PATENT SPECIFICATION

(11) 1 579 439

1 579 439

(21) Application No. 38147/77 (22) Filed 13 Sept. 1977
(31) Convention Application No. 741 167 (32) Filed 12 Nov. 1976 in
(33) United States of America (US)
(44) Complete Specification published 19 Nov. 1980
(51) INT. CL.³ E21B 10/08 // B23K 15/00 26/00
(52) Index at acceptance
E1F 31B
B3R 32B 36 37A3

(19)

(54) ROTARY ROCK BIT WITH THE BEARING PIN FUSED TO THE ROCK BIT ARM

(71) We, DRESSER INDUSTRIES, INC., a corporation organized under the laws of the State of Delaware, United States of America, of the Dresser Building, Elm & Akard Streets, Dallas, Texas, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates, in general, to the art of earth boring and more particularly to rotary rock bits.

A rotary rock bit comprises at least one rock bit arm adapted to be connected to a rotary drill string, with a rotary cutter mounted on a bearing pin extending from the rock bit arm. The cutter contacts the formations during drilling operations to form a borehole.

A seal unit may be positioned between the cutter and the bearing pin or rock bit arm in order to provide a seal between the rock bit arm and the cutter to maintain lubricant within the bearing area and prevent fluids in the borehole from entering the bearing area. The seal should run against a smooth surface in order to maintain the integrity of the seal. The cutter movement during drilling is complex and includes rapid axial and radial as well as wobbling motions. The complex cutter movement increases the difficulty in providing a satisfactory seal.

According to the present invention there is provided a method of constructing a rotary rock bit, comprising the steps of: providing a rock bit arm, said rock bit arm having a shirttail surface and a cutter receiving surface; providing a bearing pin, said bearing pin having a bearing section and a mounting section with at least a portion of said mounting section being larger in diameter than said bearing section; providing a mounting passage in said rock bit arm, said mounting passage extending from said cutter receiving surface; positioning said mounting section of said bearing pin in said mounting passage of said rock bit arm thereby forming a seam between said mounting section of said bearing pin and said mounting passage in said rock bit arm; directing a beam of energy into said seam from the side of the rock bit arm having the cutter receiving surface; causing relative movement between said beam of energy and said seam to fuse said bearing pin to said rock bit arm; and mounting a cutter upon said bearing pin.

Also according to the present invention there is provided a rotary rock bit, comprising: at least one rock bit arm, said rock bit arm having a shirttail surface and a cutter receiving surface; a mounting passage in said rock bit arm extending from said cutter receiving surface; a bearing pin connected to said rock bit arm, said bearing pin having a bearing section and a mounting section with at least a portion of the mounting section having a diameter larger than the maximum diameter of said bearing section, said mounting section being positioned in said mounting passage; a weld connecting said mounting section of said bearing pin to said rock bit arm, said weld extending from said cutter receiving surface a substantial distance into said mounting passage; and a rotary cutter mounted on said bearing pin.

Also according to the present invention there is provided a rotary rock bit, comprising: at least one rock bit arm, said rock bit arm having a shirttail surface and a cutter receiving surface; a mounting passage extending through said rock bit arm from said cutter receiving surface to said shirttail surface, said mounting passage having an annular mounting surface; a bearing pin having a bearing section and a mounting section, said mounting section having an annular mounting surface positioned in said mounting passage; a weld fusing said annular mounting surface of said mounting passage in said rock bit arm to said annular mounting surface of said mounting section of said bearing pin, said weld extending from said cutter receiving surface a substantial distance into said mounting passage; a cutter mounted on said bearing pin; and a seal between said cutter and said cutter receiving surface.

The invention will be better understood from the following description of preferred embodiments thereof, given by way of example only, reference being had to the accompanying drawings, wherein:

Figure 1 is an illustration of one arm of a rock bit with a separate bearing pin being fused to the rock bit arm in accordance with one embodiment of the invention;

Figure 2 is a pictorial illustration of the rock bit arm and bearing pin shown in Figure 1 with a rotary cutter and seal adapted to be mounted on the bearing pin;

Figure 3 is an illustration of another embodiment of the present invention;

Figure 4 is an illustration of still another embodiment of the present invention;

Figure 5 is an illustrative sketch of a side view of a portion of a rock bit arm showing bearing pin angle and offset; and

Figure 6 is an illustrative sketch of a top view of the portion of a rock bit arm shown in Figure 5.

