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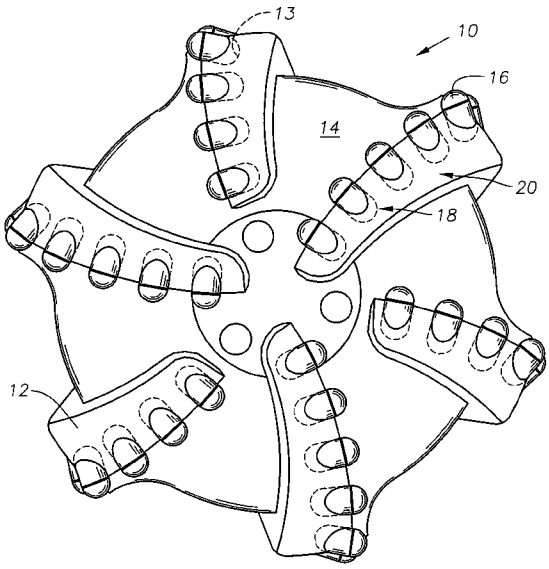
(54) **Title:** CUTTER POCKET HAVING REDUCED STRESSED CONCENTRATION

Fig. 1



(57) **Abstract:** A method for forming a drag bit using displacements having a rounded end that creates a cutter pocket having a rounded rear portion. The displacement may comprise an insert on the rounded end that remains in the drag bit during and after formation. A cutter element may then be attached to the upper portion of the insert. The rounded shape of the insert provides a more even force distribution.

WO 2009/003088 A2

CUTTER POCKET HAVING REDUCED STRESSED CONCENTRATION

RELATED APPLICATIONS

[0001] This application claims priority to and the benefit of co-pending U.S. Provisional Application Ser. No. 60/946,300, filed June 26, 2007, the full disclosure of which is hereby incorporated by reference herein.

BACKGROUND

1. Field of Invention

[0002] The disclosure herein relates to contoured cutting teeth for use with a drilling bit. More specifically, the present disclosure concerns inserts having a spherical shaped rear portion disposed in a correspondingly formed pocket, wherein the pocket is situated on the cutting surface of a drag bit. The present disclosure also concerns a method for forming the pockets on the face of a drill bit.

2. Description of Prior Art

[0003] Earth boring bits for drilling wellbores into subterranean formations include roller cone bits and drag bits. The earth boring bits are typically connectable to a drilling system via a threaded connection disposed on the bottom portion of the bit. Drag type bits includes blades formed on the lower surface of the bit. The blades comprise a raised portion of material having a generally rectangular cross-section extending roughly from the center portion of the bit surface and radially outward along a side of the bit. Cutter pockets are formed on the upper surface of the blade, wherein the respective axes of the pockets are generally parallel with other pockets on the individual blade. Typically, the pockets comprise

a hollowed out trough portion of the upper surface of the blade, wherein the pockets are formed to receive a cutting element therein.

[0004] The cutting elements can be attached in any number of ways, such as welding and brazing or other attachment means. The cutting element has a generally cylindrical shape with a cutting face on one end and planar on its other end. It is well known in the prior art to add polycrystalline diamond compact, i.e., PDC, on the face of the cutting element. The cutting element body is typically formed of a relatively hard material such as sintered tungsten carbide. The PDC layer may be mounted directly on the mounting body or on an intermediate carrier also generally made from a sintered tungsten carbide.

[0005] The bit body is usually comprised of either a tungsten carbide matrix or various forms of steel. Drilling systems typically utilize the weight on bit to press down into the rock that combined with the torque crushes the rock which causes the drilling action. Continued turning of the drill string pushes the teeth through the rock by the combined forces of the weight on bit and the torque.

[0006] Known displacements have planar ends that form cutter pockets with corresponding flat bottoms. During use of bit bodies having flat bottom cutter pockets, the geometry produces high stresses in the bit body adjacent the cutter pocket bottom. The high stresses can initiate cracking in the bit body thereby reducing bit life.

