(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 091 083 B9

(12) **CORRECTED EUROPEAN PATENT SPECIFICATION**

Note: Bibliography reflects the latest situation

(15) Correction information:
Corrected version no 1 (W1 B1)
Corrections, see page(s) 2

(48) Corrigendum issued on:
28.06.2006 Bulletin 2006/26

(45) Date of publication and mention of the grant of the patent:
19.10.2005 Bulletin 2005/42

(21) Application number: **00116020.9**

(22) Date of filing: **26.07.2000**

(51) Int Cl.:
E21B 10/26 (1980.01) *E21B 10/42* (1980.01)

(54) Bi-center bit adapted to drill casing shoe

Bi-zentrales Bohrzeug zum Bohren durch Verrohrungsschuh

Trépan de forage bicentral adapté pour forer un sabot de tubage

(84) Designated Contracting States:
DE FR GB IT

(30) Priority: **09.08.1999 US 392043**

(43) Date of publication of application:
11.04.2001 Bulletin 2001/15

(73) Proprietor: **Reedhycalog LP**
Houston,
Texas 77060 (US)

(72) Inventors:
- **Fielder, Coy M.**
  Cypress,
  Texas 77429 (US)
- **Silva, Rogerio H.**
  Spring,
  Texas 77379 (US)

(74) Representative: **Frankland, Nigel Howard et al**
FORRESTER & BOEHMERT
Pettenkoferstrasse 20-22
80336 München (DE)

(56) References cited:
GB-A- 2 328 698 **US-A- 5 678 644**
US-A- 5 803 196 **US-A- 5 873 422**

- **SILVERMAN S: "LATEST GENERATION BI-CENTER BIT BUSTS SHOE, DRILLS AHEAD" PETROLEUM ENGINEER INTERNATIONAL, HART PUBLICATIONS,US, vol. 72, no. 9, September 1999 (1999-09), page 13 XP000875825 ISSN: 0164-8322**

EP 1 091 083 B9

Description

[0001] **THE PRESENT INVENTION** is directed to downhole tools. More specifically, the present invention is directed to a bi-center drilling bit adapted to fit within and drill through a casing shoe without damage to the surrounding casing.

[0002] Bi-center bits are adapted to insertion down a well-bore having a given diameter where, once in position, the rotation of the bi-center bit creates a borehole having a selectedly greater diameter than the borehole.

[0003] In conventional bi-center bits (see for example US 5678644), the bit is designed to rotate about a rotational axis which generally corresponds to the rotational axis defined by the drill string. Such conventional designs are further provided with cutting elements positioned about the face of the tool to reveal a low back-rake angle so as to provide maximum cutting efficiency.

[0004] Disadvantages of such conventional bi-center bits lie in their inability to operate as a cutting tool within their pass-through diameter while still retaining the ability to function as a traditional bi-center bit. In such a fashion, a conventional bi-center bit which is operated within casing of its pass-through diameter will substantially damage, if not destroy the casing.

[0005] The present invention addresses the above and other disadvantages of prior bi-center drilling bits by allowing selective modification of the use of the tool within the borehole.

[0006] According to this invention there is provided a multi-center bit comprising a bit body defining a proximal end adapted for connection to a drill string and a distal end, where the distal end defines a first and a second cutting section, where each of said first and second sections define a cutting face, the first section being a pilot bit, and the second section being a reamer section intermediate the pilot bit and the proximal end, the bit body defining a first and second axis, there being a plurality of cutting elements situated on cutting blades disposed about the cutting face of the first and second sections, and said bit being adapted to consecutively, without removal, rotate about said first axis within casing without cutting said casing and rotate about the second axis within a borehole formed in formation, the bit defining a pass-through gauge, characterised in that cutter elements disposed proximate said gauge define a high effective back-rake angle of between 30° and 90° with the formation.

[0007] Preferably the reamer section defines leading and trailing cutting blades and cutting elements are disposed on the leading and trailing blades at the pass through gauge so as to define the said back-rake angle of between 30° and 90° with the formation.

[0008] Conveniently one or more stabilizing elements is disposed opposite the reamer section such that the proximal most portion of the stabilizing element does not extend beyond the most proximately disposed cutting elements on said reamer section.

[0009] Preferably the or each stabilizing element comprises a gauge pad.

[0010] Advantageously the or each stabilizer element extends to the pass-through gauge.

[0011] Conveniently the bit body is manufactured from steel.

[0012] Advantageously rotation of the bit about the first or the second axes defines substantially complete cutter overlap.

[0013] Conveniently the rotation of the bit about the first and second axis creates two distinct bottom hole patterns.

[0014] Advantageously the cutting elements are disposed on the blades so as to define an angle between the line of contact of the cutting elements and the material to be drilled of between 5° and 45°.

[0015] Other advantages of the invention will become obvious to those skilled in the art in light of the figures and the detailed description of the preferred embodiments given with reference to the accompanying drawings in which:

Figure 1 is a side view of a conventional bi-center drill bit, ***[deletion(s)]***

Figure 2 is an end view of the working face of the bi-center drill bit illustrated in Figure 1;

Figures 3A-C are end views of a bi-center bit as positioned in a borehole illustrating the pilot bit diameter, the drill hole diameter and pass through diameter, respectively;

Figures 4A-B illustrate a conventional side view of a bi-center bit as it may be situated in casing and in operation, respectively;

Figure 5 is an end view of a conventional bi-center bit;

Figure 6 illustrates a cutting structure brazed in place within a pocket milled into a rib of a conventional bi-center drill bit;

Figure 7 illustrates a schematic outline view of an exemplary bi-center bit of the prior art;

Figure 8 illustrates a revolved section of a conventional pilot section cutter coverage as drawn about the geometric axis;

Figure 9 illustrates a revolved section of a conventional pilot section cutter coverage as drawn about the pass-through axis;

Figure 10 illustrates a side view of one embodiment of the bi-center bit of the present invention:

Figure 11 illustrates an end view of the bi-center bit illustrated in Figure 10;

Figure 12 illustrates a revolved section of the pilot section of the bi-center bit illustrated in Figure 10, as drawn through the pass-through axis;

Figure 13 illustrates a revolved section of the pilot section of the bi-center bit illustrated in Figure 10, as drawn through the geometric axis:

Figure 14 illustrates a graphic profile of the cutters positioned on the reamer section of the embodiment illustrated in Figure 10.

Figure 15 illustrates a schematic view of the orientation of cutters in one preferred embodiment of the invention.

[0016] While the present invention will be described in connection with presently preferred embodiments, it will be understood that it is not intended to limit the invention to those embodiments. On the contrary, it is intended to cover all alternatives, modifications, and equivalents included within the spirit of the invention and as defined in the appended claims.

[0017] Figures 1-9 generally illustrate a conventional bi-center bit and its method of operating in the borehole.

[0018] By reference to these figures, bit body 2, manufactured from steel or other hard metal, includes a threaded pin 4 at one end for connection in the drill string, and a pilot bit 3 defining an operating end face 6 at its opposite end. A reamer section 5 is integrally formed with the body 2 between the pin 4 and the pilot bit 3 and defines a second operating end face 7, as illustrated. The term "operating end face" as used herein includes not only the axial end or axially facing portion shown in Figure 2, but also contiguous areas extending up along the lower sides of the bit 1 and reamer 5.

[0019] The operating end face 6 of bit 3 is transversed by a number of upsets in the form of ribs or blades 8 radiating from the lower central area of the bit 3 and extending across the underside and up along the lower side surfaces of said bit 3. Ribs 8 carry cutting members 10, as more fully described below. Just above the upper ends of rib 8, bit 3 defines a gauge or stabilizer section, including stabilizer ribs or gauge pads 12, each of which is continuous with a respective one of the cutter carrying rib 8. Ribs 8 contact the walls of the borehole that has been drilled by operating end face 6 to centralize and stabilize the tool 1 and to help control its vibration. (See Figure 4).

[0020] The pass-through diameter of the bi-center is defined by the three points where the cutting blades are at gauge. These three points are illustrated at Figure 2 are designated "x," "y" and "z." Reamer section 5 includes two or more blades 11 which are eccentrically positioned above the pilot bit 3 in a manner best illustrated in Figure 2. Blades 11 also carry cutting elements 10 as described below. Blades 11 radiate from the tool axis but are only positioned about a selected portion or quadrant of the tool when viewed in end cross section. In such a fashion, the tool 1 may be tripped into a hole having a diameter marginally greater than the maximum diameter drawn through the reamer section 5, yet be able to cut a drill hole of substantially greater diameter than the pass-through diameter when the tool 1 is rotated about the geometric or rotational axis "A." The axis defined by the pass-through diameter is identified at "B." (See Figures 4A-B.)

[0021] In the conventional embodiment illustrated in Figure 1, cutting elements 10 are positioned about the operating end face 7 of the reamer section 5. Just above the upper ends of rib 11. reamer section 5 defines a gauge or stabilizer section, including stabilizer ribs or kickers 17, each of which is continuous with a respective one or the cutter carrying rib 11. Ribs 11 contact the walls of the borehole that has been drilled by operating end face 7 to further centralize and stabilize the tool 1 and to help control its vibration.

