Sept. 2, 1958 M. F. BAUER 2,850,303

DOUBLE SEALED COMPRESSION FITTING

Filed Aug. 12, 1955 3 Sheets-Sheet 1

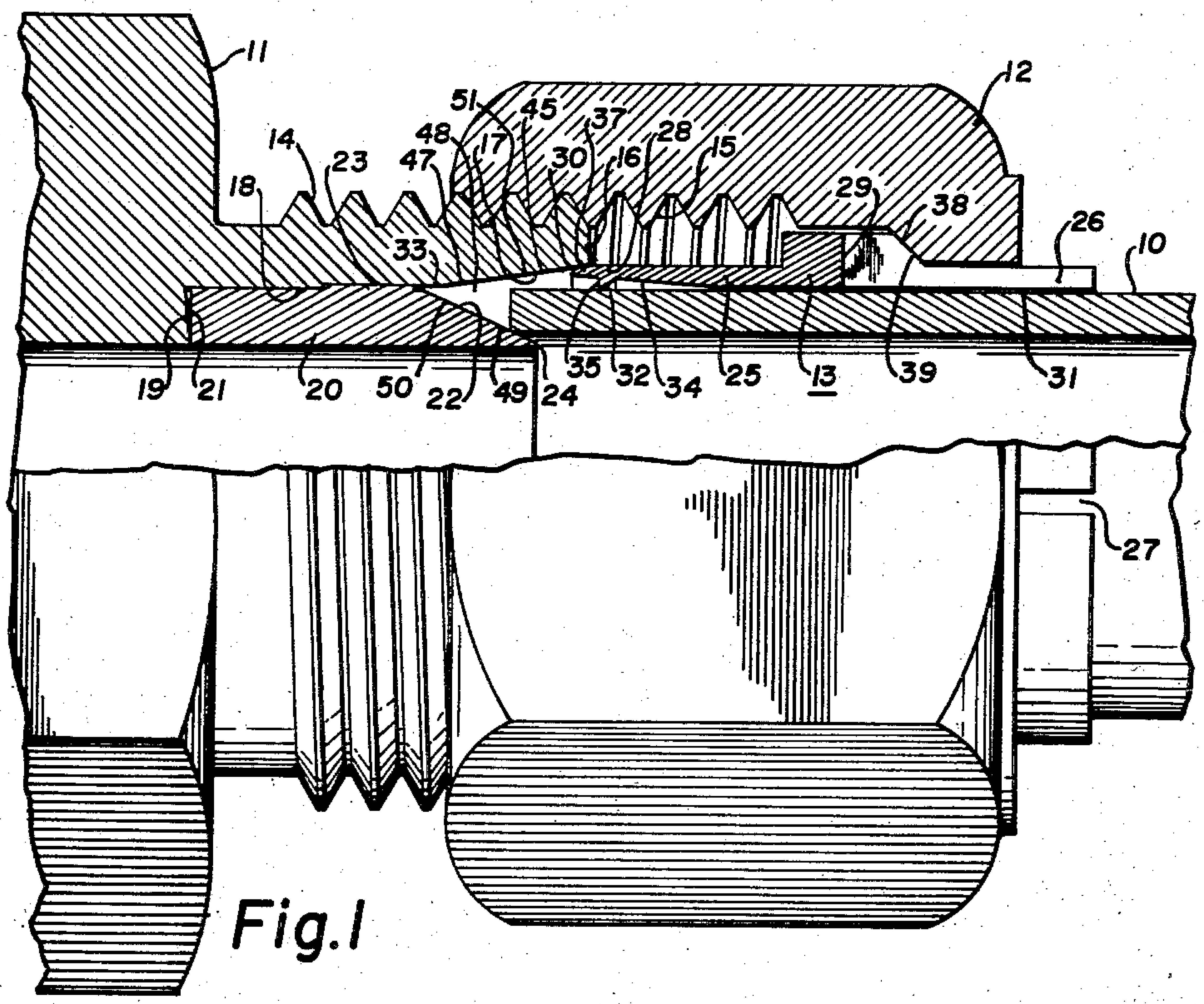


Fig.1

Fig.2

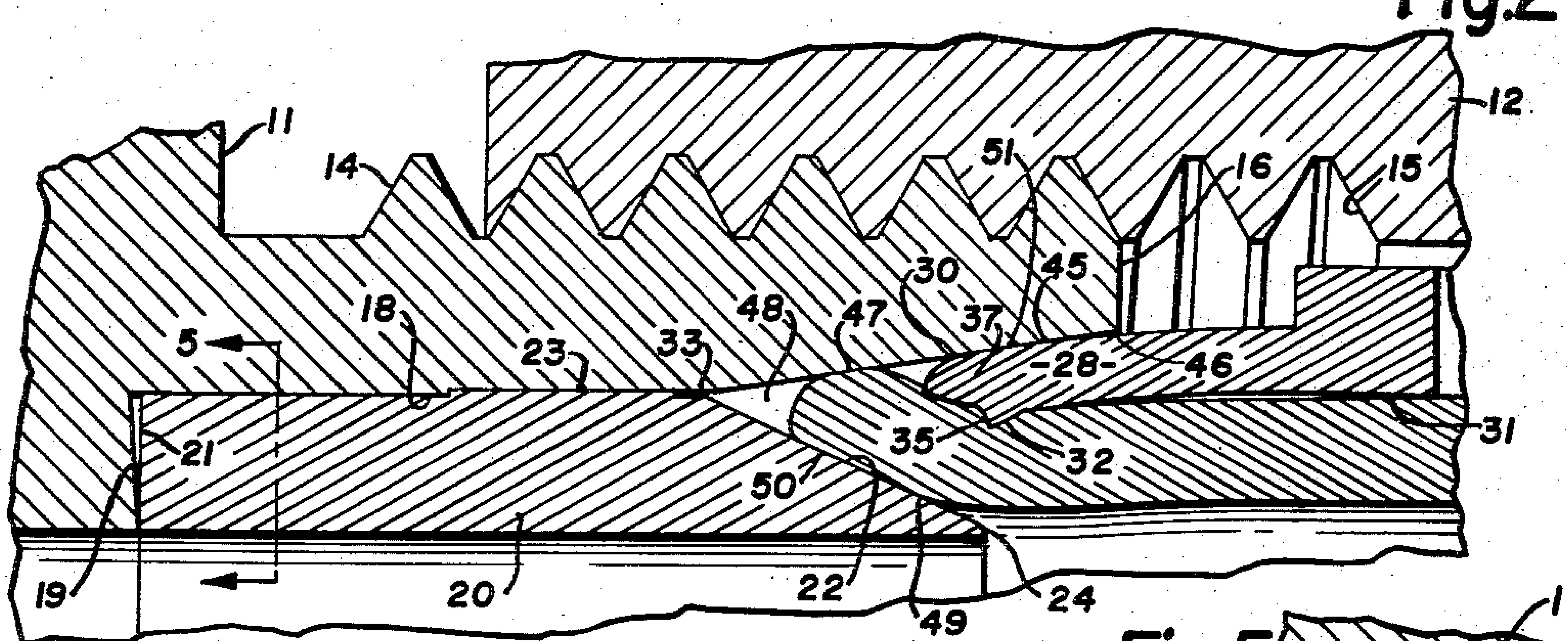
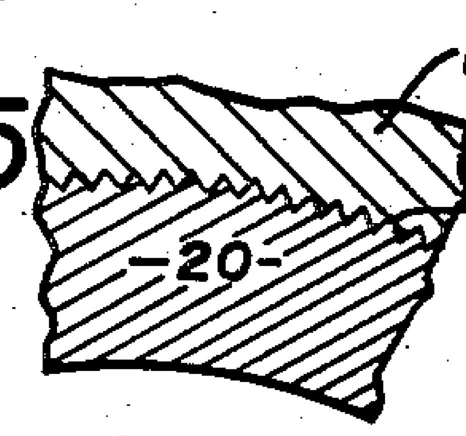