SUMMARY OF INVENTION

[0007] Disclosed herein is a drag bit and a method for creating a drag bit. In one embodiment, the drag bit comprises a blade on its cutting face, with a series of pockets on the blade formed using displacements. In one embodiment, the displacement comprises an insert on one end with removable displacement material on the other. The insert end opposite the displacement is rounded and oriented to be at the cutter pocket bottom while forming the bit.. The insert and displacement converge at a planar surface. After the displacement material is removed from the insert, a cutting element may be attached to the end of the insert. Optionally, the displacement may comprise only removable displacement material with one or more rounded ends. A method is included herein for forming the pockets on the blade of the drag bit. The method involves forming the cutter pocket with the displacement having an insert with a rounded shaped end to form a rounded cutter pocket bottom, cleaning the removable portion of the displacement, and adding a cutting element to the end of the insert. Optionally, a method is disclosed wherein a fully removable displacement is used to form a cutter pocket with a rounded bottom. After casting a bit body using the displacement, the displacement(s) can be removed and a cutting element having a rounded bottom corresponding to the cutter pocket bottom can be affixed in the cutting pocket.

BRIEF DESCRIPTION OF DRAWINGS

[0008] Some of the features and benefits of the present invention having been stated, others will become apparent as the description proceeds when taken in conjunction with the accompanying drawings, in which:

[0009] Figure 1 is a bottom view of a drill bit shown during the formation process.

[0010] Figure 2 is a side view of an example of a displacement for forming a cutter pocket.

[0011] Figure 3 is a side view of a displacement for forming a cutter pocket having an insert on one end.

[0012] Figure 4 is a partial cutaway view of a displacement forming a cutter pocket having an insert.

[0013] Figure 5 is a partial cutaway view of a cutting element comprising an insert on one end.

[0014] Figure 6 is a partial sectional view of a displacement in a bit body having an elliptical end.

[0015] Figure 7 is a partial sectional view of a displacement in a bit body having an elliptical end.

[0016] Figure 8 is a partial sectional view of a displacement in a bit body having a frusto-conical end.

[0017] Figure 9 is a partial sectional view of an example of a drilling system employing a drill bit having a cutter pocket with a rounded bottom.

[0018] Figure 10 is a partial cutaway view of a cutting element with a rounded end in a bit body.

[0019] While the invention will be described in connection with the preferred embodiments, it will be understood that it is not intended to limit the invention to that

embodiment. On the contrary, it is intended to cover all alternatives, modifications, and equivalents, as may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF INVENTION

[0020] The present invention will now be described more fully hereinafter with reference to the accompanying drawings in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the illustrated embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be through and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

[0021] It is to be understood that the invention is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents will be apparent to one skilled in the art. In the drawings and specification, there have been disclosed illustrative embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for the purpose of limitation. Accordingly, the invention is therefore to be limited only by the scope of the appended claims.

[0022] Disclosed herein is a device and method regarding forming cutter pockets and cutting elements of a drag bit. In one embodiment, a cutter pocket is formed using a displacement comprising removable displacement material and a non-removal insert having a rounded end. The displacement is oriented within a bit body casting form so when the bit body is formed, the rounded ended of the insert is integral within the bit body with the removable displacement between the insert and the bit outer surface. After removing the displacement material from the insert a cutting element can be attached to the insert's free end. Another way to form a rounded cutter element to bit body interface is to form a bit body using a rounded end displacement, wherein the entire displacement comprises removable material. In one embodiment, the cutter element(s) to bit body interface describes the contact surface between the cutter element and the bit body. The cutter element(s)/bit body interface

also describes the forces and/or force distributions transferred between the cutter element(s) and the bit body. The interface can describe a single cutting element and bit body, a plurality of cutting elements and the bit body, or all cutting elements and the bit body. After casting the bit and then cleaning the displacement from the cutter pocket, a cutting element with a correspondingly rounded bottom can be affixed in the rounded bottom cutter pocket. One of the advantages of having a rounded cutter element to bit body interface is the forces experienced by the cutting element during cutting are transferred to the bit body through the insert (or cutter element) rounded end. A rounded interface has a greater area than traditional planar or flat bit body/cutting element interfaces, thus stresses imparted by the cutting element to the bit body are more evenly distributed throughout the bit body. More even stress distribution thereby minimizes stress concentrations in the bit body. Additionally, the improvement disclosed herein removes sharp corners in the cutter pocket rear portion. In contrast, some diamond fixed cutter bits have experienced primary cutter pocket cracking, especially for the cutters located proximate to the bit axis. These cracks initiate from the joint of the cutter pocket seat and propagate down towards the nozzle and/or front blade root.