[0022] Intermediate stabilizer section defined by ribs 11 and pin 4 is a shank 14 having wrench flats 15 that may be engaged to make up and break out the tool 1 from the drill string (not illustrated). By reference again to Figure 2, the underside of the bit body 2 has a number of circulation ports or nozzles 15 located near its centerline. Nozzles 15 communicate with the inser areas between ribs 8 and 11, which areas serve as fluid flow spaces in use.

[0023] With reference now to Figures 1 and 2, bit body 2 is intended to be rotated in the clockwise direction, when viewed downwardly, about axis "A." Thus, each of the ribs 8 and 11 has a leading edge surface 8A and 11A and a trailing edge surface 8B and 11B, respectively. As shown in Figure 6, each of the cutting members 10 is preferably comprised of a mounting body 20 comprised of sintered tungsten carbide or some other suitable material, and a layer 22 of polycrystalline diamond carried on the leading face of stud 38 and defining the cutting face 30A of the cutting member. The cutting members 10 are mounted in the respective ribs 8 and 11 so that their cutting faces are exposed through the leading edge surfaces 8A and 11, respectively.

[0024] In the conventional bi-center bit illustrated in Figures 1-9, cutting members 10 are mounted so as to position the cutter face 30A at an aggressive, low angle, e.g., 15-20° backrake, with respect to the formation. This is especially true of the cutting members 10 positioned at the leading edges of bit body 2. Ribs 8 and 11 are themselves preferably comprised of steel or some other hard metal. The tungsten carbide cutter body 38 is preferably brazed into a pocket 32 and includes within the pocket the excess braze material 29.

[0025] As illustrated in profile in Figure 7, the conventional bi-center bit normally includes a pilot section 3 which defines an outside diameter at least equal to the diameter of bit body 2. In such a fashion, cutters on pilot section 3 may cut to gauge.

[0026] The cutter coverage of a conventional bi-center bit may be viewed by reference to a section rotated about a given axis. Figure 8 illustrates the cutter coverage for the pilot bit illustrated in Figures 1-2. The reveived section identifies moderate to extreme coverage overlap of the cutters, with the maximum overlap occurring at the crown or bottommost extent of pilot section 3 when said pilot section 3 is rotated about geometric axis "A." The cutter coverage illustrated in Figure 8 should be compared with the absence of cutter coverage occurring when pilot section 3 is rotated about the pass-through axis "B." (See Fig. 9.) Clearly, the bi-center bit illustrated in Figure 9 would be inefficient if used in hard or resilient formations such as a casing shoe.

[0027] When a conventional bi-center bit is rotated about its rotational axis "A," the bit performs in the manner earlier described to create a borehole having a diameter larger than its pass-through diameter. (See Figs. 4A-4B.) This result is not desirable when the bit is used in casing to drill through a casing shoe since, while the shoe might be removed, the casing above the shoe would also be damaged. Consequently, it has become accepted practice to drill through a casing shoe using a conventional drill bit which is thereafter retrieved to the surface. A bi-center bit is then run below the casing to enlarge the borehole. However, the aforedescribed procedure is costly, especially in deep wells when many thousand feet of drill pipe may need be tripped out of the well to replace the conventional drilling bit with the bi-center bit. The bi-center bit of the present invention addresses this issue.

[0028] One embodiment of the bi-center bit of the present invention may be seen by reference to Figures 10-15. Figure 10 illustrates a side view of a preferred embodiment of the bi-center bit of the present invention. By reference to the figures, the bit 100 comprises a bit body 102 which includes a threaded pin at one end 104 for connection to a drill string and a pilot bit 103 defining an operating end face 106 at its opposite end. For reasons discussed below, end face 106 defines a flattened profile. A reamer section 105 is integrally formed with body 102 between the pin 104 and pilot bit 103 and defines a second operating end face 107.

[0029] The operating end face 106 of pilot 103 is traversed by a number of upsers in the form of ribs and blades 108 radiating from the central area of bit 103. As in the conventional embodiment, ribs 108 carry a plurality of cutting members 116 The reamer section 105 is also provided with a number of blades or upsets 152, which upsets are also provided with a plurality of cutting elements 110 which themselves define cutting faces 130A.

[0030] The embodiment illustrated in Figure 10 is provided with a pilot section 103 defining a smaller cross-section of diameter than the conventional embodiment illustrated in Figures 1-8. The use of a lesser diameter for pilot section 103 serves to minimize the opportunity for damage to the borehole or casing when the tool 100 is rotated about the pass-through axis "B."

[0031] In a conventional bit, cutters 110 which extend to gauge generally include a low backrake angle for maximum efficiency in cutting. (See Figure 11.) In the bi-center bit of the present invention, it is desirable to utilize cutting elements which define a less aggressive cutter posture where they extend to gauge when rotating about the pass-through axis. In this connection, it is desirable that cutters 110 at the pass-through gauge and positioned on the leading and trailing blades 118 define a backrake angle of between 30-90 degrees with the formation. Applicant has discovered that a preferred backrake angle for soft to medium formations is 55 degrees. The orientation of cutting elements 100 to define such high backrake angles further reduces the potential for damage to casing 136 when the tool 110 is rotated about the pass-through axis "B."

[0032] In a preferred embodiment, bit 100 may be provided with a stabilizer pad 160 opposite reamer section 105. Pad 160 may be secured to bit body 102 in a conventional fashion, *e.g.*, welding, or may be formed integrally. Pad 160 serves to define the outer diametrical extent of tool 100 opposite pilot 103. (See Figure 10.) It is desirable that the uppermost extent 161 of pad 160 not extend beyond the top of cutters 121 on reamer blades 152.

[0033] When rotated in the casing, the tool 100 is compelled to rotate about pass-through axis "B" due to the physical constraints of casing 136. Casing 136 is not cut since contact with tool 100 is about the three points defined by leading edges 118 and stabilizer pad 160. As set forth above. edges 118 include cutting elements having a high backrake angle not suited to cut casing 136. Likewise, pad 160 is not adapted to cut casing 136. The cutters disposed elsewhere about operating face 107 incorporate a backrake angle of 15°-30° and thus are able to cut through the casing shoe. When the casing shoe has been cut, the tool 100 is able to rotate free of the physical restraints imposed by casing 136. In such an environment, the tool reverts to rotation about axis " "A."

[0034] The method by which the bi-center bit of the present invention may be constructed may be described as follows. In an exemplary bi-center bit, a cutter profile is established for the pilot bit . Such a profile is illustrated, for example, in Figure 8 as drawn through the geometrical axis of the tool. The pass-through axis is then determined from the size and shape of the tool.

[0035] Once the pass-through diameter is determined, a cutter profile of the tool is made about the pass-through axis. This profile will identify any necessary movement of cutters 110 to cover any open, uncovered regions on the cutter profile. These cutters 110 may be situated along the primary upset 131 or upsets 132 radially disposed about geometric axis "A."

[0036] Once positioning of the cutters 110 has been determined, the position of the upsets themselves must be established. In the example where it has been determined that a cutter 110 must be positioned at a selected distance r_1, from pass-through axis "B," an arc 49 is drawn through r, in the manner illustrated in Figure 15. The intersection of this arc 49 and a line drawn through axis "A" determines the possible positions of cutter 110 on radially disposed upsets 151.

[0037] To create a workable cutter profile for a bi-center bit which includes a highly tapered or contoured bit face introduces complexity into the placement of said cutters 110 since issues of both placement and cutter height must be addressed. As a result, it has been found preferable to utilize a bit face which is substantially flattened in cross section. (See Figure 10).

[0038] Once positioning of the upsets has been determined, the cutters 110 must be oriented in a fashion to optimize their use when tool 100 is rotated about both the pass-through axis "B" and geometric axis "A." By reference to Figures 11 and 15, cutters 110 positioned for use in a conventional bi-center bit will be oriented with their cutting surfaces oriented toward the surface to the cut, *e.g.*, the formation. In a conventional bi-center bit, however, cutters 110 so oriented on the primary upset 131 in the area 140 between axes "A" and "B" will actually be oriented 180° to the direction of cut when tool 100 is rotated about pass-through axis "B." To address this issue, it is preferable that at least most of cutters 110 situated on primary upset 131 about area 140 be oppositely oriented such that their cutting faces 130A are brought into contact with the formation or the casing shoe, as the case may be, when tool 100 is rotated about axis "B." This opposite orientation of cutter 110 is in deference to the resilient compounds often comprising the casing shoe.

[0039] Cutters 110 disposed along primary upset 131 outside of region 140 in region 141 are oriented such that their cutting faces 130A are brought into at least partial contact with the formation regardless when rotated about axis "A." Cutters 110 oppositely disposed about primary upset 131 in region 142 are oriented in a conventional fashion. (See Figure 15.)

[0040] Cutters 110 not situated on primary upset 131 oriented are disposed on radial upsets 132. These cutters 110, while their positioning may be dictated by the necessity for cutter coverage when tool 100 is rotated about axes "A" and "B," as described above, are oriented on their respective upsets 132 or are skewed to such an angle such that at least twenty percent of the active cutter face 130 engages the formation when the bi-center bit is rotated about axis "A." Restated as a function of direction of cut, the skew angle of cutters 110 is from 0°-80°.

