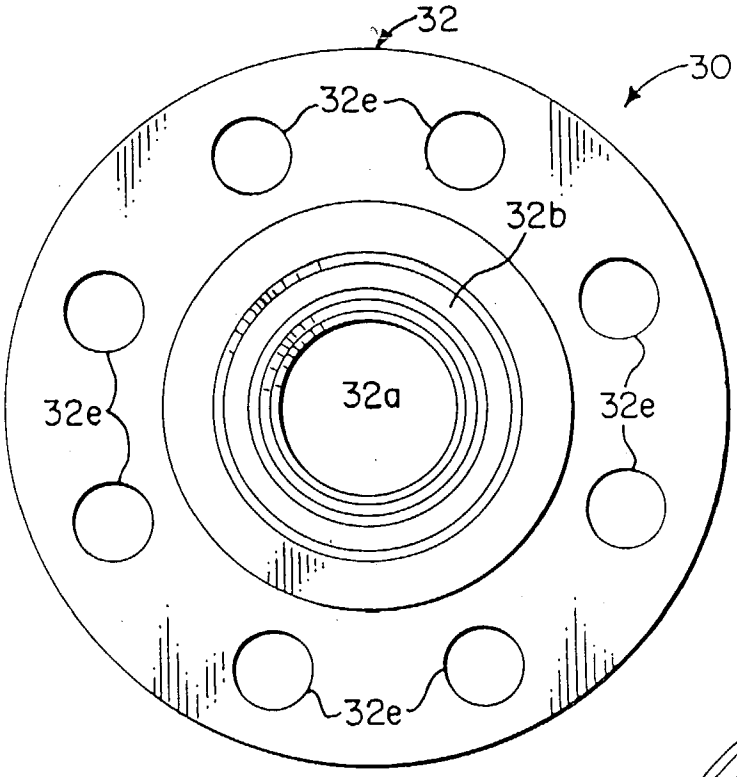


FIG. 5.

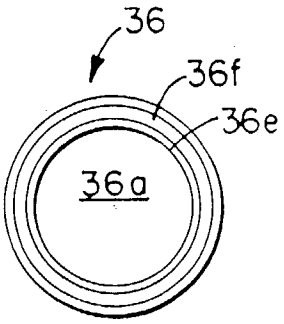


FIG. 6.

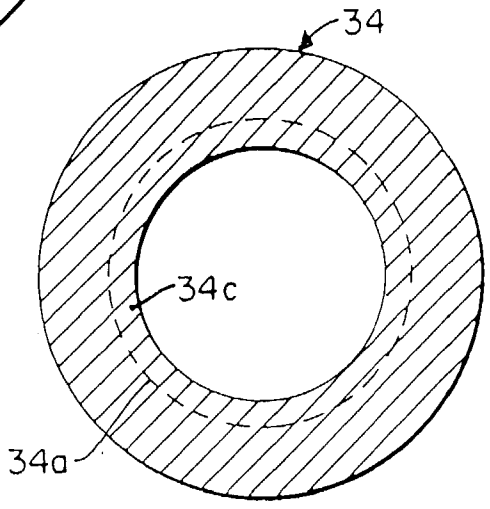


FIG. 7.

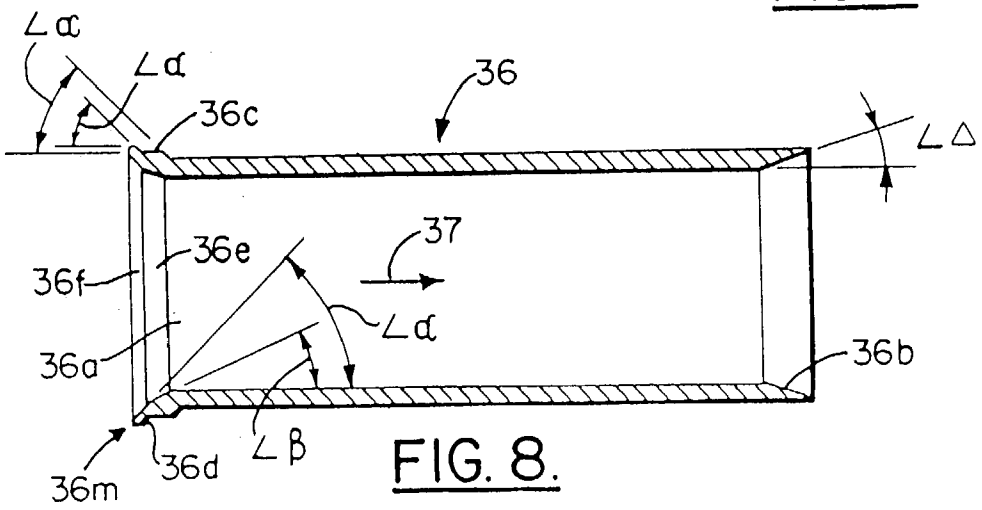


FIG. 8.

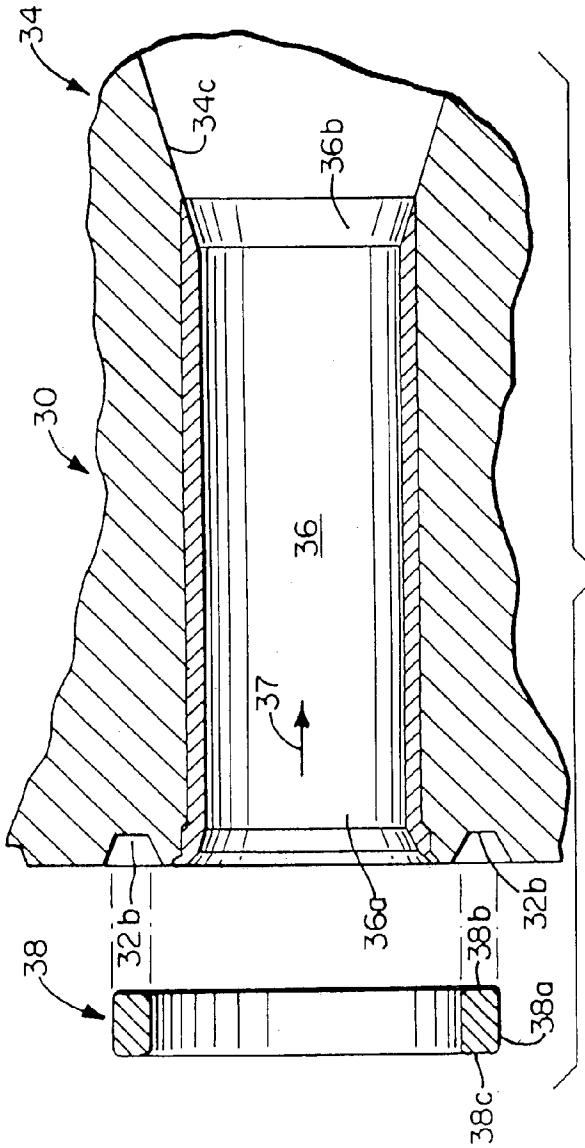


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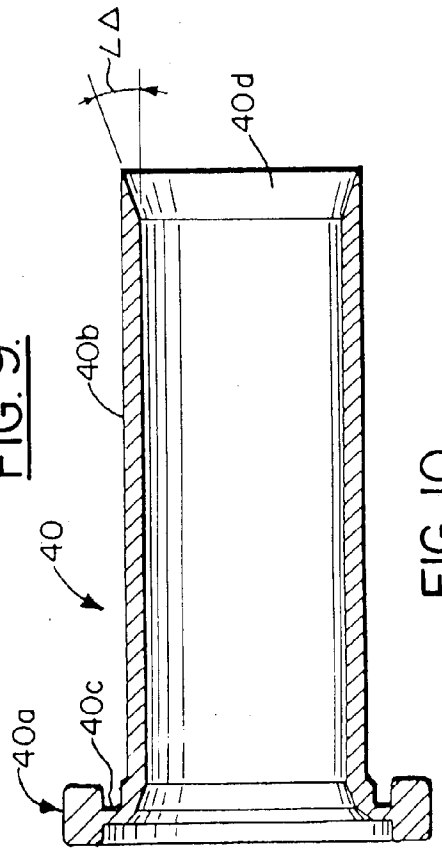


FIG. 10.

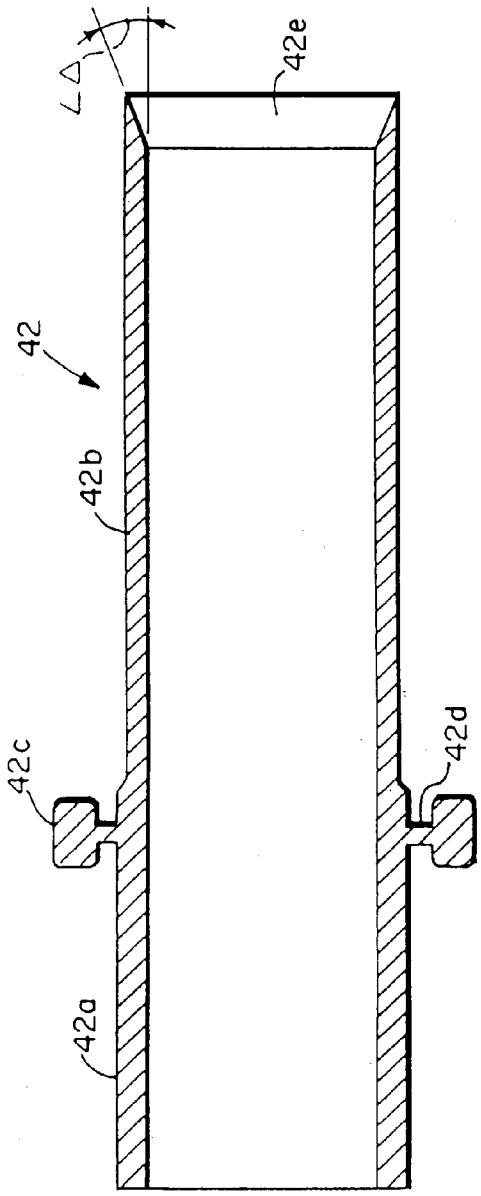


FIG. 11.

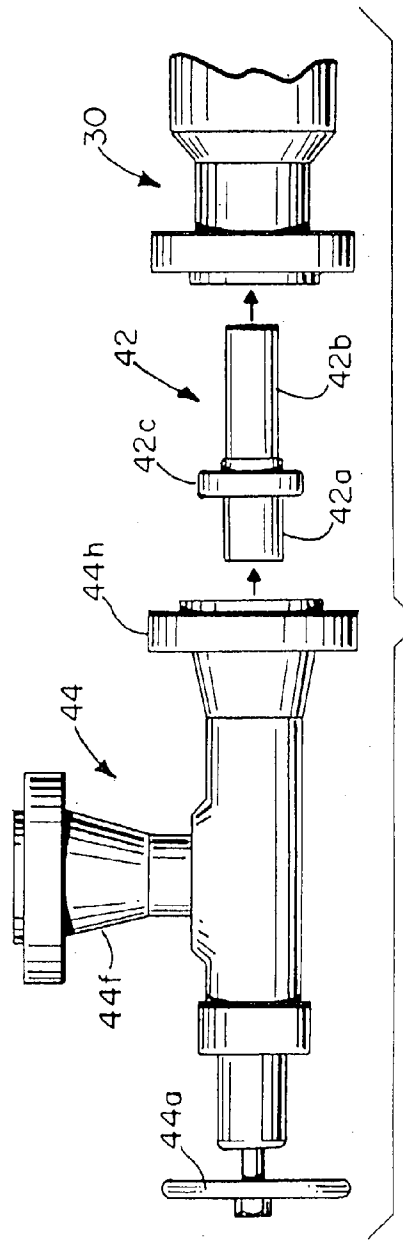


FIG. 12.