[0023] Figure 1 illustrates a bottom view of an example of a bit body 10 being formed in accordance with the present disclosure. In this embodiment, the bit body 10 comprises a series of blades 12 formed on the bit face 14, wherein the blades 12 radially extend outward from the center towards the outer radius of the bit face 14. Cutter pockets 13 are generally formed along the upper or outer edge of the blade for receiving cutting elements within the pockets. Displacements may be used in forming these cutter pockets by positioning the displacements inside a form as the bit body is being cast. One example of this novel process is provided in Figure 1 where displacements 16 were situated in a casting form before bit body raw materials were added. The displacements 16 were kept in place in the casting form during the casting process and integrated with the bit body 10. Examples of bit body raw

materials include a hard material, such as tungsten or tungsten carbide, and binder constituents. Binder constituents include copper, nickel, other soft metals, and combinations thereof. Processing the bit body raw materials within the casting form may comprise heating to soften and/or melt the binder enabling the softened binder material to migrate within the hard material, and when cooled will bind the hard materials together. However the scope of the present disclosure is not limited to a high temperature forming process, but instead other processing methods can be employed with the forming method described herein, such as a high pressure forming process, or a combination of increased pressure and increased temperature.

[0024] In one embodiment, the displacements 16 in Figure 1 comprise a material that retains its shape during the bit casting process, but are removable and can be cleaned away after the bit body 10 is removed from the form. Examples of materials for the displacements 16 include generally, graphite silicon carbide, refractory materials, compressed particulate matter, combinations thereof, and similar substances. Sand blasting is one example method that can be employed for cleaning displacement material from within the cutter pocket 13. Accordingly the displacement(s) 16 may optionally comprise erodible materials removable with some applied impact, such as by particles (for example sand), water, air, or any other stream comprising matter directed at the displacement. In this embodiment, one end of the displacement 16 is shown protruding away from the cutter face. The rearward end, or the displacement rear portion 18 (forming the cutter pocket 13) is shown in a dashed outline on the blade face 12. Optionally, use of the stress minimizing cutter pockets can be limited to the portions of the bit face having cutters exposed to localized high stresses.

[0025] Figure 2 provides a side view of an embodiment of a displacement 24 such as used to form a cutter pocket 13 in the bit body 10 of Figure 1. The displacement 24 comprises a rear section 26, a front section 28, and an indicator groove 30. A groove 30, formed

proximate to the front 28 circumscribes the displacement 24 outer periphery. The displacement 24 rear section 26 is rounded for forming a shaped cutter pocket with a rounded bottom. Optionally, the rear section 26 of this displacement 24 may be hemi-spherical, oval, or have any radial shape, with or without tapers. Examples of displacements 24 having an end with an elliptical shape are provided in a side partial sectional view in Figures 6 and 7. An example of displacements 24 having an end with a frusto-conical shape is provided in a side partial sectional view in Figure 8. In other embodiments, the front section 28 may be flat, elliptical, chamfered, or have a chisel shape. The present method also includes orienting a displacement having a rounded end within a bit body casting form so the rounded end is used to shape the bottom end 15 of a cutter pocket 13. The optional groove 30 is formed to indicate displacement position and to allow manufacturing personnel to properly align displacements 24 with the face of the blade 14. Optionally, the cutter can be formed as a uni-body assembly having a rounded rear portion, in this embodiment the cutter would not have an added insert.

