

## TEST PLUG FOR PIPES

This invention relates to a test plug for pipes.

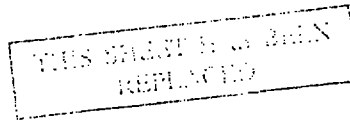
BACKGROUND TO THE INVENTION

5           In the fabrication of fluid flow systems, whether they be for the purposes of conveying liquid such as petro-chemicals, or gases such as natural gas, or even fluidized cereals as is common in the cereal processing industry, the use of conduits or pipes is  
10       common and replete. From a fabrication point of view, pipes can only be manufactured to a finite length and therefore, various lengths or elbows must be connected together in order to structure the conduit fluid conveyance means. This is accomplished by welding  
15       butt ends of pipes together or to elbows etc., or alternatively, to weld the end of a pipe to a butt flange and to juxtapose two butt flanges together by means commonly known, for example, use of bolts through each juxtaposed annular portions of each butt  
20       flange. Generally, such flanges co-operatively employ gaskets as sealing elements.

          It is increasingly desired to have these welds tested for the purposes of determining whether there is any leakage. Particularly, in the petro-chemical  
25       industry, it is now being mandated that the amount of fluid evaporating or escaping from any weld or flange/flange interface be reduced to allowable limits which, up to now, have been about 2 liters per annum to less than a  $\frac{1}{2}$  of a liter per annum per  
30       flange/flange or weld interface. When one considers that in petro-chemical plants there are thousands of such welds or butt flanges, the task of testing each of them becomes onerous and costly.

THE INVENTION

35           We have conceived a simplified test plug which



is used to test pipes, with an internal diameter of approximately  $\frac{1}{4}$  inch (1.75cm) and with modification to as great as what is desired, say even 6 to 10 feet (300cm), or more.

5           It is an object of the invention to provide a simplified test plug which can be hand carried by one or two workers, assembled within the diameter of a pipe to be tested, temporarily sealed therein so as to allow a testing step to take place which tests the  
10           integrity between an annular pipe segment and the test plug, the annular pipe segment generally including a welding interface or a flange interface, or other surface, in order to determine if this region leaks at all, and if it does, to what extent.

15           The invention therefore contemplates a test plug assembly for testing the internal integrity of a segment of pipe having an internal diameter, the assembly comprising           (a) an annular body with opposite annular faces and defining on its outer  
20           perimeter, a peripheral recess, (b) a pair of bosses (c) a pair of resilient annular members adapted to be respectively juxtaposed between a boss and an annular faces, (d) means for urging the bosses respectively against an adjacent resilient annular member so as to  
25           cause the same to frictionally engage and to seal against a boss, and its adjacent annular face, and the internal diameter of the pipe segment, and, (e) means communicating through the assembly to that plenum now defined by said recess, the annular members, and the  
30           internal diameter of the pipe, whereby the integrity of the pipe segment may be determined. Particularly, the urging means (d) is a shaft which extends between said bosses, preferably with one of the bosses being integral to the shaft, the opposite end of the shaft  
35           being threaded so as to provide means for urging the resilient annular members, respectively between an adjacent annular face and boss in order to seal the

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diameter of the pipe, there to define the plenum. In one embodiment, the communicating means (e) communicates through the shaft from its threaded end and provides communication means to the recess in the annular body, which preferably is a peripheral annular recess or race.

In another embodiment, there may be a pair of communicating means to the peripheral annular recess defined by the annulus and the urging means being a plurality of axially oriented circumferentially disposed bolts, in which case each boss may be an annulus. In order to further reduce weight, the annulus may be aluminum wherein the outer annular recess is milled from cylindrical aluminum stock; and the bosses, fabricated either from steel or aluminum solid rod or square stock and appropriately milled.

In above noted embodiments, the hydrostatic testing media is a fluid-like liquid, preferably water, which is inserted into the plug after its sealing engagement within and communicating with the inner diameter of that selected pipe space which now defines the testing plenum is itself defined by the plug and the internal pipe space diameter. Into the testing plenum, the testing media is flowed, via conduits through the plug; then, pressurized to test the integrity of that portion of the pipe that is in juxtaposed communication with the hydrostatically filled testing plenum.

In a variation of the aforesaid embodiments, the "test plug" is also an isolating-monitoring plug; namely, one that isolates pipe space from a region or interface while allowing monitoring of that pipe space on the obverse side to the test-isolation monitoring plug from that pipe interface that is to be either tested, or to which a weld is to take place, for instance, the creation of a pipe-weld-pipe interface or a pipe-weld-flange interface or any other similar

interface that is to be tested.

In its broadest application, the invention contemplates a method of testing the internal integrity of a pipe segment having an internal wall defining an internal bore having an internal bore diameter comprising the steps of (a), selecting a resilient annular member having an outer diameter less than the internal bore diameter, two bosses, each with an outer diameter less than the internal bore diameter, at least one being a disk (b), positioning, within the internal bore, the bosses on opposite sides of the resilient annular member (c), moving the bosses, relatively closer to each other to compress the resilient member therebetween into sealing engagement with the internal wall of the pipe and (d), conveying a fluid into the internal bore and against a boss to test the internal integrity of that pipe segment, juxtaposed therewith. Particularly, and in the preferred embodiment, the method of testing comprises the steps of (a), selecting an annular body with an inner annular diameter and outer annular diameter that is less than the internal bore diameter, the body having an outer peripheral race of diameter less than the outer annular diameter, two resilient annular members, each respectively having an outer diameter greater than the outer annular diameter and an inner diameter less than the outer annular diameter, two bosses, each with an outer diameter less than the internal bore diameter (b), positioning, at opposite ends of the annular body, one of the resilient annular members, then a boss (c), moving the bosses, relatively closer to each other to compress the resilient member adjacent thereto into sealing engagement among the annular member and the internal wall to thereby define an annular space among the outer peripheral race, its adjacent communicating internal wall of the pipe segment, and the annular

resilient members and (d), conveying a fluid through the annular space thereby to test the internal integrity of the pipe segment communicating therewith. Either one or two annular bosses may be selected, if one, the opposite boss is a disk boss with front and obverse faces and, when the diameter is quite large, the disk boss may be supported on its obverse face.

#### DESCRIPTION OF THE DRAWINGS

The invention will now be described by way of example and with reference to the accompanying drawings:

Figure 1 is an assembly perspective view of a test plug, according to the invention, particularly suited for pipe diameters up to 3.5" (8.9cm), approximately;

Figure 2 is a sectional view in preliminary application of the plug of Figure 1 into a butt flange pipe weld interface, the integrity of which is to be tested.

Figure 2A is the same as Figure 2 showing the fitting of the plug in sealed position;

Figure 2B is an orthogonal cross-section to that of Figure 2 and 2A further showing testing;

Figure 3 is a cross section along lines III-III of Figure 2;

Figure 4 is a partially axially cross-sectional view of an alternative embodiment of pipe plug with venting, particularly suitable for larger diameter pipes of up to about 8" (125cm);

Figure 5 is a partial section illustrative of the testing sequence for testing the integrity of the pipe flange welded interface;

Figure 6 is an end plan view of yet a third embodiment of test plug, allowing a central cavity through the plug and particularly adapted to

test pipes of internal diameters of 8" or more;

Figure 7 is an axial section along lines VII-VII of Figure 6; and,

Figure 8 is a diametrical cross-section of another embodiment of test plug, wherein one annular boss substantially occupies the total internal diameter of the plug, and hence is a disk, while providing an aperture therethrough communicating to a channel therewith for pressure or content monitoring of internal pipe space, the opposite boss being an annulus.

Figure 8A is a section of the flange-weld-pipe interface of Figure 8 but illustrating an annealing step to anneal the weld, the test plug shown in phantom.

Figure 9 is a diametrical cross-section, along lines IX-IX of Figure 10, of yet a further embodiment of the test plug of Figure 8 wherein the disk boss has no aperture and is supported by a brace structure that is particularly suitable for large internal diameter pipes, say 54" (135cm) or more of internal diameter.

Figure 10 is an end plan view, installed, of the test plug of Figure 9.

Referring to Figures 1 and 2, one embodiment of test plug is generally shown as (10) and is suitable for testing the integrity of a welded discontinuity (30) like a flange (31)-weld (30)-pipe (32) interface. The flange (31) generally is a standard butt flange, as will be apparent hereafter, while the pipe or conduit (32) is generally of a diameter up to approximately 18" (82.3cm). The welded discontinuity (30), is a weld which holds the flange (31) to the end of the pipe (32) so that a corresponding flange of a next pipe run may be bolted thereto each butt annular surface (33) of each flange (31) juxtaposed. Initially, it is the weld interface (30) whose

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integrity is to be determined; whether or not there are unseen fissures or apertures which may allow leakage of a fluid which will pass through the conduit (22) when in application as in the petro-chemical environment or otherwise. A bolted flange-flange interface could similarly be tested, as could any other pipe discontinuity.

In the first embodiment, the plug (10) includes a cylindrical shaft (11) that at one end has a threaded shank (12) and at the other end, an integral boss, plug or disk (13) so as to form an integral shaft component (14); the disk (13) has an inner bevelled or truncated cone-like peripheral surface (13'), as shown. The shaft (11) defines an internal bore (15) communicating with a flaring outer or distal end (16) that acts as an attachment means to communicate the bore to a water pressure source that, during testing, acts as a pressure media as will be explained. The bore (15) extends approximately mid-way into and along the longitudinal axis of the shaft (11), as more clearly seen in phantom in Figure 2 and in the cross section Figure 2B, and communicates with diametrically oriented channels (17), which communicate to the outside diameter surface of the shaft (11) - see Figure 2B.

The shaft (11) is adapted to pass through an annular piece, sometimes referred to as the annulus, generally referenced as (20) having an internal bore (21) sized larger than the external diameter of the shaft (11) and having at least a radial, shown in figures 1 and 2 as two radially oppositely disposed channels (22) that communicate between a stepped annular recess exteriorly circumscribing the center portion of the annulus (20) with the inner bore (21). The opposite ends of the annulus (20) are integral radially protruding disks (24) and (25), with their respective outer truncated annular surfaces (24') and

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(25') being bevelled inwardly from center to perimeter.

5 In order to complete the other rigid components of the plug (10), there is an annulus (26) whose inner bore is larger than the outer diameter of the threaded shaft (12) so as to accommodate its passing therethrough with space, the annulus having an interface (26') as a reversibly bevelled annular conical surface, and its outerface, preferably  
10 orthogonal to the longitudinal axis of the bore, yet having a stepped bore of slightly larger diameter at the interface between this space and the inner bore of the annulus so define a channelled race (26<sub>r</sub>) which accommodates a smaller elastomeric ring (R<sub>3</sub>), as will  
15 be explained. The obverse surface (26') is a reversibly bevelled annular conical surface, which might also be "truncated", as are clearly seen in Figures 2, 2A and 2B.

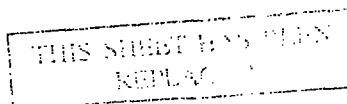
20 A second boss in the form of an annular collar (27) has its inner bore sized to accommodate the threaded shaft, to mate with a threaded nut (28) which is adapted to thread onto the shaft and to compress all the components referenced in the (20) into one integral unit. In order to provide annular sealing  
25 between juxtaposed bevelled surfaces (13') and (24'), there is an elastomeric annular ring (R<sub>1</sub>); similarly, there is an elastomeric annular ring (R<sub>2</sub>) juxtaposed between truncated conical annular surfaces (25') and (26'), the elastomeric annular seal (R<sub>3</sub>) which nests  
30 into the annular race (26<sub>r</sub>). The inner diameter of the annular race is sized to frictionally engage the outer diameter of the shaft (11) so as to a sealing fit as will be explained.

35 In order to insert the assembled plug (10) into the pipe interface so as to test the integrity of the internal diameter of the interface (30), and now referencing Figure 2, the assembled plug in its

relaxed mode is placed into the pipe flange with the interface (30) occupying or communicating with the area defined by the annular recess (23). The nut (28) is turned down, as shown by the arrow in Figure 2A, and the respective annular bevels (13') and (24') forced into closer proximity; and similarly, with juxtaposed bevels (25') and (26'), respectively forcing the respective annular rings ( $R_1$ ) and ( $R_2$ ) outward in the direction of their respective arrows ( $R_a$ ). At the same time, fluid in the direction of the arrow (F), floods the bore (15), the oppositely disposed radial channels (17) communicating water flow into the foreshaft regions referenced (40) in Figure 2B, out the radial channel (22) of the annulus (20) so as to flood the annular space (S) defined by the plug (10) in the internal diameter of the pipe flange interface. Some of the fluid would escape, flowing in the direction of arrows (60) during initial purging of any air within the space or plenum (S) while the nut (28) is turned down in the direction of the arrow (50) eventually sealing with the space (S). The annular ring ( $R_1$ ) isolates the annular space (S) between the internal bore (21) and the outside shaft diameter (11) so as to create a watertight environment.

Additional water pressure is applied so as to increase the pressure of water within space (S). The pressure of water within space (S) can be measured by a hydrostatic device, not shown, while observing the outside of the weld interface (30) to see whether any leakage occurs.