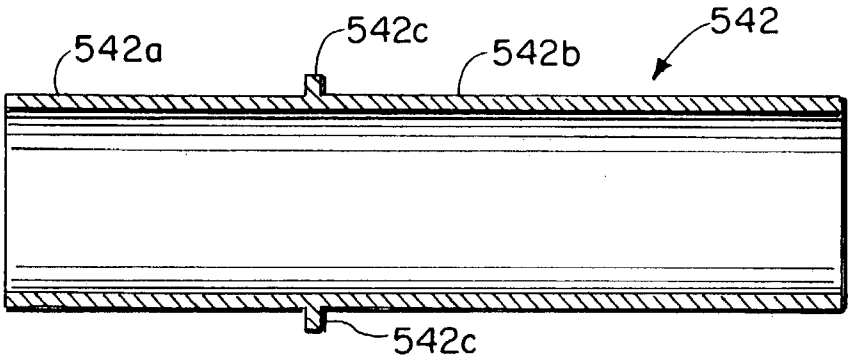


FIG. 29.

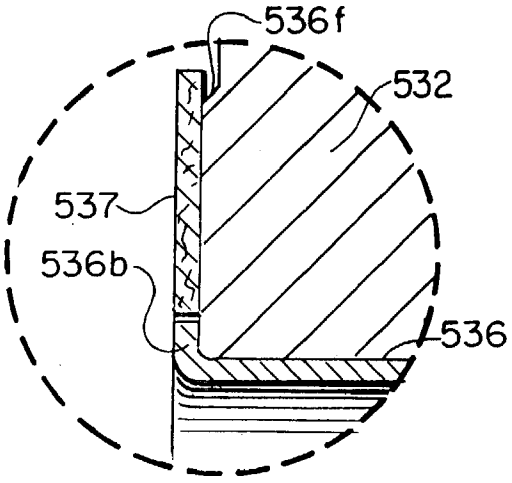


FIG. 30.

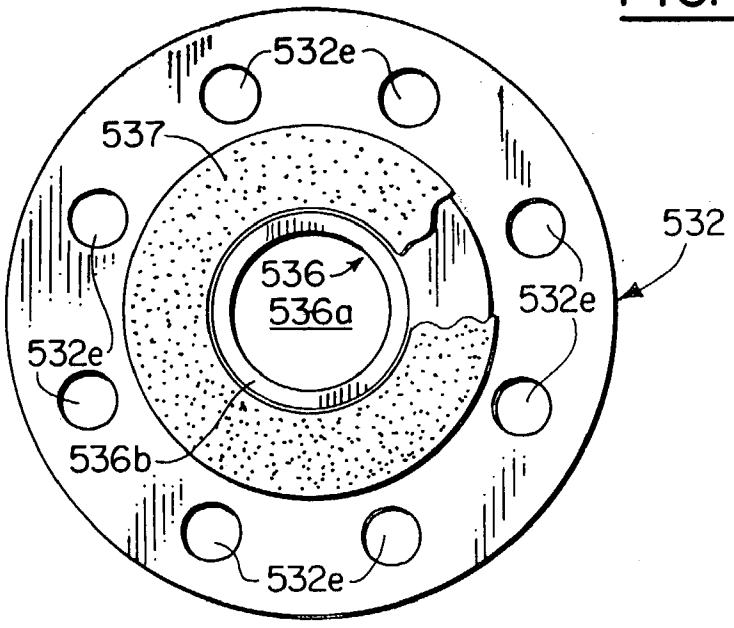


FIG. 31.

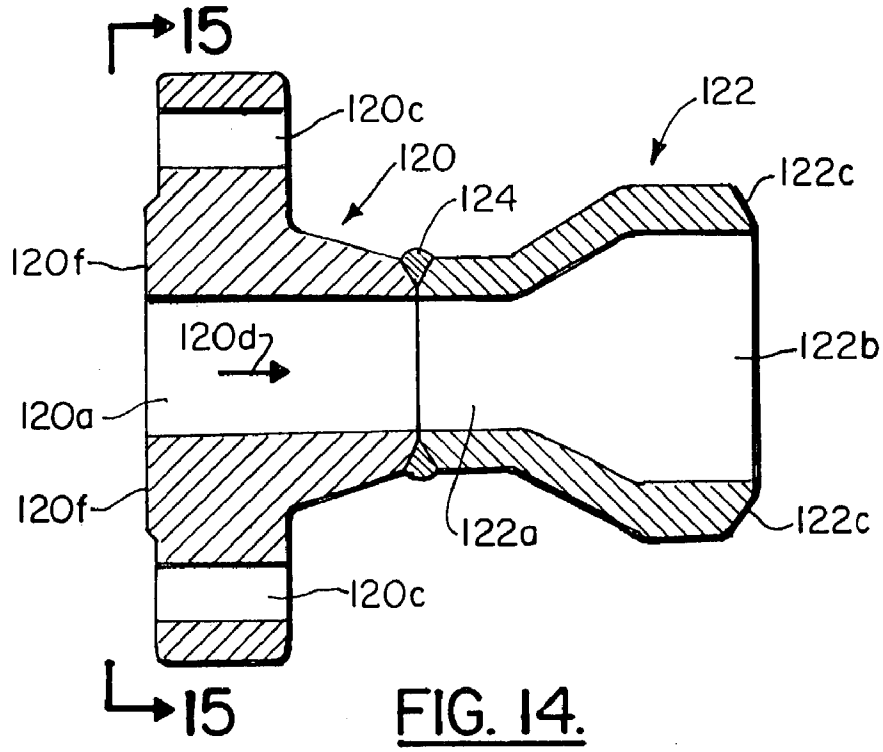


FIG. 14.
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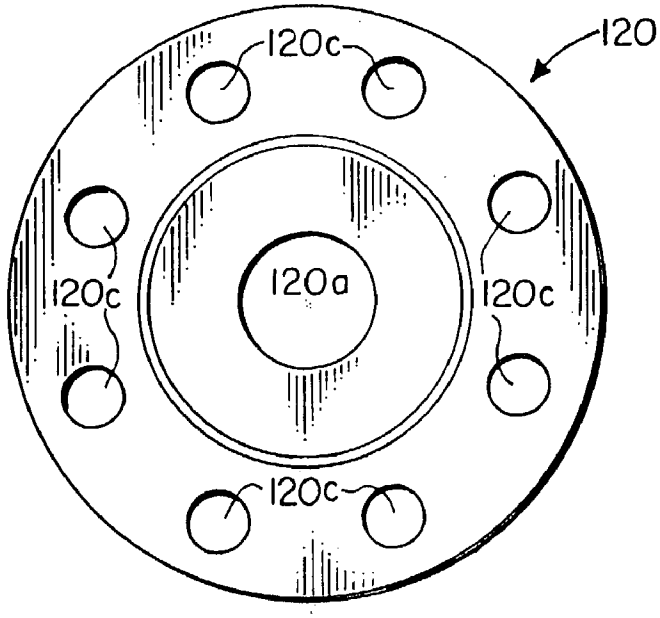


FIG. 15.
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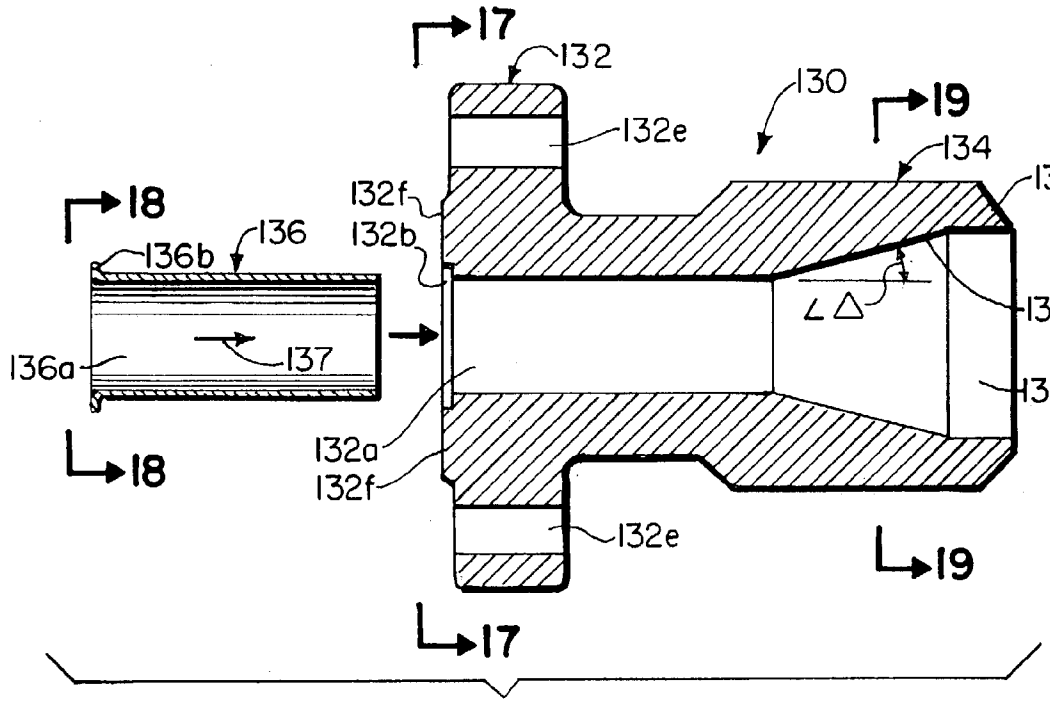


FIG. 16.

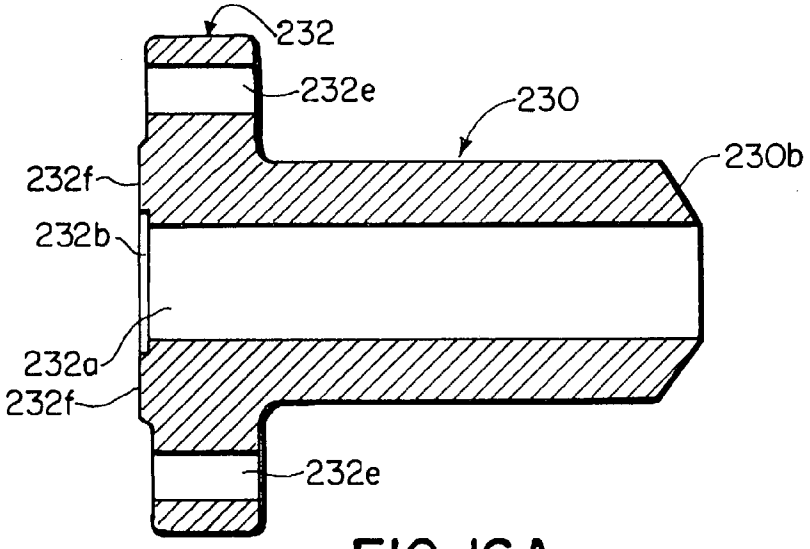


FIG. 16A.

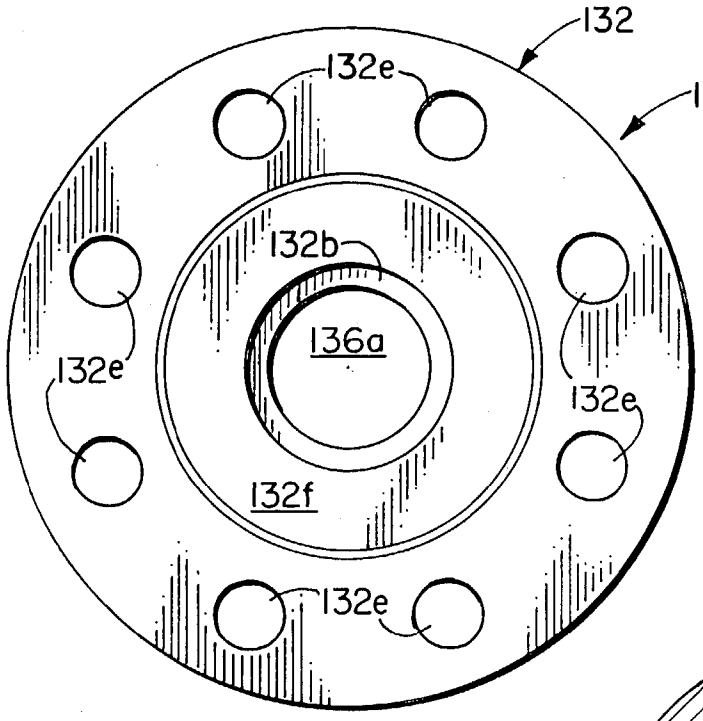


FIG. 17.