Referring now to the drawings and in particular to Figure 1, a sectional view of one arm 10 of a rotary rock bit is shown. It is to be understood that more than one arm may be used to construct a rock bit and that the structure of the other arms would be substantially identical to the arm 10. The bit includes a conventional threaded portion 18 that allows the bit to be connected to the lower end of a rotary drill string (not shown). The bit also includes a central passageway extending along the central axis of the bit to allow drilling fluid to enter from the upper section of the drill string (not shown) immediately above and pass downward to the bottom of the well bore to flush cuttings and drilling debris from the well bore.

A bearing pin 11 is constructed and processed separately from the arm 10. The bearing pin 11 can be machined separate and apart from the rock bit arm 10. The metallurgical processing to obtain desired physical properties is simplified because the bearing pin 11 can be treated separately from the rock bit arm 10. A passage 14 is machined into the arm 10. The passage 14 extends from the shirttail 17 through the arm 10. The bearing pin 11 includes a mounting section 16. The mounting section 16 is assembled in position in the passage 14. The annular mounting surface of the mounting section 16 of the bearing pin 11 is located in the passage 14. The annular mounting surface of the passage 14 and the annular mounting surface of the bearing pin 11 form a seam. A beam 19 of high-velocity electrons is directed into the beam to fuse the bearing pin 11 to the arm 10.

The beam of electrons 19 is produced by an electron beam gun 12. The electron beam gun 12 is located on the cutter receiving side of the rock bit arm 10. The rock bit arm 10 includes a cutter receiving surface 15. The beam of electrons 19 is maintained substantially coincident with the elements which describe the seam. Preferably the beam is perpendicular to the cutter receiving surface and the seam is round in cross section. The beam gun 12 is maintained at substantially a fixed distance 13 from the cutter receiving surface 15 and the beam 19 is maintained at a constant distance and angle to the axis or centreline of the bearing pin mounting section 16. This ensures an optimum weld. The strongest part of the weld will be located on the part of the connection between the bearing pin and arm that receives the greatest stress. The beam 19 is caused to move coincident with the seam by relative movement between the beam 19 and the seam. The beam has a high intensity (10 KW/mm^2) and a high-power capacity (60 KW). The welding operation is conventionally carried out in a vacuum chamber; however, it is to be understood that a laser beam could also be used and that a vacuum chamber might not be necessary. After the initial welding operation has been completed fusing the bearing pin 11 to the arm 10 a second or cosmetic pass of the beam along the seam provides a smooth notch-free surface.

Referring now to Figure 2, the rock bit arm 10 and bearing pin 11 are shown together with a rotary cutter 23 and seal 22. The cutter 23 is adapted to be rotatably positioned on the bearing pin 11 extending from the arm 10. The cutter 23 is adapted to disintegrate the earth formations as the bit is rotated. The cutting structure 24 on the surface of cutter 23 contacts and disintegrates the earth formations in a manner that is well known in the art. The cutting structure 24 shown is in the form of tungsten carbide inserts. However, it is to be understood that other cutting structure such as steel teeth may be used as a cutting structure on the cone cutter 23. The bit also includes a central passageway 25 extending along the central axis of the bit to allow the drilling fluid to enter from the upper section of the drill string (not shown) immediately above and pass downward to the bottom of the well bore to flush cuttings and drilling debris from the well bore. It is to be understood that more than one arm may be used to construct a rock bit and that the structure of the other arms would be substantially identical to the arm 10. The other arms would be connected to the arm along the faces 20 and 21.

A plurality of bearing systems will be located in the bearing area between the cutter 23 and the bearing pin 11. The bearing systems in the bearing area may include a roller bearing system, a ball bearing system, an inner-friction bearing, and a thrust button. If used, the seal 22 is positioned between the cutter 23 and the arm 10. This seal 22 retains lubricant in the bearing area around the bearing systems and prevents any materials in the well bore from entering the bearing area. The seal 22 must provide a satisfactory seal between the rock bit arm and the cutter to maintain lubricant within the bearing area and prevent fluids in the borehole from entering the bearing area. The seal should run against a smooth surface in order to maintain the integrity of the seal. The cutter movement during drilling is complex and includes rapid axial and radial as well as wobbling motions. The complex cutter movement increases the difficulty in providing a satisfactory seal. The seam 14 is uniform and smooth and provides a good receiving surface.