[0026] Figure 3 provides a side view of an alternative displacement 42 embodiment. The displacement 42 of Figure 3 comprises an insert 46 rounded on its free or bottom end (i.e. the end inserted into a rounded bottom cutter pocket 13). The displacement 42 further includes a cylindrically shaped mid section 45 attached to the insert 46. A front section 44 is shown on the mid section 45 opposite the insert 46. The mid section 45 and front section 44 may comprise above described displacement material such as graphite or silicon carbide. The insert 46 may be glued to the mid section 45 prior to being placed in the mold. Forming a bit body 10 with the displacement 42 of Figure 3 includes removing the front portion 44 and mid section 45 after the casting process. The step of removing may include the displacement cleaning/removal method as described above. Removing the mid section 45 leaves the insert 46 within the cutter pocket 13. As discussed below and illustrated in Figure 5, a cutter

element having a rounded end and a cutter face can be affixed to the insert 46 within the cutter pocket. Typical methods of adhering cutter elements in formed pockets exist, such as welding, brazing and possibly gluing. Accordingly, using the insert 46 results in cutter forces being more evenly distributed from the cutter element to the cutter blades 12 and bit 10. The insert 46 may comprise mild carbon steel, such as 1018 carbon steel, tungsten carbide, alloys, sintered tungsten carbide, low carbon alloy steels, or combinations thereof. Cutter pockets formed using displacements 42 that comprise an insert 46 may optionally be described as extending from the flat or planar surface of the insert 46 to the cutter pocket opening on the bit body surface. When described in this fashion, the insert 46 would not be in the cutter pocket and the cutter pocket would have a flat bottom defined by the insert 46 upper surface. Optionally, the cutter pocket can be described as extending to the rounded interface between the insert 46 and bit body 12, thus the insert 46 would be in the bottom of the cutter pocket. Irrespective of how a cutter pocket is described, inserts 46 having a rounded end provide a rounded cutting element to bit body interface.

[0027] Figure 4 illustrates a side partial sectional view of the displacement 42 of Figure 3 disposed in a bit body 12 cutter pocket 13. This illustrates an example of a displacement 42 combined with the bit body 12 during the casting process. The front portion 44 is removable, such as by using the above described process, thereby leaving the insert 46 within the pocket 13. The cutter pocket bottom 15 rounded configuration with the correspondingly contoured insert 46 forms a rounded cutter element to bit body interface to better distribute bit body 12 stress than the traditional flat or planar cutter element to bit body interfaces. Unlike the bit bodies having high stress concentrations from flat bottom cutting elements; earth boring bit bodies formed using the displacements (24, 42) described herein will experience a substantially equal cutter element to bit body stress distribution. Reducing stress

concentration in the bit body reduces a likelihood of crack initiation and/or crack growth, thereby increasing useful bit life.

[0028] After removing the front portion 44 of Figure 4, a cutting element 35 may be secured onto the insert 46. One example is provided in Figure 5 that illustrates a side view of the cutting element 35 comprising a cutter body 36 secured to the insert 46 within the cutter pocket 13. Here the cutting element 35 is attached to the insert 46 within the cutter pocket 13 created by the mid section 45 (Figure 4) and includes a cutter tip 38 on its outwardly facing surface. As is known, the cutter tip 38 may be a polycrystalline diamond compact (PDC) and include hard or super hard materials.

[0029] With regard to the displacement 24 shown in Figure 2, after forming a bit body 10 using a casting process, then blast removing the displacement material, a cutting element 31 (Figure 10) having a rounded bottom 32 and a cutting tip 33 is illustrated attached in the rounded bottom pocket 13. Brazing or some other means of attachment can be employed for securing the cutting element 31 within the pocket 13.

[0030] Figure 9 illustrates an embodiment of a drilling system 50 comprising the bit body 10 having a cutter pocket 13 with a rounded bottom. Here the bit body 10 is deployed on a drill string 52 and connected to a top drive 58 for rotating the drill string 52 and bit 10.

We claim:

1. A method of forming a bit body for an earth boring drill bit comprising:

combining bit body raw materials and a displacement having a rounded end into a bit body casting form;

orienting the rounded end of the displacement to extend into the bit body materials; and

processing the materials in the casting form to form a bit body, wherein the presence of the displacement extending into the bit body raw materials during the step of processing the materials forms a cutter pocket in the bit body.