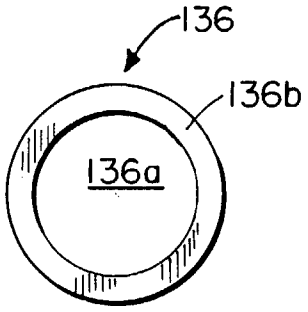


FIG. 18.

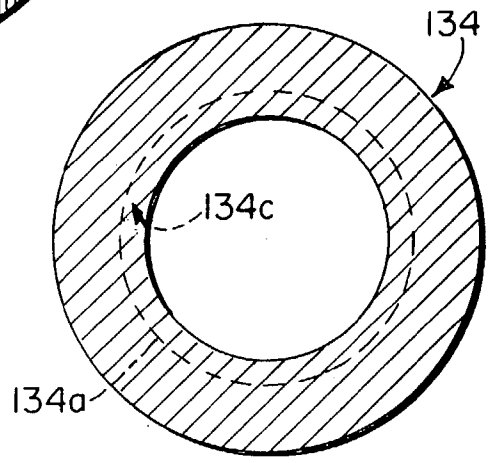


FIG. 19.

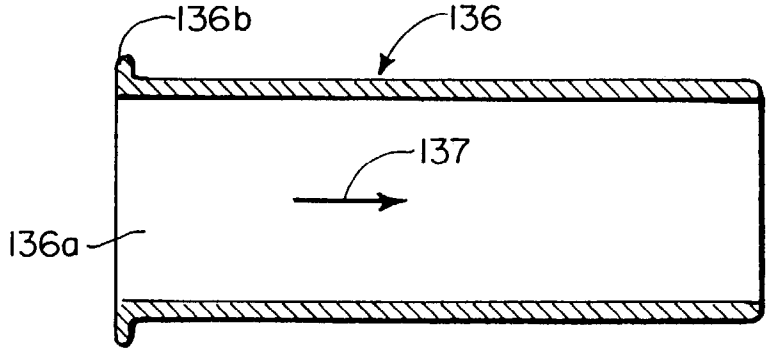


FIG. 20.

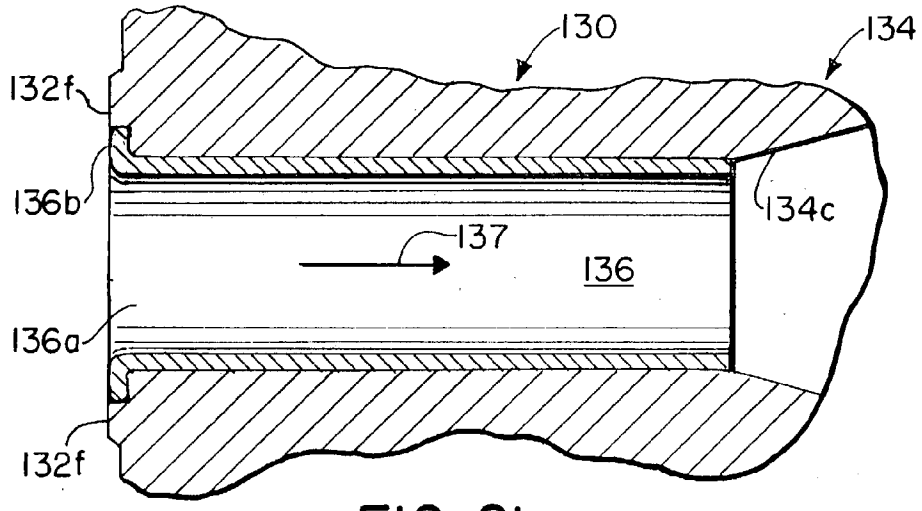


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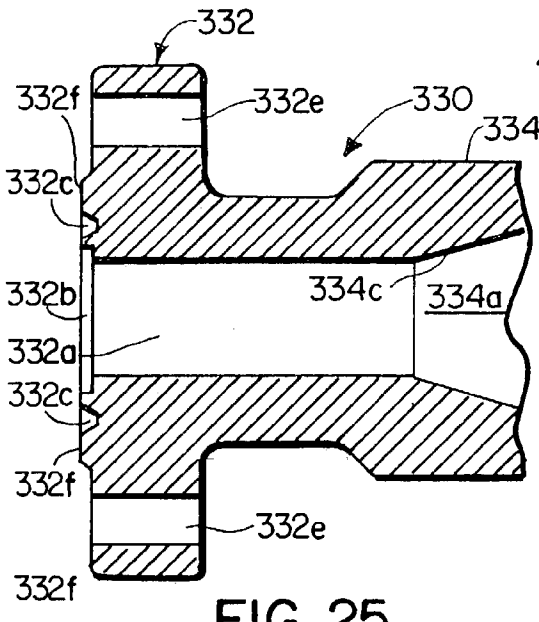


FIG. 25.

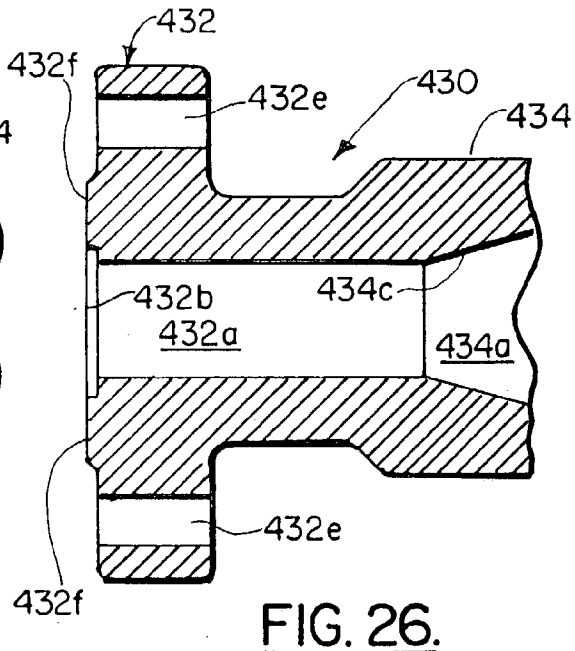


FIG. 26.

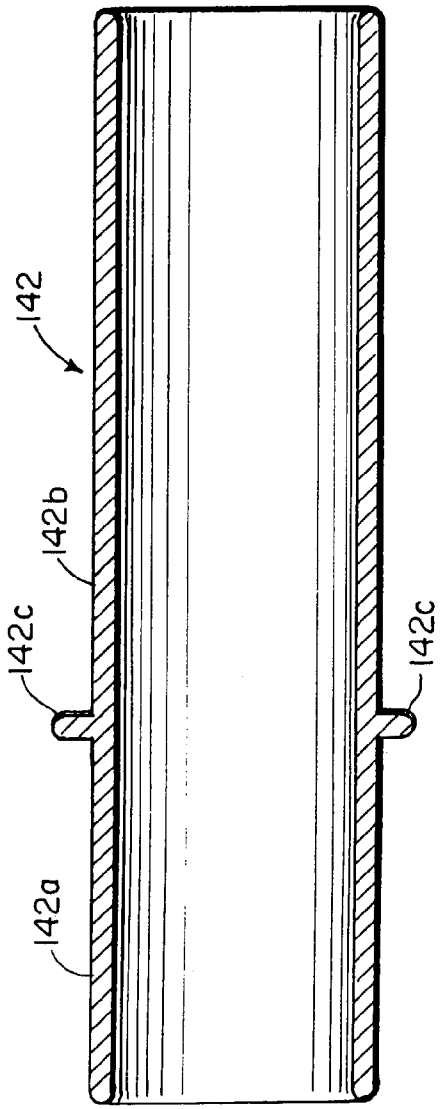


FIG. 22.

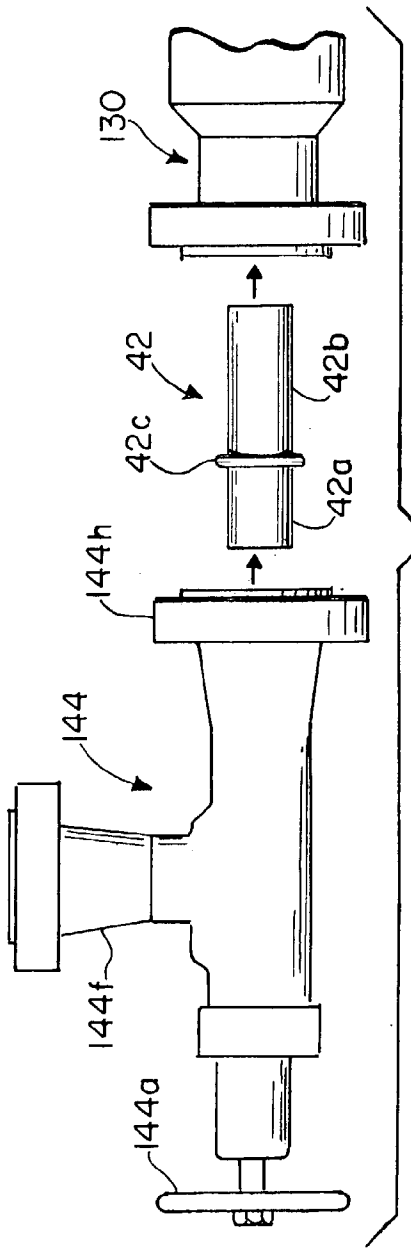


FIG. 23.

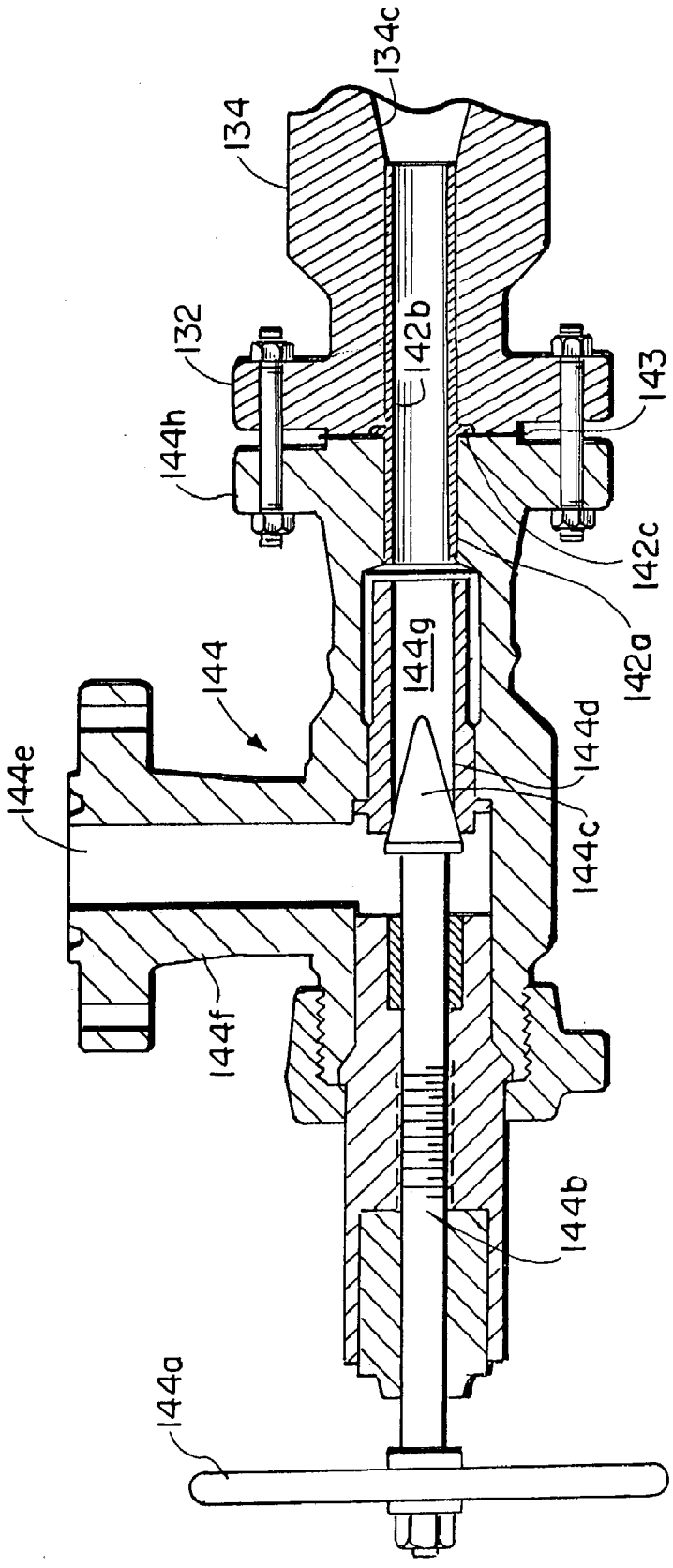

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FIG. 24.