The electron beam 19 penetrates substantially through the seam 14 and preferably all the way through the seam 14. The energy from the electron beam is applied rapidly thereby preventing heat build-up and reducing the danger of damaging the portions of the rock bit that have a low tolerance to heat such as carburized surfaces. The electron beam 19 does not add material to produce a build-up of deposit along the seam 14 and there is very little, if any, warpage. An improved rotary rock bit is produced since it is possible to join optimum bearing steel to optimum rock bit arm steel. The problems and expense of manufacturing are reduced by allowing the rock bit arm to be constructed of an appropriate grade of steel. The bearing pin can be machined separately and apart from the rock bit arm. The carburizing or other process is simplified because the bearing pin can be treated separate from the rock bit arm.

Referring now to Figure 3, a sectional view of one arm 26 of another embodiment of a rotary rock bit constructed in accordance with the present invention is shown. It is to be understood that more than one arm may be used to construct a rock bit and that the structure of the other arms would be substantially identical to the arm 26. A cutter (not shown) will be rotatably positioned on bearing pin 29 extending from the arm 26.

The bit includes a conventional threaded portion 27 that allows the bit to be connected to the lower end of a rotary drill string (not shown). The bit also includes a central passageway extending along the central axis of the bit to allow the drilling fluid to enter from the upper section of the drill string (not shown) immediately above and pass downward to the bottom of the well bore to flush cuttings and drilling debris from the well bore. A plurality of bearing systems will be located in the bearing area between the cutter and the bearing pin 29. The bearing systems in the bearing area may include ball bearing systems, roller bearing systems, and friction bearing systems.

The bearing pin 29 is constructed and processed separately from the arm 26. The bearing pin 29 can be machined separate and apart from the rock bit arm 26. The metallurgical processing is simplified because the bearing pin can be treated separately from the rock bit arm. A passage 30 is machined into the arm 26. The passage 30 extends from the shirttail 28 through the arm 26. The bearing pin 29 includes a mounting section. The mounting section is assembled in position in the passage 30. The annular mounting surface of the mounting section of the bearing pin 29 is located in the passage 30. The annular mounting surface of the passage 30 and the annular mounting surface of the bearing pin 29 form a seam. The mounting section of the bearing pin 29 includes a tang 32. The tang 32 is mounted in a chuck 33. A beam 34 of high-velocity electrons is directed into the seam to fuse the bearing pin 29 to the arm 26. The chuck 33 is used to rotate the bearing pin 29 and arm 26 during the fusing operation. Once the bearing pin 29 is fused to the arm 26, the tang 32 will be machined off flush with the shirttail 28.

The beam of electrons 34 is produced by an electron beam gun 35. The electron beam gun 35 is located on the cutter receiving side of the rock bit arm 26. The rock bit arm 26 includes a cutter receiving surface 31. The beam of electrons 34 is maintained substantially perpendicular to the cutter receiving surface 31 and the beam 34 is maintained at substantially a fixed distance 36 from the cutter receiving surface 31. This ensures an optimum weld. The strongest part of the weld will be located on the portion of the joint between the bearing pin and arm that receives the greatest stress. The beam 34 is caused to move along the seam by relative movement between the beam 34 and the seam. The beam has a high-intensity (10 KW/mm^2) and a high-power capacity (60 KW). The electron beam 34 penetrates substantially through the seam. The energy from the electron beam 34 is applied rapidly thereby preventing heat build-up and reducing the danger of damaging the portions of the rock bit that have a low tolerance to heat such as areas receiving low temperature tempering. The electron beam 34 does not add material to produce a build-up of deposit along the seam and there is very little, if any, warpage.

The welding operation is conventionally carried out in a vacuum chamber; however, it is to be understood that a laser beam could also be used and that a vacuum chamber might not be necessary. After the initial welding operation has been completed, fusing the bearing pin 29 to the arm 26 a second or cosmetic pass of the beam along the seam provides a smooth, notch-free surface. The tang 32 is machined off flush with the shirttail 28. The above described technique provides an improved rotary rock bit by allowing the joining of optimum bearing steel to optimum rock bit arm steel. The problems and expense of manufacturing are reduced by allowing the rock bit arm to be constructed of an appropriate grade of steel. The bearing pin can be machined separately and apart from the rock bit arm. The metallurgical processing is simplified because the bearing pin can be treated separate from the rock bit arm.