2. The method of claim 1 further comprising, removing the displacement from the cutter pocket.

3. The method of claim 1, wherein the displacement comprises an insert portion not removable from the bit.

4. The method of claim 1, wherein the displacement comprises a portion formed from an erodible material and an insert portion comprising the rounded end.

5. The method of claim 4, wherein the insert is integrally formed in the bit body, the method further comprising removing the removable portion, and affixing a cutting element to the insert.

6. The method of claim 1, wherein the raw materials comprise tungsten and a binder.

7. The method of claim 2 further comprising, affixing a cutting element into the cutter pocket.

8. The method claim 1, further comprising combining a plurality of displacements into the casting form to thereby form a plurality of cutter pockets.

9. The method of claim 1, wherein the cutter pocket rounded bottom end has a shape selected from the group consisting of hemispherical, elliptical, and frusto-conical.

10. The method of claim 1, wherein the displacement comprises an erodible material.

11. The method of claim 10, wherein the displacement comprises material selected from the group consisting of graphite and silicone carbide, refractory materials, compressed particles, and combinations thereof.

12. The method of claim 1 further comprising, removing at least a portion of the displacement from the formed bit body, affixing a cutting element within the cutter pocket, coupling the bit body with insert to a drill pipe, boring a wellbore with the bit body and drill pipe.

13. An earth boring bit formed using a casting process, the b it attachable to a drill string for forming a subterranean wellbore, the bit comprising:

a bit body;

a blade extending from the bit body; and

a cutter pocket having a rounded bottom end formed in the blade during the casting process, wherein the rounded bottom end is formed using a displacement having a rounded end.

14. The earth boring bit of claim 13, wherein the displacement is formed using an erodible material.

15. The earth boring bit of claim 13, wherein the displacement comprises an insert on the rounded end.

16. The earth boring bit of claim 13, wherein the displacement comprises a mid section and a rear portion having a rounded end.

17. The earth boring bit of claim 13, wherein the displacement rounded end is orientable in a bit body casting mold to form a cutter pocket having a rounded bottom.

18. The earth boring bit of claim 16, wherein the displacement mid section and rear portion comprises an erodible material.

19. The earth boring bit of claim 13, wherein the displacement comprises material selected from the group consisting of graphite and silicone carbide, refractory materials, compressed particles, and combinations thereof.

20. The earth boring bit of claim 13, wherein the rounded end has a shape selected from the group consisting of hemispherical, elliptical, and frusto-conical.

