Aug. 2, 1938. E. J. BURSELL 2,125,332

BIT CASTING MEANS, METHOD, AND ARTICLE

Filed April 5, 1937 2 Sheets-Sheet 1

Fig. 1.

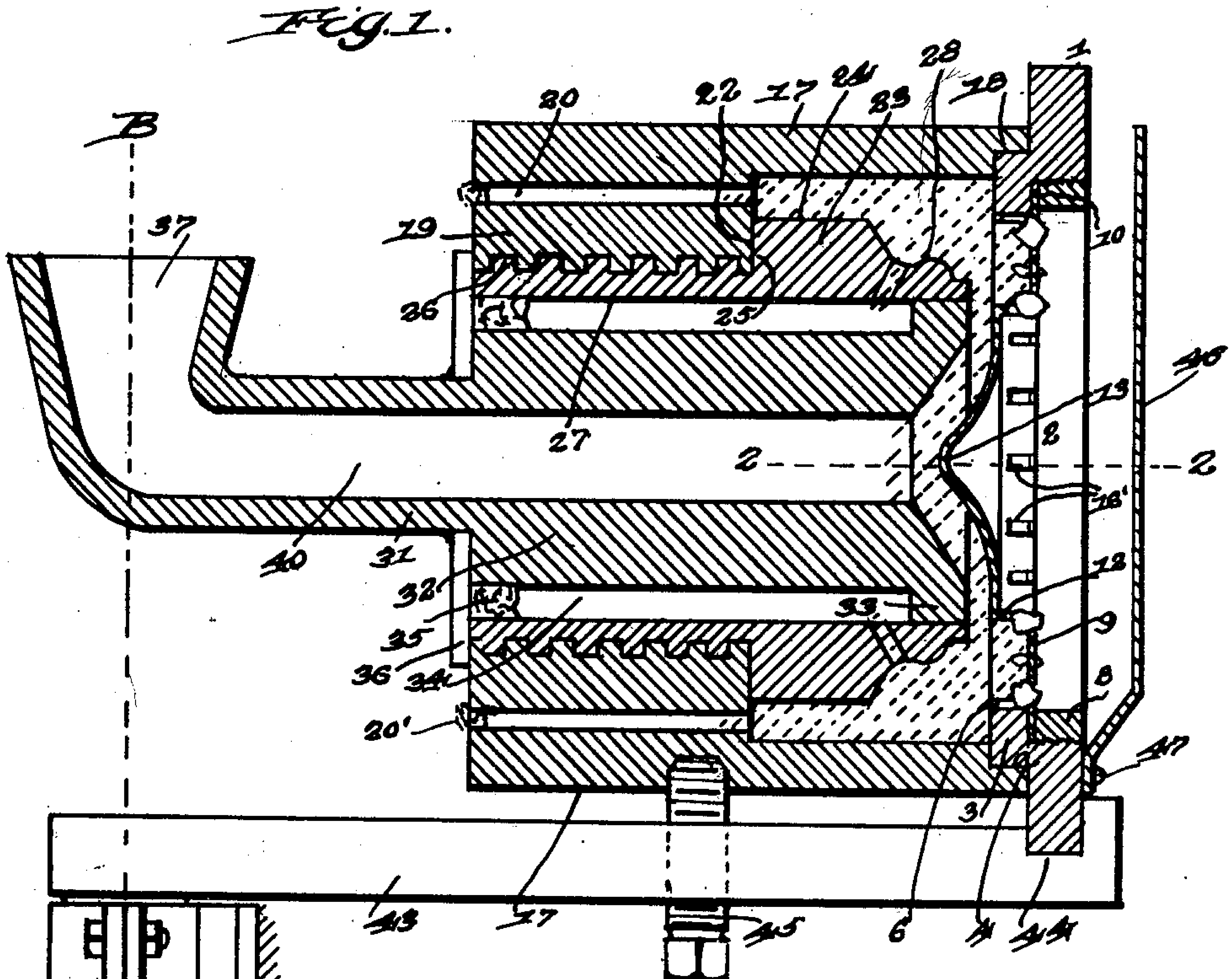

Fig. 2.