Referring now to Figure 4, still another embodiment of the present invention is illustrated. A somewhat conical passage 40 is machined into the arm 37 of a rock bit. The passage 40 extends from the shirttail 42 through the arm 37. The bearing pin 41 includes a tapered mounting section 39. The tapered mounting section 39 is assembled in position in the conical passage 40. The annular mounting surface of the passage 40 and the annular mounting section 39 form a seam. A beam 44 of high-velocity electrons is directed into the seam to fuse the bearing pin 41 to the arm 37. The beam of electrons 44 is maintained supbstantially coincident with the elements which describe the seam. The beam 44 is maintained at substantially a fixed distance 45 from the cutter receiving surface 43. This ensures an optimum weld. The strongest part of the weld will be located on the part of the connection between the bearing pin and arm that receives the greatest stress. The beam 19 is caused to move coincident with the seam by relative movement between the beam 19 and the seam.

The bearing pin angle and offset of the cone axes of rotation are important features in rock bit design. In the embodiments shown in Figures 1-4, the bearing pin angle and offset is provided by having the central axis of the mounting section of the bearing pin coincident with the central axis of the bearing pin journal section. The arm segment is machined for various desired bearing pin angles and offsets. As shown in Figures 5 and 6, different bearing pin angles and offsets can be provided by making the central axis of the mounting section of the bearing pin non-coaxial with the central axis of the journal portion of the bearing pin. As shown in Figure 5, the rock bit arm 47 includes a mounting passage 52. The bearing pin includes a bearing pin mounting section 51 and a bearing pin journal section 48. The central axis 50 of the bearing pin mounting section 51 is not coaxial with central axis 49 of the bearing pin journal portion 48. It will be appreciated that various bearing pin angles can be provided by constructing the bearing pin so that the central axis 50 and central axis 49 have an appropriate relationship.

Referring now to Figure 6, a top view of a section of the arm 47 taken horizontally through the arm 47 is illustrated. The central axis 49 of the bearing pin mounting section 51 intersects the line formed by the meeting of faces 54 and 55 of the arm 47. This is the zero offset position. The central axis 50 of the journal portion 48 of the bearing pin is positioned offset from the central axis 49. This provides the rolling cuter mounted on the bearing pin with an offset. The amount of offset is shown by 53 in Figure 6.

The above described method provides an improved rotary rock bit by allowing the joining of optimum bearing steel to optimum rock bit arm steel. The problems and expense of manufacturing are reduced by allowing the rock bit arm to be constructed of an appropriate grade of steel. The bearing pin can be machined separate and apart from the rock bit arm. The metallurgical processing is simplified because the bearing pin can be treated separate from the rock bit arm. The bearing pin material need not be compatible with the arm material for heat treating process. Various bearing angles and offsets can be provided.

WHAT WE CLAIM IS:—

1. A method of constructing a rotary rock bit, comprising the steps of: providing a rock bit arm, said rock bit arm having a shirttail surface and a cutter receiving surface; providing a bearing pin, said bearing pin having a bearing section and a mounting section with at least a portion of said mounting section being larger in diameter than said bearing section; providing a mounting passage in said rock bit arm, said mounting passage extending from said cutter receiving surface; positioning said

mounting section of said bearing pin in said mounting passage section of said bearing pin in said mounting passage of said rock bit arm thereby forming a seam between said mounting section of said bearing pin and said mounting passage in said rock bit arm; directing a beam of energy into said seam from the side of the rock bit arm having the cutter receiving surface; causing relative movement between said beam of energy and said seam to fuse said bearing pin to said rock bit arm; and mounting a cutter upon said bearing pin.

2. A method according to claim 1 including the additional steps of again directing a beam of energy into said seam and causing relative movement between said beam of energy and said seam after said bearing pin has been fused to said rock bit arm, to provide a smooth surface.

3. A method according to claim 1 or claim 2 wherein said beam of energy is projected all the way through said mounting passage during the step of causing relative movement between said beam of energy and said seam to fuse said bearing pin to said rock bit arm.