In the embodiment of Figures 4 and 5, which is particularly suitable for internal pipe diameters up to approximately 125cm because test plugs with larger diameter than about 9cm, Figures 1 through 3, become too heavy for workmen to carry thus, the same consists of a shaft (41) having an external end boss or disk (42) at one end and a threaded portion (43) at the



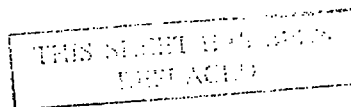
opposite end, the shaft and disk defining a central bore (44). The disk (42) is welded at (45) to an annular end disk plate (46) whose inner margin (46') is a bevelled annulus to accommodate "O" ring (R<sub>1</sub>).  
5 There is an opposite annular end disk (47) with a similar inner annular bevel (47') to accommodate annular ring (R<sub>2</sub>) but the disk (47) also has an aperture therethrough (48) which allows passage of a hydrostatic flooding and testing circuit, generally  
10 shown as (50) to extend therethrough. The plug (40) includes an annular piece (60) defining an inner bore (61) which accommodates the shaft (41) and an outside circumferential race (62), the bottom of which communicates with a hydrostatic filling channel (63)  
15 communicating to the testing circuit (50) in the fashion shown. As such, the circuit (50) has a threaded hose (51) whose distal end threads into and sealingly mates with a corresponding thread (T) defined by the outer extremity of the bore (63) to  
20 make a fluid channel passing through the disk (47) and communicating with the race (62). The bore (44) acts as a venting channel to allow venting of the internal pipe (32) when the plug (40) is being inserted into the flanged pipe bounded by the peripheral weld (30) which is put in place to sealingly attach one to the  
25 other - see Figure 5. It may also be an advantage to conduct a second testing circuit which is referenced (65) to test everything that is to the right of the plug (40), as shown in that figure. Thus, the same  
30 bore (44) acts as the venting of the space to the right of the plug (40) as during insertion and removal into the pipe (33) or alternatively, to accommodate a second circuit for testing the pipe from plug (40) onwards to the left thereof, if this be required, by  
35 utilizing testing circuit (65).

If the space (S) which is bounded by the plug (40) and the internal pipe (33) flange (31) and

circumferential weld (30) is to be tested, then preferably threaded hose (51) is positioned so as to be vertical over the bore (44) and the testing circuit (50) consist of a hydrostatic pressure gauge (P) communicating thereto and, to a venting valve (V), with turn-off and turn-on switches, and a hydraulic fluid control valve (H) with its corresponding turn-on and turn-off ( $H_1$ ). Water is periodically allowed to flow through valve (H) into space (S) by opening ( $H_1$ ) and closing ( $V_1$ ) and venting of the air within the space (S) is achieved by reversing valve positions ( $H_1$ ) and ( $V_1$ ) so air vents out of valve (V) in accordance with the arrow thereabove. This cycling occurs until the space (S) is filled with water and then pressuring of the water takes place so that the pressure gauge (P) registers the hydrostatic pressure on the circumferential weld seam (30) to test the integrity of the same.

Referring Figures 6 and 7 and to the third embodiment of the invention, the same consists of an annular plug (80) consisting of mirror end annular bosses or plates (81) and an annulus (82) with an outer circumferential race (83). The juxtaposed faces of the annular plates (81) and the annulus (82) are respectively bevelled at ( $81'$ ) and ( $82'$ ), as shown, so as to accommodate the seating of "O" rings ( $R_1$ ) and ( $R_2$ ) therebetween. Each of the annular disks (81) have a plurality of apertures (83) therethrough circumferentially disposed so as to permit the passage therethrough of a nut-bolt arrangement, generally shown as (85) consisting of a bolt head (86) which is welded at (87) to the exterior face of each annular disk (81), the opposite end of the bolts (85) having a threaded shaft portion (86) accommodating a nut (87) which can be turned down onto an underlying washer (88). The annulus (82) may have appropriate diameters, as may the disks (81) to accommodate





internal pipe diameters over 8", as may be required.

The annulus (82) defines a filling and pressure channel (90) which communicates through the annulus (82) to the outside annular race (83), and  
5 diametrically opposite thereto a venting channel (91'). The plug (80) can be inserted into large diameter pipes exceeding 8", the bolts (87) tied down so as to force "O" rings ( $R_1$ ) and ( $R_2$ ) against the inner diameter of the pipe-flange interface to be  
10 tested. Liquid media is channelled into the space (S) defined by the race (83) and the inner wall of the pipe flange interface while venting of any air exits the diametrically disposed venting channel (90"). Testing of the interface in a similar fashion occurs.

15 Because of the great weight of the annular plug (80), particularly when made of steel, or steel alloys such as stainless steel, each annular plate (81) has four adjusting heads (95) diametrically paired and consisting of a protruding butt (96) having a threaded  
20 bore (97) accommodating a threaded bolt (98) which extends therethrough and whose distal end is adapted to turn against the internal diameter of the pipe (32), to locate the plug (80) co-axial with the pipe (32). Locking nuts may then be turned down to lock  
25 each bolt (98), as shown in phantom in Figure 7, against the internal diameter of the pipe (32) that is being tested. Thereafter, flange nuts (87) are turned down to apply the pressure on the "O" rings ( $R_1$ ) and ( $R_2$ ) sealing them against the inner walls of the  
30 pipe flange interface so that the annular space (S) is a sealed plenum. Hydrostatic filling of the space (S) occurs as above noted, and pressure venting in the fashion, as earlier described, can take place. It is convenient to make the annulus (20), (60), (82) from  
35 aluminum in order to reduce its weight, and in certain applications even the bosses (13), (26), (46), (47), (81) may be made from appropriate aluminum stock but





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in some applications, particularly in the cereal industry, the whole plug will have to be made from stainless steel in order to meet health standards.

Referring now to yet a further embodiment and to  
5 Figures 8 and 8A, a test plug (190) also acts as an isolation and pipe space monitoring plug, and has an annular boss flange (81) and an opposite (annular) flange (181) in the form of a disk defining a central axial aperture (182) therethrough which communicates  
10 to a monitoring conduit reference (65') and into the internal pipe space diameter, referenced (PS), of the pipe (32) to the left of the disk (181) which can be perceived to be a long continuous pipe space of a fluid conveying conduit in an existing installation to  
15 which it is now desired that these be affixed onto the end of the pipe (32), a flange shown in phantom as (31). Thus, particularly in instances where the pipe space (PS) is part of a conduit, in a petro-chemical plant, it must first be drained of contents;  
20 nevertheless, these are residual airborne hydrocarbons in the pipe space (PS) and also embedded into the inner surface walls of the pipe space (PS). When welding to such existing pipe space (PS), present safety standards require that the pipe space (SP)  
25 walls first be cleaned; this is expensive. With the isolation test plug configuration (190), this is not necessary.

The test plug (190) has the two O rings (R1) and R2) which are urged respectively against boss (81) and  
30 annulus (82) on the one hand, and disk (181) and the opposite end of annulus (82) to urge the O rings (R1,R2) against the inner walls of the pipe that is now defined as the plenum space (S). Cooling water may be inserted into the pipe space (S) by flowing water  
35 through conduit (90) into the plenum space (S) to outflow from conduit (91). When cold water is used, the temperature of the pipe to the left of the plug

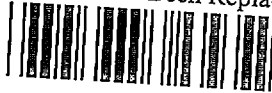


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(190) maintains the pipe at a non-flammable temperature for the hydrocarbons that may reside in the pipe space (PS). Either a gas monitor, not shown, or other temperature sensitive device may be pushed  
5 into from right to left, the testing circuit conduit (65') through the conduit (182) into the pipe space (PS) for monitoring while welding of the weld (30) takes place.

After welding another plug (290), similar to  
10 that of (190) is positioned, as shown in phantom, on the inside surface of the pipe (32) and the integrity of the weld (30) tested by applying appropriate fluid pressures to the space, referenced (S290), defined by the O rings (R1) and (R2), the annulus (82), and the  
15 internal diameter of the interface of the pipe (32), weld (30) and flange (31). Throughout this testing the other isolation test plug (190) can be left in position. Once the integrity of the weld (30) has been assured, in some instances, it is also necessary  
20 to stress-relieve the weld (30). This is accomplished by applying an annular stress-relieving heater, referenced (500) over the weld (30); the heater has an overcovering insulation (505). The pipe-weld-flange interface (30,31,32) is brought up to the annealing  
25 temperature while water is still flowed into channel (90) and out channel (91) for plug (190), keeping cool that pipe juxtaposed to the water-filled plenum (S) and maintaining a cool temperature of the pipe to the left thereof and particularly, to the pipe space (PS).  
30 It has been found that the width of the plug between bosses (81) or between boss (81) and the disk boss (181) is preferably about 6" and the position of the plug (190) from the weld (30) should be at least, for safety purposes, about 2'. In petro-chemical  
35 applications, the distal end of the conduit (65') which actually allows venting and monitoring of the pipe space (PS) is open ended and should be at least



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35' or more away from the physical location of the plug (190). The cooling waterflow through the circuit (90), (S), (91') should be at a positive pressure of around 100 PSIG.

5           The operational sequence placing a flange, phantom flange (31), in Figures 8 and 8A, would be as follows. Drain the pipe (32) and pipe space (PS) of all hydrocarbon liquids and then place the plug (190) into place in a fashion, as earlier described and then  
10           inflow water into the annular space (S) by flowing water into conduit (90) and out of conduit (91). The monitoring pipe or tube (65') extends at least 35' away from site of the flange (190) and monitors, the temperature and volatiles within the pipe space (PS),  
15           (the monitoring devices not being shown).

          The flange 31 is then welded by weld (30) to the end of the pipe (32) after the pipe end has been appropriately dressed. Leaving the plug (190) in place, a second plug (290), similarly configured, is  
20           positioned on the inside surface of the weld to define a testing plenum (S290) which is flooded with water in a similar fashion to that of plug (190) thereupon the integrity of the flange-weld-pipe interface is determined. Thereafter, the second test plug (290)  
25           is removed and the weld (30) stress-relieved, as follows. Now referring to Figure 8, the test plug (190) is still left in place and the water continues to flow into and out of the space (S) via the respective pipes (90) and (90'). An annular heater  
30           (500) is placed on the outside circumference of the weld (30) and an overcovering annular insulating sleeve (505) is placed thereover and the weld (30) brought up to its annealing temperature in order to stress-relieve the pipe-weld-flange interface. After  
35           the annealing step, the annular heater (500) and insulating annulus (505) are removed; the weld allowed to become cool and then at a time convenient, the plug

(190) can be dis-assembled.

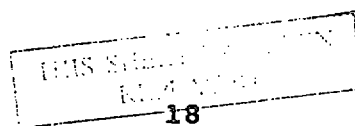
Referring now to Figures 9 and 10, and yet a further embodiment of test plug, the same is generally indicated as (190'), all other reference numbers being the same as those of the embodiments of Figure 8 and Figure 8A. The disk boss (181) is replaced with a solid disk boss (181') and when the diameter of the internal pipe space is greater than say, approximately 54" (greater than about 137cm), great pressure against the disk boss (181') will cause it to bulge. Thus, there is required the use of a support disk (300) and a support base structure (301) featuring two orthogonally oriented, radially disposed cross bars (302) and (304), the distal ends of which are welded at (310) to the internal diameter of the pipe (32) and defined by an annular extended pipe segment (320) which, after use, can be cut off as will be described. Alternatively, not shown, the cross arms can be welded to the pipe distal end. Each cross arm (302) and (304) has axially oriented support elements (307), which extend to and are secured to support disk (300), preferably as shown in Figures 9 and 10 as being integral. The support structure (301) provides support by its abutting disk (300) being flush with the obverse side of the disk boss (181') preventing bulging of the disk boss (181'). The test plug (190') is assembled and mounted into the internal space (PS) of the pipe (32), as shown, and water is flowed into the annular space (S) through communicating channels, not referenced but now to be understood as being similar to channels (90) and (90'), shown in Figure 8.

If the pipe (32) is extremely long, say 100 metres or more, the whole pipe (32) to the left of the test plug (190'), pipe space (PS), can be tested by causing a high pressure, referenced (HF) (high force) to be exerted in the direction of the two arrows onto the boss (181') face; bowing of the disk (181') is

inhibited by the disk (300) and the support structure (301). After the pipe space (PS) integrity has been "tested", the support structure (301) can be cut away from the pipe (32) as by an acetylene torch or the like; the support structure (301) is removed; then, the test plug (190') can be dis-assembled in a manner as earlier described or if required, the pipe end that has been severed can be now dressed, flanged as by welding, as herein before described, that new the pipe-weld-flange interface now tested by re-locating test plug (190') in juxtaposition with the interface in the fashion as earlier described.

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## WE CLAIM:

1. A test plug assembly for testing the internal integrity of a segment of pipe having an internal diameter, the assembly comprising:
  - (a) an annular body with opposite annular faces and defining on its outer perimeter, a recess;
  - (b) a pair of bosses;
  - (c) a pair of resilient annular peripheral members adapted to be respectively juxtaposed between a boss and an adjacent annular face;
  - (d) means for urging the bosses respectively against the adjacent resilient annular member so as to cause them to frictionally engage and to relatively seal the resilient member with the internal diameter of the pipe segment and the adjacent annular face; and,
  - (e) means communicating through the assembly to that plenum now defined by said recess, the sealed annular members and the internal diameter of that pipe segment juxtaposed therewith whereby the integrity of that pipe segment may be determined.
2. The test plug assembly as claimed in claim 1, wherein the urging means (d) is a shaft which extends between said bosses.
3. The test plug assembly as claimed in claim 2, wherein one boss is integral to said shaft;
4. The test plug assembly as claimed in claim 3, wherein the end opposite to the integral boss defines an aperture which extends as a bore into the said shaft and communicates to a channel which extends to communicate with the outside diameter of the shaft.



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5. The test plug assembly as claimed in claim 4, wherein the end opposite the integral boss is threaded.

6. The test plug assembly as claimed in claim 1, wherein at least one boss is annular.

7. The test plug assembly as claimed in claim 2, wherein at least one boss is annular.

8. The test plug assembly as claimed in claim 3, wherein at least one boss is annular.

9. The test plug assembly as claimed in claim 4, wherein at least one boss is annular.

10. The test plug assembly as claimed in claim 5, wherein at least one boss is annular.

11. The test plug assembly as claimed in claim 1, wherein both bosses are annular.

12. The test plug assembly as claimed in claim 2, wherein both bosses are annular.

13. The test plug assembly as claimed in claim 3, wherein both bosses are annular.

14. The test plug assembly as claimed in claim 4, wherein both bosses are annular.

15. The test plug assembly as claimed in claim 5, wherein both bosses are annular.

16. The test plug assembly as claimed in claim 1, wherein the means communicating through the assembly to the plenum includes two channels, one for venting of the plenum, the other for filling with a

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hydrostatic testing media.