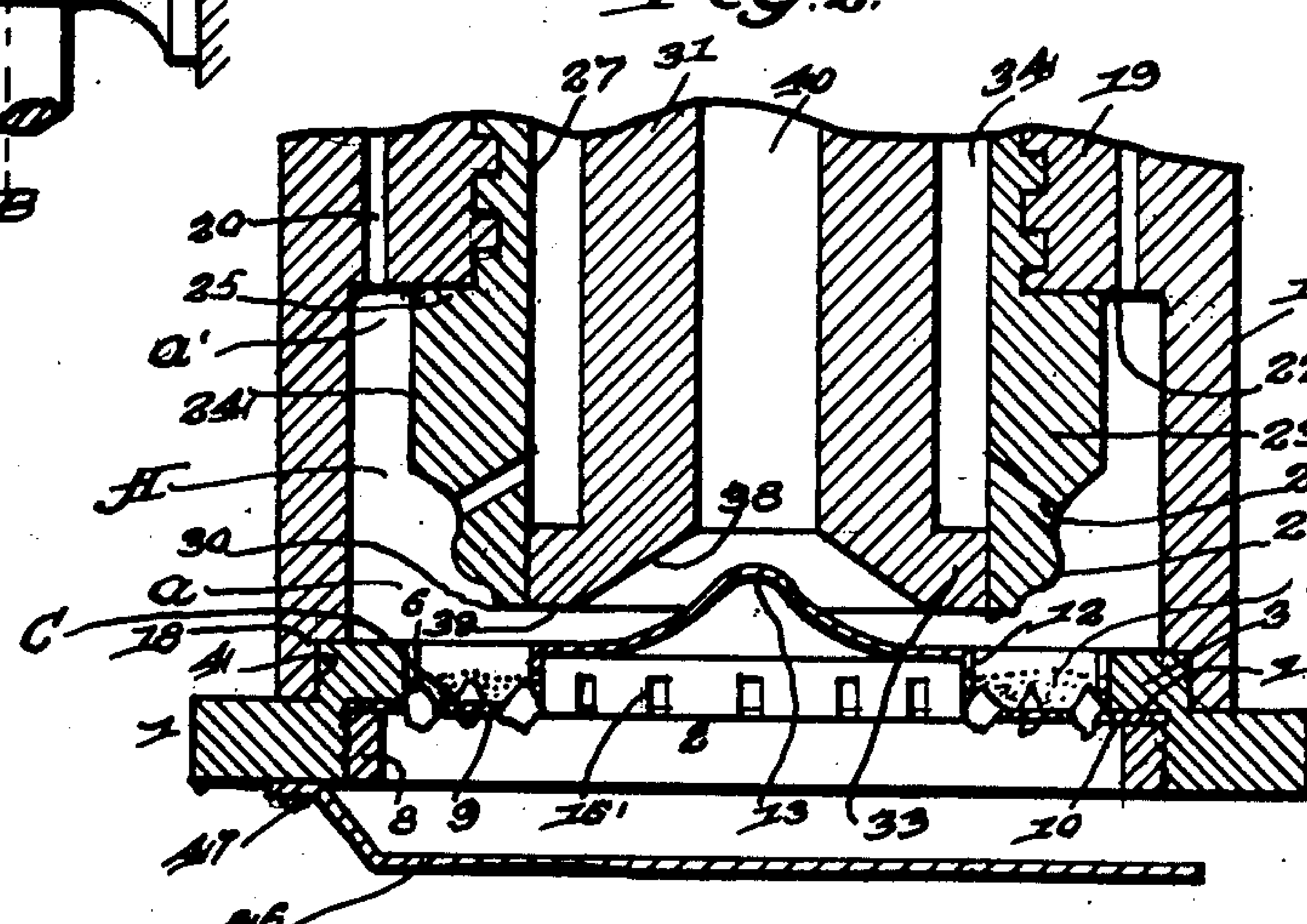

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Fig. 3.