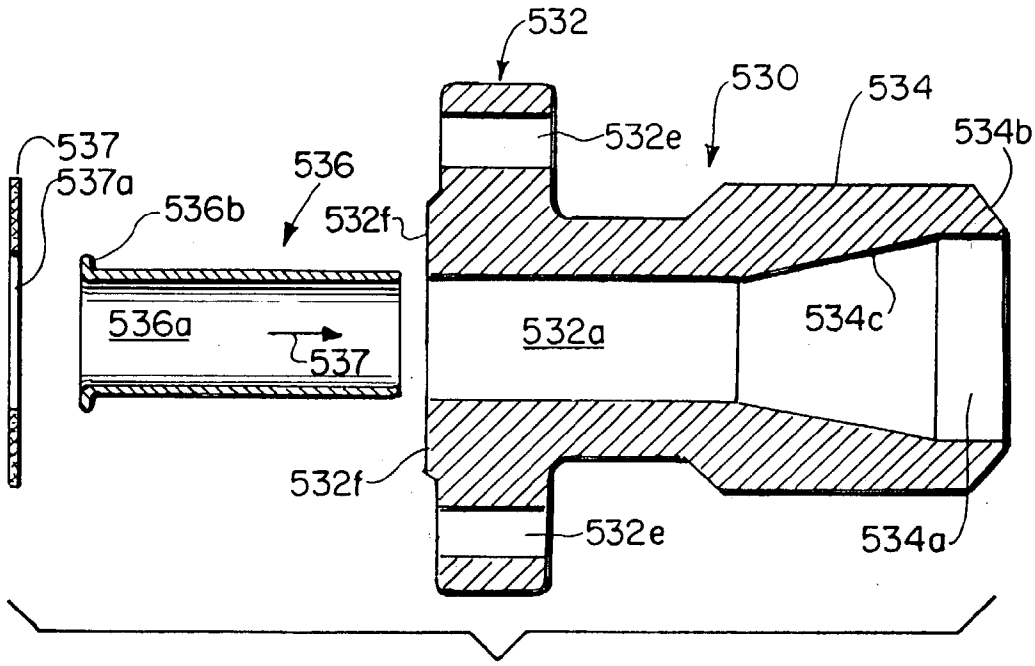

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FIG. 27.

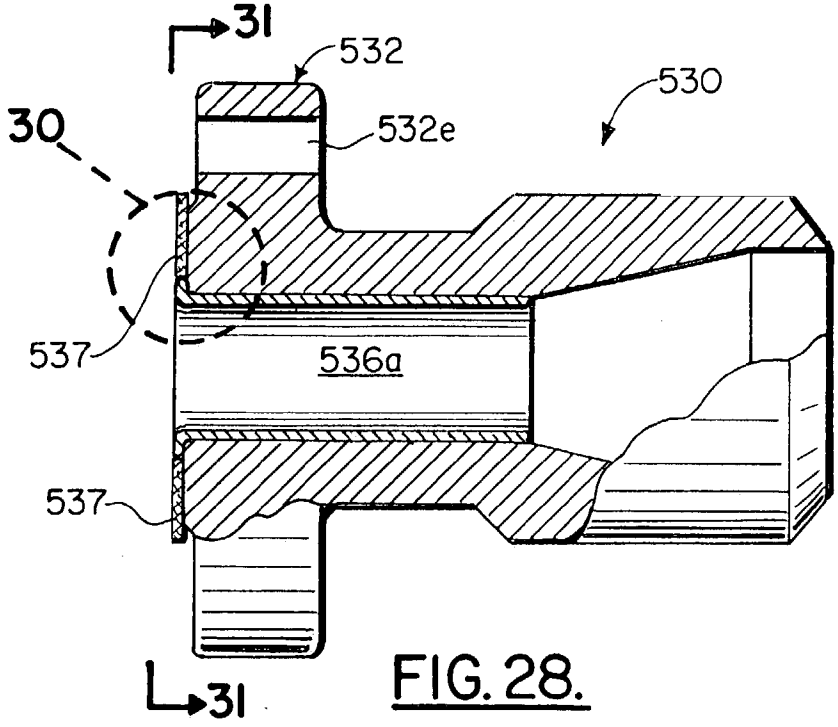

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FIG. 28.

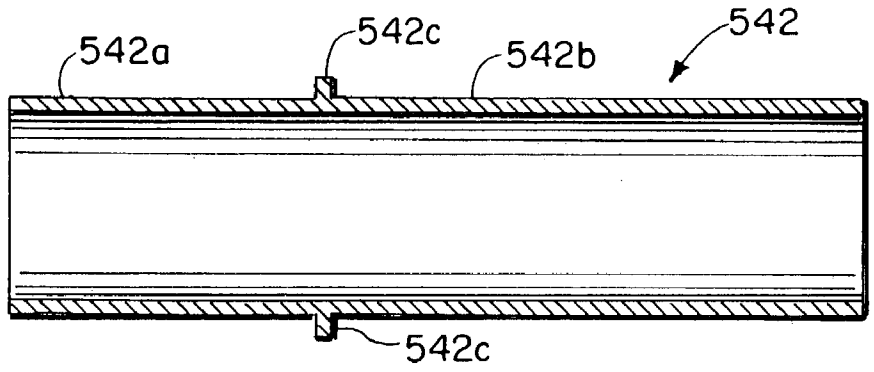


FIG. 29.

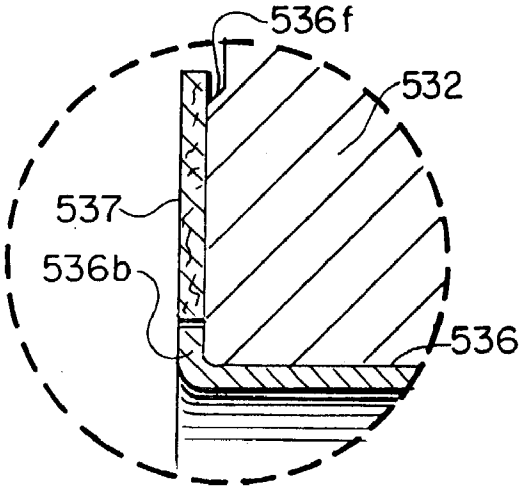


FIG. 30.

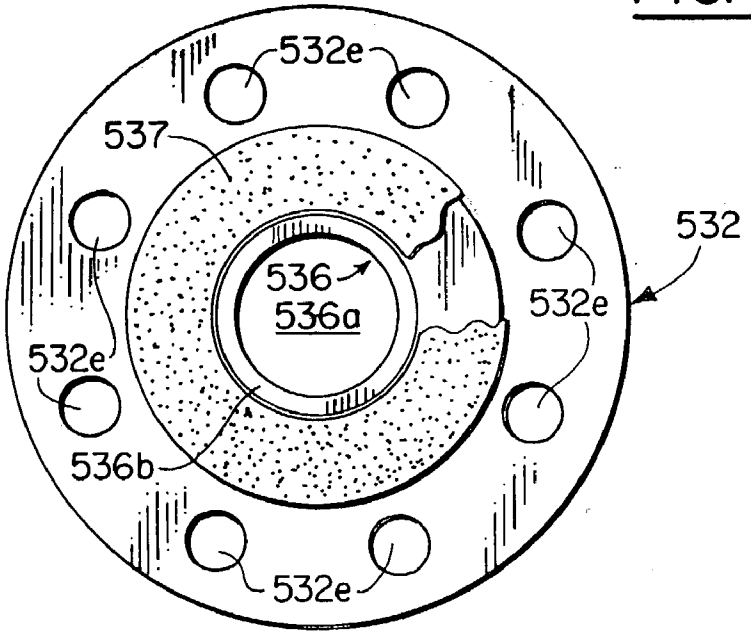


FIG. 31.

PIPE FLANGE ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of pending U.S. patent application Ser. No. 08/759,272 filed Dec. 2, 1996, now allowed.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to pipe flanges. In particular, the invention relates to pipe flanges used in high pressure petroleum and natural gas production.

[0004] 2. Description of the Related Art

[0005] Erosion and corrosion of the interior of high pressure steel pipe by the fluids flowing therethrough commonly occurs in the vicinity of the weld joint joining smaller diameter pipe to larger diameter pipe in which fluids are flowing from the smaller diameter pipe to the larger diameter pipe. The fluids flowing through such pipe may be under high pressures from 50 pounds per square inch to 10,000 pounds per square inch or more and have very high velocity flowing through the pipe and may have corrosive and abrasive elements therein. Such pressures are commonly encountered when natural gas, petroleum, and associated fluids are flowing out of deep gas and petroleum wells.

[0006] Such erosion requires constant monitoring and periodic replacement of welded metal pipe joints and flanges of such pipelines to prevent rupture of the pipeline due to erosion. Periodic replacement of welded pipe joints and flanges to prevent pipeline rupture due to erosion is expensive, sometime dangerous to personnel making the replacement, and commonly requires the interruption of flow through the pipeline. Rupture of such pipelines can cause serious injury or death of personnel in the area of the rupture, explosions, catastrophic damage to equipment, loss of expensive petroleum and gas, and serious pollution of the environment.

[0007] Elimination or reduction of the erosion of such pipe joints and flanges in high pressure pipelines is therefore highly desirable.

[0008] Exemplary of the Patents of the related art are the following U.S. Pat. Nos. 2,290,333; 2,310,927; 2,354,900; 2,806,718; 2,982,311; 3,018,120; 3,228,096; 3,235,291; 3,284,107; 3,284,108; 4,277,091; 4,691,740 and 4,995,427.

SUMMARY OF THE INVENTION

[0009] In accordance with the present invention there is provided an erosion resistant pipe flange assembly for preventing erosion of metal pipe flanges connecting pipe. The pipe flange assembly includes a flange section, a reducer section integrally formed with the flange section, and a replaceable liner for preventing erosion of the interior of the pipe flange assembly.

[0010] The invention has the advantage of greatly reducing and/or eliminating the erosion of pipe joints and flanges by high pressure fluids flowing therein.