[0041] In the present specification "comprise" means "includes or consists of" and "comprising" means "including or consisting of".

[0042] The features disclosed in the foregoing description, or the following Claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

Claims

1. A multi-center bit (100) comprising a bit body (102) defining a proximal end (104) adapted for connection to a drill string and a distal end, where the distal end defines a first (103) and a second (105) cutting section, where each of said first and second sections define a cutting face, the first section (103) being a pilot bit, and the second section (105) being a reamer section intermediate the pilot bit (103) and the proximal end (104), the bit body defining a first and second axis, there being a plurality of cutting elements (110) situated on cutting blades (108, 152) disposed about the cutting face of the first and second sections, and said bit being adapted to consecutively, without removal, rotate about said first axis within casing without cutting said casing and rotate about the second axis within a borehole formed in formation, the bit defining a pass-through gauge, **characterised in that** cutter elements (110) disposed proximate said gauge define a high effective back-rake angle of between 30° and 90° with the formation.

2. The bit of Claim 1 wherein the reamer section (105) defines leading and trailing cutting blades (118) and cutting elements (110) are disposed on the leading and trailing blades (118) at the pass through gauge so as to define the said back-rake angle of between 30° and 90° with the formation.

3. The bit of Claim 1 or 2 wherein one or more stabilizing elements (160) is disposed opposite the reamer section (105) such that the proximal most portion of the stabilizing element (160) does not extend beyond the most proximately disposed cutting elements (110) on said reamer section.

4. The bit of Claim 3 wherein the or each stabilizing element (160) comprises a gauge pad.

5. The bit of Claim 3 or 4 wherein the or each stabilizer element (160) extends to the pass-through gauge.

6. The bit of any one of the preceding Claims wherein the bit body (102) is manufactured from steel.

7. The bit of any one of the preceding Claims wherein rotation of the bit (100) about the first or the second axes defines substantially complete cutter overlap.

8. The bit of any one of preceding Claims wherein the rotation of the bit (100) about the first and second axis creates two distinct bottom hole patterns.

9. The bit of any one of the preceding Claims wherein the cutting elements (110) are disposed on the blades (108, 152) so as to define an angle between the line of contact of the cutting elements (110) and the material to be drilled of between 5° and 45°.

Patentansprüche

1. Multi-zentraler Meißel (100) mit einem Meißelkörper (102), der ein proximales Ende (104), das zur Verbindung mit einem Bohrgestänge gestaltet ist, und ein distales Ende bildet, wobei das distale Ende einen ersten (103) und einen zweiten (105) Schneidabschnitt bildet, wobei jeder von genannten ersten und zweiten Abschnitten eine Schneidfläche bildet,

wobei der erste Abschnitt (103) ein Führungsmeißel ist und der zweite Abschnitt (105) ein Räumerabscbnitt zwischen dem Führungsmeißel (103) und dem proximalen Ende (104) ist, wobei der Meißelkörper eine erste und zweite Achse bildet, eine Vielzahl von Sehneidelementen (110) an Schneidplatten (108, 152) angeordnet ist, die um die Schneidfläche der ersten und zweiten Abschnitte angeordnet sind, und genannter Meißel gestaltet ist, um sich nacheinander, ohne Abfuhr, um genannte erste Achse in einer Verrohrung ohne Schneiden von genannter Verrohrung zu drehen und sich um genannte zweite Achse in einem in einer Formation ausgebildeten Bohrloch zu drehen, wobei der Meißel einen Durchgangskaliber bildet, **dadurch gekennzeichnet, daß** in der Nähe von genanntem Kaliber angeordnete Schneidelemente (110) einen hocheffektiven Spitzspanwinkel von zwischen 30° und 90° mit der Formation bilden.

2. Meißel nach Anspruch 1, **dadurch gekennzeichnet, daß** der Räumerabschnitt (105) vordere und hintere Schneidplatten (118) definiert und Schneidelemente (110) an den vorderen und hinteren Platten (118) an dem Durchgangskaliber angeordnet sind, um genannten Spitzenspanwinkel zwischen 30° und 90° mit der Formation zu bilden.

3. Meißel nach Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** ein oder mehrere Stabilisierungselement(e) (160) gegenüber dem Räumerkschnitt (105) angeordnet ist/sind, so daß der am nahesteu befindliche Abschnitt des Stabilisierungselements (160) sich nicht über die am nahesten angeordneten Schneidelemente (110) an genanntem Räumerabschnitt erstreckt.

4. Meißel nach Anspruch 3, **dadurch gekennzeichnet, daß** das oder jedes Stabilisierungselement (160) einen Kaliberblock umfaßt.

5. Meißel nach Anspruch 3 oder 4, **dadurch gekennzeichnet, daß** das oder jedes Stabilisierungselement (160) sich zum Durchgangskaliber erstreckt.

6. Meißel nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** der Meißelkörper (102) aus Stahl hergestellt ist.

7. Meißel nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** eine Drehung des Meißels (100) um die erste oder die zweite Achse eine im wesentlichen vollständige Schneidenüberlappung bildet

8. Meißel nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** die Drehung des Meißels (100) die erste und zweite Achse zwei verschiedene Grundlochmuster erzeugt.

9. Meißel nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, daß** die Schneidelemente (110) an den Platten (108, 152) derart angeordnet sind, daß sie einen Winkel zwischen der Kontaktlinie der Schneidelemente (110) und dem zu bohrenden Material von zwischen 5° und 45° bilden.

Revendications

1. Trépan de forage (100) à centres multiples, comprenant un corps de trépan (102) définissant une extrémité proximale (104) adaptée à être connectée à un train de forage, et une extrémité distale, dans lequel l'extrémité distale définit une première section de taille (103) et une seconde section de taille (105), chacune de ladite première et de ladite seconde section définissant une face de taille, la première section (103) étant un trépan pilote, et la seconde section (105) étant une section de déblaiement intermédiaire entre le trépan pilote (103) et l'extrémité proximale (104), le corps de trépan définissant un premier et un second axe, une pluralité d'éléments de coupe (110) étant situés sur des lames de coupe (108, 152) disposées autour de la face de taille de la première et de la seconde section, et ledit trépan étant adapté à tourner consécutivement, sans enlèvement, autour dudit premier axe dans un carter sans découper ledit carter, et à tourner autour du second axe dans un trou de forage formé dans une formation, le trépan définissant une jauge de traversée, **caractérisé en ce que** les éléments de coupe (110) disposés à proximité de ladite jauge définissent un angle de dépouille effectif élevé entre 30° et 90° avec la formation.

2. Trépan selon la revendication 1, dans lequel la section de déblaiement (105) définit une lame de coupe de tête et une lame de coupe de queue (118), et des éléments de coupe (110) sont disposés sur la lame de tête et sur la lame de queue (118) au niveau de la jauge de traversée, de façon à définir ledit angle de dépouille entre 30° et 90° avec la formation.

3. Trépan selon la revendication 1 ou 2, dans lequel un ou plusieurs éléments de stabilisation (160) est/sont disposé(s) à l'opposé de la section de déblaiement (105) de sorte que la portion la plus proximale de l'élément de stabilisation (160) ne s'étend pas au-delà des éléments de coupe (110) disposés de la façon la plus proximale sur ladite section de déblaiement.

4. Trépan selon la revendication 3, dans lequel l'élément de stabilisation (60) ou chaque élément de stabilisation comprend un coussinet de jauge.

5. Trépan selon la revendication 3 ou 4, dans lequel l'élément de stabilisation (160) ou chaque élément de stabilisation s'étend vers la jauge de traversée.

6. Trépan selon l'une quelconque des revendications précédentes, dans lequel le corps de trépan (102) est fabriqué en acier.

7. Trépan selon l'une quelconque des revendications précédentes, dans lequel la rotation du trépan (100) autour du premier ou du second axe définit un chevauchement de coupe sensiblement complet.

8. Trépan selon l'une quelconque des revendications précédentes, dans lequel la rotation du trépan (100) autour du premier et du second axe engendre deux modèles de forage inférieur distincts.

9. Trépan selon l'une quelconque des revendications précédentes, dans lequel les éléments de coupe (110) sont disposés sur les lames (108, 152) de manière à définir un angle entre la ligne de contact des éléments de coupe (110) et le matériau à forer compris entre 5° et 45°.