Fig. 1

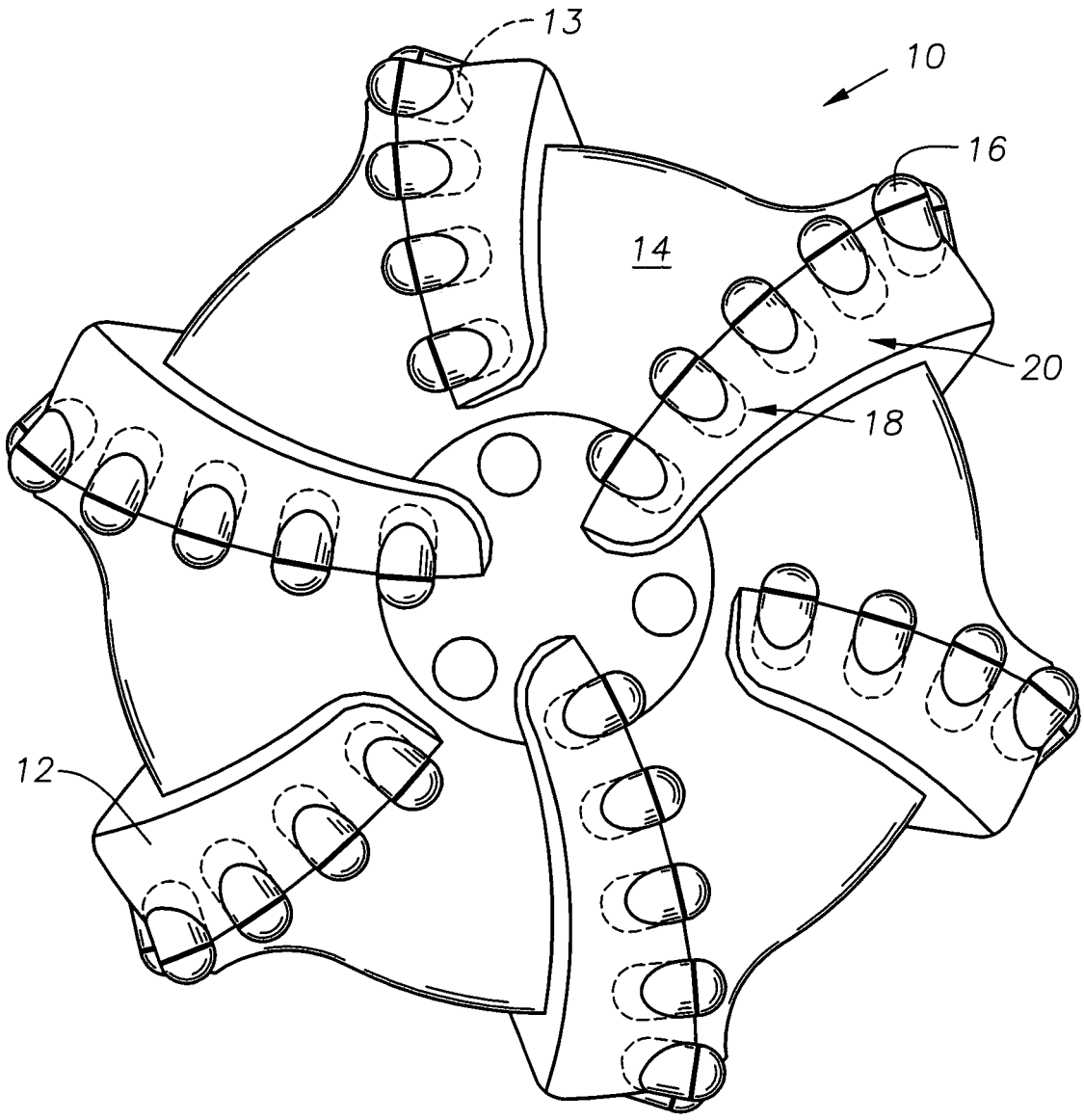


Fig. 2

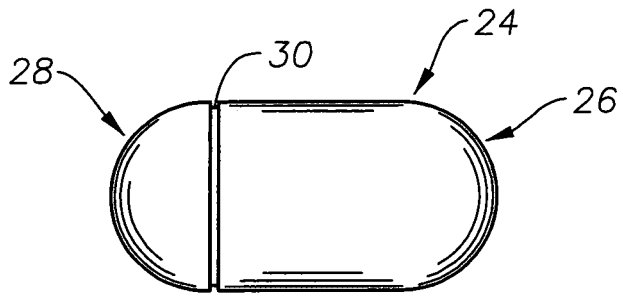


Fig. 3

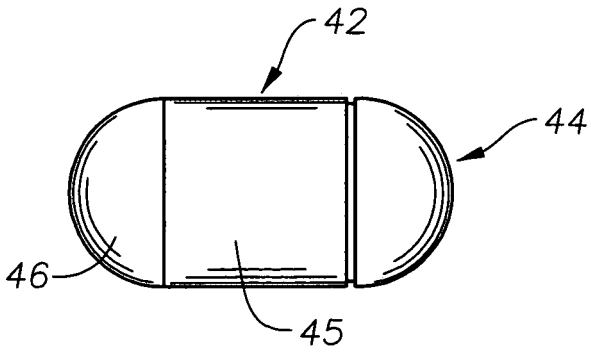


Fig. 4