[0011] The invention has the additional advantage of reducing or eliminating dangerous ruptures and explosions in flange and reducer assemblies of the prior art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] **FIG. 1** is a cross-sectional, side view of a prior art flange and ring assembly having a weld neck reducer welded thereto;

[0013] **FIG. 2** is a plan view of the flange shown in **FIG. 1** taken along line **2-2** of **FIG. 1**;

[0014] **FIG. 3** is a plan view of the ring shown in **FIG. 1** taken along line **3-3** of **FIG. 1**;

[0015] **FIG. 4** is a cross-sectional, side view of the flange and liner of the invention;

[0016] **FIG. 5** is a plan view of the flange shown in **FIG. 4** taken along line **5-5** of **FIG. 4**;

[0017] **FIG. 6** is a plan view of the liner shown in **FIG. 4** taken along line **6-6** of **FIG. 4**;

[0018] **FIG. 7** is a cross-sectional, plan view of the flange shown in **FIG. 4** taken along line **7-7** of **FIG. 4**;

[0019] **FIG. 8** is an enlarged, detailed view of the liner shown in **FIG. 4**;

[0020] **FIG. 9** is a partly cut-away, enlarged, detailed view of a portion of the flange shown in **FIG. 4** with the liner seated therein and a ring aligned for placement in the flange;

[0021] **FIG. 10** is a cross-sectional, enlarged, detailed view of a second embodiment of the liner of the invention having a ring connected thereto;

[0022] **FIG. 11** is a side view of a third embodiment of the liner of the invention for insertion in a choke assembly and in the flange of the invention;

[0023] **FIG. 12** is a side view of a third embodiment of the liner of the invention aligned for insertion in a choke assembly and in the flange of the invention;

[0024] **FIG. 13** is a side, partly cross-sectional view of the third embodiment of the liner of the invention inserted and seated in the choke assembly shown in **FIG. 11** and the flange of the invention with the choke assembly being bolted to the flange of the invention;

[0025] **FIG. 14** is a cross-sectional, side view of a prior art raised face flange and ring assembly having a weld neck reducer welded thereto;

[0026] **FIG. 15** is a plan view of the flange shown in **FIG. 14** taken along line **15-15** of **FIG. 14**;

[0027] **FIG. 16** is a cross-sectional, side view of a fourth embodiment of a flange and liner of the invention;

[0028] **FIG. 16A** is a cross-sectional, side view of a fifth embodiment of a flange and liner of the invention;

[0029] **FIG. 17** is a plan view of the flange shown in **FIG. 16** taken along line **17-17** of **FIG. 16**;

[0030] **FIG. 18** is a plan view of the liner shown in **FIG. 16** taken along line **18-18** of **FIG. 16**;

[0031] **FIG. 19** is a cross-sectional, plan view of the flange shown in **FIG. 16** taken along line **19-19** of **FIG. 16**;

[0032] **FIG. 20** is an enlarged, detailed view of the liner shown in **FIG. 16**;

[0033] **FIG. 21** is a partly cut-away, enlarged, detailed view of a portion of the flange shown in **FIG. 16** with the liner seated therein;

[0034] **FIG. 22** is a side view of a sixth embodiment of the liner of the invention for insertion in a choke assembly and in the flange of the fifth embodiment of the invention;

[0035] **FIG. 23** is a side view of the sixth embodiment of the liner of the invention aligned for insertion in a choke assembly and in the flange of the fifth embodiment of the invention;

[0036] **FIG. 24** is a side, partly cross-sectional view of the sixth embodiment of the liner of the invention inserted and seated in the choke assembly shown in **FIG. 23** and the flange of the fifth embodiment of the invention with the choke assembly being bolted to the flange of the fifth embodiment of the invention.

[0037] **FIG. 25** is a cross-sectional, enlarged, partly cut-away view of a seventh embodiment of the invention having a tapered groove in the face thereof similar to the embodiment shown in **FIG. 4**;

[0038] **FIG. 26** is a cross-sectional, side view of an eighth embodiment of a flange and liner of the invention similar to the embodiment shown in **FIG. 16**;

[0039] **FIG. 27** is a cross-sectional, exploded side view of a ninth embodiment of a flange and liner of the invention;

[0040] **FIG. 28** is a cross-sectional, assembled side view of the flange and liner of **FIG. 27**;

[0041] **FIG. 29** is a side view of a tenth embodiment of the liner of the invention for insertion in a choke assembly and in the flange of the ninth embodiment of the invention;

[0042] **FIG. 30** is a detailed view of the area of the flange and liner assembly shown in **FIG. 28** in the dotted circle labeled **30**; and

[0043] **FIG. 31** is a plan view of the flange shown in **FIG. 28** taken along line **31-31** of **FIG. 28**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0044] FIGS. **1-3** illustrate the conventional procedure used in the art for connecting small diameter metal pipe such as steel pipe to larger diameter metal pipe. Referring now to FIGS. **1-3**, a prior art metal pipe flange is generally indicated by the numeral **20**. Pipe flange **20** has a central cylindrical bore **20***a* through which fluids under superatmospheric pressure flow.

[0045] A prior metal art weld neck reducer generally indicated by the numeral **22** is welded to pipe flange **20** by weld **24**. Weld neck reducer **22** has a central cylindrical bore **22***a* axially aligned with a larger central cylindrical bore **22***b*. The diameter of central bore **22***a* is identical to the diameter of central bore **20***a* of flange **20**. Pipe (not shown) having a central bore diameter identical to the central cylindrical bore diameter **22***b* of weld neck reducer **22** may then be welded to the end **22***c* of weld neck reducer **22**.

[0046] A circular ring generally indicated by the numeral **26** is aligned for placement in circular tapered groove **20***b* to function as a seal when a second flange (not shown) identical to flange **20** is bolted to pipe flange **20** by bolts (not shown) placed in cylindrical bolt holes **20***c* of flange **20**. Thus, small pipe (not shown), such as two-inch steel line pipe, connected to flange **20** can be connected to larger diameter pipe (not shown), such as four-inch steel line pipe, by welding the larger pipe to the end **22***c* of weld neck reducer **22**. Two-inch and four-inch steel line pipe referred to herein refers to the nominal size of the pipe as is known to those skilled in the art, not to the inside or outside diameter of the pipe.

[0047] Circular ring **26** is a hollow cylinder **26***a* having two flat faces **26***b* and **26***c*. Flat face **26***b* is received in groove **20***b* and is deformed when a second flange (not shown) is bolted to flange **20** as mentioned above. Circular ring **26** is deformed to assume the shape of groove **20***b* when the bolts (not shown) connecting flange **20** to the second flange (not shown) are tightened with sufficient torque to force the two flanges into contact with each other. Thus, circular ring **26** forms a high pressure seal between flange **20** and the second flange (not shown) is bolted thereto.

[0048] In common practice, a small diameter metal pipe, such as a two-inch steel line pipe, conveys high pressure fluids such as gas and/or petroleum, to flange **20**. The fluids flow through bore **20***a* in flange **20** in the direction indicated by the arrow **20***d* and onward through bore **22***b* of weld neck reducer **22** to a larger diameter metal pipe (not shown) welded to the end **22***c* of weld neck reducer **22**.

[0049] Erosion of the interior walls of bore **20***a* of flange **20** and the interior walls of bore **22***a* of weld neck reducer **22** by the fluids flowing therethrough commonly occurs in the vicinity of weld **24**. The fluids flowing through flange **20** and weld neck reducer **22** may be under pressures from 2,000 pounds per square inch to 10,000 pounds per square inch and have very high velocity flowing through the pipe. Petroleum and gas fluids commonly contain particles of sand therein which are abrasive and accelerate the rate of erosion in the vicinity of weld **24**.

[0050] Referring now to FIGS. **4-9**, the present invention can be seen to include a metal flange assembly generally indicated by the numeral **30** having a flange section generally indicated by the numeral **32** and a reducer section generally indicated by the numeral **34**. Flange assembly **30** is preferably integrally formed from a single piece of high-strength, corrosion and abrasion resistant steel alloy and meets or exceeds API (American Petroleum Institute) standards for strength and dimensions.

[0051] Flange section **32** has a central cylindrical bore **32***a*. Reducer section **34** has a central cylindrical bore **34***a* axially aligned with cylindrical bore **32***a* and having a larger diameter than central cylindrical bore **32***a*. Central cylindrical bore **32***a* is joined to central cylindrical bore **34***a* by a tapered or beveled section **34***c*. Metal pipe such as steel pipe (not shown) having a central bore diameter identical to the central cylindrical bore diameter **34***a* of reducer section **34** may then be welded to the end **34***b* of reducer section **34**.

[0052] As shown in **FIGS. 4, 6, 8**, and **9**, flange assembly **30** has a replaceable metal liner generally indicated by the numeral **36** which is received in central cylindrical bore **32***a*. Preferably, flange liner **36** is slidably received in said central cylindrical bore **32***a* and fits snugly therein. Flange liner **36** has a central cylindrical bore **36***a* through which fluids flow in the direction indicated by the arrow **37** shown in **FIGS. 4, 8**, and **9**. Preferably, flange liner **36** has an interior beveled

portion **36***b* forming an angle Å which is aligned with the beveled portion **34***c* of reducer section **34** to decrease turbulence at the downstream end of flange liner **36**. Liner **36** is preferably integrally formed from a single piece of high-strength, corrosion and abrasion resistant steel alloy and meets or exceeds API (American Petroleum Institute) standards for strength and dimensions.

[**0053**] Liner **36** also preferably has a lip section **36***m* at the upstream end thereof including two lips **36***c* and **36***d* shown in **FIG. 8** at the upstream end thereof for seating liner **36** in grooves **32***c* and **32***d,* respectively, of flange section **32** shown in **FIG. 4**. Lips **36***c* and **36***d* have outside edges which preferably form an angle á with the outside surface of liner **36**. Liner **36** also has two inside bevels **36***e* and **36***f*. Bevel **36***e* preferably forms an angle a with the inside surface of liner **36**, and bevel **36***f* preferably forms an angle á with the outside surface of liner **36**. Preferably angle á is 45°, angle â is 22.5°, and angle Å is 15°. If desired, different bevel angles may be utilized, or a single bevel or arc could be utilized in the upstream end of liner **36** to reduce turbulence in the fluids flowing in the vicinity of the upstream end of liner **36**.

[**0054**] Liner **36** has a length sufficient to completely enclose and protect the entire length of central cylindrical bore **32***a* from erosion by fluids and sand particles which may flow therethrough. Liner **36** is made from erosion and abrasion resistant metal alloy. Liner **36** is preferably replaced periodically as liner **36** is eroded and/or abraded by the fluids and sand particles flowing therethrough prior to liner **36** being punctured or ruptured due to erosion and/or abrasion. Periodic replacement of liner **36** prior to rupture of liner **36** prevents erosion of central cylindrical bore **32***a* of flange assembly **30**. The resultant prevention of the erosion of central bore **32***a* greatly extends the life of flange assembly **30** and prevents dangerous ruptures and explosions which have occurred in flange and reducer assemblies of the prior art such as the prior art flange and weld neck reducer assemblies shown in FIGS. **1-3**.

[**0055**] A circular ring generally indicated by the numeral **38** in **FIG. 9** is aligned for placement in circular tapered groove **32***b* to function as a seal when a second flange (not shown) identical to flange **20** shown in **FIG. 1** is bolted to flange section **32** of flange assembly **30** by bolts (not shown) placed in cylindrical bolt holes **32***e* of flange section **32**. Thus, small pipe (not shown), such as pipe two-inch steel line pipe, connected to flange section **32** by a flange identical to flange **20**, can be connected to larger diameter pipe (not shown), such four-inch steel line pipe, by welding the larger pipe to the end **34***b* of reducer section **34**.

[**0056**] Circular ring **38** is identical to ring **26** shown in **FIG. 1** and is a hollow cylinder **38***a* having two-flat faces **38***b* and **38***c*. Flat face **38***b* is received in groove **32***b* and is deformed when a second flange (not shown) identical to flange **20** is bolted to flange assembly **30** as mentioned above. Circular ring **38** is deformed to assume the shape of groove **32***b* when the bolts (not shown) connecting flange assembly **30** to the second flange (not shown) identical to flange **20** is tightened with sufficient torque to force the two flanges into contact with each other. Thus, circular ring **38** forms a high pressure seal between flange assembly **30** and the second flange (not shown) identical to flange **20** bolted thereto.

[**0057**] In **FIG. 10** is shown a second embodiment of the flange liner of the invention generally indicated by the numeral **40**. Flange liner **40** has ring **40***a* integrally formed with hollow cylindrical liner body **40***b* and connected to liner body **40***b* by rib **40***c,* and is otherwise identical to liner **36**. Ring **40***a* is identical in shape to ring **38** shown in **FIG. 9**, and is received in groove **32***b* of flange assembly **30** when liner **40** is substituted for ring **38** and liner **36** in flange assembly **30**. Ring **40***a* deforms in the same manner as ring **38** when a second flange (not shown) identical to flange **20** is bolted to flange assembly **30**. Preferably, flange liner **40** has an interior beveled portion **40***d* having an angle Å which is aligned with the beveled portion **34***c* of reducer section **34** to decrease turbulence at the downstream end of flange liner **40**.