17. The test plug assembly as claimed in claim 2, wherein the means communicating through the assembly to the plenum includes two channels, one for venting of the plenum, the other for filling with a hydrostatic testing media.

18. The test plug assembly as claimed in claim 3, wherein the means communicating through the assembly to the plenum includes two channels, one for venting of the plenum, the other for filling with a hydrostatic testing media.

19. The test plug assembly as claimed in claim 4, wherein the means communicating through the assembly to the plenum includes two channels, one for venting of the plenum, the other for filling with a hydrostatic testing media.

20. The test plug assembly as claimed in claim 5, wherein the means communicating through the assembly to the plenum includes two channels, one for venting of the plenum, the other for filling with a hydrostatic testing media.

21. The test plug assembly as claimed in claim 2, wherein:

- (1) the bosses are annuli including;
- (2) means for axially urging the annuli relative to each other.

22. The test plug assembly as claimed in claim 21, wherein:

- (3) each annular boss extends radially inward to its own boss inner diameter which is less than the internal diameter of the plug annular body.

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23. The test plug assembly as claimed in claim 22, wherein the annular boss defines axially oriented apertures radially disposed at a radius less than the internal diameter of the annular body and wherein means (d) are nut and bolt pairs wherein the bolt extends axially through corresponding apertures of each annular boss and the nut urges the bosses relatively toward each other.

24. The test plug assembly as claimed in claim 1, wherein one boss is a disk with a front face and an obverse face.

25. The test plug assembly as claimed in claim 23, including a disk boss support structure fixedly secured to the pipe and juxtaposed against the obverse face of the disk boss so as to prevent bulging of the disk boss when significantly high pressures are imposed upon the face of the disk boss.

26. A method of testing the internal integrity of a pipe segment having an internal wall defining an internal bore having an internal bore diameter comprising the steps of:

(a) selecting,

(i) a resilient annular member having an outer diameter less than the internal bore diameter;

(ii) two bosses, each with an outer diameter less than the internal bore diameter, at least one being a disk;

(b) positioning, within the internal bore, the bosses on opposite sides of the resilient annular member;

(c) moving, the bosses, relatively closer to each other to compress the resilient member therebetween into sealing engagement with the internal



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wall of the pipe; and,

(d) conveying a fluid into the internal bore and against a boss to test the internal integrity of that pipe segment, juxtaposed therewith.

27. A method of testing the internal integrity of a pipe segment having an internal wall defining an internal bore having an internal bore diameter comprising the steps of:

(a) selecting,

(i) an annular body with an inner annular diameter and outer annular diameter that is less than the internal bore diameter, the body having an outer peripheral race of diameter less than the outer annular diameter;

(ii) two resilient annular members, each respectively having an outer diameter greater than the outer annular diameter and an inner diameter less than the outer annular diameter;

(iii) two bosses, each with an outer diameter less than the internal bore diameter;

(b) positioning, at opposite ends of the annular body, one of the resilient annular members, then a boss;

(c) moving, the bosses, relatively closer to each other to compress the resilient member adjacent thereto into sealing engagement among the annular member and the internal wall to thereby define an annular space among the outer peripheral race, its adjacent communicating internal wall of the pipe segment, and the annular resilient members; and,

(d) conveying a fluid through the annular space thereby to test the internal integrity of the pipe segment communicating therewith.

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28. The method as claimed in claim 27, wherein the selecting the boss step (a), (iii), selects two annular bosses each with an inner diameter less than the inner annular diameter of the annular body.

29. The method as claimed in claim 27, wherein the selecting the boss step (a), (iii), selects a disk boss with front and obverse faces and an annular boss with an inner diameter less than the inner annular diameter of the annular body.

30. The method as claimed in claim 29, including the step of supporting the disk boss on its obverse face to prevent bowing of the boss when that pipe space juxtaposed with the face of the boss is communicating with the internal diameter of the pipe space being tested.

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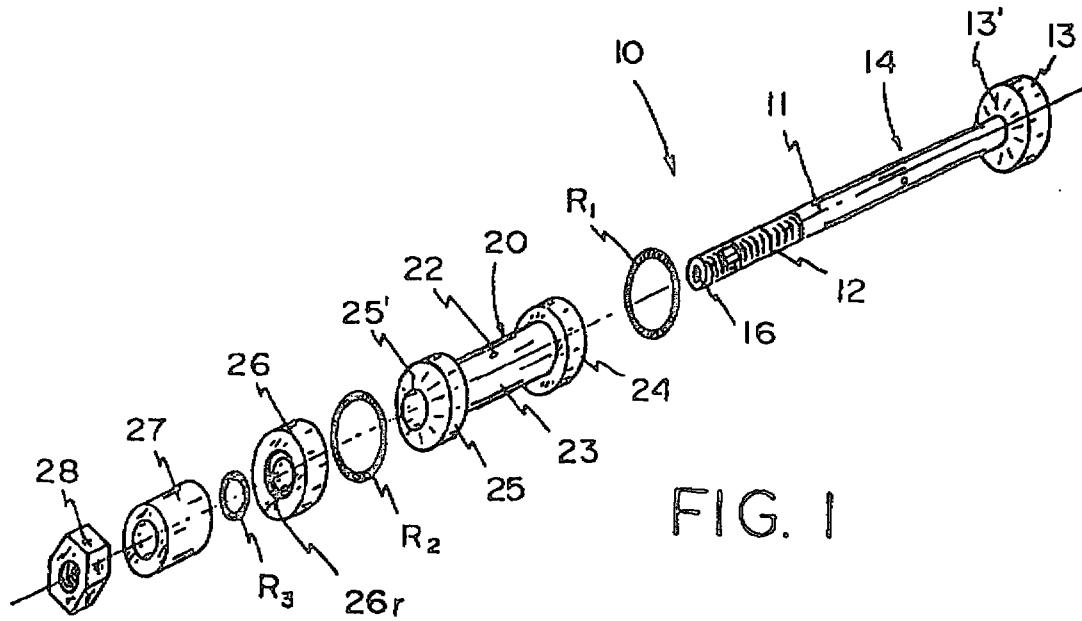
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FIG. 1

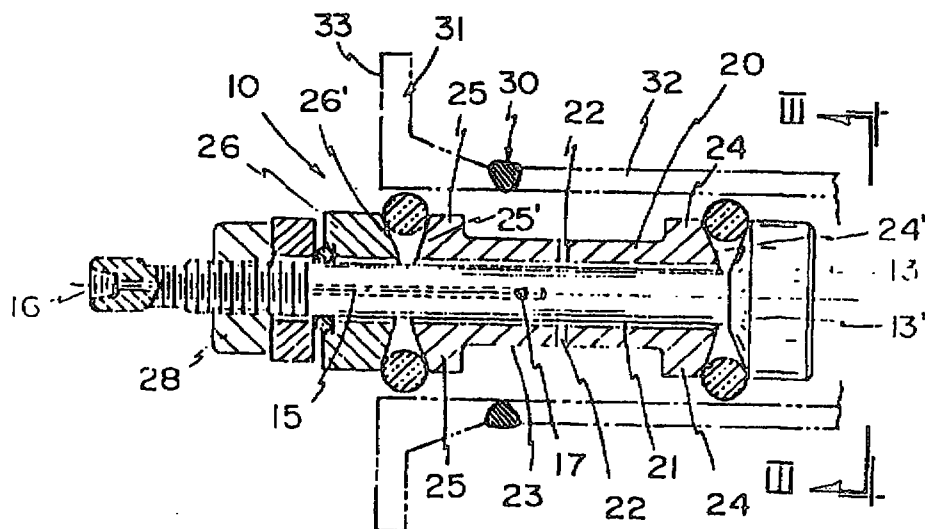


FIG. 2

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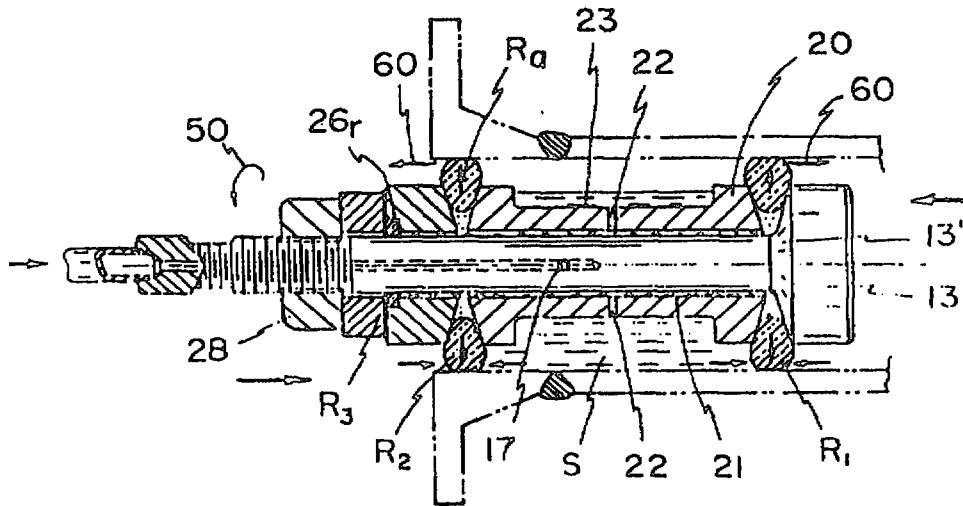


FIG. 2A

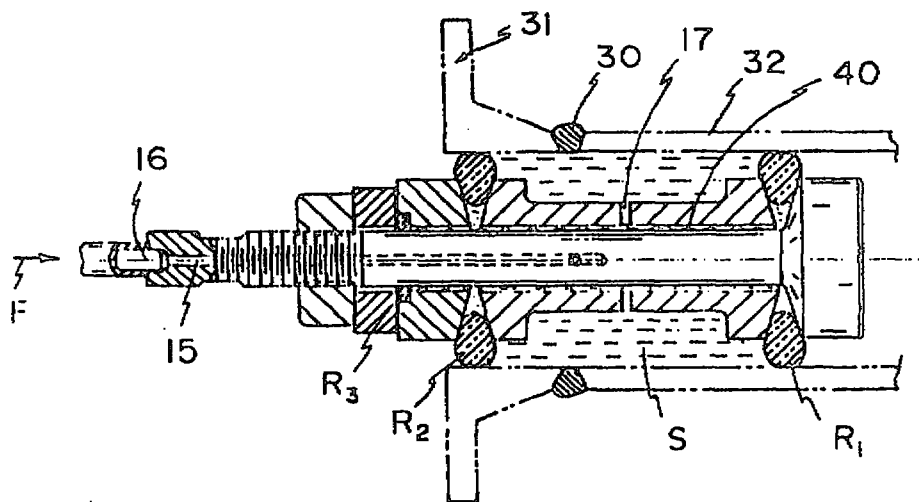


FIG. 2B

3 / 8

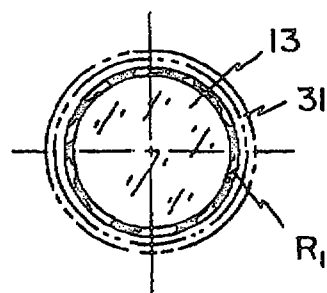
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FIG. 3