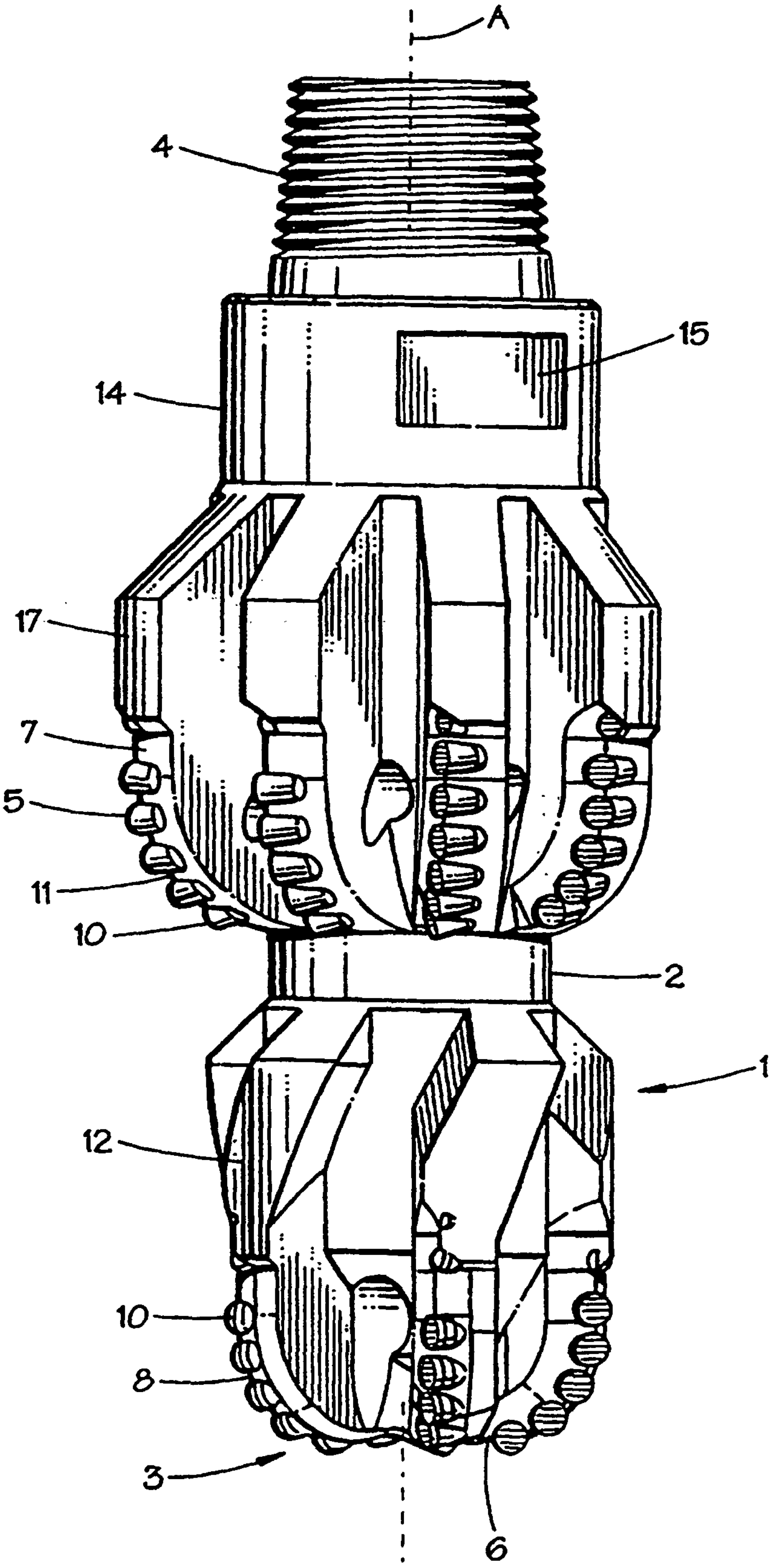


FIG. 1

FIG. 7

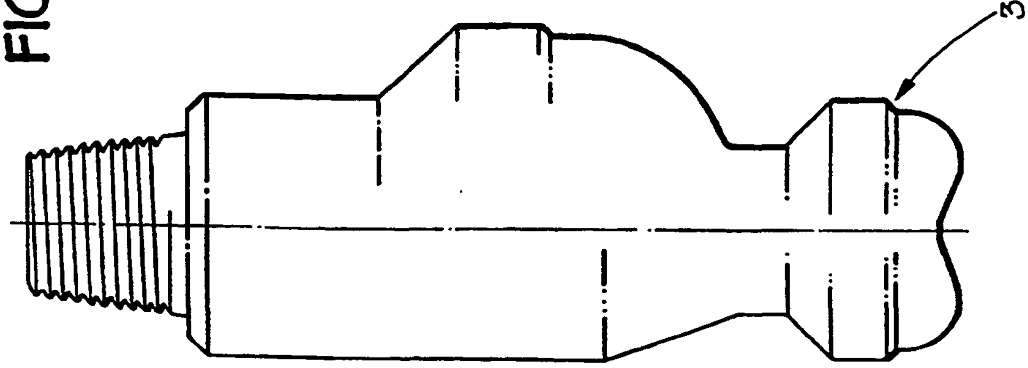


FIG. 2

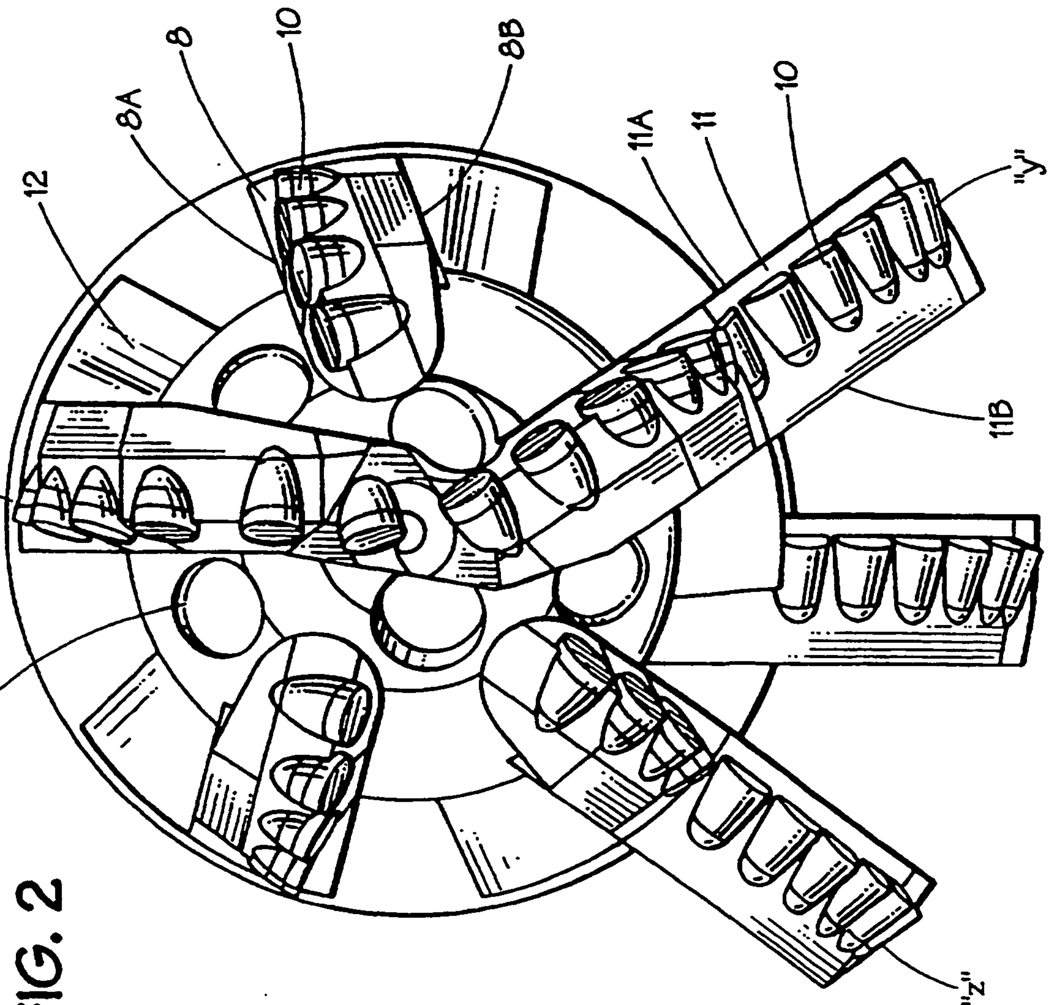


FIG. 7
(PRIOR ART)