[**0058**] In FIGS. **11-13** is shown a third embodiment of the liner of the invention generally indicated by the numeral **42**. Liner **42** is used to connect a conventional choke assembly generally indicated by the numeral **44** to the flange assembly **30** of the present invention. Liner **42** is similar to liner **40** having an additional hollow cylindrical section **42***a* integrally formed therewith for receipt in the discharge flange **44***a* of choke **44**. Hollow cylindrical section **42***a* is preferably slidably received in discharge flange **44***a* and is snugly received therein. Liner **42** has a ring **42***c* connected to hollow cylindrical section **42***a* and **42***b* by circular rib **42***d*. Ring **42***c* is identical in shape to ring **38** shown in **FIG. 9**, and is received in groove **32***b* of flange assembly **30** when liner **42** is placed in flange assembly **30** as shown in **FIG. 13**. Ring **42***c* deforms in the same manner as ring **38** when flange **44***h* of choke **44** is bolted to flange assembly **30**. Preferably, flange liner **42** has an interior beveled portion **42***e* having an angle Å which is aligned with the beveled portion **34***c* of reducer section **34** to decrease turbulence at the downstream end of flange liner **42**.

[**0059**] Choke assembly **44** is a conventional choke assembly well known in the art. As known to those skilled in the art, choke assembly **44** has a circular handle **44***a* connected to a rotatable threaded shaft **44***b* having a cone **44***c* on the end thereof which fits against seat **44***d*. As shown in **FIG. 13**, cone **44***c* is seated against seat **44***d,* preventing flow therethrough. When handle **44***a* is rotated to turn shaft **44***b* and withdraw cone **44***c* away from seat **44***d,* fluids can flow through hollow cylindrical passage **44***e* in flange **44***f* around cone **44***c* and into hollow cylindrical passage **44***g* in flange **44***h*. From passage **44***f* fluids flow into hollow cylindrical section **42***a,* hollow cylindrical section **42***b,* and outward through beveled portion **42***e*.

[**0060**] An additional flange (not shown) may be bolted to flange **44***a* of choke **44** to supply fluids such as petroleum and gas thereto. Flange assembly **30** of the invention is shown bolted in **FIG. 13** to flange **44***h* of the discharge end of choke **44**. Liner **42** prevents erosion of the hollow cylindrical portion of flange **44***a* covered by hollow cylindrical section **42***a* of liner **42**, and liner **42** prevents erosion of the portion of flange assembly **30** of the invention covered by hollow cylindrical portion **42***b* of liner **42**.

[**0061**] The present invention thus greatly reduces and/or sometimes eliminates the erosion of pipe joints and flanges by high pressure fluids flowing therein. All of the liners **36**, **40** and **42** are preferably replaced periodically as the liners **36**, **40**, and **42** are eroded and/or abraded by the fluids and

sand particles flowing therethrough prior to the liners being punctured or ruptured due to erosion and/or abrasion. Periodic replacement of liners **36**, **40**, and **42** prior to rupture thereof prevents erosion of central cylindrical bore **32***a* of flange assembly **30**, and periodic replacement of liner **42** also prevents the discharge port in the discharge flange of the choke from eroding. The resultant prevention of the erosion of central bore **32***a* greatly extends the life of flange assembly **30** and prevents dangerous ruptures and explosions which have occurred in flange and reducer assemblies of the prior art such as the prior art flange and weld neck reducer assemblies shown in FIGS. **1-3**.

[**0062**] All of the liners **36**, **40** and **42** are preferably integrally formed from a single piece of high-strength, corrosion and abrasion resistant steel alloy and meet or exceed API (American Petroleum Institute) standards for strength and dimensions. Preferably all of the liners **36**, **40** and **42** are slidably received in said central cylindrical bore **32***a* and fit snugly therein.

[**0063**] Therefore, erosion of flange assembly **30** can be prevented by the method of periodically disconnecting the flange assembly **30** in which an old, abraded or eroded liner **36**, **40**, or **42** is located from the adjacent conventional flange connected to flange assembly **30**, sliding the old liner **36**, **40**, or **42** out of flange assembly **30**, placing a new liner **36**, **40**, or **42** in flange assembly **30**, and reconnecting flange assembly **30** containing the new liner **36**, **40**, or **42** to the adjacent flange. The time interval or period of replacement of liners **36**, **40**, or **42** will be determined by the rate of flow, pressure, and abrasive nature of the fluids flowing therethrough, and by observing the rate of erosion and/or abrasion of the liners **36**, **40**, and **42** in the field or area where the liners **36**, **40**, and **42** and flange assemblies **30** are utilized.

[**0064**] Preferably flange assembly **30** is machined or formed from a solid piece of steel. However, flange assembly **30** could be formed from a reducer section being welded or otherwise bonded to a flange section, with the liner **36**, **40**, or **42** being placed therein.

[**0065**] The prior art flange **20** shown in **FIG. 1** is referred to in the art as a ring joint flange. **FIGS. 14 and 15** illustrate the conventional procedure used in the art for connecting small diameter metal pipe such as steel pipe to larger diameter metal pipe. Referring now to **FIGS. 14 and 15**, a prior art metal pipe flange is generally indicated by the numeral **120** and has a flat raised face **120***f*. The prior art flange **120** shown in **FIG. 15** is referred to in the art as a raised face flange. Pipe flange **120** has a central cylindrical bore **120***a* through which fluids under superatmospheric pressure flow.

[**0066**] A prior metal art weld neck reducer generally indicated by the numeral **122** is welded to pipe flange **120** by weld **124**. Weld neck reducer **122** has a central cylindrical bore **122***a* axially aligned with a larger central cylindrical bore **122***b*. The diameter of central bore **122***a* is identical to the diameter of central bore **120***a* of flange **120**. Pipe (not shown) having a central bore diameter identical to the central cylindrical bore diameter **122***b* of weld neck reducer **122** may then be welded to the end **122***c* of weld neck reducer **122**.

[**0067**] A second flange (not shown) identical to flange **120** is bolted to pipe flange **120** by bolts (not shown) placed in cylindrical bolt holes **120***c* of flange **120**. Preferably, a thin, flat, circular gasket is placed between the two flanges as is known in the art. Thus, small pipe (not shown), such as two-inch steel line pipe, connected to flange **120** can be connected to larger diameter pipe (not shown), such as four-inch steel line pipe, by welding the larger pipe to the end **122***c* of weld neck reducer **122**. Two-inch and four-inch steel line pipe referred to herein refers to the nominal size of the pipe as is known to those skilled in the art, not to the inside or outside diameter of the pipe.

[**0068**] When the bolts (not shown) connecting flange **120** to the second flange (not shown) are tightened with sufficient torque to force the two flanges into contact with each other, a high pressure seal between flange **120** and the second flange (not shown) bolted thereto.

[**0069**] In common practice, a small diameter metal pipe, such as a two-inch steel line pipe, conveys high pressure fluids such as gas and/or petroleum, to flange **120**. The fluids flow through bore **120***a* in flange **120** in the direction indicated by the arrow **120***d* and onward through bore **122***b* of weld neck reducer **122** to a larger diameter metal pipe (not shown) welded to the end **122***c* of weld neck reducer **122**.

[**0070**] Erosion of the interior walls of bore **120***a* of flange **120** and the interior walls of bore **122***a* of weld neck reducer **122** by the fluids flowing therethrough commonly occurs in the vicinity of weld **124**. The fluids flowing through flange **120** and weld neck reducer **122** may be under pressures from 2,000 pounds per square inch to 10,000 pounds per square inch and have very high velocity flowing through the pipe. Petroleum and gas fluids commonly contain particles of sand therein which are abrasive and accelerate the rate of erosion in the vicinity of weld **124**.

[**0071**] Referring now to **FIGS. 16 and 17-21**, the fourth embodiment of the flange and liner of the present invention can be seen to include a metal flange assembly generally indicated by the numeral **130** having a flange section generally indicated by the numeral **132** with a flat, raised face **132***f* and a reducer section generally indicated by the numeral **134**. Flange assembly **130** is preferably integrally formed from a single piece of high-strength, corrosion and abrasion resistant steel alloy and meets or exceeds API (American Petroleum Institute) standards for strength and dimensions.

[**0072**] Flange section **132** has a central cylindrical bore **132***a*. Reducer section **134** has a central cylindrical bore **134***a* axially aligned with cylindrical bore **132***a* and having a larger diameter than central cylindrical bore **132***a*. Central cylindrical bore **132***a* is joined to central cylindrical bore **134***a* by a tapered or beveled section **134***c*. Metal pipe such as steel pipe (not shown) having a central bore diameter identical to the central cylindrical bore diameter **134***a* of reducer section **134** may then be welded to the end beveled end **134***b* of reducer section **134**.

[**0073**] As shown in **FIGS. 16, 18, 20**, and **21**, flange assembly **130** has a replaceable metal liner generally indicated by the numeral **136** which is received in central cylindrical bore **132***a*. Preferably, flange liner **136** is slidably received in said central cylindrical bore **132***a* and fits snugly therein. Flange liner **136** has a central cylindrical bore **136***a* through which fluids flow in the direction indicated by the arrow **137** shown in **FIGS. 16 and 20**. Liner **136** is prefer-

ably integrally formed from a single piece of high-strength, corrosion and abrasion resistant steel alloy and meets or exceeds API (American Petroleum Institute) standards for strength and dimensions.

[0074] Liner **136** also preferably has a lip section **136***b* at the upstream end thereof shown in **FIGS. 16, 18, 20** and **21** for seating liner **136** in recess **132***b* of flange section **132** shown in **FIG. 16**. Recess **132***b* is generally cylindrical in shape to receive lip **136***b* of liner **136**.

[0075] Liner **136** has a length sufficient to completely enclose and protect the entire length of central cylindrical bore **132***a* from erosion by fluids and sand particles which may flow therethrough. Liner **136** is made from erosion and abrasion resistant metal alloy. Liner **136** is preferably replaced periodically as liner **136** is eroded and/or abraded by the fluids and sand particles flowing therethrough prior to liner **136** being punctured or ruptured due to erosion and/or abrasion. Periodic replacement of liner **136** prior to rupture of liner **136** prevents erosion of central cylindrical bore **132***a* of flange assembly **130**. The resultant prevention of the erosion of central bore **132***a* greatly extends the life of flange assembly **130** and prevents dangerous ruptures and explosions which have occurred in flange and reducer assemblies of the prior art such as the prior art flange and weld neck reducer assemblies shown in **FIGS. 14 and 15**.

[0076] A second flange (not shown) identical to flange **120** shown in **FIG. 14** is bolted to flange section **132** of flange assembly **130** by bolts (not shown) placed in cylindrical bolt holes **32***e* of flange section **132**. Thus, small pipe (not shown), such as pipe two-inch steel line pipe, connected to flange section **132** by a flange identical to flange **120**, can be connected to larger diameter pipe (not shown), such four-inch steel line pipe, by welding the larger pipe to the end **134***b* of reducer section **134**. When the bolts (not shown) connecting flange assembly **130** to the second flange (not shown) identical to flange **120** is tightened with sufficient torque to force the two flanges into contact with each other. Thus, a high pressure seal is formed between flange assembly **130** and the second flange (not shown) identical to flange **120** bolted thereto. Preferably, a thin, flat, circular gasket having a central circular opening therein is placed between flange section **132** and the flange such as flange **120** to be bolted thereto. Such gaskets are known in the art and are usually one-sixteenth to one-eighth inch thick.