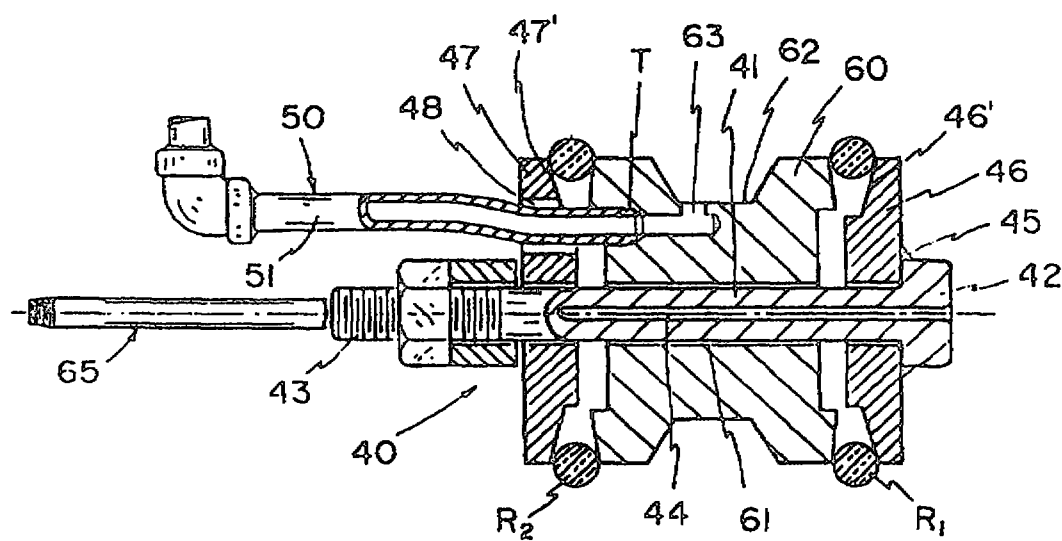


FIG. 4

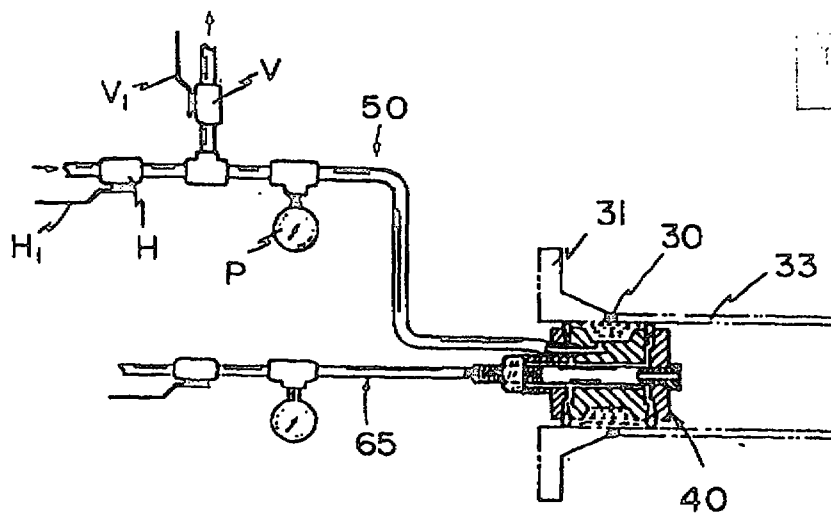


FIG. 5

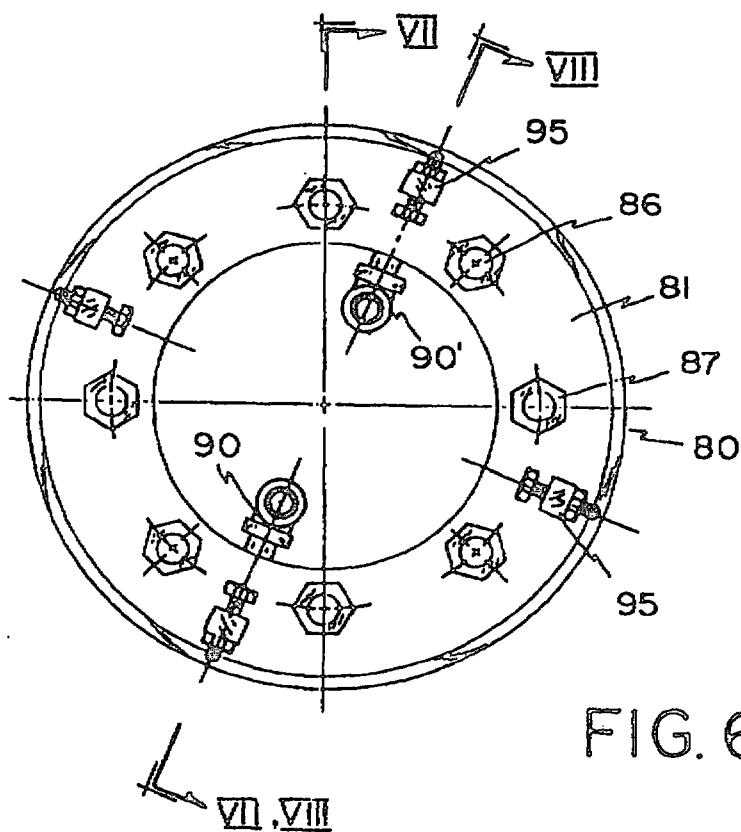


FIG. 6

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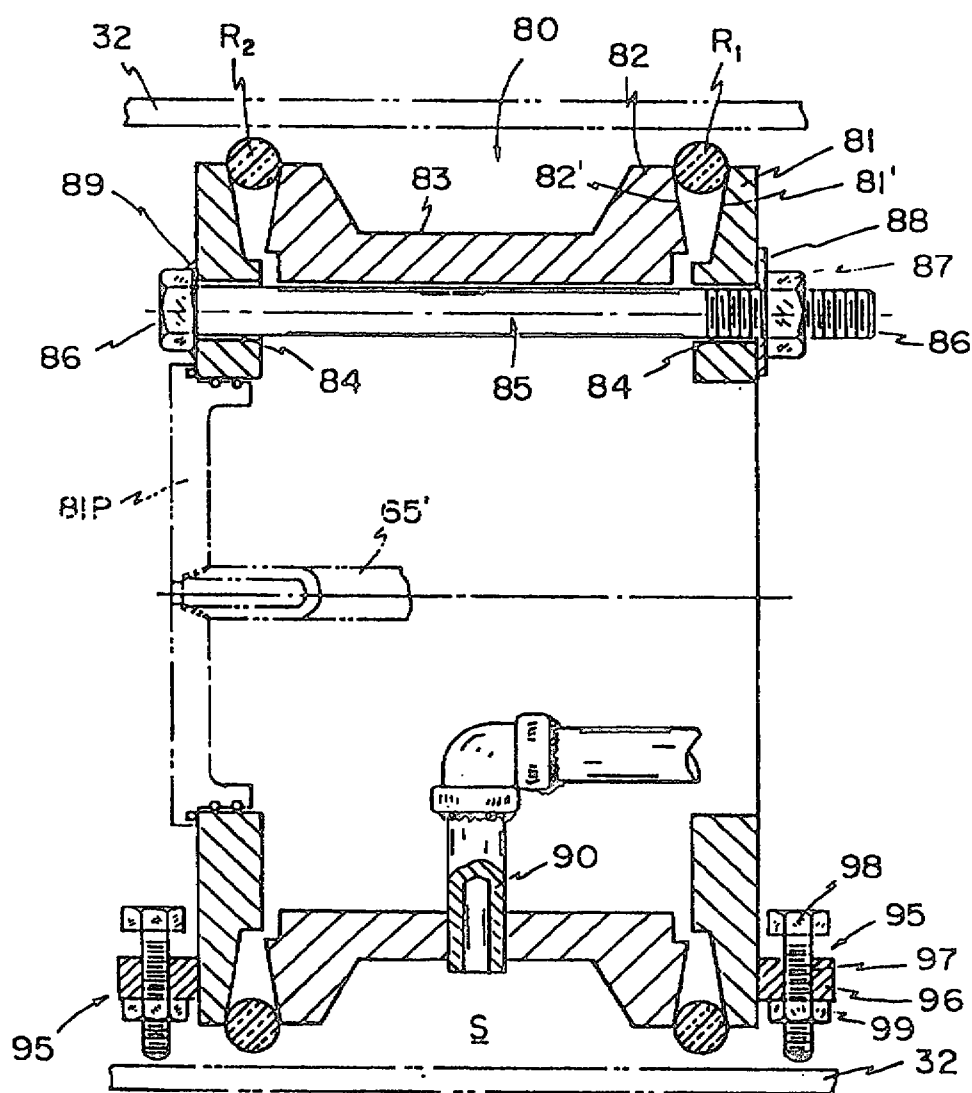
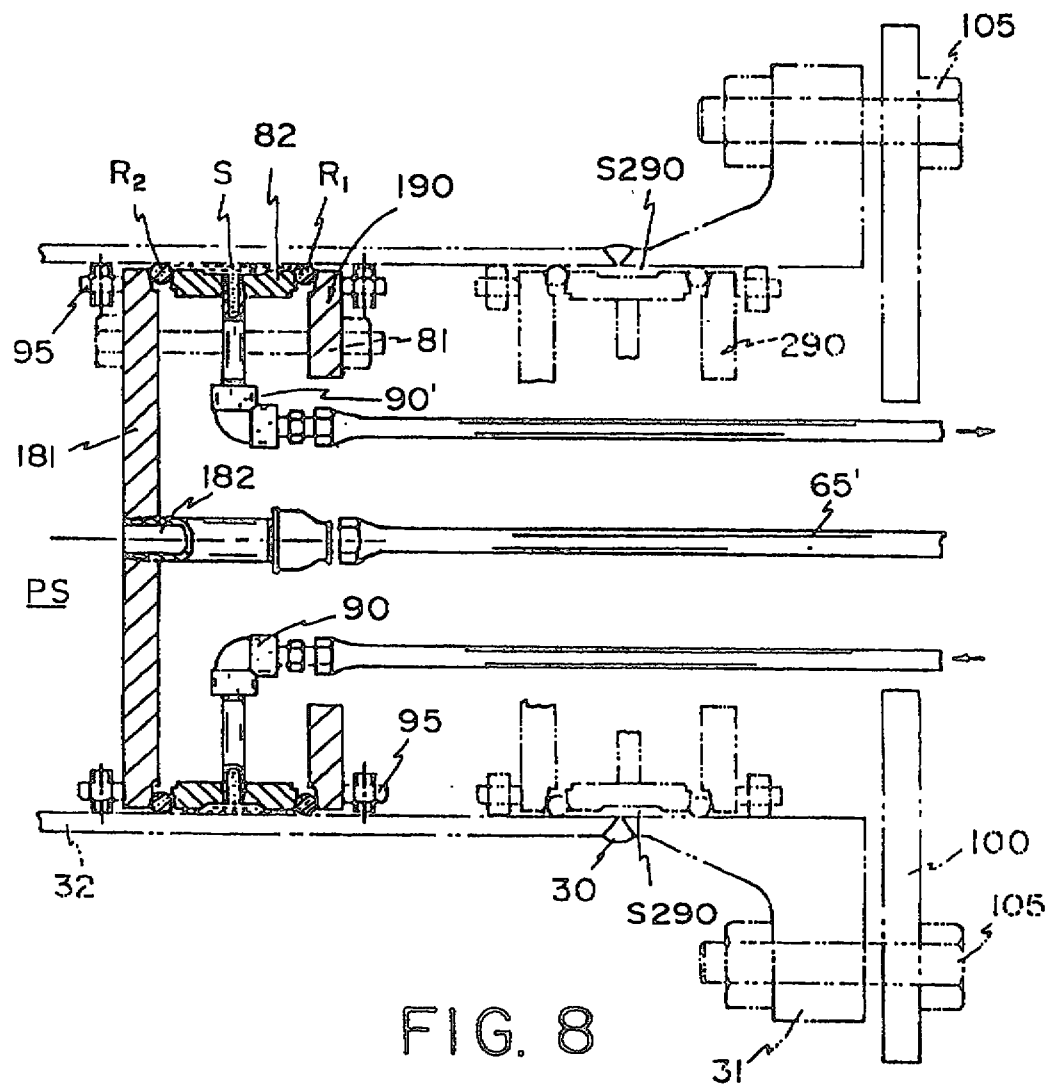


FIG. 7

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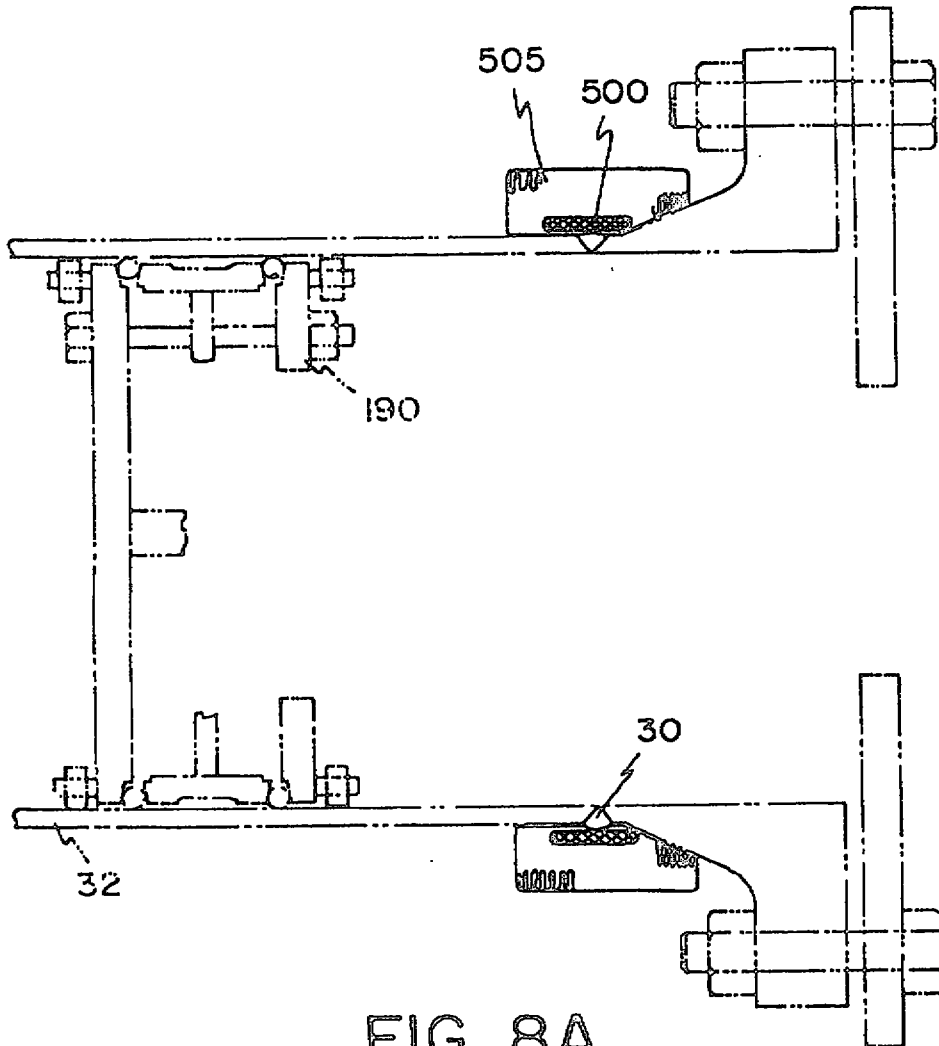