Fig.5



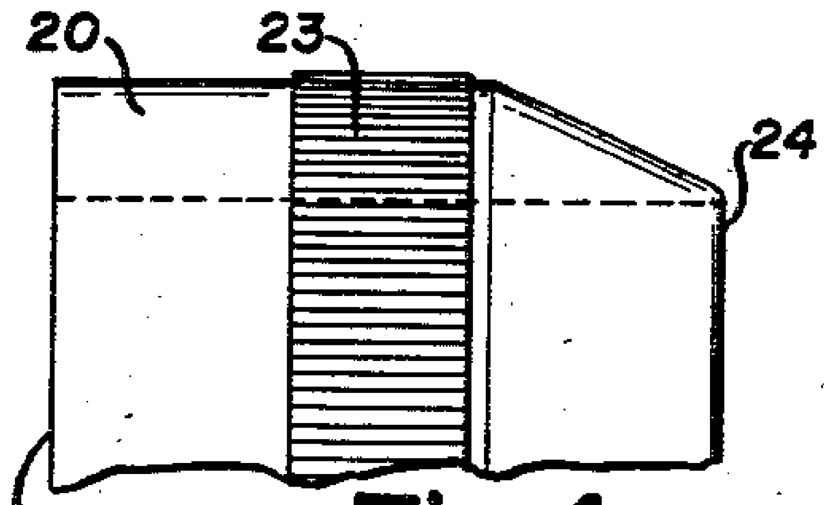


Fig.4

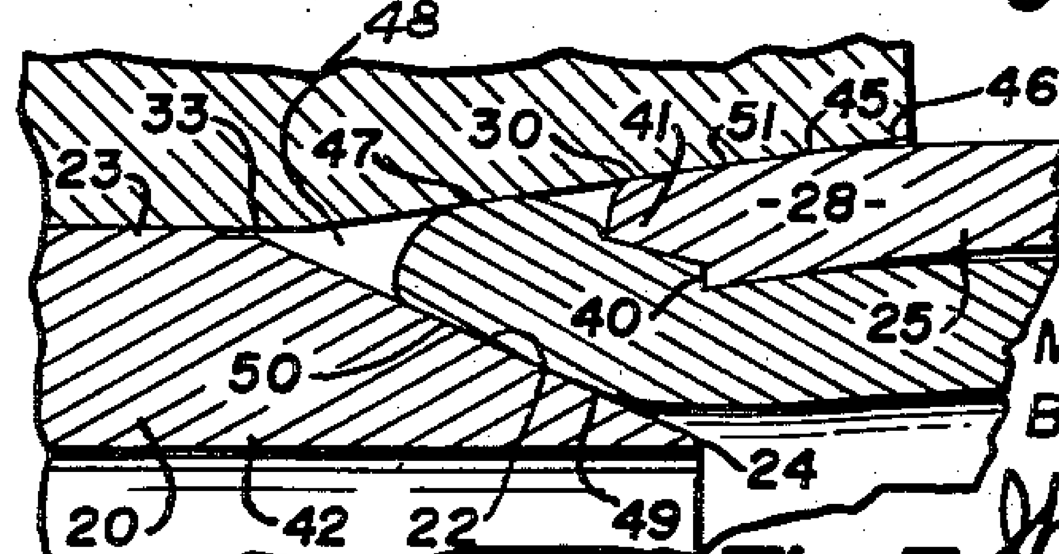


Fig.3

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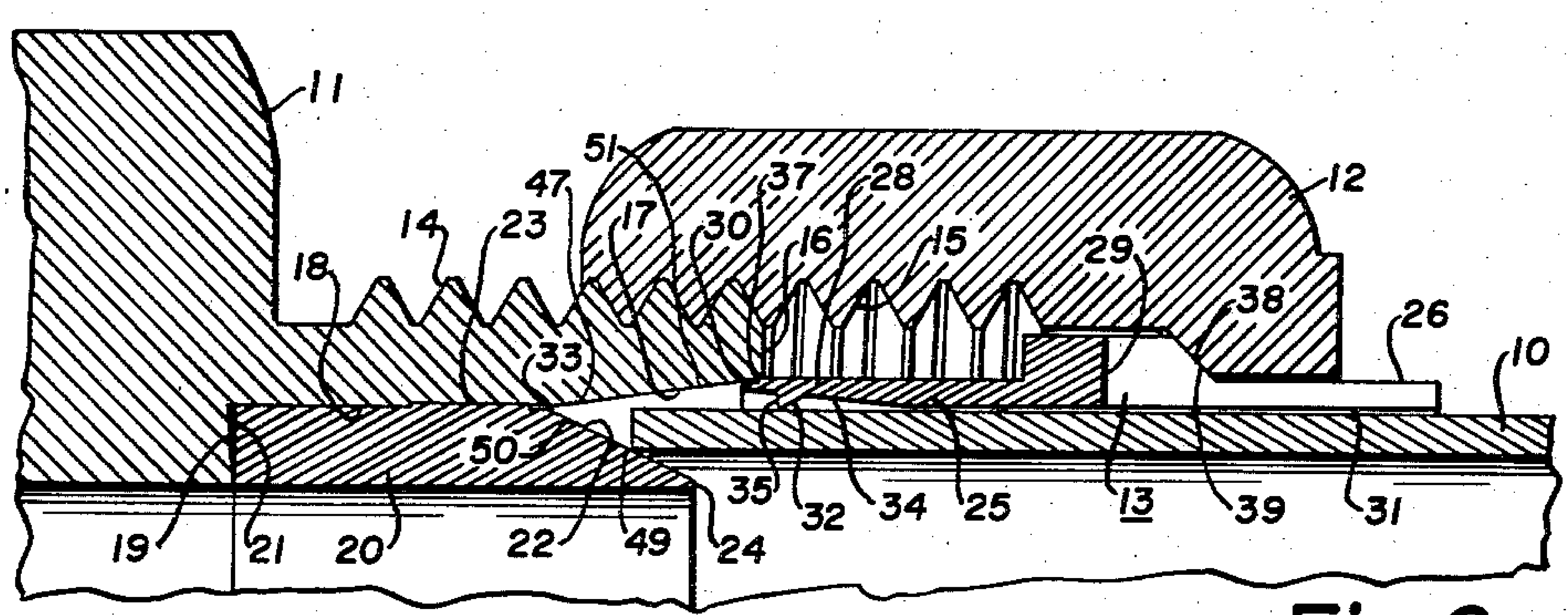