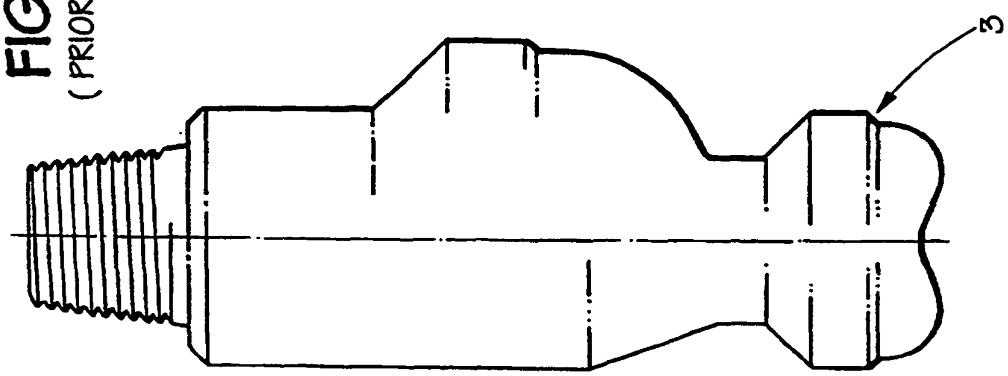
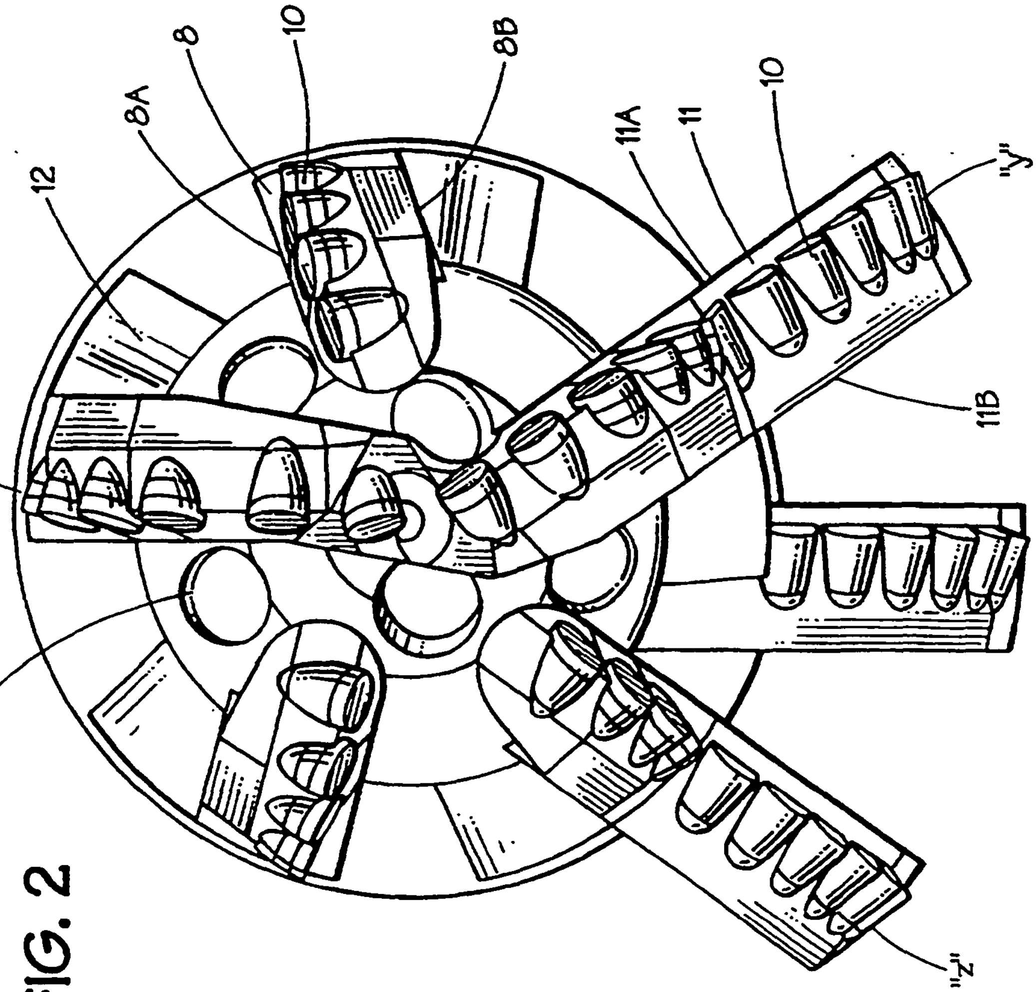