[0077] In **FIG. 16***a* is shown a fifth embodiment of the flange and liner assembly of the invention generally indicated by the numeral **230**. Flange **230** is adapted to receive liner **136** and connect two sections of pipe (not shown) which have the same diameter, whereas flange **130** shown in **FIG. 16** is adapted to connect a first pipe to a larger diameter second pipe. Flange assembly **230** is preferably integrally formed from a single piece of high-strength, corrosion and abrasion resistant steel alloy and meets or exceeds API (American Petroleum Institute) standards for strength and dimensions. Flange **230** has a flange section generally indicated by the numeral **232** having recess **232***b* therein for receiving the lip section **136***b* of liner **136** at the upstream end thereof in a similar manner to that shown in **FIGS. 16, 18, 20** and **21** for seating liner **136** in recess **132***b* of flange section **132** shown in FIG. **16**. Recess **232***b* is generally cylindrical in shape to receive lip **136***b* of liner **136**.

[0078] Flange section **232** has a central cylindrical bore **232***a* and a flat, raised face **232***f*. Central cylindrical bore **232***a* has the same diameter throughout its entire length. Metal pipe such as steel pipe (not shown) having a central bore diameter identical to the central cylindrical bore diameter **232***a* may then be welded to the beveled end **230***b* of flange **230**. Thus, pipe (not shown), such as pipe two-inch steel line pipe, connected to flange section **232** by a flange identical to flange **120**, can be connected to pipe (not shown) of the same diameter by welding the larger pipe to the beveled end **230***b* of flange **230**. When the bolts (not shown) connecting flange assembly **230** to the second flange (not shown) identical to flange **120** is tightened with sufficient torque to force the two flanges into contact with each other. Thus, a high pressure seal is formed between flange assembly **230** and the second flange (not shown) identical to flange **120** bolted thereto.

[0079] In FIGS. **22-24** is shown a sixth embodiment of the liner of the invention generally indicated by the numeral **142**. Liner **142** is used to connect a conventional choke assembly generally indicated by the numeral **144** to the flange assembly **130** of the present invention. Liner **142** is similar to liner **140** having an additional hollow cylindrical section **142***a* integrally formed therewith for receipt in the discharge flange **144***h* of choke **144**. Hollow cylindrical section **142***a* is preferably slidably received in discharge flange **144***h* and is snugly received therein. Liner **142** has a circular rib **142***c* connected to the intersection of hollow cylindrical section **142***a* and hollow cylindrical section **142***b*. Ring **142***c* is received in recess **132***b* of flange **132** of flange assembly **130** when liner **142** is placed in flange assembly **130** as shown in **FIG. 24**. Preferably, a thin, flat, circular gasket **143** having a central circular opening having a diameter identical to the outside diameter of liner **142** is placed between flange **144***h* and flange **132**. Such gaskets **143** are known in the art and are usually one-sixteenth to one-eighth inch thick.

[0080] Choke assembly **144** is a conventional choke assembly well known in the art. As known to those skilled in the art, choke assembly **144** has a circular handle **144***a* connected to a rotatable threaded shaft **144***b* having a cone **144***c* on the end thereof which fits against seat **144***d*. As shown in **FIG. 24**, cone **144***c* is seated against seat **144***d*, preventing flow therethrough. When handle **144***a* is rotated to turn shaft **144***b* and withdraw cone **144***c* away from seat **144***d*, fluids can flow through hollow cylindrical passage **144***e* in flange **144***f* around cone **144***c* and into hollow cylindrical passage **144***g* in flange **144***h*. From passage **144***g* fluids flow into hollow cylindrical section **142***a*, hollow cylindrical section **142***b*, and outward through beveled portion **134***c*.

[0081] An additional flange (not shown) may be bolted to flange **144***f* of choke **144** to supply fluids such as petroleum and gas thereto. Flange assembly **130** of the invention is shown bolted in **FIG. 24** to flange **144***h* of the discharge end of choke **144**. Liner **142** prevents erosion of the hollow cylindrical portion of flange **144***a* covered by hollow cylindrical section **142***a* of liner **142**, and liner **142** prevents erosion of the portion of flange assembly **130** of the invention covered by hollow cylindrical portion **142***b* of liner **142**.

[0082] Referring now to **FIG. 25**, there is shown a cross-sectional, enlarged, partly cut-away view of a seventh embodiment of the invention generally indicated by the numeral **330** having a tapered groove **332***c* in the face **332***f*

thereof similar to the embodiment shown in **FIG. 4**. Flange assembly **330** invention can be seen to include a flange section generally indicated by the numeral **332** and a reducer section generally indicated by the numeral **334**. Flange assembly **330** is preferably integrally formed from a single piece of high-strength, corrosion and abrasion resistant steel alloy and meets or exceeds API (American Petroleum Institute) standards for strength and dimensions.

[**0083**] A circular ring generally indicated by the numeral **38** in **FIG. 9** can be aligned for placement in circular tapered groove **332***c* of flange **330**, as ring **38** was aligned for placement in circular tapered groove **32***b* of flange assembly **30** shown in **FIG. 9**, to function as a seal when a second flange (not shown) identical to flange **20** shown in **FIG. 1** is bolted to flange section **332** of flange assembly **330** by bolts (not shown) placed in cylindrical bolt holes **332***e* of flange section **332**. Thus, small pipe (not shown), such as pipe two-inch steel line pipe, connected to flange section **332** by a flange identical to flange **20**, can be connected to larger diameter pipe (not shown), such four-inch steel line pipe, by welding the larger pipe to the end of reducer section **334**.

[**0084**] As mentioned above in the description of the embodiment of the invention shown in **FIG. 9**, circular ring **38** is identical to ring **26** shown in **FIG. 1** and is a hollow cylinder **38***a* having two-flat faces **38***b* and **38***c*. Flat face **38***b* is received in groove **332***c* and is deformed when a second flange (not shown) identical to flange **20** is bolted to flange assembly **330** as mentioned above. Circular ring **38** is deformed to assume the shape of groove **332***c* when the bolts (not shown) connecting flange assembly **330** to the second flange (not shown) identical to flange **20** are tightened with sufficient torque to force the two flanges into contact with each other. Thus, circular ring **38** forms a high pressure seal between flange assembly **330** and the second flange (not shown) identical to flange **20** bolted thereto.

[**0085**] Flange section **330** has a central cylindrical bore **330***a*. Reducer section **334** has a conical cylindrical bore **334***a* axially aligned with cylindrical bore **330***a* and having any desired end shape. For example, the end of reducer section **334** could be beveled as shown in **FIG. 16** or any other desired shape. For example, the end of reducer section **334** could be vertical, rather than beveled as shown in **FIG. 16**. Metal pipe such as steel pipe (not shown) having a central bore diameter identical to the diameter of the end of reducer section **334** may then be welded to the end of reducer section **334**.

[**0086**] Flange assembly **330** shown in **FIG. 25** is adapted to receive in central cylindrical bore **332***a* the replaceable metal liner generally indicated by the numeral **136** shown in **FIGS. 16, 18, 20**, and **21**. Preferably, flange liner **136** is slidably received in said central cylindrical bore **332***a* and fits snugly therein. As stated above, flange liner **136** has a central cylindrical bore **136***a* through which fluids flow in the direction indicated by the arrow **137** shown in **FIGS. 16 and 20**. Liner **136** is preferably integrally formed from a single piece of high-strength, corrosion and abrasion resistant steel alloy and meets or exceeds API (American Petroleum Institute) standards for strength and dimensions.

[**0087**] Liner **136** also preferably has a lip section **136***b* at the upstream end thereof shown in **FIGS. 16, 18, 20** and **21** for seating liner **136** in central cylindrical bore **332***a* and recess **332***b* of flange section **332** shown in **FIG. 25**. Recess **332***b* is generally cylindrical in shape to receive lip **136***b* of liner **136**.

[**0088**] Liner **136** has a length sufficient to completely enclose and protect the entire length of central cylindrical bore **332***a* from erosion by fluids and sand particles which may flow therethrough. Liner **136** is made from erosion and abrasion resistant metal alloy. Liner **136** is preferably replaced periodically in bore **332***a* as liner **136** is eroded and/or abraded by the fluids and sand particles flowing therethrough prior to liner **136** being punctured or ruptured due to erosion and/or abrasion. Periodic replacement of liner **136** prior to rupture of liner **136** prevents erosion of central cylindrical bore **332***a* of flange assembly **330**. The resultant prevention of the erosion of central bore **332***a* greatly extends the life of flange assembly **330** and prevents dangerous ruptures and explosions which have occurred in flange and reducer assemblies of the prior art such as the prior art flange and weld neck reducer assemblies shown in FIGS. **1-3**.

[**0089**] Referring now to **FIG. 26**, there is shown a cross-sectional, enlarged, partly cut-away view of a eighth embodiment of the invention generally indicated by the numeral **430** having a raised face similar to the embodiment shown in FIGS. **14-16** and **17-21**. Flange assembly **430** invention can be seen to include a flange section generally indicated by the numeral **432** having a flat, raised face **432***f* and a reducer section generally indicated by the numeral **434**. Flange assembly **430** is preferably integrally formed from a single piece of high-strength, corrosion and abrasion resistant steel alloy and meets or exceeds API (American Petroleum Institute) standards for strength and dimensions.

[**0090**] Flange section **430** has a central cylindrical bore **430***a*. Reducer section **434** has a conical cylindrical bore **434***a* axially aligned with cylindrical bore **430***a* and having any desired end shape. For example, the end of reducer section **434** could be beveled as shown in **FIG. 16** or any other desired shape. For example, the end of reducer section **434** could be vertical, rather than beveled as shown in **FIG. 16**. Metal pipe such as steel pipe (not shown) having a central bore diameter identical to the diameter of the end of reducer section **434** may then be welded to the end of reducer section **434**.

[**0091**] Flange assembly **430** shown in **FIG. 26** is adapted to receive in central cylindrical bore **434***a* the replaceable metal liner generally indicated by the numeral **136** shown in **FIGS. 16, 18, 20**, and **21**. Preferably, flange liner **136** is slidably received in said central cylindrical bore **432***a* and fits snugly therein. As stated above, flange liner **136** has a central cylindrical bore **136***a* through which fluids flow in the direction indicated by the arrow **137** shown in **FIGS. 16 and 20**. Liner **136** is preferably integrally formed from a single piece of high-strength, corrosion and abrasion resistant steel lo alloy and meets or exceeds API (American Petroleum Institute) standards for strength and dimensions.

[**0092**] Liner **136** also preferably has a lip section **136***b* at the upstream end thereof shown in **FIGS. 16, 18, 20** and **21** for seating liner **136** in central cylindrical bore **432***a* and recess **432***b* of flange section **432** shown in **FIG. 26**. Recess **432***b* is generally cylindrical in shape to receive lip **136***b* of liner **136**.

[**0093**] Liner **136** has a length sufficient to completely enclose and protect the entire length of central cylindrical

bore **432***a* from erosion by fluids and sand particles which may flow therethrough. Liner **136** is made from erosion and abrasion resistant metal alloy. Liner **136** is preferably replaced periodically in bore **432***a* as liner **136** is eroded and/or abraded by the fluids and sand particles flowing therethrough prior to liner **136** being punctured or ruptured due to erosion and/or abrasion. Periodic replacement of liner **136** prior to rupture of liner **136** prevents erosion of central cylindrical bore **432***a* of flange assembly **430**. The resultant prevention of the erosion of central bore **432***a* greatly extends the life of flange assembly **430** and prevents dangerous ruptures and explosions which have occurred in flange and reducer assemblies of the prior art such as the prior art flange and weld neck reducer assemblies shown in FIGS. **14-15**.

[**0094**] Referring now to **FIGS. 27, 28, 30**, and **31** the ninth embodiment of a flange and liner of the invention can be seen to include a metal flange assembly generally indicated by the numeral **530** having a flange section generally indicated by the numeral **532** and a reducer section generally indicated by the numeral **134**. Flange assembly **530** is preferably integrally formed from a single piece of high-strength, corrosion and abrasion resistant steel alloy and meets or exceeds API (American Petroleum Institute) standards for strength and dimensions.