4. A method according to any preceding claim wherein said beam is maintained substantially perpendicular to said cutter receiving surface to fuse said bearing pin to said rock bit arm.

5. A method according to any preceding claim wherein the mounting section of the bearing pin is annular.

6. A method according to any preceding claim wherein said bearing section has a centerline and said mounting section has a centerline and including the step of constructing said bearing pin so that said centerlines are inclined to each other to provide a desired bearing pin angle.

7. A method according to claim 6 wherein said centerlines are displaced from each other to provide offset.

8. A method according to claim 7 wherein said beam is maintained at a constant distance and angle to the centerline of the bearing pin mounting section.

9. A method according to any of claims 1-7 wherein an energy source is used to direct the beam of energy into said seam, wherein the beam of energy is aligned with the seam, and wherein the energy source is maintained substantially at a fixed distance from said cutter receiving surface during said step of causing relative movement between said beam of energy and said seam to fuse said bearing pin to said rock bit arm.

10. A method according to any of claims 1-7 including the step of maintaining said beam substantially perpendicular to said cutter receiving surface during said step of causing relative movement between said beam of energy and said seam.

11. A rotary rock bit, comprising:

at least one rock bit arm, said rock bit arm having a shirttail surface and a cutter receiving surface;

a mounting passage in said rock bit arm extending from said cutter receiving surface;

a bearing pin connected to said rock bit arm, said bearing pin having a bearing section and a mounting section with at least a portion of the mounting section having a diameter larger than the maximum diameter of said bearing section, said mounting section being positioned in said mounting passage;

a weld connecting said mounting section of said bearing pin to said rock bit arm, said weld extending from said cutter receiving surface a substantial distance into said mounting passage; and

a rotary cutter mounted on said bearing pin.

12. A rotary rock bit, comprising:

at least one rock bit arm, said rock bit arm having a shirttail surface and a cutter receiving surface;

a mounting passage extending through said rock bit arm from said cutter receiving surface to said shirttail surface, said mounting passage having an annular mounting surface;

a bearing pin having a bearing section and a mounting section, said mounting section having an annular mounting surface positioned in said mounting passage;

a weld fusing said annular mounting surface of said mounting passage in said rock bit arm to said annular mounting surface of said mounting section of said bearing pin, said weld extending from said cutter receiving surface a substantial distance into said mounting passage;

a cutter mounted on said bearing pin; and

a seal between said cutter and said cutter receiving surface.

13. A method of constructing a rotary rock bit, substantially as hereinbefore described with reference to the accompanying drawings.

14. A rotary rock bit, substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

A. A. THORNTON & CO.,
Chartered Patent Agents,
Northumberland House,
303/306 High Holborn,
London,WC1V 7LE.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1980. Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