FIG. 8A

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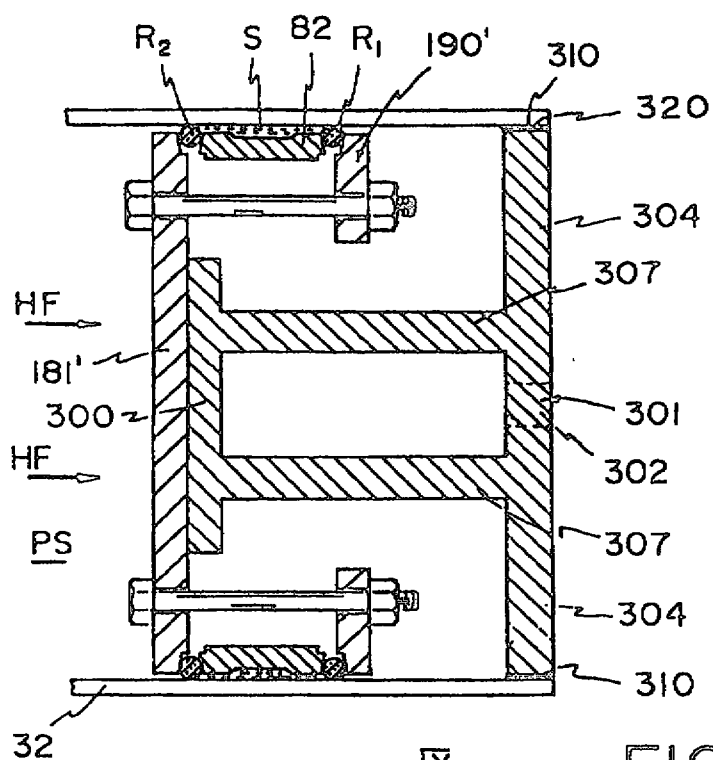
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FIG. 9

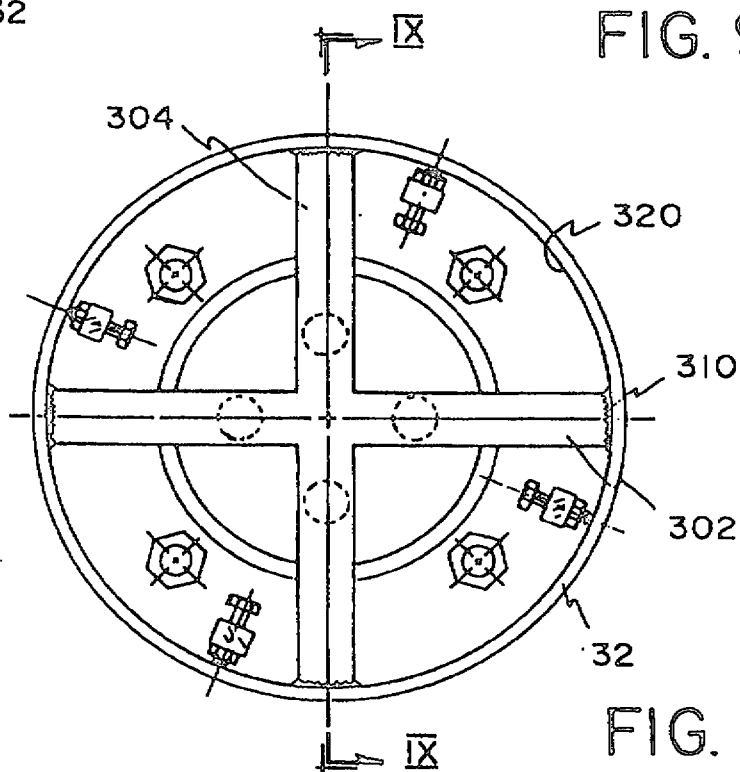
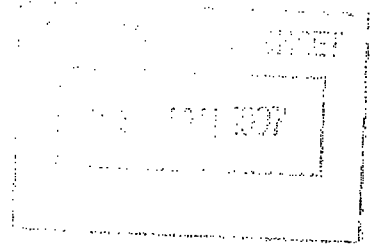


FIG. 10



is used to test pipes, with an internal diameter of approximately ½ inch (1.75cm) and with modification to  
5 as great as what is desired, say even 6 to 10 feet (300cm), or more.

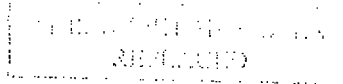
It is an object of the invention to provide a  
simplified test plug which can be hand carried by one  
10 or two workers, assembled within the diameter of a pipe to be tested, temporarily sealed therein so as to allow a testing step to take place which tests the integrity between an annular pipe segment and the test  
15 plug, the annular pipe segment generally including a welding interface or a flange interface, or other surface, in order to determine if this region leaks at all, and if it does, to what extent.

The invention therefore contemplates a test plug  
20 assembly for testing the internal integrity of a segment of pipe having an internal diameter, the assembly comprising (a) an annular body with opposite annular faces and defining on its outer  
perimeter, a peripheral recess, (b) a pair of annular  
25 bosses, (c) a pair of resilient annular members adapted to be respectively juxtaposed between a boss and an annular face, (d) means for urging the bosses respectively against an adjacent resilient annular  
member so as to cause the same to frictionally engage  
30 and to seal against a boss, and its adjacent annular face, and the internal diameter of the pipe segment, and, (e) means communicating through the assembly to that plenum now defined by said recess, the annular  
members, and the internal diameter of the pipe,  
35 whereby the integrity of the pipe segment may be determined.

In another embodiment, there may be a pair of communicating means to the peripheral annular recess defined by the annulus and the urging means being a plurality of axially oriented circumferentially disposed bolts, in which case each boss may be an annulus. In order to further reduce weight, the annulus may be aluminum wherein the outer annular recess is milled from cylindrical aluminum stock; and the bosses, fabricated either from steel or aluminum solid rod or square stock and appropriately milled.

In above noted embodiments, the hydrostatic testing media is a fluid-like liquid, preferably water, which is inserted into the plug after its sealing engagement within and communicating with the inner diameter of that selected pipe space which now defines the testing plenum is itself defined by the plug and the internal pipe space diameter. Into the testing plenum, the testing media is flowed, via conduits through the plug; then, pressurized to test the integrity of that portion of the pipe that is in juxtaposed communication with the hydrostatically filled testing plenum.

In a variation of the aforesaid embodiments, the "test plug" is also an isolating-monitoring plug; namely, one that isolates pipe space from a region or interface while allowing monitoring of that pipe space on the obverse side to the test-isolation monitoring plug from that pipe interface that is to be either tested, or to which a weld is to take place, for instance, the creation of a pipe-weld-pipe interface or a pipe-weld-flange interface or any other similar



18

## WE CLAIM:

1. A test plug assembly (80,190) for testing the integrity of a segment of pipe (33) having an internal pipe diameter (32) , the assembly (80,190) having an annular body (83), with opposite annular faces (82), the annular body defining, an inner body diameter and about its outer perimeter, a peripheral annular recess (83) with a channel (90) communicating through the annular body (81) from the peripheral annular recess (83) to the inner body diameter characterized by:
- (a) a pair of annular bosses (81);
  - (b) a pair of resilient annular members ( $R_1R_2$ ), each adapted to be respectively juxtaposed between an annular boss (81) and an adjacent annular face (82); and,
  - (c) means (85) for urging the bosses (81) respectively against the adjacent resilient annular member ( $R_1R_2$ ), so as to cause each to frictionally engage and to relatively seal the resilient member ( $R_1R_2$ ) between an annular region of the internal diameter of the pipe segment and the adjacent annular face (82') whereby to create a testing plenum (S), between pipe (32) and body (81).
2. The test plug assembly (80,190) as claimed in claim 1, characterized in that the urging means urges an annular boss (81) against an adjacent annular face (82').
3. The test plug assembly (80,190) as claimed in claim 1 or 2, characterized in that the channel (90) communicating through the body to the plenum has two channels (80,90'), one (90) for venting of the plenum, the other (90') for filling with a hydrostatic testing media.

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4. The test plug assembly (80,190) as claimed in claim 1, 2 or 3 characterized in that each annular boss (81) defines a plurality of axially oriented apertures (84) radially disposed at a radius less than the internal body diameter and a nut and bolt set (85,86,87) extending axially through corresponding apertures (84) of each annular boss (81) and through the annular body diameter, each nut and bolt set (85,86,87) urging the bosses (81) relatively toward each other.

5. An isolation plug (190) formed from the test plug (80,190) assembly as claimed in claims 1 through 4, wherein one annular boss (81P,181,181') extends as a disk (81P,181,181') having a front face and an obverse face thereby to isolate that internal pipe diameter (PS) from the testing plenums and the internal body diameter.

6. The test plug assembly (80,190) as claimed in claim 5, including a disk boss support (301) structure fixedly secured (310) to the pipe and juxtaposed (306) against the obverse face of the disk boss (181') so as to prevent bulging of the disk boss (181') when significantly high pressures are imposed upon the front face (HF) of the disk boss (181').

7. A method of testing the internal integrity of a pipe segment (33) having an internal wall defining an internal pipe diameter (32) comprising the steps of:

(a) selecting,

(i) an annular body (81) with an inner annular body diameter and outer annular diameter that is less than the internal pipe bore diameter, the body (81) having an outer peripheral race (83) of diameter less than the outer

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diameter of the annular body which defines opposite annular faces (82);  
(ii) two resilient annular members ( $R_1, R_2$ ), each respectively having an outer diameter greater than, and an inner diameter less than the outer diameter of the annular body (32);  
(iii) two bosses (81, 81P, 181), each with an outer diameter less than the internal pipe bore diameter;

(b) positioning at opposite annular faces (82), a resilient annular member ( $R_1, R_2$ ) and against it, a boss (81);

(c) moving, the bosses (81), relatively closer to each other to compress the resilient member (R) adjacent thereto into sealing engagement among the annular member (R) and the internal pipe wall (32) to thereby define an annular space (S) among the outer peripheral race (81), its adjacent communicating internal wall (32) of the pipe segment, and the annular resilient members (R); and,

(d) conveying a fluid through the annular space (S) thereby to test the internal integrity of the pipe segment (32) communicating therewith.

8. A method of isolating a downstream internal pipe bore region (PS) wherein the isolating method comprises the steps of:

(1) selecting,

(i) an annular body (83) with an inner annular diameter and outer annular diameter that is less than the internal pipe bore diameter, the body having an outer peripheral race (83) of diameter less than the outer diameter of the annular body (83) wherein the annular body defines





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opposite annular faces (82);

(ii) two resilient annular members ( $R_1, R_2$ ), each respectively having an outer diameter greater than, and an inner diameter that is less than the outer diameter of the annular body (83);

10

(iii) two bosses (81, 81P, 181), each of which is annular (81) and with an outer diameter less than the internal pipe bore diameter, one boss (81) being an annular boss (81);

15

(2) positioning, within the pipe bore, against opposite annular faces (82), a resilient annular member ( $R_1, R_2$ ) and against each adjacent annular member ( $R_1, R_2$ ), an upstream boss (81P, 181) which isolates an upstream region (PS) of the internal bore from a downstream region thereof, and downstream the annular boss (81) to define downstream from the downstream boss (81), the downstream internal pipe bore region;

20

(3) moving, the bosses (81, 81P, 181), relatively closer to each other to compress the resilient member ( $R_1, R_2$ ) adjacent thereto into sealing engagement among the annular members ( $R_1, R_2$ ) and the internal wall (32) to thereby define an annular space among the outer peripheral race, its adjacent communicating internal wall of the pipe segment, and the annular resilient members ( $R_1, R_2$ ); and,

25

30

(4) conveying a cooling fluid through the annular space defined by the annular body, the resilient annular members the juxtaposed region of the internal bore.

35

8. The method as claimed in claims 7, wherein one of the bosses (81) is a disk boss (81P, 181).

9. A method of isolating and testing an internal

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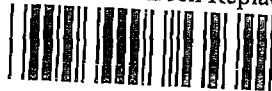
pipe bore by first performing the method of claim 8;  
then, performing the testing of isolating method of  
claim 7.

5        10.    A method of isolating and testing an internal  
pipe bore by first performing the method of claim 9;  
then, performing the testing of isolating method of  
claim 7.

10       11.    A method of isolating and testing an internal  
pipe bore by first performing the method of claim 9;  
then, performing the testing of isolating method of  
claim 8.

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## ABSTRACT OF THE DISCLOSURE

5 A test plug assembly (80,190) which tests the  
internal integrity of a segment of pipe (33) having an  
internal diameter (32). The assembly (80,190)  
comprises an annular body (83) with opposite annular  
faces (82) and defining on its outer perimeter, an  
annular recess (83) , a pair of bosses (81,81P,181), a  
10 pair of resilient annular members ( $R_1, R_2$ ) adapted to be  
respectively juxtaposed between an adjacent boss (83)  
and an annular face (82); means (85) for urging the  
bosses (81,81P,181) respectively against the adjacent  
resilient annular member (R) so as to urge the same in  
15 frictionally engage and to seal against the internal  
diameter of the selected pipe segment (32) and, means  
(90) communicating through the assembly (80,190) to  
that plenum (S) now defined by said recess (83), the  
resilient annular members (R) and the internal  
20 diameter of the pipe (32) whereby the integrity of  
that pipe segment (32) may be determined.

integrity is to be determined; whether or not there are unseen fissures or apertures which may allow leakage of a fluid which will pass through the conduit (32) when in application as in the petro-chemical environment or otherwise. A bolted flange-flange interface could similarly be tested, as could any other pipe discontinuity.

In the first embodiment, the plug (10) includes a cylindrical shaft (11) that at one end has a threaded shank (12) and at the other end, an integral boss, plug or disk (13) so as to form an integral shaft component (14); the disk (13) has an inner bevelled or truncated cone-like peripheral surface (13'), as shown. The shaft (11) defines an internal bore (15) communicating with a flaring outer or distal end (16) that acts as an attachment means to communicate the bore to a water pressure source that, during testing, acts as a pressure media as will be explained. The bore (15) extends approximately mid-way into and along the longitudinal axis of the shaft (11), as more clearly seen in phantom in Figure 2 and in the cross section Figure 2B, and communicates with diametrically oriented channels (17), which communicate to the outside diameter surface of the shaft (11) - see Figure 2B.

The shaft (11) is adapted to pass through an annular piece, sometimes referred to as the annulus, generally referenced as (20) having an internal bore (21) sized larger than the external diameter of the shaft (11) and having at least a radial bore, shown in figures 1 and 2 as two radially oppositely disposed channels (22) that communicate between a stepped annular recess 23 exteriorly circumscribing the center portion of the annulus (20) with the inner bore (21). The opposite ends of the annulus (20) are integral radially protruding disks (24) and (25), with their respective outer truncated annular surfaces (24') and

(25') being bevelled inwardly from center to perimeter.

