

PATENT SPECIFICATION

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(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.

15 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 20 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 25 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 30 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 35 rotary rock bit, comprising the steps of: providing a rock bit arm, said rock bit arm 40 having a shirtpail 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 45 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 50 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 shirtpail 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 55 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 60 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 shirtpail surface and a cutter receiving surface; a mounting passage extending 65 through said rock bit arm from said cutter receiving surface to said shirtpail surface, said mounting passage having an annular mounting surface; a bearing pin having a bearing section and a mounting section, said 70

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mounting section having an annular mounting surface positioned in said mounting passage; a weld fusing said annular mounting surface of said mounting section in said 5 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 10 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 15 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 20 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 25 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;

30 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 35 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 40 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 45 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 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995 1000 1005 1010 1015 1020 1025 1030 1035 1040 1045 1050 1055 1060 1065 1070 1075 1080 1085 1090 1095 1100 1105 1110 1115 1120 1125 1130 1135 1140 1145 1150 1155 1160 1165 1170 1175 1180 1185 1190 1195 1200 1205 1210 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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 5 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 10 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 15 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 20 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 25 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 30 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.

35 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 40 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 45 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 50 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 55 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 60 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 65 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 70 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 75 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, 80 roller bearing systems, and friction bearing systems.

85 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 90 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 95 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 100 to the arm 26, the tang 32 will be machined off flush with the shirttail 28.

105 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 110 distance 36 from the cutter receiving surface 31. This ensures an optimum weld. The strongest part of the weld will be located 115 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 120 has a high-intensity (10 KW/mm²) and a 130

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 5 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 10 to produce a build-up of deposit along the seam and there is very little, if any, warp-age.

The welding operation is conventionally carried out in a vacuum chamber; however, 15 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 20 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 shirrtail 28. The above described technique provides an improved 25 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 30 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 35 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. 40 The passage 40 extends from the shirrtail 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 45 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 50 44 is maintained substantially 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. 55 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 60 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 70 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 75 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 80 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. 85

Referring now to Figure 6, a top view of a section of the arm 47 taken horizontally 90 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 95 axis 50 of the journal portion 48 of the bearing pin is positioned offset from the central axis 49. This provides the rolling cutter mounted on the bearing pin with an offset. The amount of offset is shown by 100 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 105 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 110 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. 115 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 120 rock bit arm, said rock bit arm having a shirrtail 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 125 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 130

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 5 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 10 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.

50 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 55 arm.

60 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 shirrtail surface and a cutter receiving surface; 70 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 80 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 85 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 90 arm having a shirrtail surface and a cutter receiving surface;

a mounting passage extending through said rock bit arm from said cutter receiving surface to said shirrtail surface, said mounting passage having an annular mounting 95 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; 100

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 105 pin, said weld extending from said cutter receiving surface a substantial distance into said mounting passage;

a cutter mounted on said bearing pin; and 110

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 115 drawings.

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

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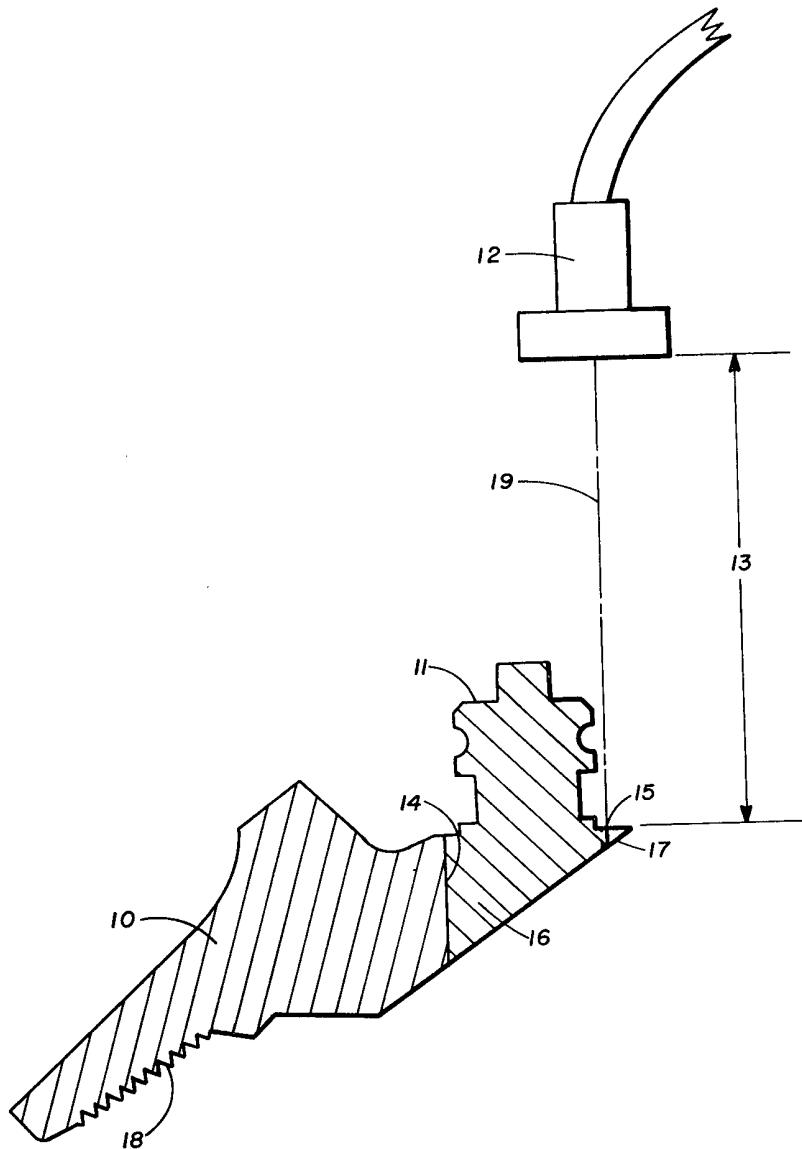