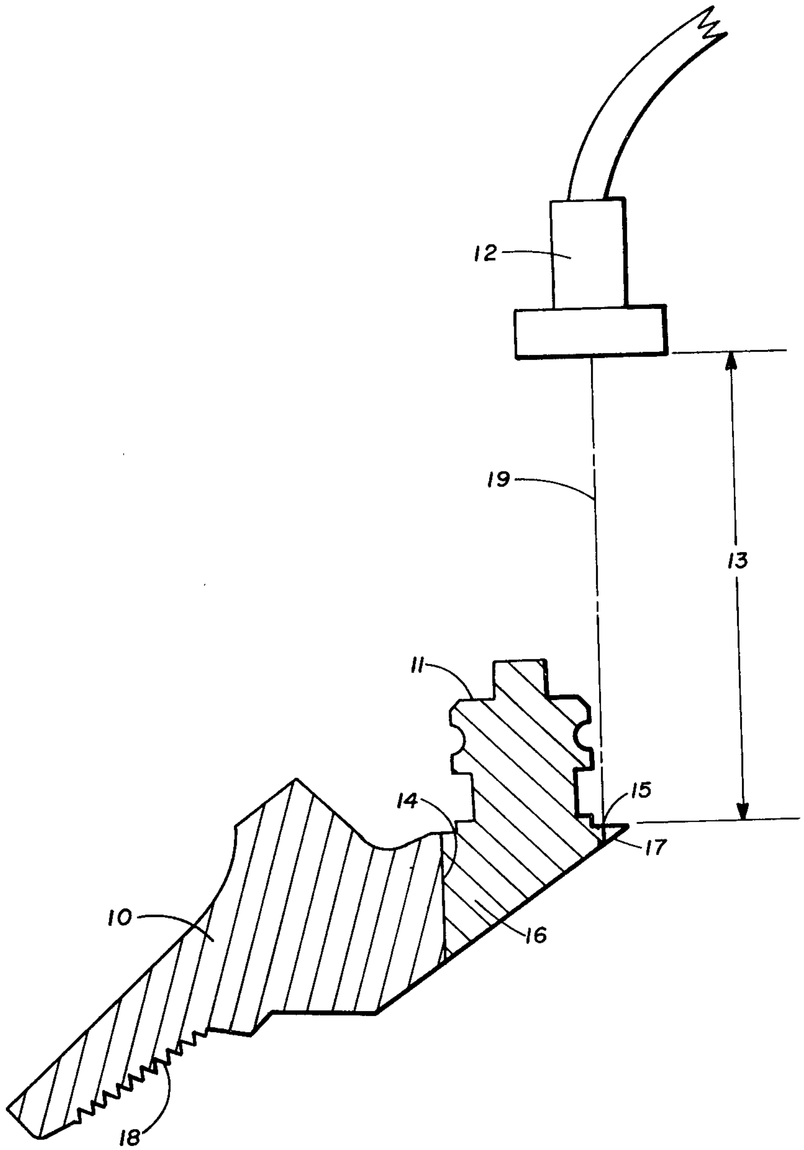

FIG. 1

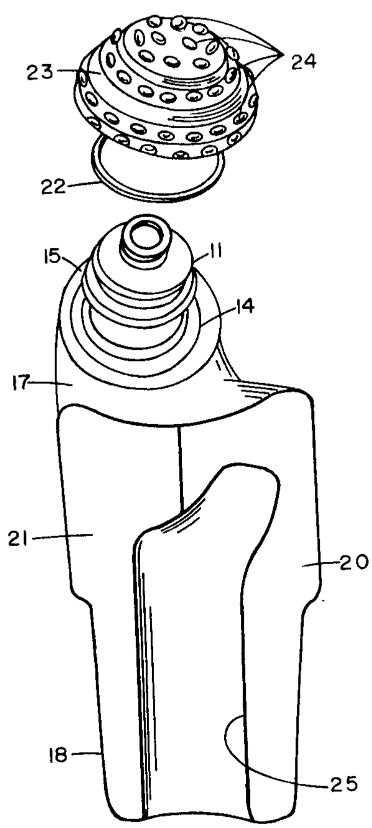

FIG. 2

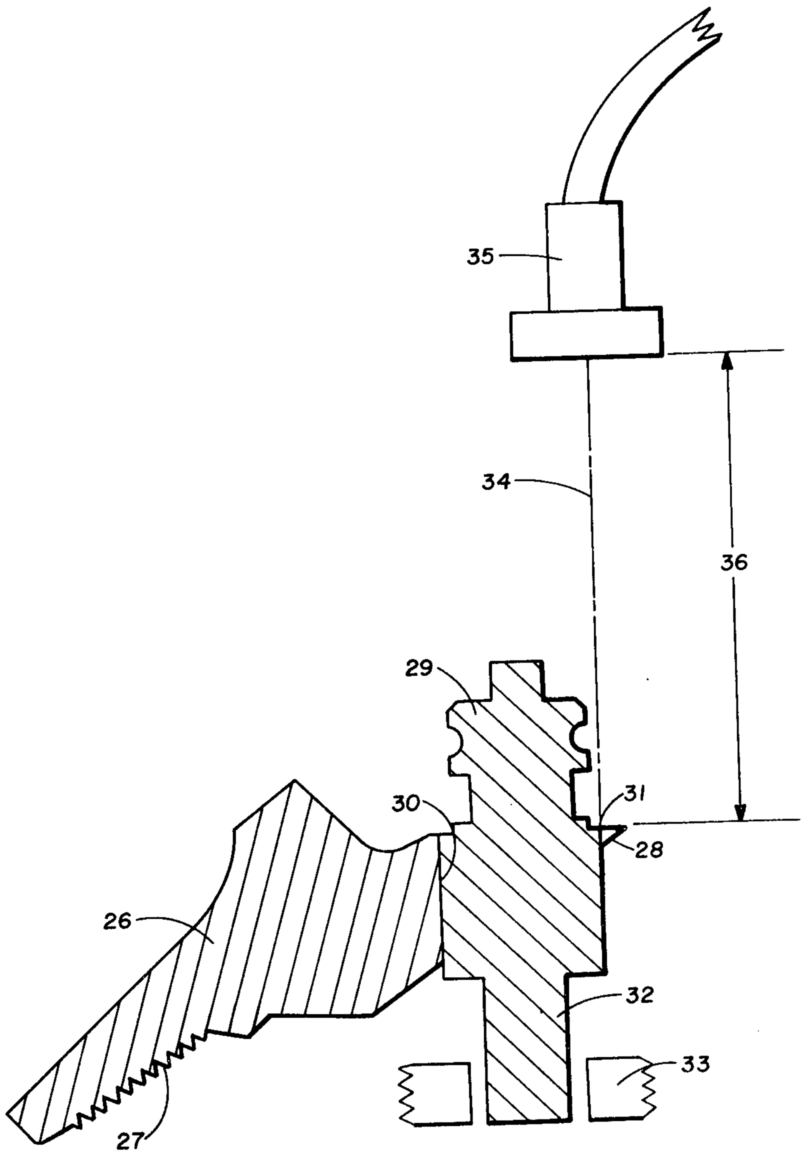

FIG. 3