Fig. 6

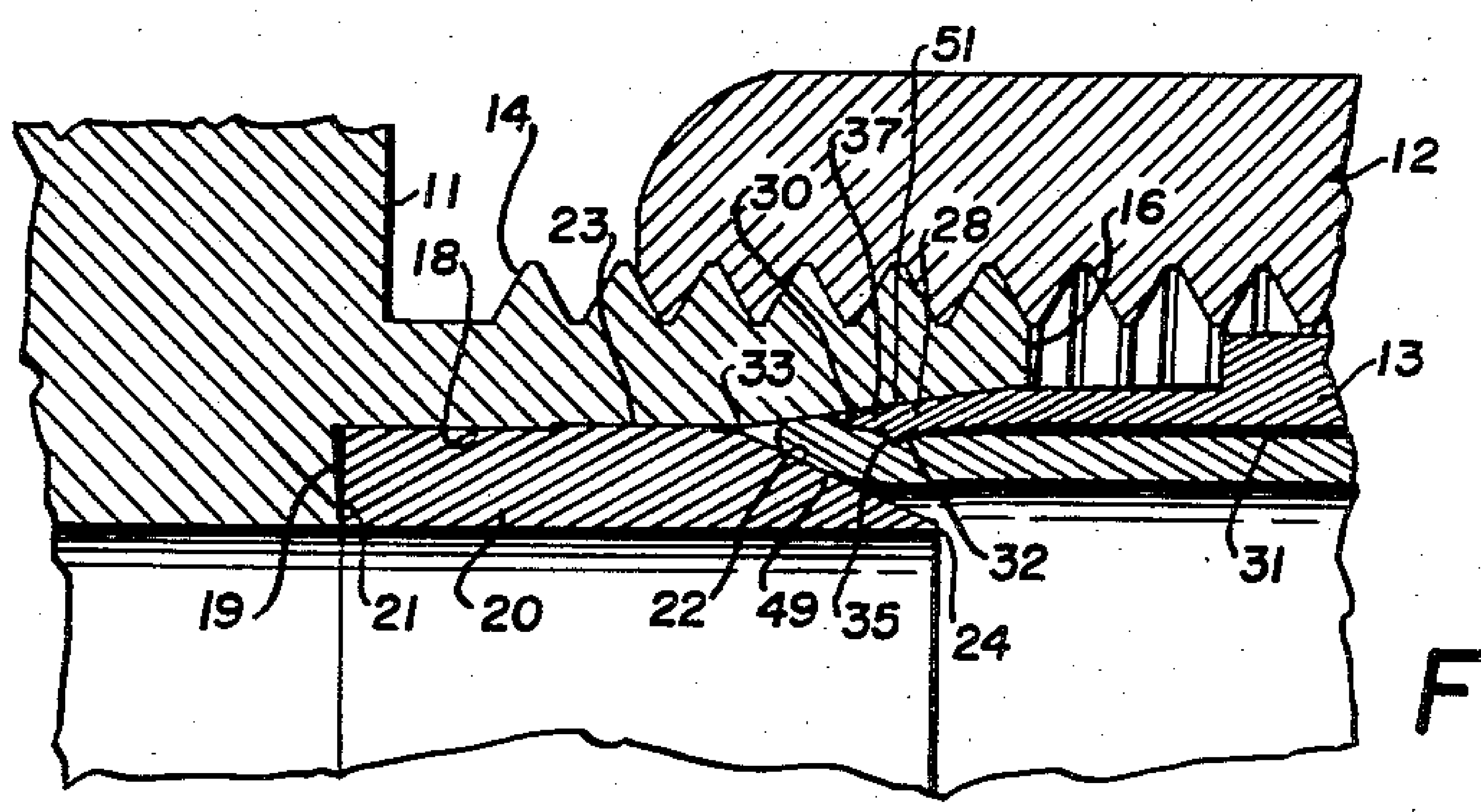

Fig. 7

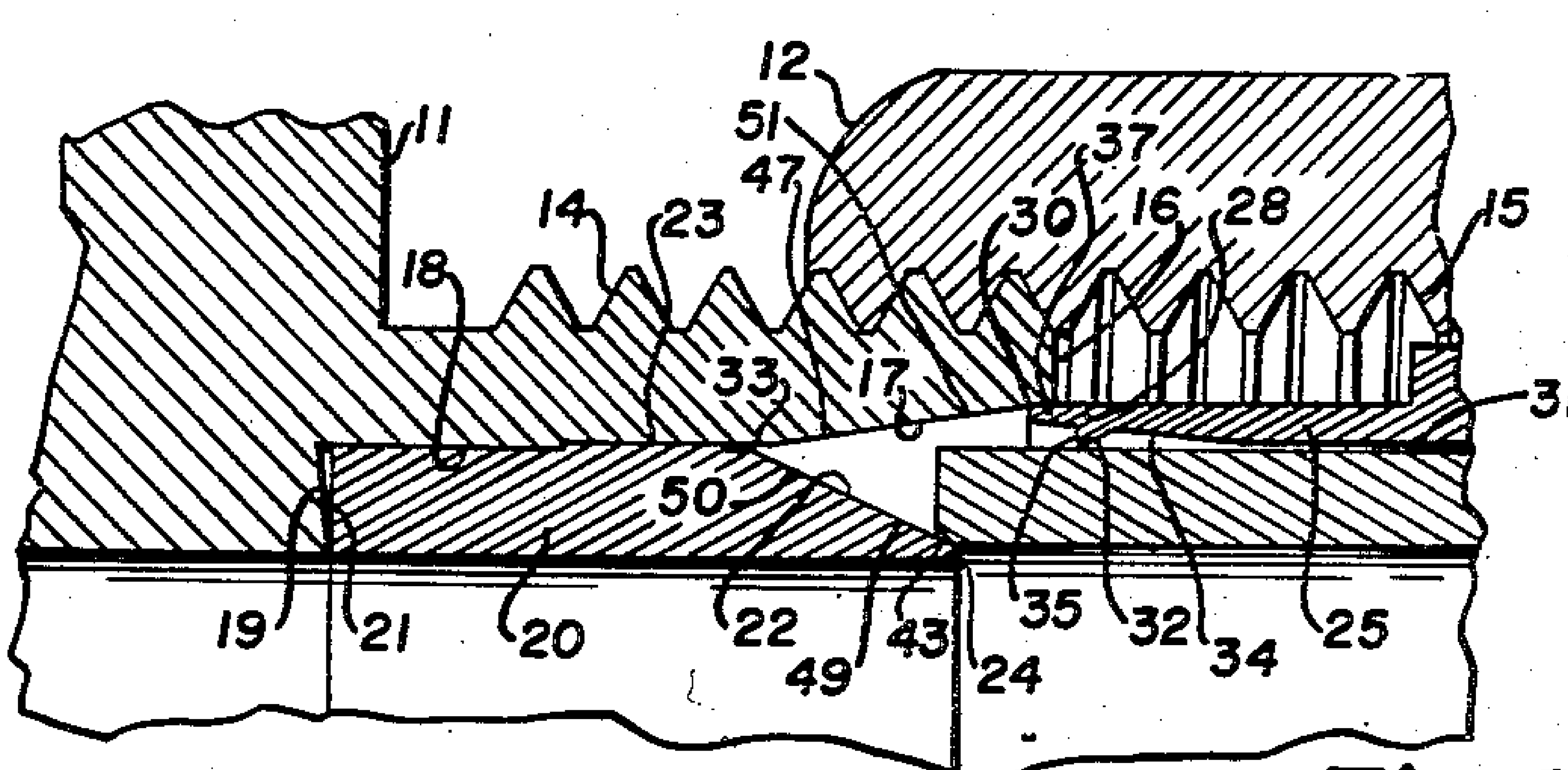

Fig. 8