FIG. 2



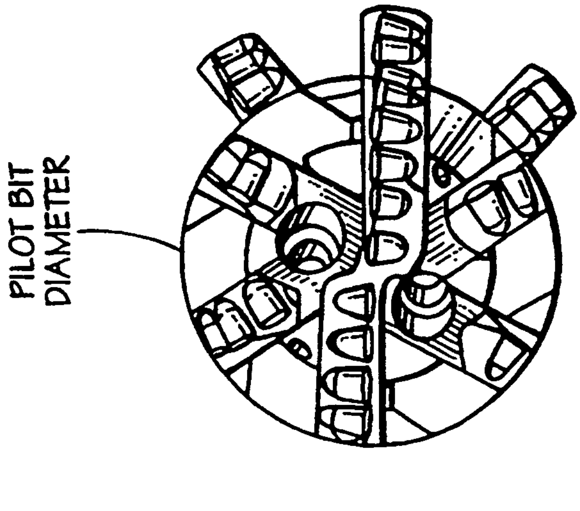


FIG. 3A

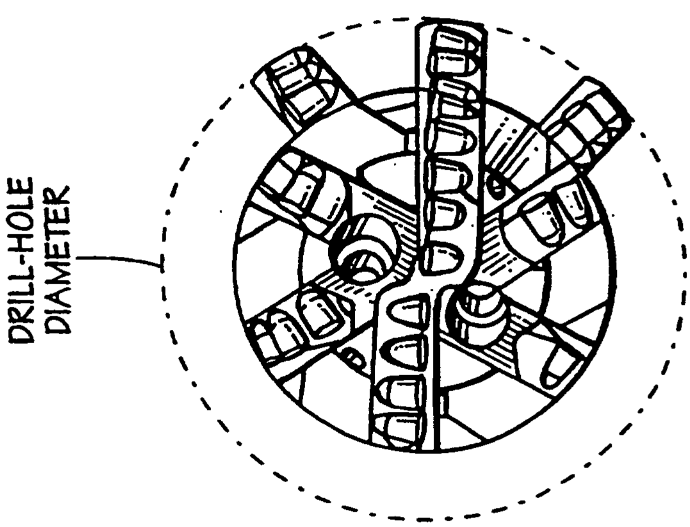


FIG. 3B

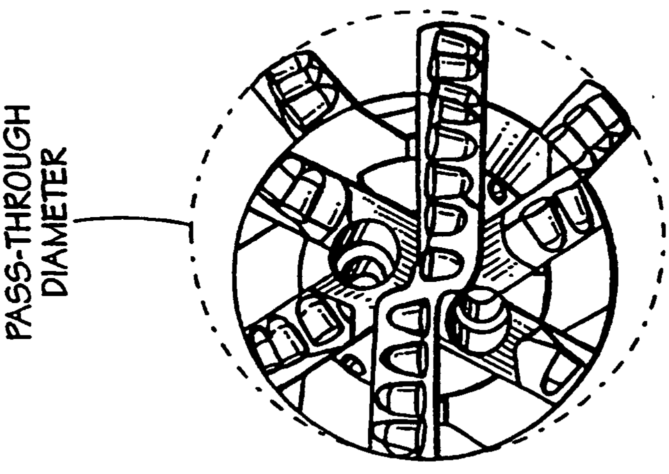


FIG. 3C

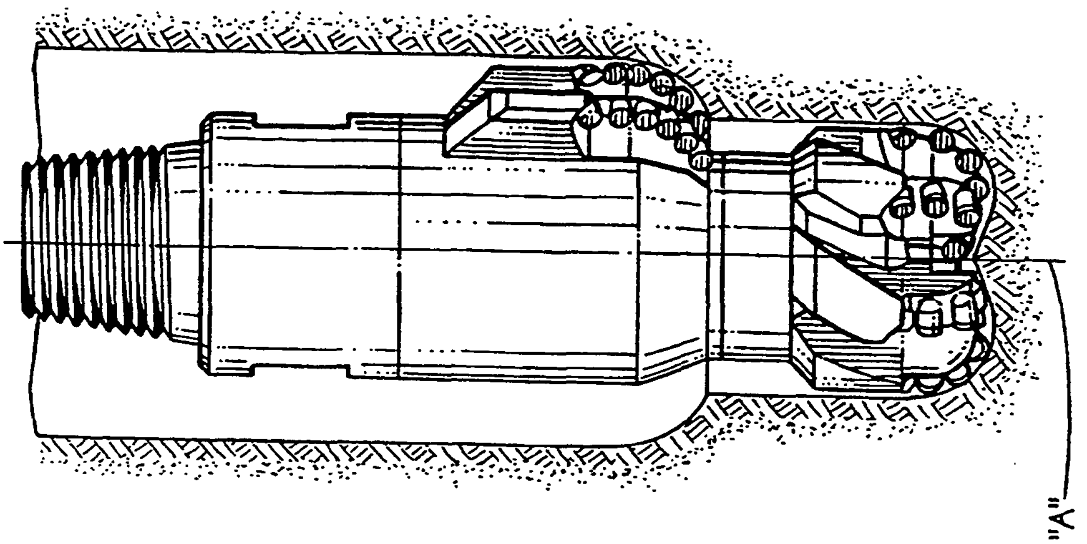


FIG. 4B

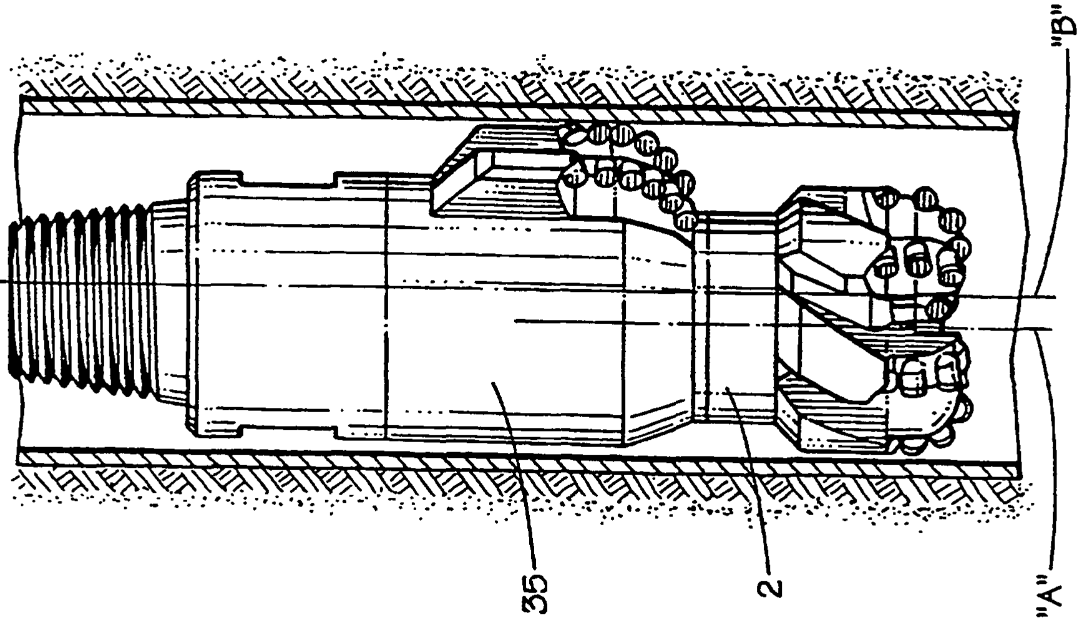


FIG. 4A

FIG. 5

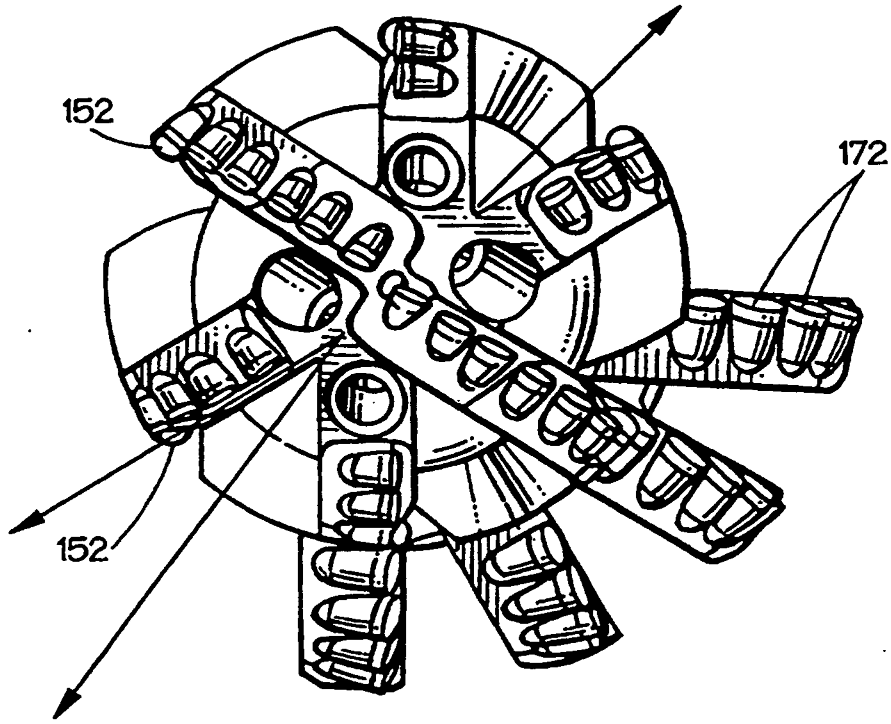
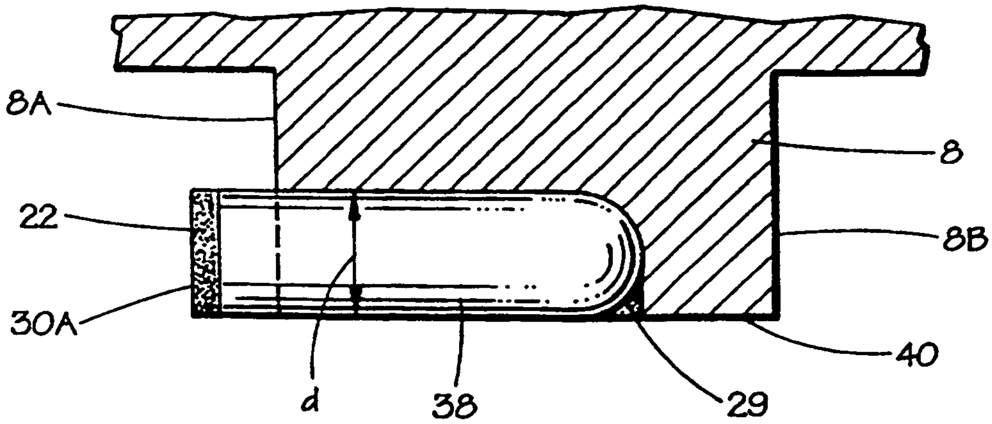