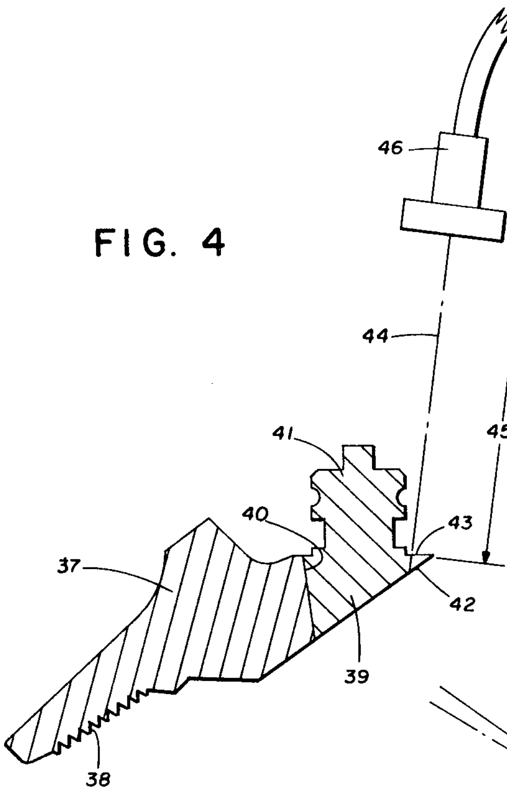

FIG. 4

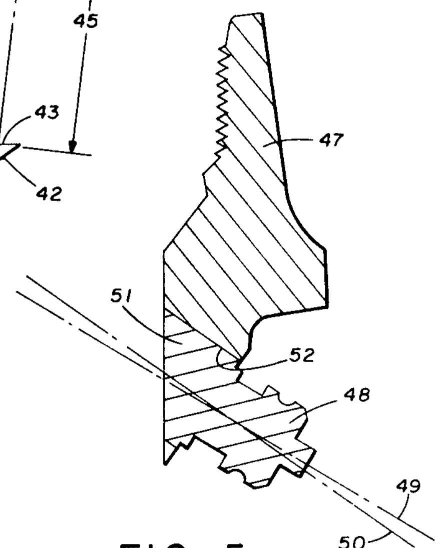

FIG. 5

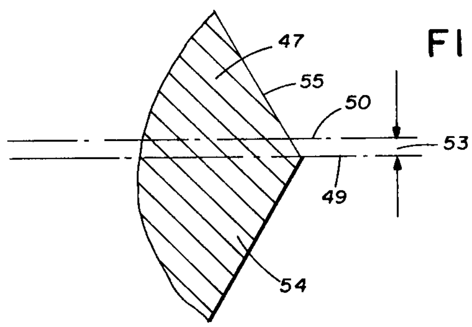

FIG. 6