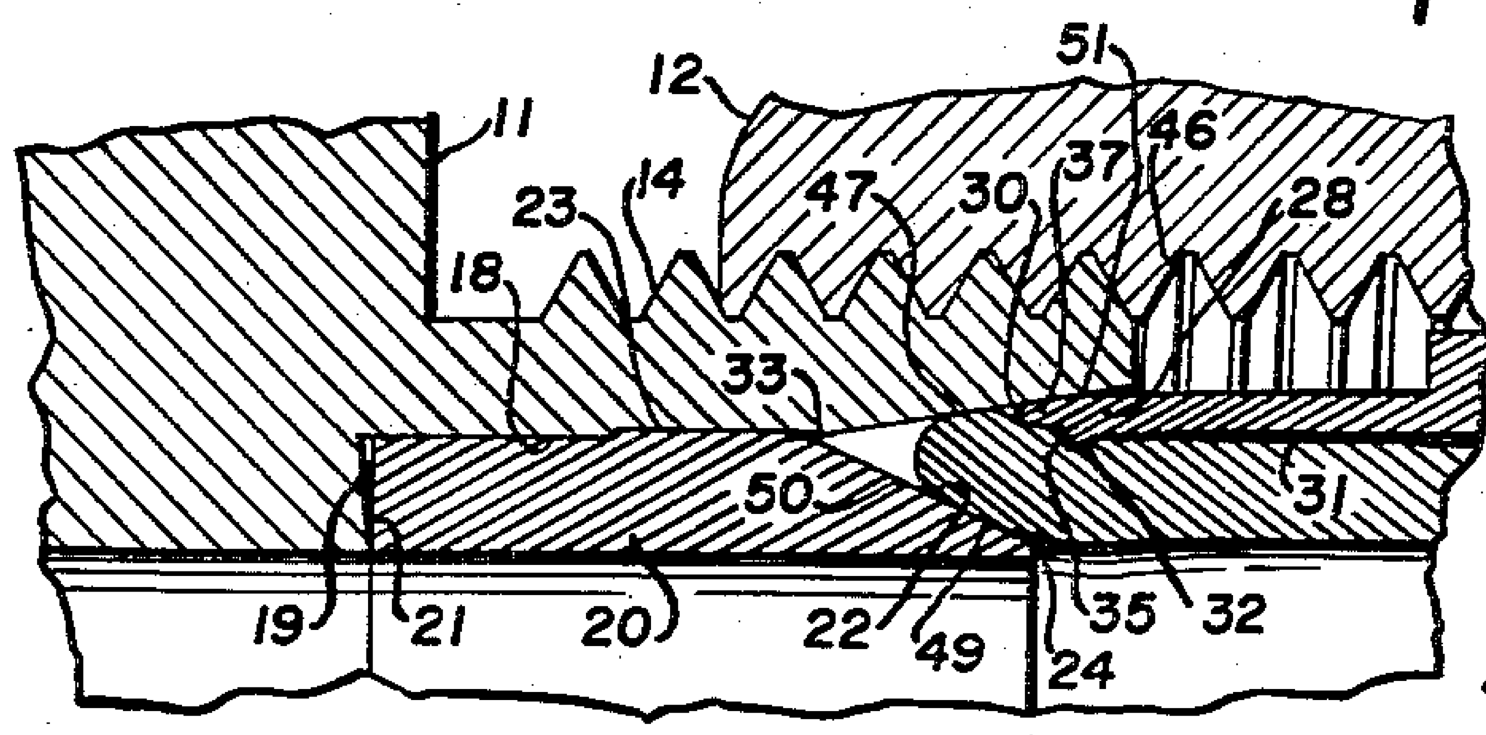

Fig. 9

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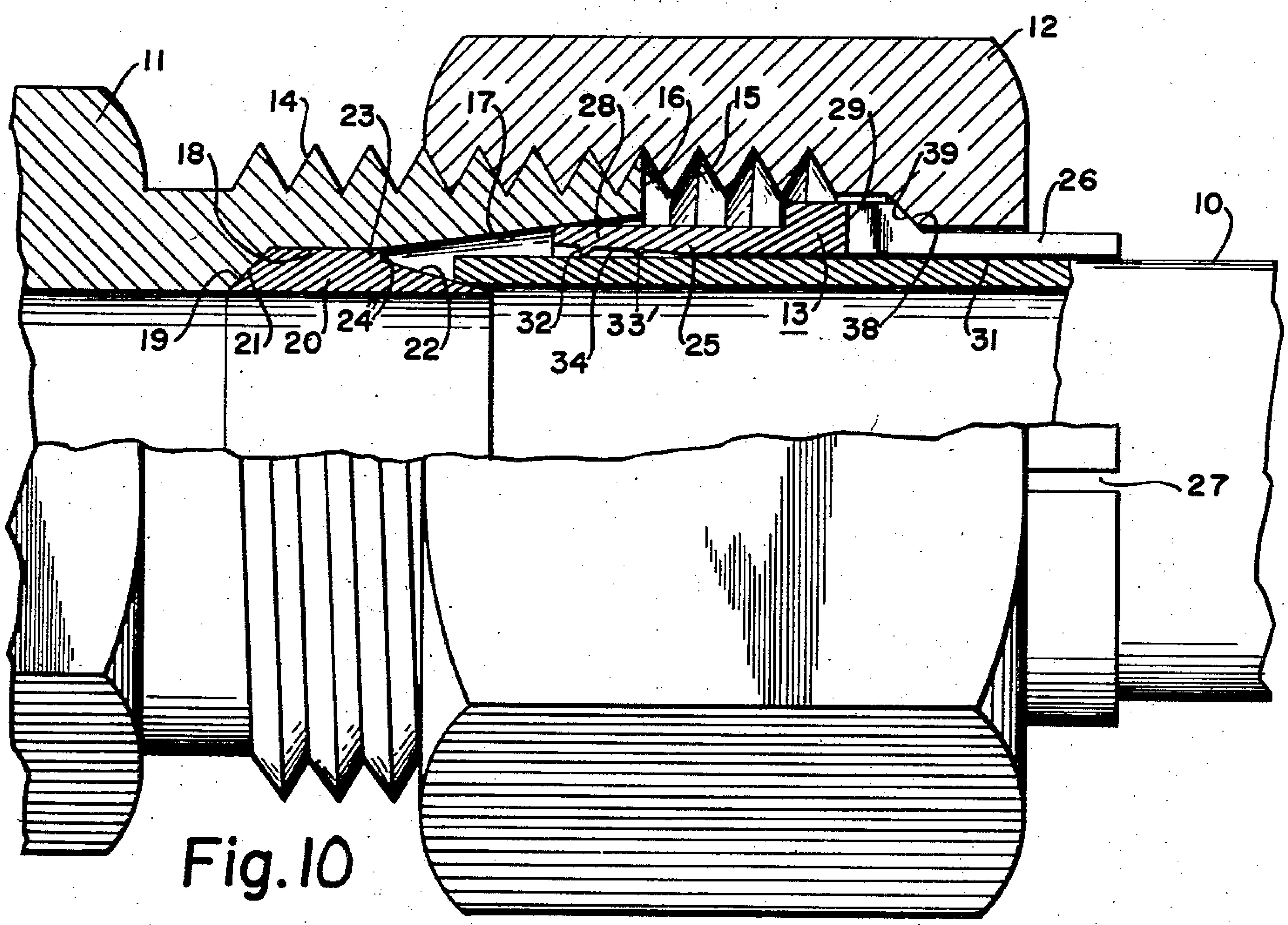