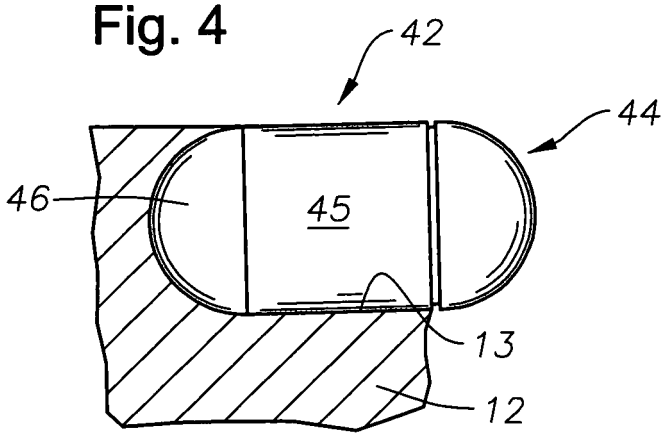


Fig. 5

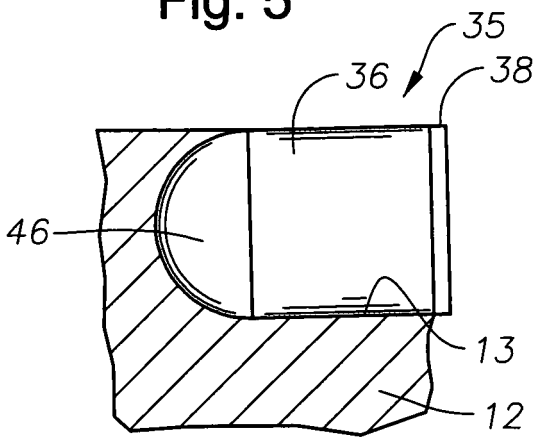


Fig. 6

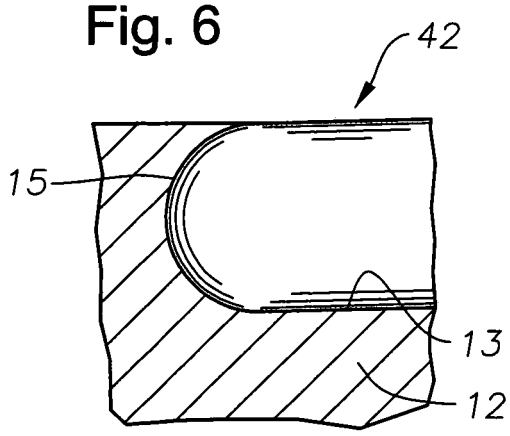
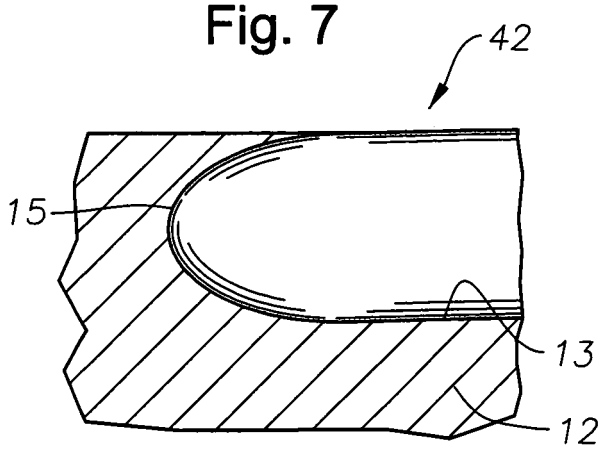