In order to complete the other rigid components of the plug (10), there is an annulus (26) whose inner bore is larger than the outer diameter of the threaded shaft (12) so as to accommodate its passing therethrough with space, the annulus having an interface (26') as a reversibly bevelled annular conical surface, and its outerface, preferably orthogonal to the longitudinal axis of the bore, yet having a stepped bore of slightly larger diameter at the interface between this space and the inner bore of the annulus so as to define a channelled race (26<sub>r</sub>) which accommodates a smaller elastomeric ring (R<sub>3</sub>), as will be explained. The obverse surface (26') is a reversibly bevelled annular conical surface, which might also be "truncated", as are clearly seen in Figures 2, 2A and 2B.

A second boss in the form of an annular collar (27) has its inner bore sized to accommodate the threaded shaft, to mate with a threaded nut (28) which is adapted to thread onto the shaft and to compress all the components of the plug referred above into one integral unit. In order to provide annular sealing between juxtaposed bevelled surfaces (13') and (24'), there is an elastomeric annular ring ( $R_1$ ); similarly, there is an elastomeric annular ring ( $R_2$ ) juxtaposed between truncated conical annular surfaces (25') and (26'), and an elastomeric annular seal ( $R_3$ ) which nests into the annular race (26<sub>r</sub>). The inner diameter of the annular race is sized to frictionally engage the outer diameter of the shaft (11) so as to provide a sealing fit as will be explained.

In order to insert the assembled plug (10) into  
the pipe interface so as to test the integrity of the  
internal diameter of the interface (30), and now  
referencing Figure 2, the assembled plug in its

opposite end, the shaft and disk defining a central bore (44). The disk (42) is welded at (45) to an annular end disk plate (46) whose inner margin (46') is a bevelled annulus to accommodate "O" ring (R<sub>1</sub>).

5 There is an opposite annular end disk (47) with a similar inner annular bevel (47') to accommodate annular ring (R<sub>2</sub>) but the disk (47) also has an aperture therethrough (48) which allows passage of a hydrostatic flooding and testing circuit, generally  
10 shown as (50) to extend therethrough. The plug (40) includes an annular piece (60) defining an inner bore (61) which accommodates the shaft (41) and an outside circumferential race (62), which includes  
15 a hydrostatic filling channel (63) communicating with the testing circuit (50) in the fashion shown. As such, the circuit (50) has a threaded hose (51) whose distal end threads into and sealingly mates with a corresponding thread (T) defined by the outer extremity of the bore (63) to  
20 make a fluid channel passing through the disk (47) and communicating with the race (62). The bore (44) acts as a venting channel to allow venting of the internal pipe (32) when the plug (40) is being inserted into the flanged pipe bounded by the peripheral weld (30)  
25 which is put in place to sealingly attach one to the other - see Figure 5. It may also be an advantage to conduct a second testing circuit which is referenced (65) to test everything that is to the right of the plug (40), as shown in that figure. Thus, the same  
30 bore (44) serves to vent the interior of the pipe (33) during insertion and removal of the plug (40) or, alternatively, accommodates a second circuit for testing the interior of the pipe (32), if required, by  
35 utilizing testing circuit (65).

If the space (S) which is bounded by the plug (40) and the internal pipe (32) flange (31) and

circumferential weld (30) is to be tested, then preferably threaded hose (51) is positioned so as to be vertical over the bore (44) and the testing circuit (50) includes a hydrostatic pressure gauge (P) communicating with the hose (51), a venting valve (V) having a switch ( $V_1$ ), and a hydraulic fluid control valve (H) with its corresponding switch ( $H_1$ ). Water is periodically allowed to flow through valve (H) into space (S) by opening ( $H_1$ ) and closing ( $V_1$ ) and venting of the air within the space (S) is achieved by reversing valve positions ( $H_1$ ) and ( $V_1$ ) so air vents out of valve (V) in accordance with the arrow thereabove. This cycling occurs until the space (S) is filled with water and then pressuring of the water takes place so that the pressure gauge (P) registers the hydrostatic pressure on the circumferential weld seam (30) to test the integrity of the same.

Referring Figures 6 and 7 and to the third embodiment of the invention, the same consists of an annular plug (80) consisting of mirror end annular bosses or plates (81) and an annulus (82) with an outer circumferential race (83). The juxtaposed faces of the annular plates (81) and the annulus (82) are respectively bevelled at ( $81'$ ) and ( $82'$ ), as shown, so as to accommodate the seating of "O" rings ( $R_1$ ) and ( $R_2$ ) therebetween. Each of the annular disks (81) have a plurality of apertures (84) therethrough circumferentially disposed so as to permit the passage therethrough of a nut-bolt arrangement, generally shown as (85) consisting of a bolt head (86) which is welded at (89) to the exterior face of one of the annular disks (81), the opposite end of the bolts (85) having a threaded shaft portion (86) accommodating a nut (87) which can be turned down onto an underlying washer (88). The annulus (82) may have appropriate diameters, as may the disks (81) to accommodate

internal pipe(32) diameters over 8", as may be required.

The annulus (82) defines a filling and pressure channel (90) which communicates through the annulus (82) to the outside annular race (83), and

5 diametrically opposite thereto a venting channel (90'). The plug (80) can be inserted into large diameter pipes exceeding 8", the bolts (87) tied down so as to force "O" rings ( $R_1$ ) and ( $R_2$ ) against the inner diameter of the pipe-flange interface to be  
10 tested. Liquid media is channelled into the space (S) defined by the race (83) and the inner wall of the pipe flange interface while venting of any air exits the diametrically disposed venting channel (90").

Testing of the interface in a similar fashion occurs.

15 Because of the great weight of the annular plug (80), particularly when made of steel, or steel alloys such as stainless steel, each annular plate (81) has four adjusting heads (95) diametrically paired and consisting of a protruding butt (96) having a threaded  
20 bore (97) accommodating a threaded bolt (98) which extends therethrough and whose distal end is adapted to turn against the internal diameter of the pipe (32), to locate the plug (80) co-axial with the pipe (32). Locking nuts may then be turned down to lock  
25 each bolt (98), as shown in phantom in Figure 7, against the internal diameter of the pipe (32) that is being tested. Thereafter, flange nuts (87) are turned down to apply the pressure on the "O" rings ( $R_1$ ) and ( $R_2$ ) sealing them against the inner walls of the  
30 pipe flange interface so that the annular space (S) is a sealed plenum. Hydrostatic filling of the space (S) occurs as above noted, and pressure venting in the fashion, as earlier described, can take place. It is convenient to make the annulus (20), (60), (82) from  
35 aluminum in order to reduce its weight, and in certain applications even the bosses (13), (26), (46), (47), (81) may be made from appropriate aluminum stock but

in some applications, particularly in the cereal industry, the whole plug will have to be made from stainless steel in order to meet health standards.

Referring now to yet a further embodiment and to  
5 Figures 8 and 8A, a test plug (190) also acts as an isolation and pipe space monitoring plug, and has an annular boss flange (81) and an opposite (annular) flange (181) in the form of a disk defining a central axial aperture (182) therethrough which communicates  
10 to a monitoring conduit reference (65') and into the internal pipe space diameter, referenced (PS), of the pipe (32) to the left of the flange (181) which can be perceived to be a long continuous pipe space of a fluid conveying conduit in an existing installation to  
15 which it is now desired that there be affixed onto the end of the pipe (32), a flange shown in phantom as (31). Thus, particularly in instances where the pipe space (PS) is part of a conduit, in a petro-chemical plant, it must first be drained of contents;  
20 nevertheless, there are residual airborne hydrocarbons in the pipe space (PS) and also embedded into the inner surface walls of the pipe space (PS). When welding to such existing pipe space (PS), present safety standards require that the pipe space (SP)  
25 walls first be cleaned; this is expensive. With the isolation test plug configuration (190), this is not necessary.

The test plug (190) has the two O rings (R1) and R2) which are urged respectively against boss (81) and  
30 annulus (82) on the one hand, and disk (181) and the opposite end of annulus (82) to urge the O rings (R1,R<sub>2</sub>) against the inner walls of the pipe that is now defined as the plenum space (S). Cooling water may be inserted into the pipe space (S) by flowing water  
35 through conduit (90) into the plenum space (S) to outflow from conduit (90'). When cold water is used, the temperature of the pipe to the left of the plug

REPLACEMENT SHEET

14

(190) maintains the pipe at a non-flammable temperature for the hydrocarbons that may reside in the pipe space (PS). Either a gas monitor, not shown, or other temperature sensitive device may be pushed into from right to left, the testing circuit conduit (65') through the conduit (182) into the pipe space (PS) for monitoring while welding of the weld (30) takes place.

After welding, another plug (290), similar to that of (190) is positioned, as shown in phantom, on the inside surface of the pipe (32) and the integrity of the weld (30) tested by applying appropriate fluid pressures to the space, referenced (S290), defined by the O rings (R1) and (R2), the annulus (82), and the internal diameter of the interface of the pipe (32), weld (30) and flange (31). Throughout this testing the other isolation test plug (190) can be left in position. Once the integrity of the weld (30) has been assured, in some instances, it is also necessary to stress-relieve the weld (30). This is accomplished by applying an annular stress-relieving heater, referenced (500) over the weld (30); the heater has an overcovering insulation (505). The pipe-weld-flange interface (30,31,32) is brought up to the annealing temperature while water is still flowed into channel (90) and out channel (90') for plug (190), keeping cool that pipe juxtaposed to the water-filled plenum (S) and maintaining a cool temperature of the pipe to the left thereof and particularly, to the pipe space (PS). It has been found that the width of the plug between bosses (81) or between boss (81) and the disk boss (181) is preferably about 6" and the position of the plug (190) from the weld (30) should be at least, for safety purposes, about 2'. In petro-chemical applications, the distal end of the conduit (65') which actually allows venting and monitoring of the pipe space (PS) is open ended and should be at least

AUG 007

REPLACEMENT SHEET

15

35' or more away from the physical location of the plug (190). The cooling waterflow through the circuit (90), (S), (90') should be at a positive pressure of around 100 PSIG.

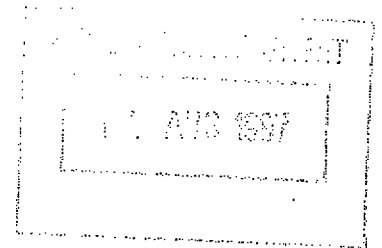
5           The operational sequence placing a flange, phantom flange (31), in Figures 8 and 8A, would be as follows. Drain the pipe (32) and pipe space (PS) of all hydrocarbon liquids and then place the plug (190) into place in a fashion, as earlier described and then  
10           inflow water into the annular space (S) by flowing water into conduit (90) and out of conduit (90'). The monitoring pipe or tube (65') extends at least 35' away from site of the flange (190) and monitors, the temperature and volatiles within the pipe space (PS),  
15           (the monitoring devices not being shown).

          The flange 31 is then welded by weld (30) to the end of the pipe (32) after the pipe end has been appropriately dressed. Leaving the plug (190) in place, a second plug (290), similarly configured, is  
20           positioned on the inside surface of the weld to define a testing plenum (S290) which is flooded with water in a similar fashion to that of plug (190) thereupon the integrity of the flange-weld-pipe interface is determined. Thereafter, the second test plug (290)  
25           is removed and the weld (30) stress-relieved, as follows. Now referring to Figure 8, the test plug (190) is still left in place and the water continues to flow into and out of the space (S) via the respective pipes (90) and (90'). An annular heater  
30           (500) is placed on the outside circumference of the weld (30) and an overcovering annular insulating sleeve (505) is placed thereover and the weld (30) brought up to its annealing temperature in order to stress-relieve the pipe-weld-flange interface. After  
35           the annealing step, the annular heater (500) and insulating annulus (505) are removed; the weld allowed to become cool and then at a time convenient, the plug

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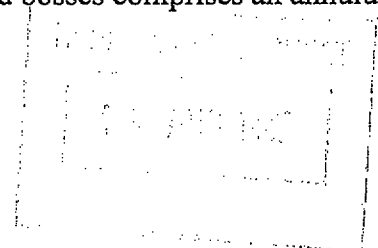
inhibited by the disk (300) and the support structure (301). After the pipe space (PS) integrity has been "tested", the support structure (301) can be cut away from the pipe (32) as by an acetylene torch or the like; the support structure (301) is removed; then, the test plug (190') can be dis-assembled in a manner as earlier described or if required, the pipe end that has been severed can be now dressed, flanged as by welding, as here and before described. The pipe-weld-flange interface can then be tested by relocating test plug (190') in juxtaposition with the interface in the fashion as earlier described.





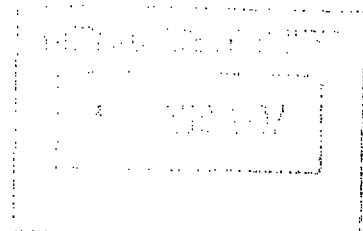
**THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:**

1. An apparatus for isolating an interior surface segment of a pipe having an internal diameter, said apparatus comprising:
  - a) an annular body with oppositely facing annular ends and defining, on its outer perimeter, a recess;
  - b) a pair of bosses, each of said bosses being located on opposite ends of said annular body and coaxial therewith;
  - c) a pair of resilient annular members adapted to be respectively and coaxially juxtaposed between each of said bosses and said annular faces;
  - d) means for urging the bosses respectively towards said annular body thereby deforming said resilient members in a radially outward direction against the internal surface of said pipe so as to form a seal there between, whereby a sealed annular space is defined between said recess on said annular body, the pipe internal surface and said resilient members;
  - e) a means communicating through said apparatus to said annular space whereby a hydrostatic fluid may be introduced into said space;
  - f) a vent extending through said apparatus for providing communication between interior segments of said pipe on opposite ends of said assembly.
2. An apparatus as claimed in claim 1 wherein said means for urging comprises a shaft which extends between said bosses.
3. An apparatus as claimed in claim 2 wherein said means communicating through said apparatus comprises a first channel for introducing said hydrostatic fluid into said annular space and a second channel for venting said annular space.
4. An apparatus as claimed in claim 3 wherein one of said bosses is integral to said shaft.
5. An apparatus as claimed in claim 4 wherein the other of said bosses comprises an annulus and wherein said shaft extends through said annular boss.