Fig. 10

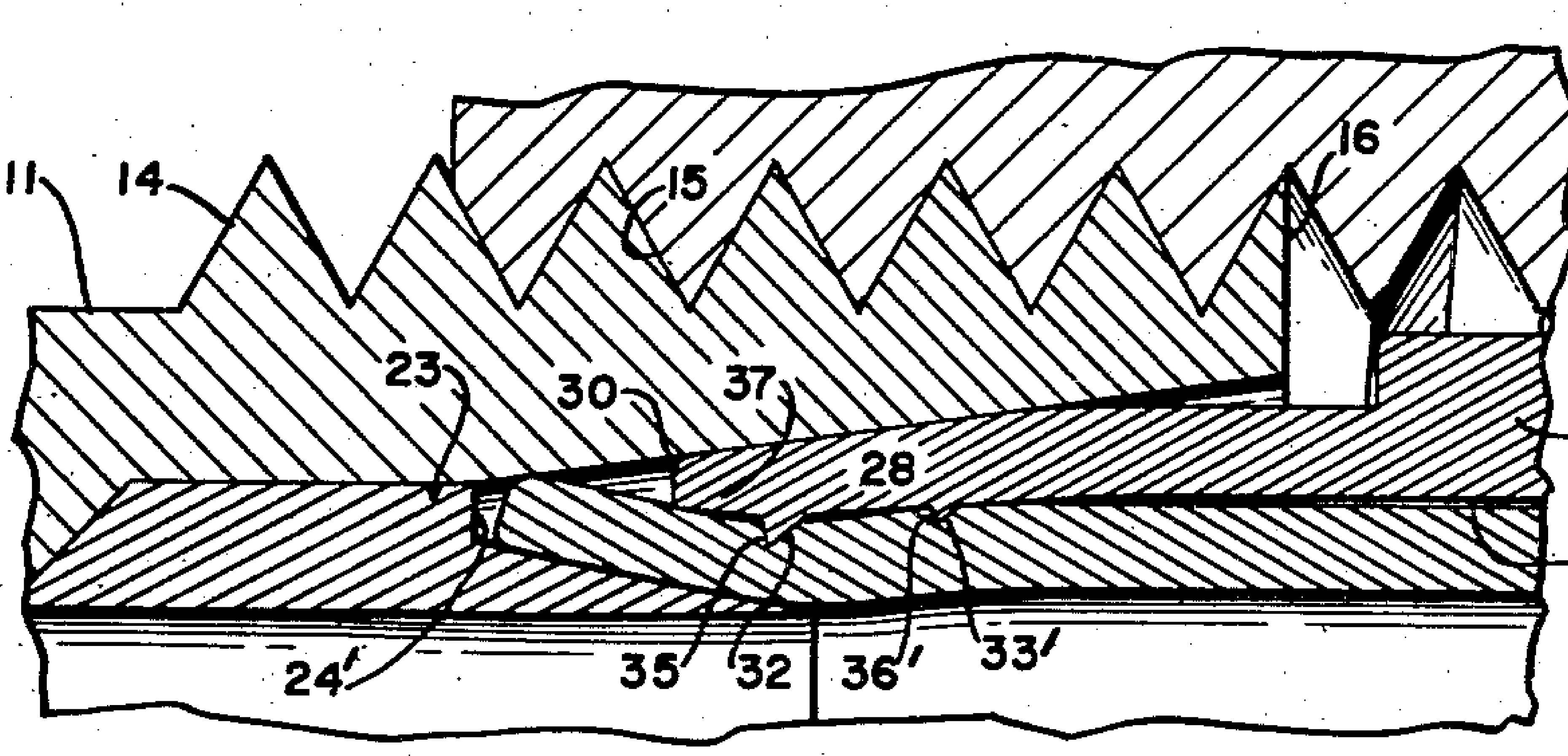

Fig. 11

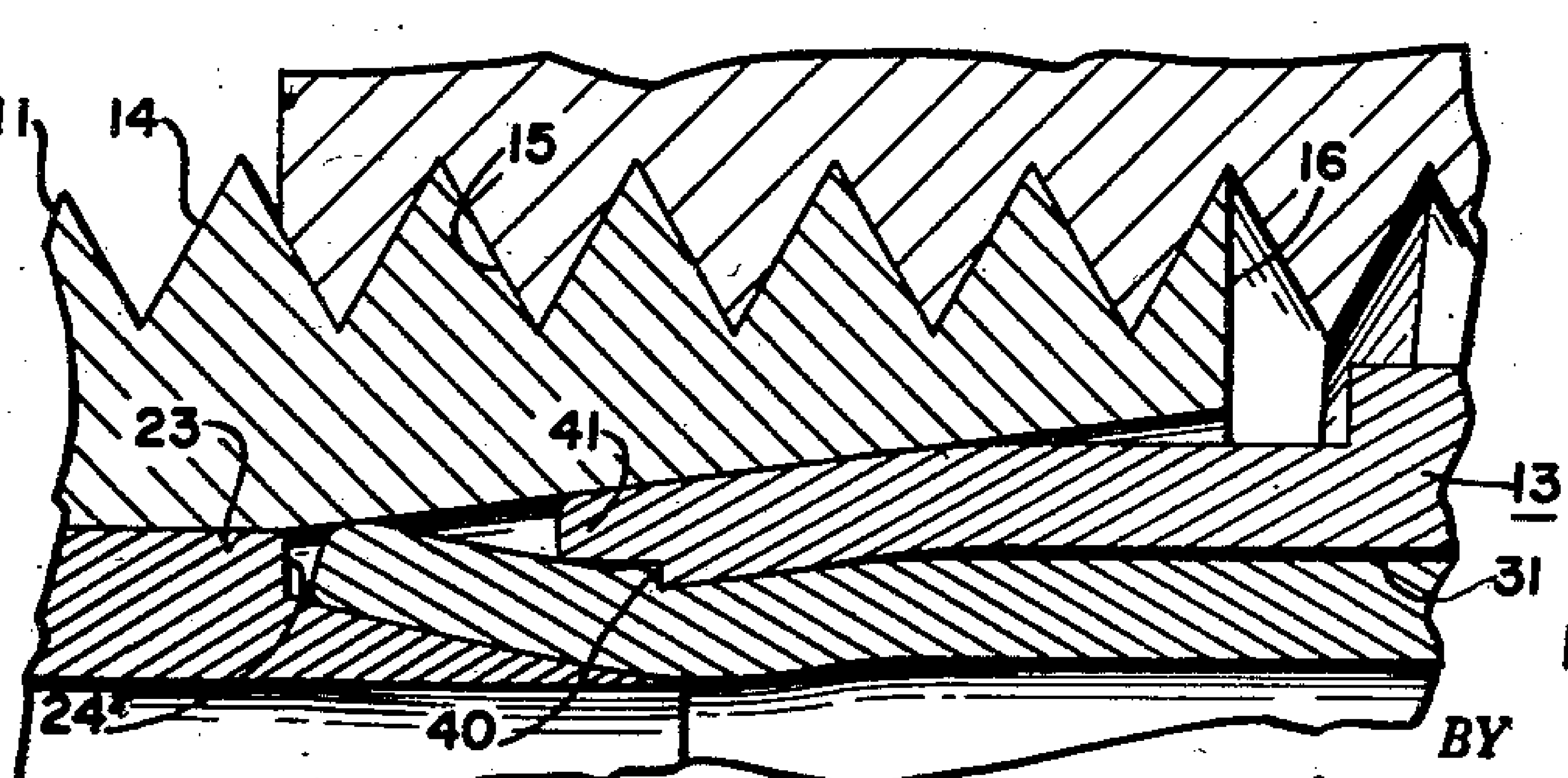

Fig. 12

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United States Patent Office

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DOUBLE SEALED COMPRESSION FITTING

Matthew F. Bauer, Cleveland Heights, Ohio

Application August 12, 1955, Serial No. 528,073

3 Claims. (Cl. 285—341)

My invention relates to tube couplings for connecting a tube to a connection body.

This application is a continuation-in-part of my application, Serial No. 410,352, filed February 15, 1954, for tube couplings.

In the art, there are generally two types of tube couplings, namely, the flare type and the no-flare type. With the flare type of tube coupling, the end of the tube is flared preparatory to assembly and during assembly the flared end of the tube is engaged on opposite sides thereof to make the seal. With the no-flare type of tube coupling, the end of the tube is merely inserted into the no-flare coupling and during assembly a contractible sleeve, which is part of the no-flare coupling, is contracted about the tube to make the seal.

In my invention the tube coupling is a combination of both types of couplings.

An object of my invention is the provision of a tube coupling which during the initial stages of assembly functions as a no-flare type, but which during the latter stages of assembly is converted over to the flare type.

Another object of my invention is the provision of a tube coupling having a contractible sleeve for making a biting engagement with the tube taken in combination with an improved feature of a flare seat upon which the end of the tube is forced for self-flaring the end of the tube in advance of the biting engagement.

Another object is the provision of a tube coupling which provides a "rock-bottom," "hit-home" feeling during the tightening of the nut in assembling the fitting.

Still another object of my invention is the provision of a tube coupling which accommodates tubing having variable wall thicknesses, ranging from a thin wall to a relatively heavy wall.

A still further object is the provision of a tube coupling which may be assembled and disassembled an unlimited number of times.

Another object of my invention is the provision of a tube coupling body having a wedge insert upon which a self-flare is made as the nut is tightened.

Another object of my invention is the provision of a wedge insert having its outside surface knurled so that it may be forcibly pressed or driven into a counterbore in the tube coupling body.

Another object of my invention is the provision of a wedge insert having a laterally extending end wall which abuts against a laterally extending end wall in the tube coupling body, the end wall in the tube coupling body having a reverse slope and sealing engaging the end of the wedge insert at substantially the bore of the tube coupling body.

Another object of my invention is the provision of a wedge insert having a rounded nose at its advance end against which the inside wall of the tube may initially engage.

Another object of my invention is the provision of a tube coupling body having a converging annular walled chamber to receive the end of a tube, the space in advance of the tube being generally triangular in shape.

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Another object of my invention is the provision of a self-flaring tube coupling connection wherein the outside surface of the self-flare makes a sealing engagement with a cam wall against which it is forcibly pressed or coined.

Another object of my invention is the provision of a tube coupling body having a wedge wall which supports the inside of the tube in opposition to the inward camming force of the contractible sleeve which engages the outside of the tube.

Another object of my invention is the provision of a tube coupling body defining a converging annular walled chamber having minimum spaced wall portions arresting the movement of said tube thereinbetween and maximum spaced wall portions arresting the movement of the sleeve and tube as a unit thereinbetween.

Other objects and a fuller understanding of my invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

Figure 1 is an enlarged side view of a tube coupling embodying the features of my invention, the upper part being shown in section to illustrate the relationship of parts prior to the time that the nut is tightened, the view being approximately five times scale for a half-inch tube;

Figure 2 is an enlarged and fragmentary cross-sectional view of the forward end portion of the sleeve shown in Figure 1, the view being approximately 10 times scale;

Figure 3 is a modified form of the forward end portion of the sleeve shown in Figure 2;

Figure 4 is a fragmentary side view of the wedge insert, showing the knurled outer surface portion;

Figure 5 is a fragmentary cross-sectional view, taken along the line 4—4 of Figure 2, showing principally the knurled section;

Figures 6 and 7 are enlarged views of the tube coupling showing the use of a relatively thin wall tubing, the Figure 6 being a view prior to assembly and the Figure 7 being the view subsequent to assembly;

Figures 8 and 9 are enlarged views of the tube coupling showing the use of a relatively heavy wall tubing, the Figure 8 being a view before assembly and the Figure 9 being the view after assembly;

Figure 10 is a modified form of the tube coupling shown in Figure 1;

Figure 11 is an enlarged and fragmentary and cross-sectional view of the forward end portion of the sleeve shown in Figure 10; and

Figure 12 is a modified form of the forward end portion of the sleeve shown in Figure 11 being similar to the sleeve shown in Figure 3.

With reference to Figure 1 of the drawing, my invention comprises generally a coupling or connection body **11**, a coupling nut **12**, and a contractible sleeve **13** adapted to contractibly engage a tube **10**. The coupling body **11** is provided at its right-hand end with male threads **14**, which are adapted to be threadably engaged by female threads **15** provided in the nut **12** for pressing the sleeve into engagement with the tube. The male threads **14** and the female threads **15** constitute connection means for drawing the connecting body **11** and the coupling nut **12** toward each other. As illustrated, the connection body **11** is provided with a laterally extending outer wall or an entrance end portion **16** with substantially a conical opening **45** extending into said body from said outer wall **16**. The conical opening **45** receives the sleeve **13** and the end of the tube **10** and has an internal annular cam surface **17** with a first end portion **46** disposed adjacent the outer wall **16** and a second end portion **47** within the body member disposed longitudinally remote from the outer wall **16**.