Fig. 7



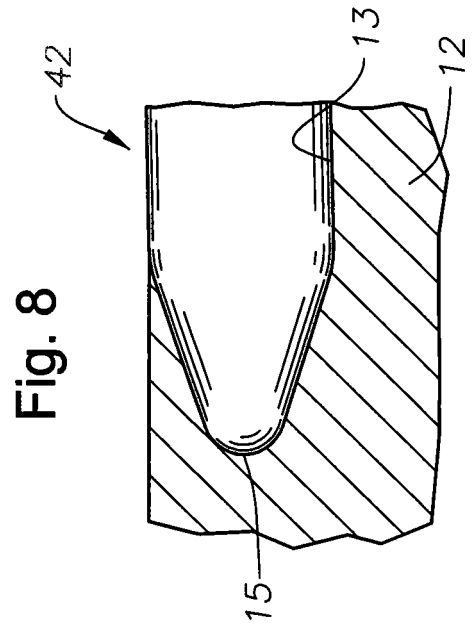


Fig. 8

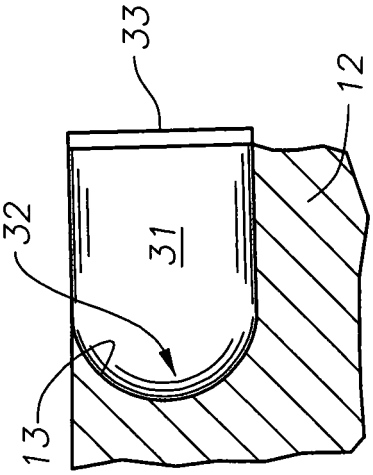


Fig. 10

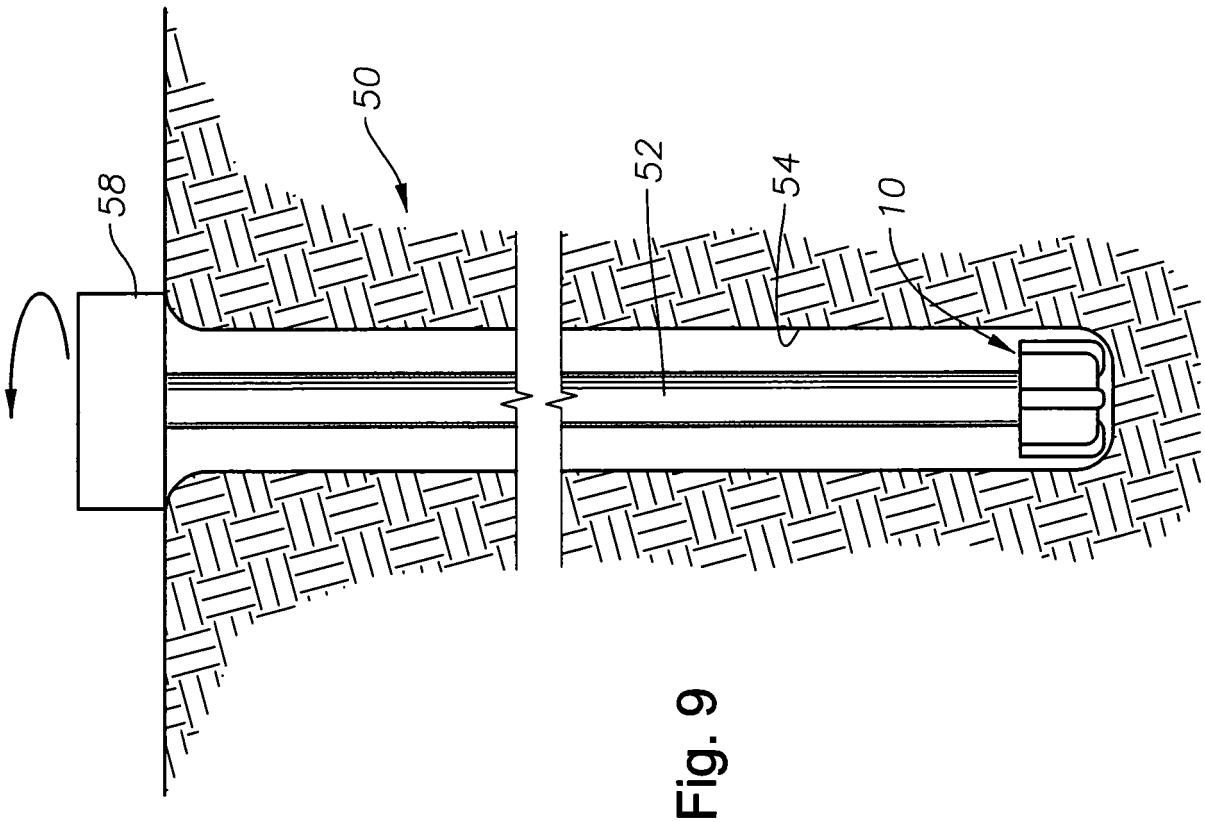


Fig. 9