6. An apparatus as claimed in claim 5 wherein said vent extends through the length of said shaft.
7. An apparatus as claimed in claim 6 wherein said first and second channels extend through a portion of the length of said shaft.
8. An apparatus as claimed in claim 1 wherein said means for urging comprises a plurality of circumferentially spaced bolts extending between said bosses.
9. An apparatus as claimed in claim 8 wherein said means communicating through said apparatus comprises a first channel for introducing said hydrostatic fluid into said annular space and a second channel for venting said annular space.
10. An apparatus as claimed in claim 9 wherein said first and second channels are connected directly to said annular body.
11. An apparatus as claimed in claim 10 wherein a first of said pair of bosses comprises a flange having a generally central orifice and the second of said pair of bosses comprises an annulus.
12. An apparatus as claimed in claim 11 wherein said vent comprises a conduit extending from said aperture in said first boss and through said second boss.
13. An apparatus as claimed in claim 10 wherein both of said bosses comprise annuli.
14. An apparatus as claimed in claim 13 wherein said vent comprises the hollow space defined by the centers of said annular bosses and said annular body.
15. An apparatus as claimed in claim 14 wherein said first and second channels extend through one of said bosses.





16. An apparatus as claimed in claim 15 further including a plurality of centering pins circumferentially spaced about one of said bosses.

17. A method of applying a hydrostatic pressure to the interior surface of a segment of a pipe having an internal diameter, said method comprising the steps of:

1) positioning within said pipe, at said segment, an apparatus comprising:

a) an annular body with oppositely facing annular ends and defining, on its outer perimeter, a recess;

b) a pair of bosses, each of said bosses being located on opposite ends of said annular body and coaxial therewith;

c) a pair of resilient annular members adapted to be respectively and coaxially juxtaposed between each of said bosses and said annular faces;

d) means for urging the bosses respectively towards said annular body thereby deforming said resilient members in a radially outward direction against the internal surface of said pipe so as to form a seal there between, whereby a sealed annular space is defined between said recess on said annular body, the pipe internal surface and said resilient members;

e) a means communicating through said apparatus to said annular space whereby a hydrostatic fluid may be introduced into said space;

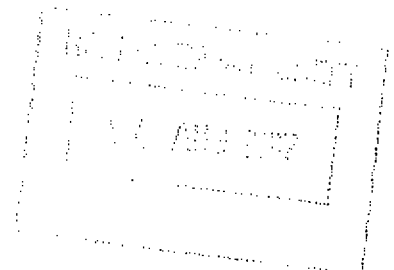
f) a vent extending through said apparatus for providing communication between interior segments of said pipe on opposite ends of said assembly;

2) urging said bosses towards said annular body, thereby creating said sealed annular space;

3) filling said annular space with a hydrostatic fluid, under pressure, through said means communicating through said apparatus;

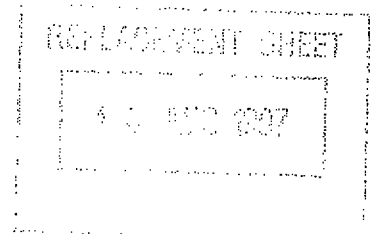
4) establishing a high pressure within said annular space.

18. A method as claimed in claim 17 wherein the diameter of said apparatus is slightly less than the diameter of said pipe being tested.

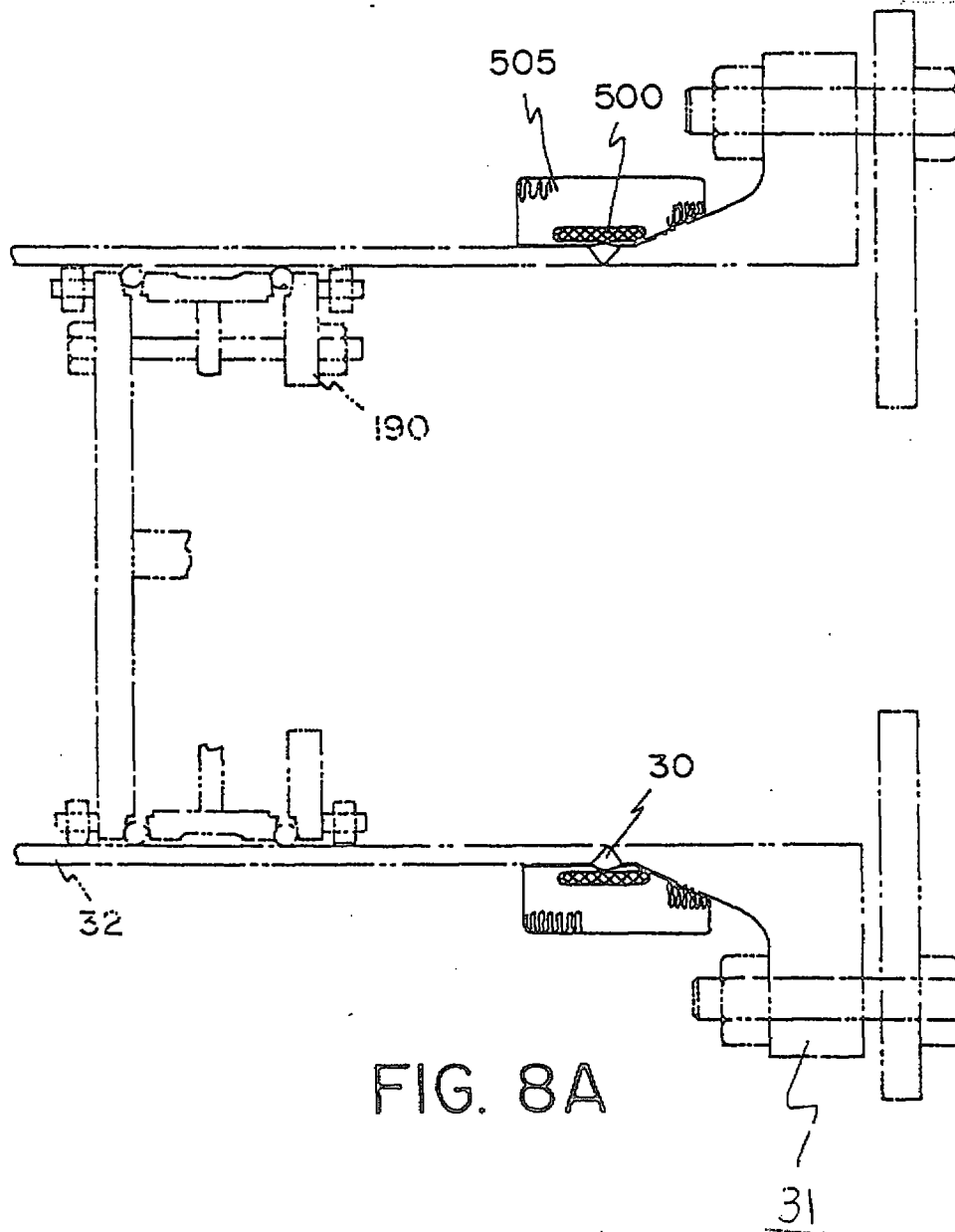




19. A method as claimed in claim 18 wherein said pressure within said annular space is monitored.
20. A method as claimed in claim 17 for testing the structural integrity of a segment of a pipe wherein said method further includes monitoring said pressure within said annular space.
21. A method as claimed in claim 17 for isolating a section of a pipe wherein one of said bosses comprises a flange having a generally central orifice, said other boss comprises an annulus, and said vent comprises a conduit extending from said orifice through said other boss.
22. A method as claimed in claim 21 wherein said hydrostatic fluid is used to maintain said segment of pipe at a desired temperature.
23. A method as claimed in claim 17 for isolating a section of a pipe wherein both of said bosses comprise annuli and said vent comprises the internal space within said bosses and said annular body.
24. A method as claimed in claim 23 wherein said hydrostatic fluid is used to maintain said segment of pipe at a desired temperature.



7 / 8



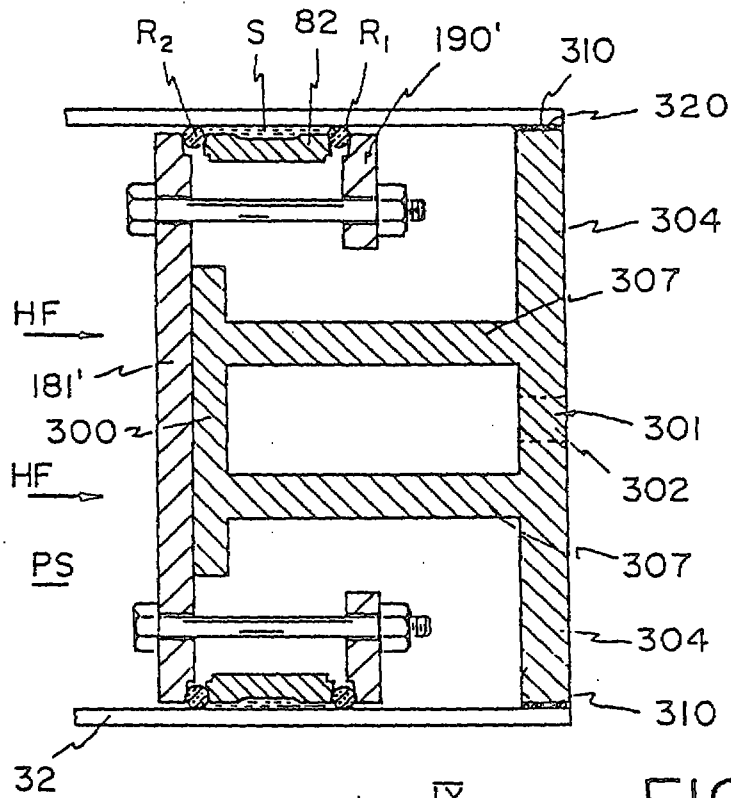


FIG. 9

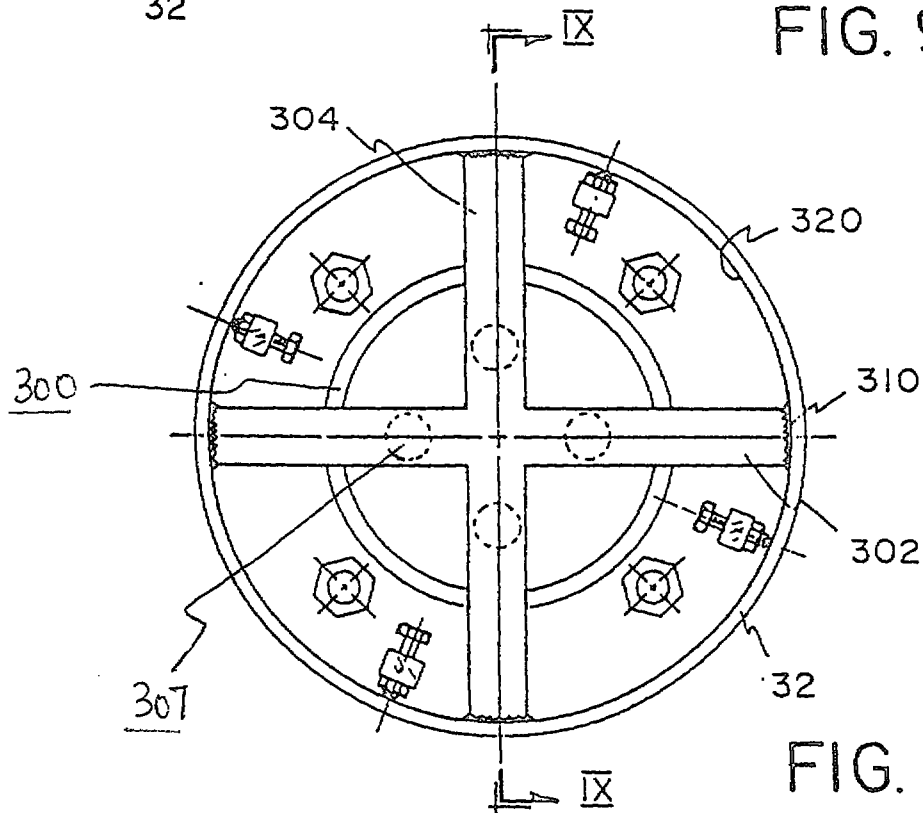
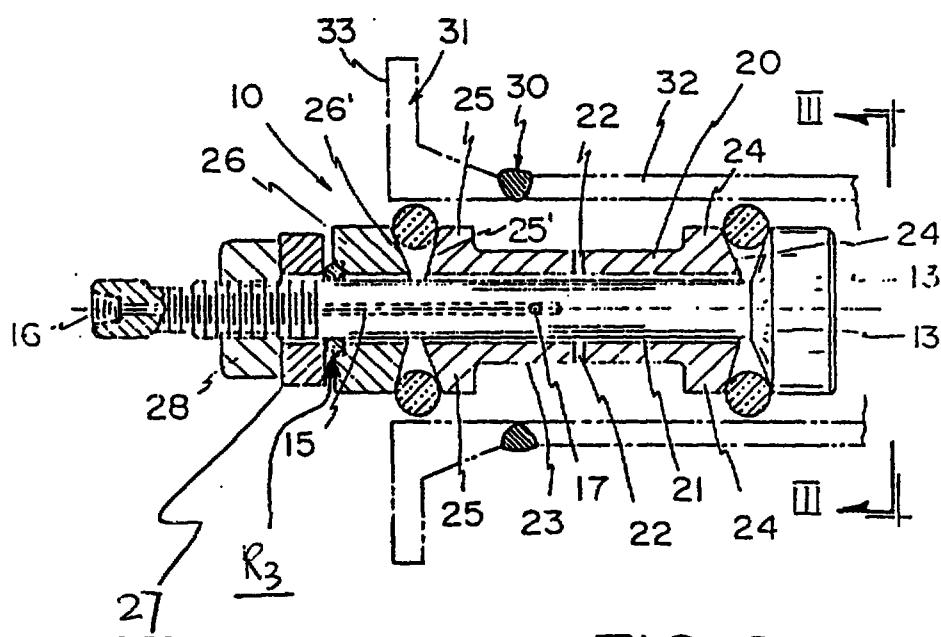
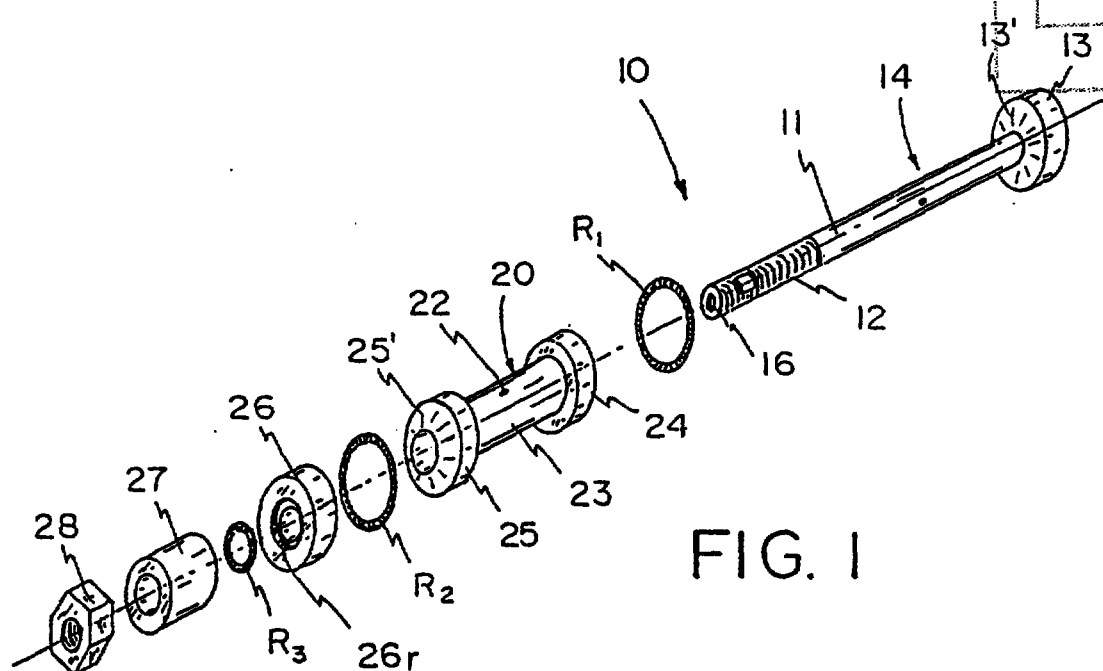