FIG. 1

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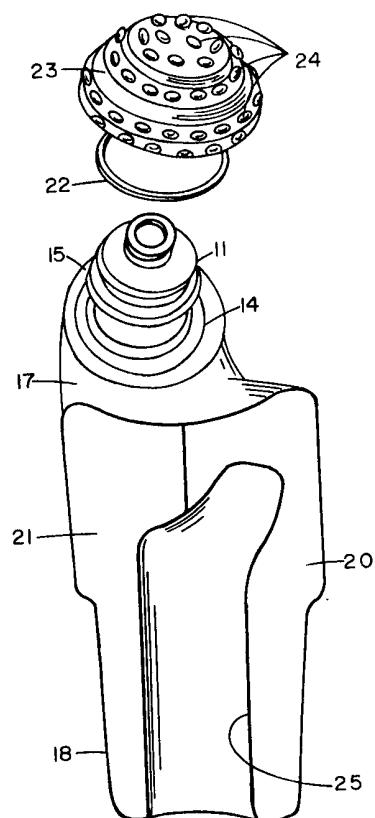


FIG. 2

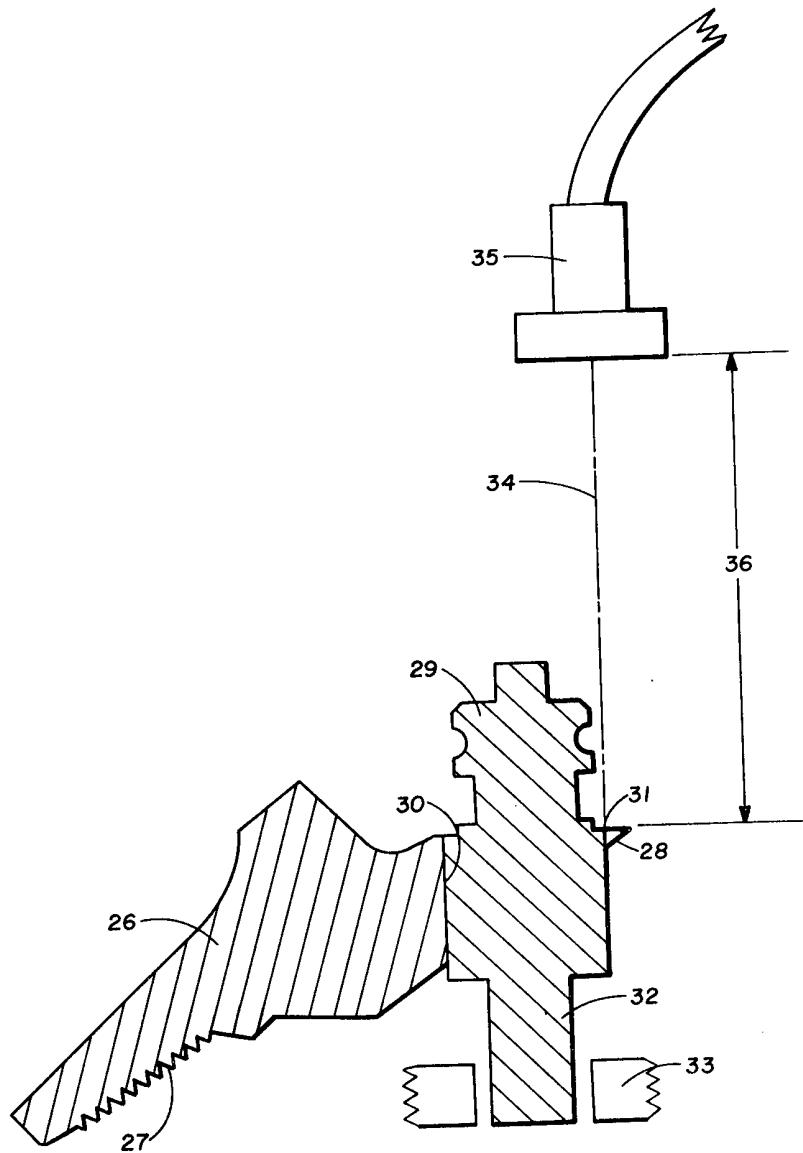


FIG. 3