The first end portion **46** has a maximum diameter and the second end portion **47** has a minimum diameter. The internal annular cam surface **17** slopes radially inwardly in substantially a straight line from the first end portion **46** to the second end portion **47** and defines an acute angle with respect to the longitudinal axis of the tube. Extending longitudinally beyond the inwardly converging cam surface **17** is a socket or counter bore **18** which is provided with a terminating end surface **19**. The taper of the inwardly converging cam surface **17** may be preferably about nine degrees and preferably may lie in a range of approximately eight to twelve degrees, but may be in a wider range of approximately seven to twenty degrees, measured with respect to the longitudinal axis of the tube.

Mounted in the socket **18** is a wedge insert **20** having an abutting end surface **21** and an annular wedge wall or a flare end surface **22**. In assembly, the insert **20** is pressed into the socket **18** until the abutting end surface **21** abuts against the terminating end surface **19** for making a fluid sealing engagement therebetween. In order to resist longitudinal movement of the insert **20** out of the socket **18**, there is provided a knurled portion **23** which provides longitudinal spaced ribs therearound to make an interlocking engagement with the wall of the counter bore or socket **18**. As the wedge insert **20** is pressed or driven into the counter bore or socket **18**, the smooth or unknurled forward portion acts as a guide and elevated ribs of the knurled portion **23** cut or make their own longitudinal grooves into the wall of the socket or counter bore **18** so that the wedge insert becomes a permanent part of the connection body **11**. The terminating end surface **19** of the socket **18** is disposed at a reverse slope of approximately five degrees so that when the abutting end surface **21** of the wedge insert is pressed against the terminating end surface **19** a good fluid seal is made therebetween at substantially the bore of the connection body **11**. While I preferably use a knurled section to hold the insert **20** in the socket **18**, it is understood that any other suitable means may be employed for this purpose.

When my coupling is used for joining steel tubing to a connection body, I preferably construct the wedge insert **20** of steel which is capable of being quench-hardenable throughout its entire mass and thereafter tempered or drawn back to a hardness value greater than that of the tube. I find that steel known as 4140, heat-treated throughout its entire mass and tempered to a hardness value of approximately 30 to 45 Rockwell, is satisfactory for my insert. When my coupling is used with copper tubing, the insert is preferably constructed of hard brass so that the insert has a hardness value greater than that of the copper tubing. When my coupling is used with stainless steel tubing the wedge insert may be made of hardenable stainless steel. As illustrated, in the drawing, the flare end surface **22** of the insert **20** terminates at its pointed end in a rounded nose **24**. It is to be noted that the outwardly converging cam surface **17** and the annular wedge wall or flare end surface **22** define sides of a substantially triangular space comprising a converging annular walled chamber. The annular wedge wall **22** defines in conjunction with the opening **45** an annular converging space **48** pointing away from the outer wall **16** to receive the end of the tube which extends beyond the contractible end portion of the sleeve **13**. The annular wedge wall **22** has a first end region **49** having a minimum diameter to fit inside the tube and has a second end region **50** with a maximum diameter upon which the end of the tube slides as it is being flared. The annular wedge wall **22** slopes radially outwardly in substantially a straight line from the first end region **49** to the second end region **50** and defines an acute angle with respect to the longitudinal axis of the tube. The internal annular cam surface **17** and the anular wedge wall **22** are angularly disposed with respect to each other and define an acute angle therebetween. The second end portion **47** of the internal annular cam surface **17** and the second end region **50** of the annular wedge wall **22** converge toward each other, and they have surfaces with a radial distance therebetween less than the wall thickness of the tube to wedgingly receive the end of the tube. The internal annular cam surface **17** has an intermediate portion **51** between the first and second end portions **46** and **47**. The intermediate end portion **51** is longitudinally coextensive with and surrounds the first end region **49** of the annular wedge wall **22**.

The sleeve **13** has a bore **31** adapted to surround the tube and comprises a continuous annular body **25** provided with rearwardly extending segmental fingers **26** which grip the tube when the nut is tightened. When my coupling is used with steel tubing, this sleeve is preferably constructed of steel which is capable of being quench-hardenable throughout its entire mass and thereafter tempered or drawn back to a hardness value greater than that of the tube. I find that steel known as 4140, heat-treated throughout its entire mass and tempered to a hardness value of approximately 30 to 45 Rockwell, is satisfactory for my sleeve. When my coupling is used with copper tubing, the sleeve is preferably constructed of hard brass so that the insert has a hardness value greater than that of the copper tubing. When my coupling is used with stainless steel tubing the sleeve may be made of hardenable stainless steel.

In the manufacturing of the sleeve, the fingers **26** are provided by making slots **27** in the rearward section thereof at annularly spaced intervals thereabout. In Figure 1, four slots are used, but any number may be used. The continuous annular body **25** has a leading or forward contractible end portion **28** and a rearward end portion **29**. As illustrated, the end portion **29** constitutes the forward terminus for the slots **27**. The leading or forward contractible end portion **28** has at its forward end a cam surface **30** which engages the inwardly converging camming surface **17** of the connection body **11**. The inside surface of the leading or forward contractible end portion **28** of the sleeve is preferably provided with a major rib **32** which is longitudinally spaced from the end of the sleeve. The inside diameter of the rib **32** is preferably about the same diameter as the bore **31** of the sleeve. In order to provide for making the rib, the inside surface of the forward end portion of the sleeve is recessed at an angle preferably about five degrees, thereby making the recess wall **34**. The depth of the major rib **32** may be in the neighborhood of .012 inch. The rib 32 is provided with forward edge **35** which constitutes a biting edge for biting into the tube.

The forward edge **35** constitutes laterally extending circumferential walls terminating in circumferential cutting edge to bite and make its own grooves into the outside surface of the tube. The forward edge **35** of the rib **32** faces the annular wedge wall **22**. The radial distance between the first end region **49** of the annular wedge wall and the intermediate portion **51** of the internal annular cam surface **17** is less than the lateral wall thickness of the tube plus the lateral thickness of the sleeve between the outer cam surface **30** and the circumferential cutting edge of the rib **32**. The outer cam surface **30** prior to assembly has a diameter less than the maximum diameter of the first end portion **46** of the internal annular cam surface **17** and greater than the minimum diameter of the second end portion **47** of the internal annular cam surface **17** and initially contacts the internal annular cam surface **17** between the first end portion **46** and the intermediate portion **51**.

The portion of the sleeve in advance of the major rib **32** constitutes an auxiliary body or shell **37**. This shell functions to support the outside wall of the tube in advance of the major rib **32**. The intermediate part of the entire sleeve, that is, the rearward end of the continuous annular body 25 and the forward end of the segmental fingers 26 is enlarged to provide a tapered or cam shoulder 38 against which a cam shoulder 39 of the nut engages for pressing the contractible sleeve into the inwardly converging cam surface 17 of the connection body 11. The tightening of the nut against the cam shoulder 38 of the sleeve contracts the segmental fingers about the tube for supporting the tube against vibration. It is to be noted that the cam shoulder 39 on the nut oppositely faces the converging cam surface 17 and the terminating end surface 19 of the socket, as well as the flare end surface 22 of the insert.

In assembly, as the sleeve is pressed forward by the tightening of the nut, the outer annular cam surface 30 of the sleeve forceably engages the inwardly converging cam surface 17 of the connection body and thereby produces a camming action which cams or deflects the leading or forward contractible end portion 28 of the sleeve against the tube. The camming action embeds the rib 32 into the tube. The rib 32 makes its own groove in the outer surface of the tube so that as the nut is further tightened, the end of the tube is forced into the triangular space with the inner surface of the tube riding upwardly upon the annular wedge wall or flare end surface 22 of the insert for self-flaring the end of the tube in advance of the major rib 32.

From the above description, it is noted that the coupling during the initial stages of the assembly operates as a no-flare fitting, whereby the outside and inside walls of the sleeve make fluid sealing engagement respectively with the converging cam surface 17 of the connection body 11 and the outside surface of the tube. As the nut is further tightened during the final stages of the assembly of the coupling, the inside surface of the tube rides up upon the annular wedge wall or flare end surface 22 for flaring the tube, whereby another seal is effected between the tube and the insert 20. In other words, during the final stage of assembly, the flare end of the tube is pressed between the sleeve and the annular wedge wall or flare end surface 22 of the insert 20. The force of the end of the tube against the annular wedge wall or flare end surface 22 forces the entire insert into the socket 18, whereby the abutting end surface 21 of the insert makes good fluid seal engagement with the terminating end surface 19 of the connection body 11.