FIG. 6



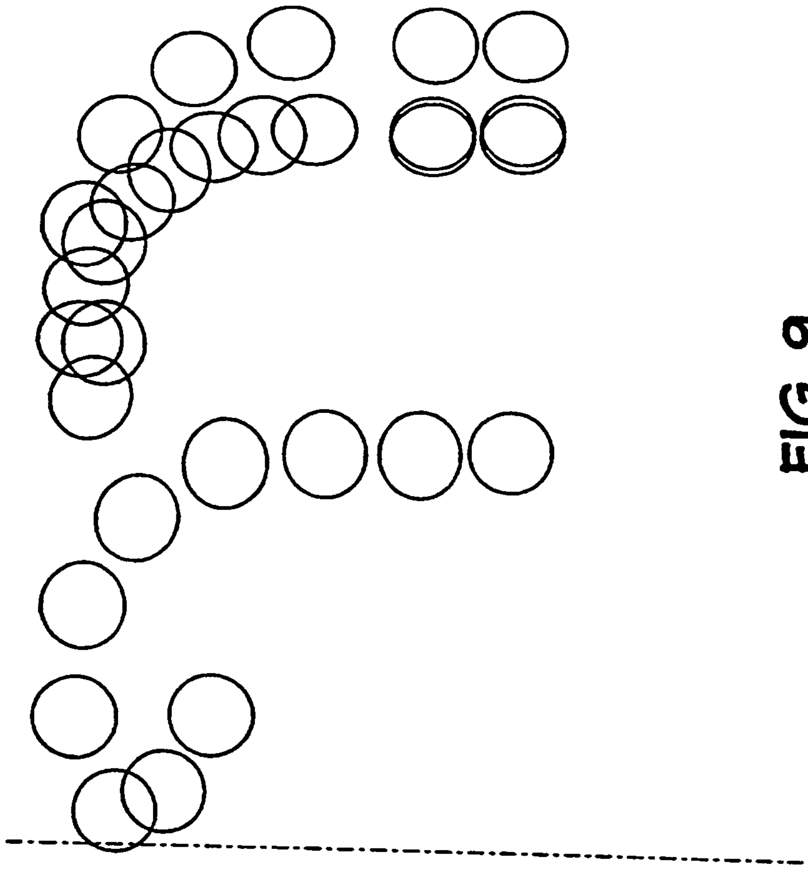


FIG. 9

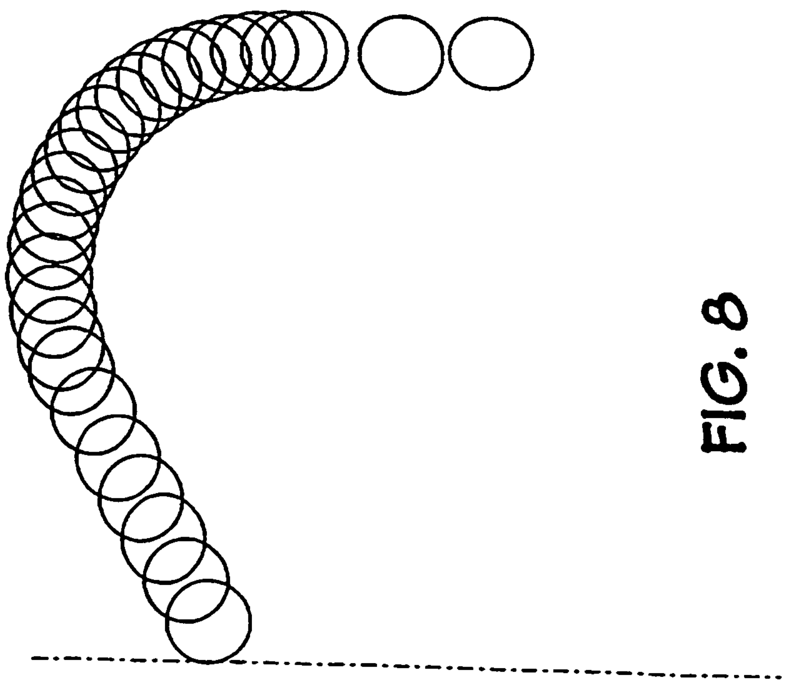


FIG. 8

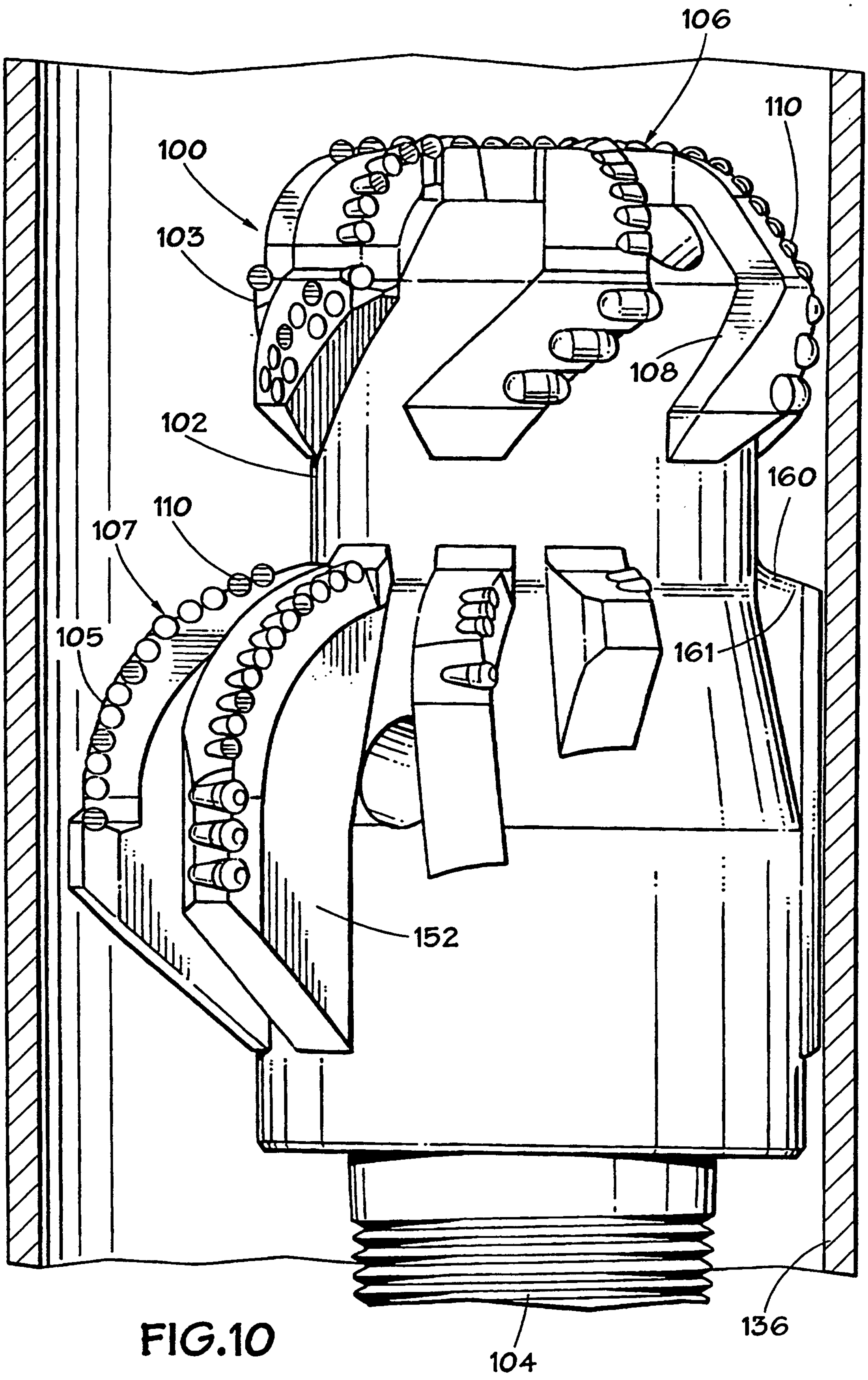


FIG.10

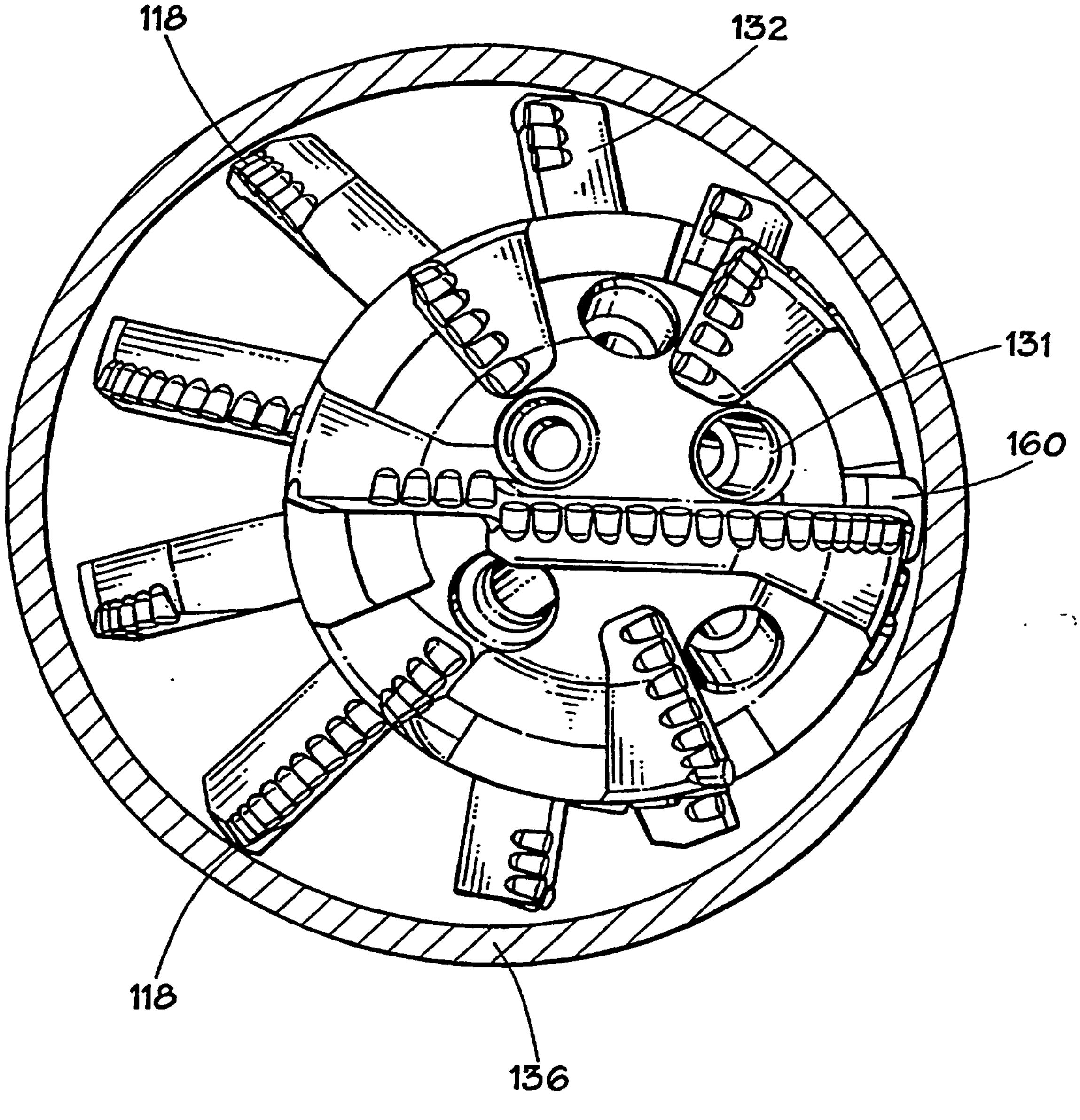