[**0095**] Flange section **532** has a central cylindrical bore **532***a*. Reducer section **534** has a central cylindrical bore **534***a* axially aligned with cylindrical bore **532***a* and having a larger diameter than central cylindrical bore **532***a*. Central cylindrical bore **532***a* is joined to central cylindrical bore **534***a* by a tapered or beveled section **534***c*. Metal pipe such as steel pipe (not shown) having a central bore diameter identical to the central cylindrical bore diameter **534***a* of reducer section **534** may then be welded to the end beveled end **534***b* of reducer section **534**.

[**0096**] As shown in **FIGS. 27, 28, 30** and **31**, flange assembly **530** has a replaceable metal liner generally indicated by the numeral **536** which is received in central cylindrical bore **532***a*. Preferably, flange liner **536** is slidably received in said central cylindrical bore **532***a* and fits snugly therein. Flange liner **536** has a central cylindrical bore **536***a* through which fluids flow in the direction indicated by the arrow **537** shown in **FIG. 27**. Liner **536** is preferably integrally formed from a single piece of high-strength, corrosion and abrasion resistant steel alloy and meets or exceeds API (American Petroleum Institute) standards for strength and dimensions.

[**0097**] Liner **536** is slidably received in central cylindrical bore **532***a* of flange assembly **530** as shown in **FIG. 28**. Liner **536** has a lip section **536***b* at the upstream end thereof shown in **FIGS. 27, 28, 30**, and **31** which rests against the raised face **532***f* of flange section **532** when liner **536** is received in central cylindrical bore **532***a*.

[**0098**] A circular gasket **537** having circular opening **537***a* therein is placed around liner **536** and against raised face **532***f* as shown in **FIGS. 28, 30**, and **31**. Any conventional gasket material known in the art may be used to make circular gasket **537**.

[**0099**] Liner **536** has a length sufficient to completely enclose and protect the entire length of central cylindrical bore **532***a* from erosion by fluids and sand particles which may flow therethrough. Liner **536** is made from erosion and abrasion resistant metal alloy. Liner **536** is preferably replaced periodically as liner **536** is eroded and/or abraded by the fluids and sand particles flowing therethrough prior to liner **536** being punctured or ruptured due to erosion and/or abrasion. Periodic replacement of liner **536** prior to rupture of liner **536** prevents erosion of central cylindrical bore **532***a* of flange assembly **530**. The resultant prevention of the erosion of central bore **532***a* greatly extends the life of flange assembly **530** and prevents dangerous ruptures and explosions which have occurred in flange and reducer assemblies of the prior art such as the prior art flange and weld neck reducer assemblies shown in **FIGS. 14 and 15**.

[**0100**] A second flange (not shown) identical to flange **120** shown in **FIG. 14** is bolted to flange section **532** of flange assembly **530** by bolts (not shown) placed in cylindrical bolt holes **532***e* of flange section **532**. Thus, small pipe (not shown), such as pipe two-inch steel line pipe, connected to flange section **532** by a flange identical to flange **120**, can be connected to larger diameter pipe (not shown), such four-inch steel line pipe, by welding the larger pipe to the end **534***b* of reducer section **534**. When the bolts (not shown) connecting flange assembly **530** to the second flange (not shown) identical to flange **120** is tightened with sufficient torque to force the two flanges with gasket **537** therebetween into contact with gasket **537**. Thus, a high pressure seal is formed between flange assembly **530** and the second flange (not shown) identical to flange **120** bolted thereto.

[**0101**] In FIGS. **29** is shown a tenth embodiment of the liner of the invention generally indicated by the numeral **542** for insertion in a choke assembly. Liner **542** is used to connect a conventional choke assembly generally indicated by the numeral **144** in **FIG. 24** to the flange assembly **530** of the present invention. Liner **542** is similar to liner **536** having an additional hollow cylindrical section **542***a* integrally formed therewith for receipt in the discharge flange **144***h* of choke **144**. Hollow cylindrical section **542***a* is preferably slidably received in discharge flange **144***h* and is snugly received therein. Liner **542** has a circular rib **542***c* connected to the intersection of hollow cylindrical section **142***a* and hollow cylindrical section **542***b*. Ring **542***c* rests against the raised face **542***f* flange **532** of flange assembly **530** when liner **542** is placed in flange assembly **530**. Preferably, a thin, flat, circular gasket **143** is placed between flange **144***h* and flange **532**. Such gaskets **143** are known in the art and are usually one-sixteenth to one-eighth inch thick.

[**0102**] Although the preferred embodiments of the invention have been described in detail above, it should be understood that the invention is in no sense limited thereby, and its scope is to be determined by that of the following claims:

What is claimed is:

1. An erosion and abrasion resistant metal pipe flange assembly having a flat, raised face flange section at the upstream end thereof connectable to a conventional metal pipe flange and a beveled downstream end for welding metal pipe thereto, the pipe flange assembly being used in containing and conveying high pressure fluids flowing from a smaller diameter pipe to a larger diameter pipe, said pipe flange assembly comprising:

a. a metal flange section having a flat, raised face and a central cylindrical bore therein extending completely through said flange section and said flat, raised face, said central cylindrical bore having a recess adjacent to the upstream end thereof in said raised face, said metal flange section having a flange integrally formed therewith at one end thereof for connecting said metal flange section to a conventional metal pipe flange, and

b. a metal reducer section integrally formed with said flange section, said metal reducer section having a central cylindrical bore therein which is larger in diameter than said central cylindrical bore of said flange section, said metal reducer section having the outer surface of the end thereof adjacent to said cylindrical bore of said metal reducer section beveled for welding a pipe thereto, said central cylindrical bore of said flange section being joined to said central cylindrical bore of said reducer section by a beveled section, and

c. a replaceable hollow metal cylindrical liner for preventing erosion and abrasion of the interior of said pipe flange assembly, said liner having two ends and a lip section at one end thereof adapted for seating in said recess, said lip section extending completely around said one end of said liner, said liner being slidably received in said central cylindrical bore of said flange section and slidably removable from said central bore of said flange section when said liner becomes eroded and abraded.

2. The pipe flange assembly of claim 1 wherein said reducer section has a central, cylindrical bore therein which communicates with said central cylindrical bore of said flange section.

3. The pipe flange assembly of claim 1 wherein said central cylindrical bore of said reducer section is axially aligned with said central cylindrical bore of said flange section.

4. An erosion and abrasion resistant metal pipe flange assembly having a flange at the upstream end thereof connectable to a conventional metal pipe flange and a downstream end for welding metal pipe thereto, the pipe flange assembly being used in containing and conveying high pressure fluids flowing from a smaller diameter pipe to a larger diameter pipe, said pipe flange assembly comprising:

a. a metal flange section having a central cylindrical bore therein extending completely through said flange section, said flange section having a first circular groove therein for receipt of a hollow, cylindrical sealing ring, said central cylindrical bore having a second groove adjacent to the upstream end thereof, said metal flange section having a flange integrally formed therewith at one end thereof for connecting said metal flange section to a conventional metal pipe flange, and

b. a metal reducer section integrally formed with said flange section, said metal reducer section having a central cylindrical bore therein which is larger in diameter than said central cylindrical bore of said flange section, said central cylindrical bore of said flange section being joined to said central cylindrical bore of said reducer section by a beveled section, and

c. a replaceable hollow metal cylindrical liner for preventing erosion and abrasion of the interior of said pipe flange assembly, said liner having two ends and a lip section at one end thereof adapted for seating in said second groove contained in said flange section, said lip section extending completely around said one end of said liner, said liner being slidably received in said central cylindrical bore of said flange section and slidably removable from said central bore of said flange section when said liner becomes eroded and abraded.

5. The pipe flange assembly of claim 4 wherein said reducer section has a central, cylindrical bore therein which communicates with said central cylindrical bore of said flange section.

6. The pipe flange assembly of claim 4 wherein said central cylindrical bore of said reducer section is axially aligned with said central cylindrical bore of said flange section.

7. An erosion and abrasion resistant metal pipe flange assembly having a flat, raised face flange section at the upstream end thereof connectable to a conventional metal pipe flange and a downstream end for welding metal pipe thereto, the pipe flange assembly being used in containing and conveying high pressure fluids flowing from a smaller diameter pipe to a larger diameter pipe, said pipe flange assembly comprising:

a. a metal flange section having a flat, raised face and a central cylindrical bore therein extending completely through said flange section and said flat, raised face, said central cylindrical bore having a recess adjacent to the upstream end thereof in said raised face, said metal flange section having a flange integrally formed therewith at one end thereof for connecting said metal flange section to a conventional metal pipe flange, and

b. a metal reducer section integrally formed with said flange section, said metal reducer section having a central cylindrical bore therein which is larger in diameter than said central cylindrical bore of said flange section, said central cylindrical bore of said flange section being joined to said central cylindrical bore of said reducer section by a beveled section, and

c. a replaceable hollow metal cylindrical liner for preventing erosion and abrasion of the interior of said pipe flange assembly, said liner having two ends and a lip section at one end thereof adapted for seating in said recess, said lip section extending completely around said one end of said liner, said liner being slidably received in said central cylindrical bore of said flange section and slidably removable from said central bore of said flange section when said liner becomes eroded and abraded.

8. The pipe flange assembly of claim 7 wherein said reducer section has a central, cylindrical bore therein which communicates with said central cylindrical bore of said flange section.

9. The pipe flange assembly of claim 7 wherein said central cylindrical bore of said reducer section is axially aligned with said central cylindrical bore of said flange section.

10. An erosion and abrasion resistant metal pipe flange assembly having a flat, raised face flange section at the upstream end thereof connectable to a conventional metal pipe flange and a beveled downstream end for welding metal pipe thereto, the pipe flange assembly being used in con-

taining and conveying high pressure fluids flowing from a smaller diameter pipe to a larger diameter pipe, said pipe flange assembly comprising:

a. a metal flange section having a flat, raised face and a central cylindrical bore therein extending completely through said flange section and said flat, raised face, said central cylindrical bore having a recess adjacent to the upstream end thereof in said raised face, said metal flange section having a flange integrally formed therewith at one end thereof for connecting said metal flange section to a conventional metal pipe flange, and

b. a replaceable hollow metal cylindrical liner for preventing erosion and abrasion of the interior of said pipe flange assembly, said liner having two ends and a lip section at one end thereof adapted for seating in said recess, said lip section extending completely around said one end of said liner, said liner being slidably received in said central cylindrical bore of said flange section and slidably removable from said central bore of said flange section when said liner becomes eroded and abraded.

11. The pipe flange assembly of claim 10 wherein said reducer section has a central, cylindrical bore therein which communicates with said central cylindrical bore of said flange section.

12. The pipe flange assembly of claim 10 wherein said central cylindrical bore of said reducer section is axially aligned with said central cylindrical bore of said flange section.

13. An erosion and abrasion resistant metal pipe flange assembly having a flat, raised face flange section at the upstream end thereof connectable to a conventional metal pipe flange and a downstream end for welding metal pipe thereto, the pipe flange assembly being used in containing and conveying high pressure fluids flowing from a smaller diameter pipe to a larger diameter pipe, said pipe flange assembly comprising:

a. a metal flange section having a flat, raised face and a central cylindrical bore therein extending completely through said flange section and said flat, raised face, said metal flange section having a flange integrally formed therewith at one end thereof for connecting said metal flange section to a conventional metal pipe flange, and

b. a metal reducer section integrally formed with said flange section, said metal reducer section having a central cylindrical bore therein which is larger in diameter than said central cylindrical bore of said flange section, said central cylindrical bore of said flange section being joined to said central cylindrical bore of said reducer section by a beveled section, and

c. a replaceable hollow metal cylindrical liner for preventing erosion and abrasion of the interior of said pipe flange assembly, said liner having two ends and a lip section at one end thereof adapted for seating against said flat, raised face, said lip section extending completely around said one end of said liner, said liner being slidably received in said central cylindrical bore of said flange section and slidably removable from said central bore of said flange section when said liner becomes eroded and abraded.

14. The pipe flange assembly of claim 13 wherein said reducer section has a central, cylindrical bore therein which communicates with said central cylindrical bore of said flange section.

15. The pipe flange assembly of claim 13 wherein said central cylindrical bore of said reducer section is axially aligned with said central cylindrical bore of said flange section.

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