The circumferential cutting edge of the rib 32 cuts its own grooves into the outside surface of the tube with the laterally extending circumferential wall 35 pressing against the side wall of the groove. The laterally extending circumferential side wall 35 of the rib and the side wall of the groove against which it presses provide a driving engagement between the tube 10 and the sleeve 13 thereby carrying the tube along with the sleeve forcing the inside surface of the end of the tube with a wedging movement against the annular wedge wall 22 to flare the end of the tube in advance of the circumferential cutting edge 35 of the rib 32. The flaring of the end of the tube permits the sleeve 13 and the tube 10 carried therealong to move farther into the conical opening 45 for pressing the end of the tube wedgingly into the converging space between the second end portion 47 of the internal annular cam surface 17 and the second end region 50 of the annular wedge wall 22 with the outside surface of the tube making a wedging contact against the second end portion 47 of the internal annular cam surface 17 and the inside surface of the tube making a wedging contact with the second end region 50 of the annular wedge wall 22. These wedging contacts limit the movement of the tube into the converging space between the second end portion 47 of the internal annular cam surface 17 and the second end region 50 of the annular wedge wall 22. The flaring of the end of the tube also permits the sleeve 13 and the tube 10 carried therealong to move farther into the conical opening 45 for pressing the tube and the contractible end portion 28 of the sleeve wedgingly into the converging space between the first end region 49 of the annular wedge wall 22 and the intermediate portion 51 of the internal annular cam surface 17 with the outer surface on the sleeve making a wedging engagement against the intermediate portion 51 of the internal annular cam surface 17 and with the inside surface of the tube making a wedging engagement with the first end region 49 of the annular wedge wall 22. These first and second wedging engagements in combination with the driving engagement between the laterally extending circumferential wall and the side wall of the groove against which it presses arrest the movement of the sleeve 13 into the converging space between the intermediate portion 51 of the internal annular cam surface 17 and the first end region 49 of the annular wedge wall 22. The circumferential cutting edge of the rib 32 upon final assembly of the tube is laterally spaced from the first end region 49 of the annular wedge wall 22 for a distance which is less than the lateral distance of the wall thickness of the tube.

During the final stages of assembly, the shell 37 functions as a preformed chip, filling substantially all the small triangular space between the outside surface of the tube and the inwardly converging cam surface 17, with the result that there is no more space into which loose metal from the tube in advance of the major rib 32 may flow when an extraordinarily heavy force is applied to the tightening of the nut. The wall thickness of the shell 37 may be .010 inch to .020 inch and the length thereof may be preferably about 1/32 inch or slightly longer. In actual observation, with a coupling cut in section, the small triangular space is substantially undiscernible, because the metal under pressure tends to flow somewhat to make the triangular space in actual construction smaller than it appears upon the drawing, which does not take into account the flow of the metal under pressure. Inasmuch as the annular wedge wall or flare end surface 22 supports the end of the tube, the coupling may be assembled and disassembled an unlimited number of times because upon each assembly, the joined parts produce a "rock-bottom," "hit-home" feeling to the nut, since there is no substantial space into which the metal which is under sealing pressure may flow.

Figure 2 shows the parts in the assembled condition with the view enlarged. In Figure 3, I show a modified form of the leading or forward end portion of the sleeve in that the ribs have been replaced by a forward biting edge or shoulder 40 which bites into the tube for making a sealing engagement therewith. The action of the forward biting edge 40 after it makes its own groove into the tube is substantially the same as that for the ribs. The shell 41 is also provided in advance of the forward biting edge 40 in order to support the metal of the tube in advance of the biting edge, as well as to substantially seal the small triangular space between the outside surface of the tube and the inwardly converging cam surface 17 of the connection body. The assembly of the coupling with the modified sleeve in Figure 3 is the same as that for the sleeve shown in Figures 1 and 2.

From the foregoing description, it is noted that my coupling is a combination of both the flare and the no-flare types of couplings, and I obtain the advantages of each while overcoming their disadvantages. Thus, I avoid the necessity for flaring the tube in advance of assembly of the coupling as would be necessary with a flare fitting and I overcome the disadvantage of the no-flare fitting in that I obtain a "rock-bottom," "hit-home" feeling when tightening the nut for repeated assembly of the fitting.

In Figures 1, 2, and 3 of the drawing, the wall thickness of the tubing is approximately .049 inch. With my assembled coupling cut in section and under actual observation, the end of the tube would have a small triangular space 48 in advance thereof. The Figures 6 and 7 show the use of my coupling with tubing having a wall thickness of approximately .035 inch. Here the triangular space 48 in advance of the end of the tube is somewhat smaller than it is in Figures 1, 2, and 3. The Figures 8 and 9 show the use of my coupling with tubing having a wall thickness of approximately .065 inch. In this instance, the triangular space 48 in advance of the end of the tube is somewhat larger than it is in Figures 1, 2, and 3.

My tube coupling accommodates tubing having a wide range of wall thicknesses. One aspect of the invention is that regardless of the wall thickness of the tubing, the distance between the forward end of the tube and the forward end of the sleeve bears about the same relation to each other in the assembled fitting. One would ordinarily conclude that this relationship could not be, and it is difficult to explain the reason therefor. Regardless of the explanation, it is to be pointed out that the rib 32 or the biting edge 40 of the sleeve makes a driving connection between the sleeve and the tube. This driving connection forces the forward end of the tube against the flared wedge wall 22 and thereby self-flares the end of the tube. At the same time, the forward end of the tube is coined or pressed into the triangular space 48. As the forward end of the tube is pressed into the triangular space 48, the outside surface of the forward end of the tube is coined between 47 and 50 and possibly extruding the wedged end of the tube therebetween with the result the end of the tube becomes tapered and elongated. In actual practice, the outer surface of the tube at the forward end thereof at 47 becomes tapered and burnished as the nut is tightened, providing a first perfect sealing area between both sides of the tube against the minimum spaced wall portions 47 and 50.

In the final assembly of the tubing, the minimum spaced wall portions between 47 and 50 arrest the forward movement of the tube therebetween, into the triangular space 48. One novelty of the connection is that the forward end of the tube is arrested in its forward movement between the minimum spaced wall portions 47 and 50, while the sleeve and tube as a unit is arrested in its forward movement between the maximum spaced wall portions 51 and 49, providing a second perfect sealing area.

It is to be noted that the invention has a first perfect sealing area for the tube alone between 47 and 50 and a second perfect sealing area for the tube and sleeve as a unit between 51 and 49. These two perfect sealing areas are longitudinally spaced apart and both sealing areas reside between tapered wedging surfaces, namely, the cam wall 17 and the wedge wall 22. Ordinarily when an attempt is made to match machine tolerances to obtain two perfect sealing areas at two longitudinally spaced tapered regions, such as shown in this invention, difficulty arises from the inability to match such tolerances. Both areas do not effect their seal simultaneously. Usually one area "hit-home" or seals before the other. In this invention, the matching of tolerances is accomplished automatically and constitutes one of the unexpected results of my invention. The problem of matching tolerances becomes all the more complex when it is realized that my fitting accommodates tubing having varying tube wall thicknesses. One explanation for the automatic accommodation of matching tolerances arises from two facts: (1) that the coining of the end of tube at 47 allows the end of tube to wedgingly move forward into triangular space 48, and (2) that probably with tubing of different wall thicknesses, the rib 32 or the biting edge 40 may variably skid or move longitudinally with respect to the tube so that a first perfect seal is made at the end of the tube between 47 and 50 simultaneously with the making of a second perfect seal for the sleeve and tube as a unit between 51 and 49. No determination can be made as to whether such variable skidding takes place and no determination can be ascertained as to what otherwise might take place when my tube coupling is being assembled, but I do know from actual observation that a first perfect seal is made at the end of the tube between 47 and 40 and a second perfect seal is made with the sleeve and tube as a unit between 51 and 49.

It must be understood, however, that the first and second perfect seals could not be effected unless the minimum spaced wall portions 47 and 50 arrested the forward movement of the tube therebetween, and unless the maximum spaced wall portions 51 and 49 arrested the forward movement of the sleeve and tube as a unit therebetween. This relationship holds true for tubing of variable wall thicknesses. When the first and second perfect seals are effected at the two spaced regions, the nut has a solid "rock-bottom," "hit-home" feeling.