FIG.11

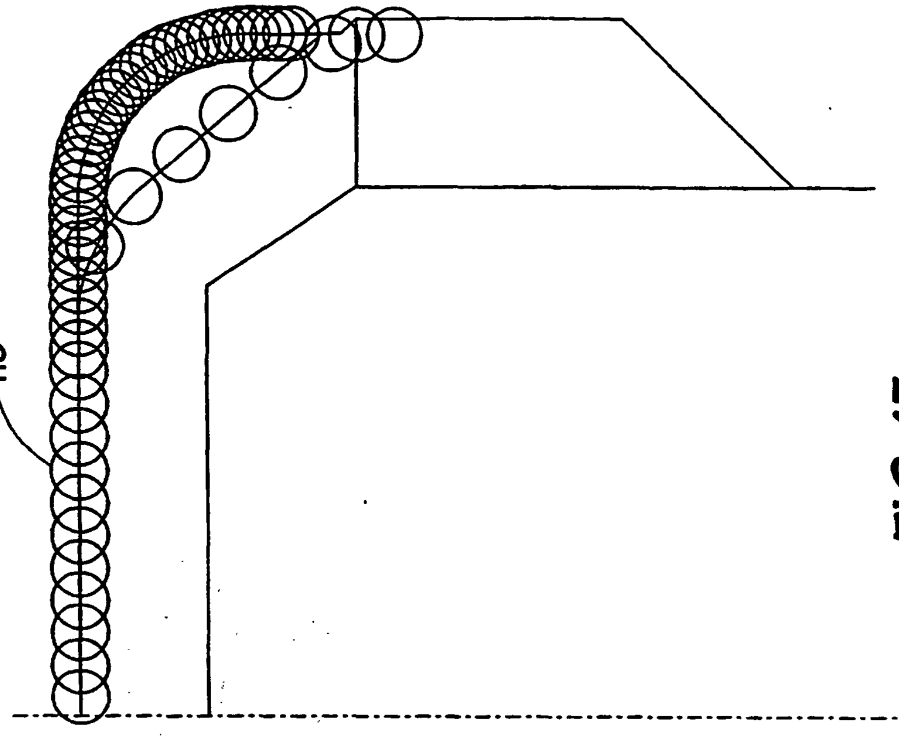


FIG. 13

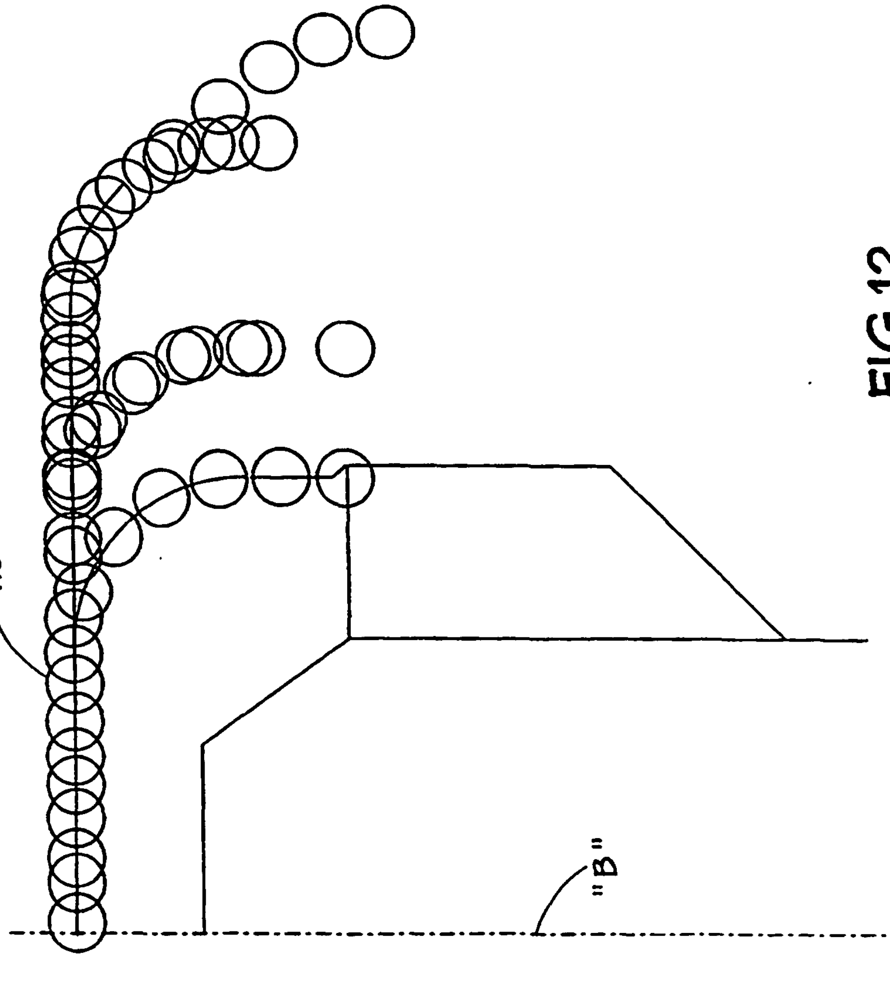


FIG.12

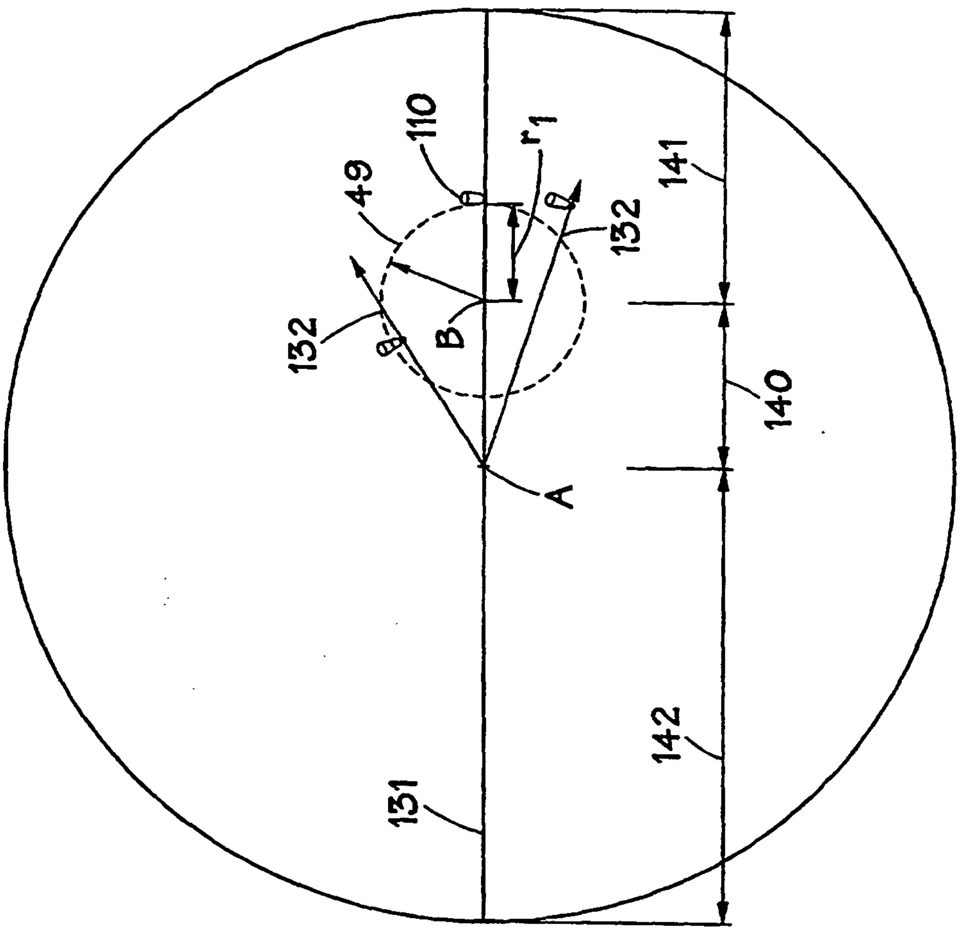


FIG.15

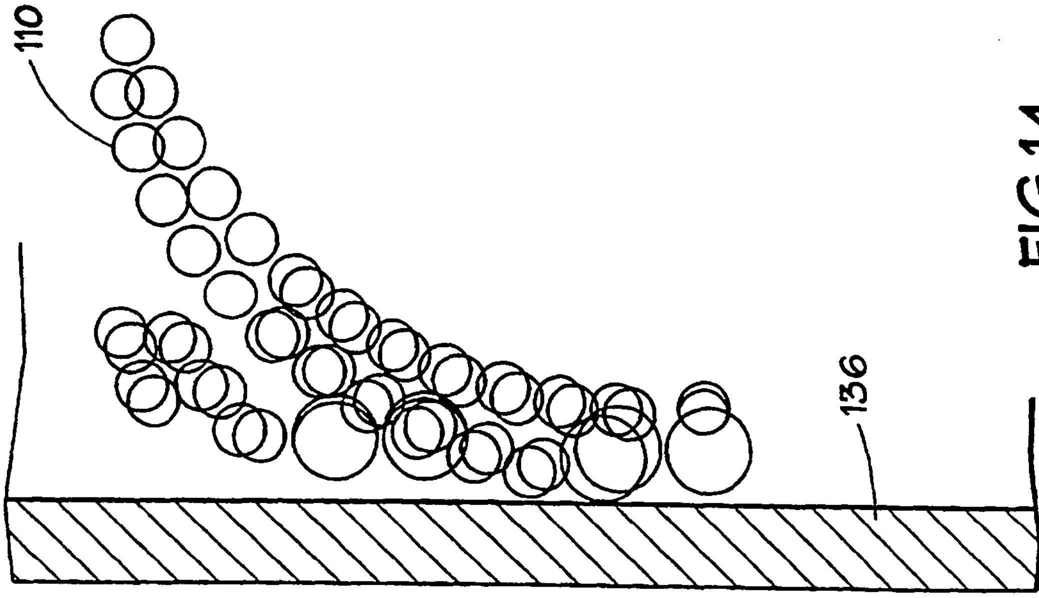


FIG.14