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FIG. 4

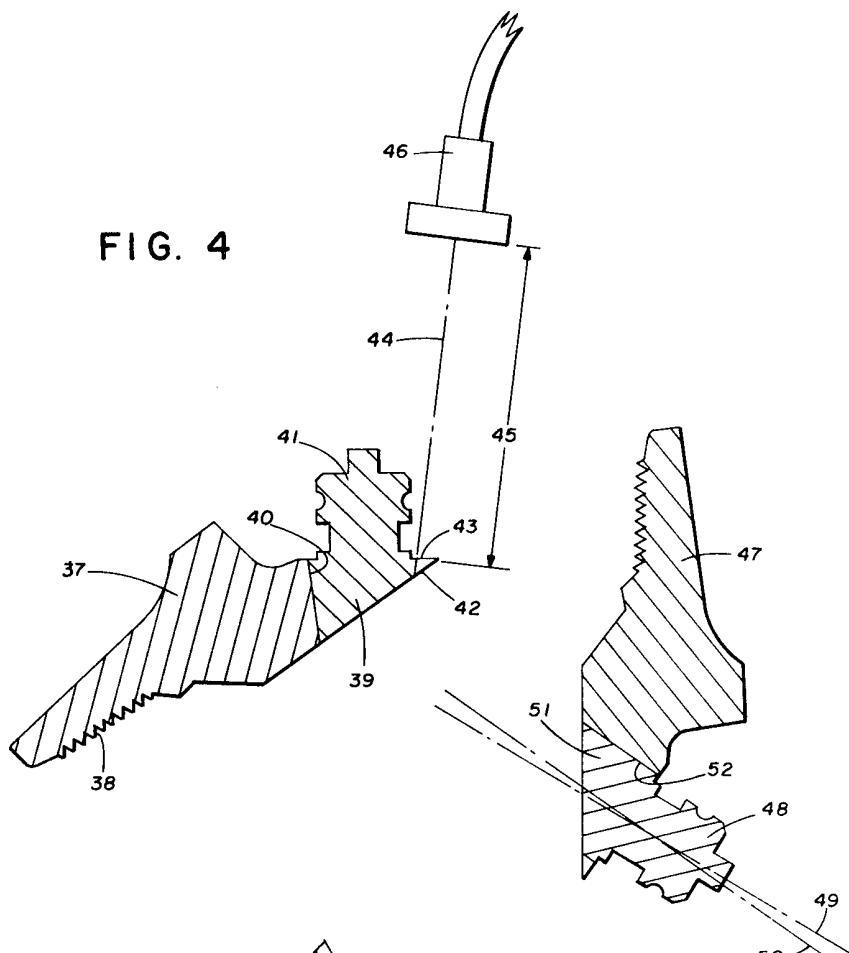


FIG. 5

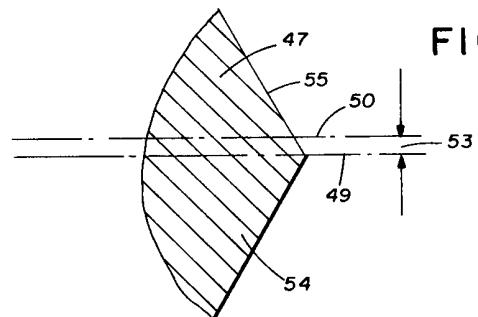


FIG. 6