FIG. 10

1 / 8

REPLACEMENT SHEET

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14 AUG 1997

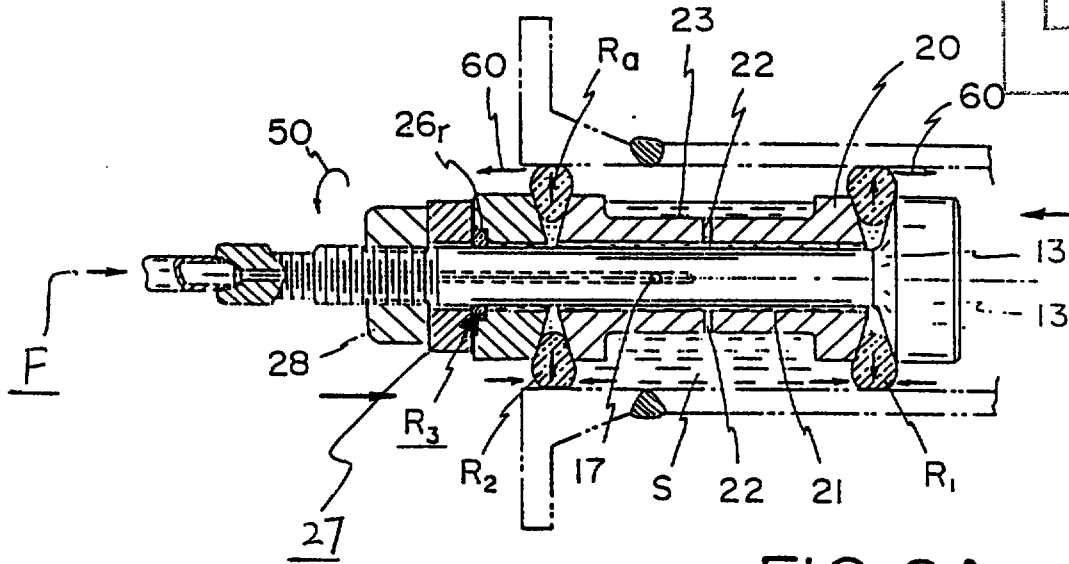


FIG. 2A

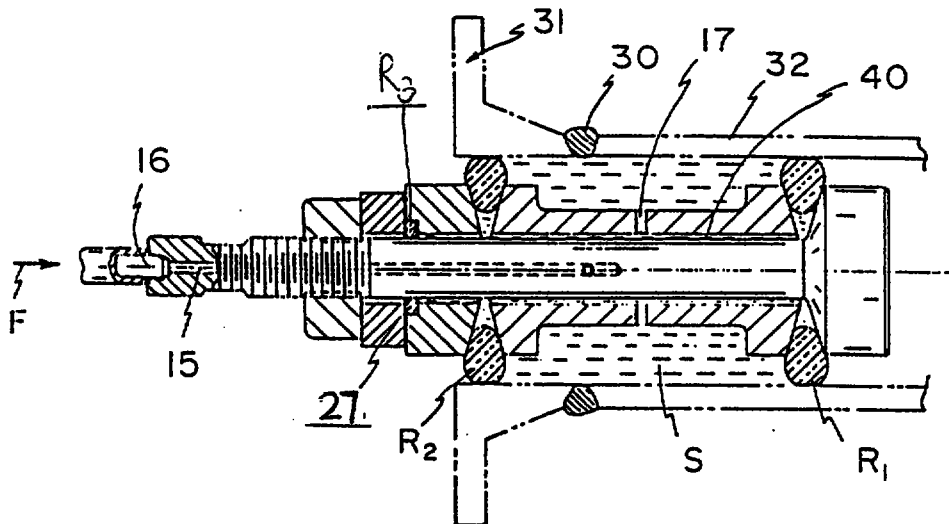


FIG. 2B

3 / 8

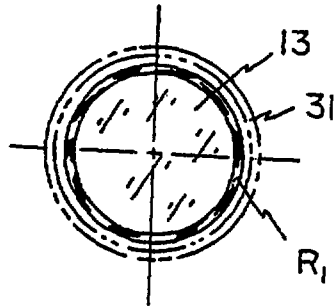
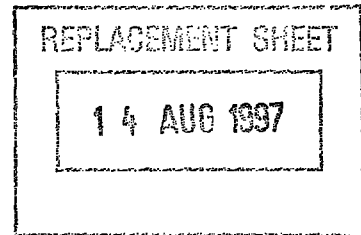


FIG. 3

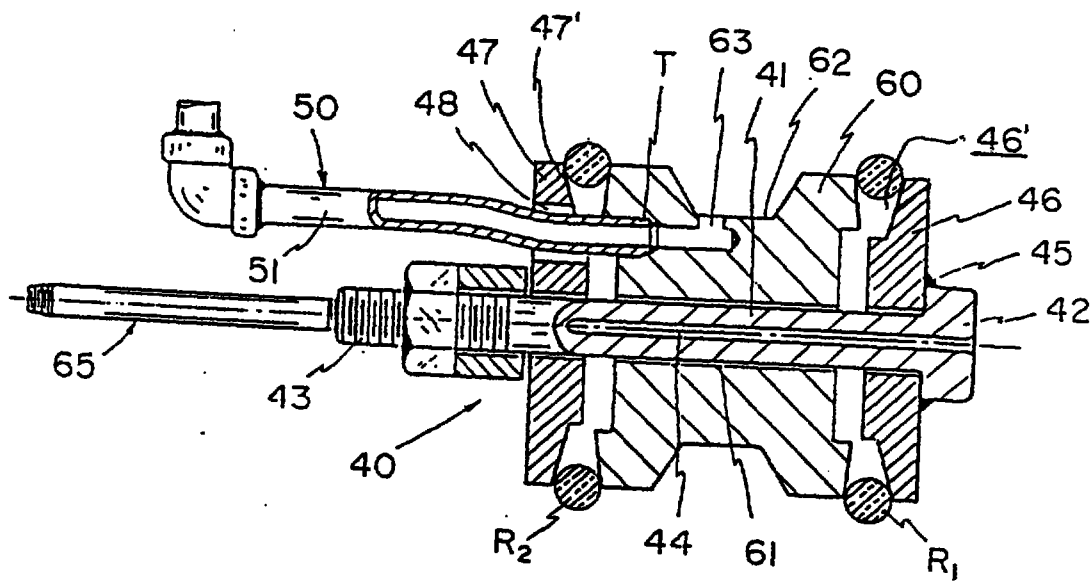


FIG. 4



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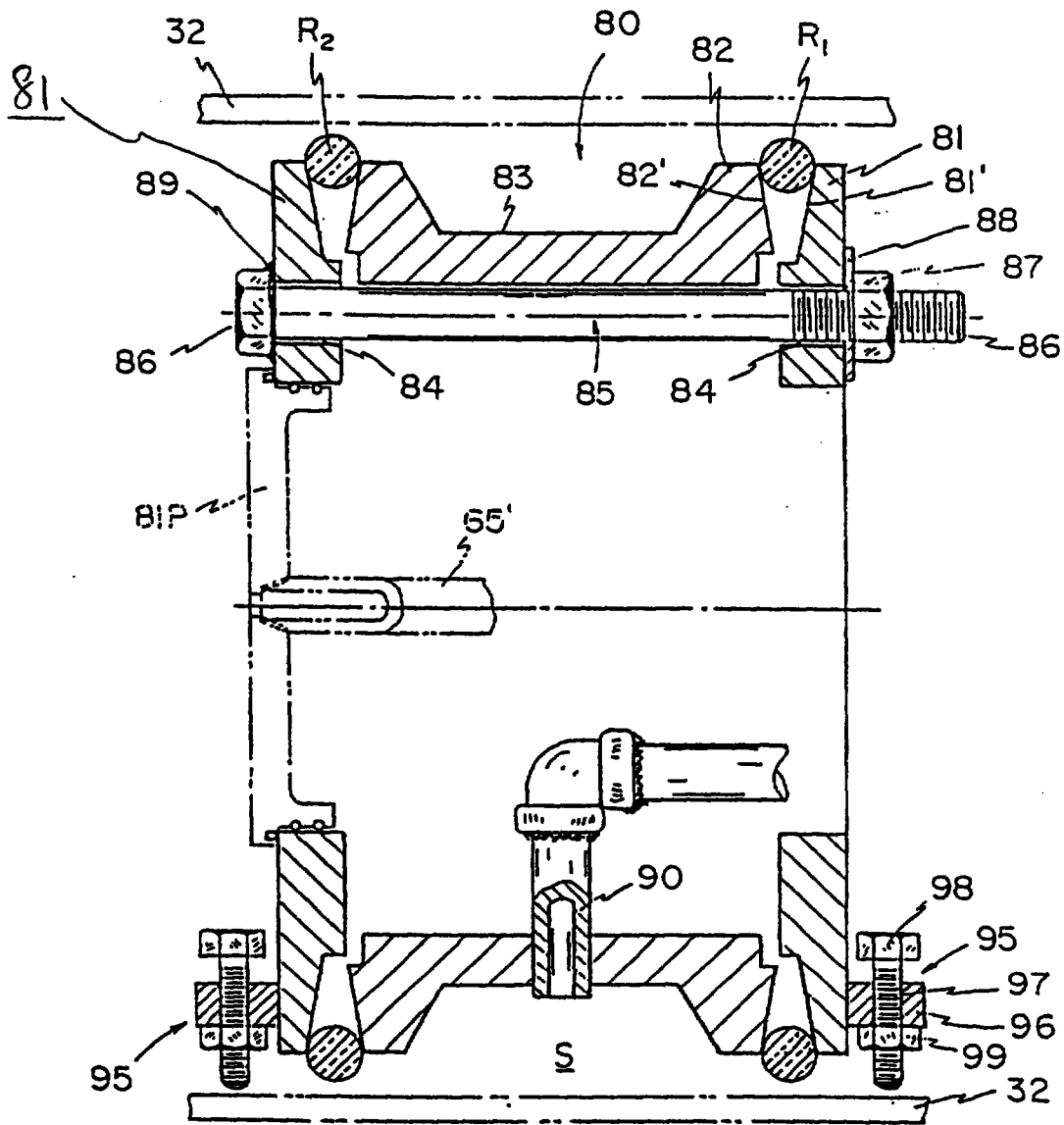


FIG. 7

|                                                                            |    |                                                               |
|----------------------------------------------------------------------------|----|---------------------------------------------------------------|
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A test plug assembly which tests the internal integrity of a segment of pipe having an internal diameter. The assembly comprises an annular body with opposite annular faces and defining on its outer perimeter, an annular recess, a pair of bosses, a pair of resilient annular members adapted to be respectively juxtaposed between an adjacent boss and annular face; means for urging the bosses respectively against the adjacent resilient annular member so as to urge the same to frictionally engage and to seal against the internal diameter of the selected pipe segment and, means communicating through the assembly to that plenum now defined by said recess, the resilient annular members and the internal diameter of the pipe whereby the integrity of that pipe segment may be determined.