The matching of tolerances to provide the first and second perfect seals at different longitudinally spaced regions becomes all the more inexplicable because with the thin wall tubing, as shown in Figures 6 and 7 for example, the end of the tube rides higher on the wedge wall 22 than does a thick wall tubing, as shown in Figures 8 and 9. At the same time, the entrance engagement of the forward end of the sleeve into the cam wall 17 is the same for both a thin wall tube and a heavy wall tube. Therefore, the distance between the forward end of the tube and the forward end of the sleeve in Figure 6 is longer than the distance between the forward end of the tube and the forward end of the sleeve in Figure 8. Yet in the final assembly of the two different wall thicknesses of tubing, as shown in Figures 7 and 9, respectively, the first perfect seal is effected at the forward end of the tube between 47 and 50 and a second perfect seal is effected with the tube and sleeve as a unit between 51 and 49. Just how the parts become juxtaposed to provide the first and second perfect seals with both a thin wall tube and a heavy wall tube, and accommodate themselves to the cam wall 17 and the wedge wall 22, is not fully understood except that it constitutes an unexpected result. Even though a thin wall tube and a sleeve may not start out in the same juxtaposition as a thick wall tube and a sleeve may start out, still in final assembly they both end up making a first perfect seal between 47 and 50 and a second perfect seal between 51 and 49.

This illustrates the fact that the ratio of the distance between the biting edge of said sleeve and the end of said tube on a thin walled tube before and after assembly of the coupling connection is greater than the ratio of the distance between the biting edge of the sleeve and the end of said tube on a thick walled tube before and after assembly of said coupling connection.

The cam wall 17 and the wedge wall 22 slope toward each other and define substantially a triangular apex meeting at a point 33 lying in a diameter substantially the same as the outside diameter of the tube. The diameter at the region 47 where the end of the tube engages the cam wall 17 is greater than the diameter where the apex meets at the point 33. The diameter for the region 51 where the outside surface of the sleeve engages the cam wall 17 is greater than the diameter of the region 47. The distance between 47 and 50, which defines the minimum spaced wall portions, has a radial dimension less than the wall thickness of the tube, with the result that there is always a triangular space 48 in advance of the end of the tube. The distance between 51 and 49, which defines the maximum spaced wall portions has a radial dimension less than the combined lateral wall thickness of the tube and the sleeve as a unit, including the biting edge of the rib 32 or the biting shoulder 40, with the result that the rib or biting shoulder is always forced to penetrate the wall of the tube and makes a driving connection therewith.

The insert 20 has a bore 42 which meets with the wedge wall 22 and defines a substantially triangular end. The end as shown in the drawings is rounded at 24 to give additional strength at the apex region and to facilitate the insertion of a tube thereagainst. In Figure 8 the inside edge of the tube has been chamfered at **43** in order to effect an enlargement so that the tube may slide upon the wedge wall **22**.

The angle which the annular wedge wall or flare end surface **22** makes with the longitudinal axis of the fitting is preferably about 25 degrees and may lie in a range in the neighborhood of 15 to 45 degrees. The forward edge of the major rib **32** and the forward edge **40** of the step for the sleeve in Figure 3 is in the neighborhood of .012 inch, and is always less than the thickness of the tube to be joined. The forward shell **37** in Figures 1 and 2 and the forward shell **41** in Figure 3 limit the penetration of the edges into the tube. Also in all views of the drawing, the biting edge of the major rib **32** and the edge **40** of the sleeve shown in Figure 3 make their own grooves into the tube and encircle the flare end surface of the insert so that the metal of the tube which is pressed therebetween is firmly anchored by the biting engagement. In other words, the biting engagement of the sleeve when the coupling is assembled is supported on both sides of the tube. The function of the forward shell in advance of the biting engagement is to aid in limiting the penetration of the biting edges in the tube so as to prevent cutting off the tube. It is to be noted that the biting engagement is essential in assembling the coupling in that there is always positive assurance that the end of the tube is forced to ride upon the flare end surface, guaranteeing a perfect seal each time that a connection is made.

The modified form of the tube coupling illustrated in Figures 10, 11 and 12 embody essentially the same structure as shown in Figures 1 through 9. Like parts in Figures 10 through 12 have been indicated by the same reference numerals utilized in Figures 1 through 9 and where the structure differs, different reference numerals have been utilized. The sleeve **25** shown in Figures 10 and 11 differs from that shown in Figures 1, 2 and 3 in that a second rib **33′** has been added in addition to the rib **32**. The reference numeral **24′** indicates the most axially inner end of the annular converging space **48** and the numeral **36′** is the forward edge of the rib **33′**. The insert **20** is essentially the same except for a slightly different shape and has been indicated however with the same reference numerals. The annular converging space **48** illustrated in Figures 1, 2 and 3, as well as in Figures 10, 11 and 12 may also be referred to as an annular tapered end portion. The use of the term "annular tapered end portion" includes that shown in Figures 1 through 3, as well as that shown in Figures 10 through 12. The structure in Figures 10 through 12 differs in that the cam wall and the wedge wall do not come to a sharp point. However, if these two walls were extended, they would meet in a sharp point or apex.

The drawings are drawn to scale for a one-half inch tubing and the relationship of the parts, dimensions and angles represent the invention in its preferred form. The angle for the cam wall **17** and for the wedge wall **22** remain substantially the same as shown on the drawings for different tubing diameters. The wall thickness of the sleeve remains substantially the same as shown on the drawings for different tubing diameters.

Although this invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. A coupling connection between a connection body having a flow bore and a tube having an inside and an outside annular surface, a sleeve having a bore with said tube extending therethrough, said sleeve having a contractible end portion beyond which the end of said tube extends, said contractible end portion of said sleeve having an annular inside and outside surface and a circumferential wall extending in a generally radially inwardly direction and terminating in a circumferential biting edge at the axial inner end portion of the sleeve capable of biting into the outside surface of said tube and effecting a driving connection therewith, said connection body having an axially directed inwardly converging annular walled chamber having outer cam and inner wedge side walls both sloping relative to the longitudinal axis of said body and toward each other with said side walls defining substantially an annular tapered end portion at their axial inner ends, the tapered end portion of said annular walled chamber having a radial distance between the side walls thereof which is less than the radial distance between the inside and outside surfaces of said tube, the axial outer ends of said outer cam wall and said inner wedge wall having respectively diameters at least equal to the outside diameter of the axial inner end of said contractible end portion of said sleeve and no greater than the diameter of the inside surface of said tube, said cam wall at said axial inner end thereof having a diameter that is closer to that of the outside surface of an unflared tube than to that of the outside surface of the axial inner end of said contractible end portion of said sleeve, said outer cam wall being axially longer than said wedge wall whereby with said unflared tube engaging said wedge wall said axial inner end of said contractible end portion of said sleeve will engage said cam wall at an initial contact place axially spaced outwardly from the end of said tube, said cam wall between said initial contact place and said axial inner end thereof sloping to define an acute angle at substantially all places therealong with respect to the longitudinal axis of the tube, said inner axial end of said cam wall terminating axially inwardly of said outer axial end of said wedge wall, forcing means engaging said sleeve axially outwardly of said biting edge for forcing the outside surface of said contractible end portion of said sleeve against the cam wall of said annular walled chamber and camming the circumferential biting edge of said sleeve into said tube supported upon said wedge wall with said biting edge engaging said tube axially outwardly of the end of said tube and thereby providing said driving connection therewith, said wedge wall supporting said tube in opposition to said camming force and causing said wedge wall to flare the end of said tube, said forcing means, upon the circumferential biting edge of said sleeve engaging said tube, forcing the end of said tube axially into said tapered end portion of said annular walled chamber with the bore of said tube in communication with said flow bore of said connection body and forcing the sleeve and tube as a unit forwardly in between said walls, said tapered end portion of said chamber arresting the forward movement of the end of said tube with the outer peripheral edge of the axial inner end of said tube being deformed by and forming a wedging contact against said cam wall to provide a first annular fluid seal means, said outer cam and inner wedge walls arresting the forward movement of said sleeve and said tube as a unit thereinbetween with said sleeve wedging itself between said tube and said cam wall to provide a second annular fluid seal means including an inner fluid seal between the circumferential biting edge of said sleeve and said tube and an outer fluid seal between the outside surface of said contractible end portion of said sleeve and said cam wall, and said first fluid seal being in advance of said sleeve and axially spaced therefrom with a portion of the outside surface of said tube disposed between said sleeve and said first fluid seal.

2. A coupling connection as claimed in claim 1, where-

in the angle of the cam wall against which the outer surface of the end of the tube engages at said first fluid seal means and the angle of the cam wall against which the outside surface of said contractible end portion of said sleeve engages at said outer fluid seal are substantially the same.

3. A coupling connection as claimed in claim 1, wherein the outer cam and inner wedge walls and movement of the sleeve and tube therein under urging of said forcing means effecting a juxtapositioning of said sleeve and tube relative to said walls thereby causing the ratio of the distance between the biting edge of said sleeve and the end of said tube on a thin walled tube before and after assembly of said coupling connection to be greater than the ratio of the distance between the biting edge of said sleeve and the end of said tube on a thick walled tube before and after assembly of said coupling connection.

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