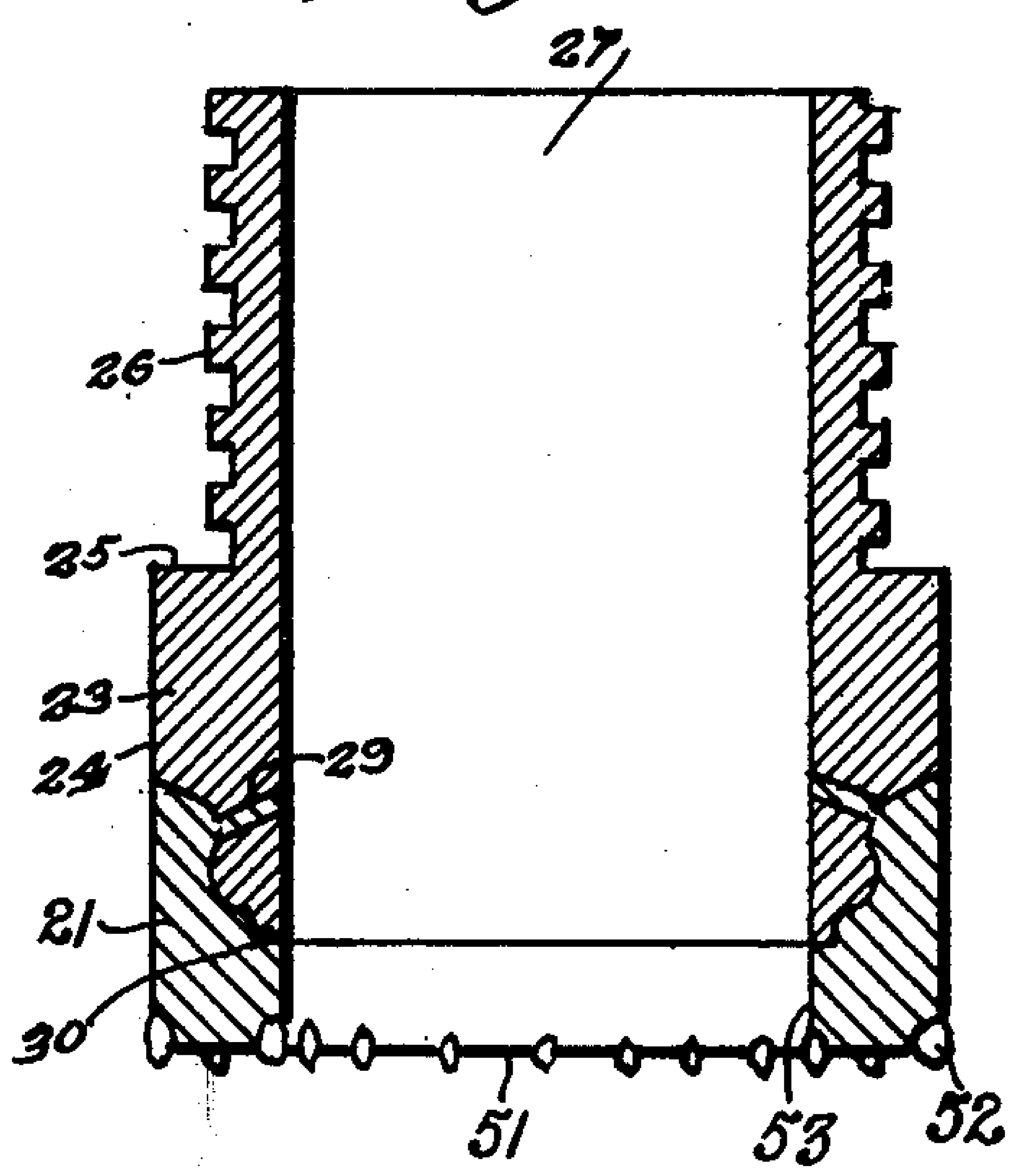


Fig. 4.

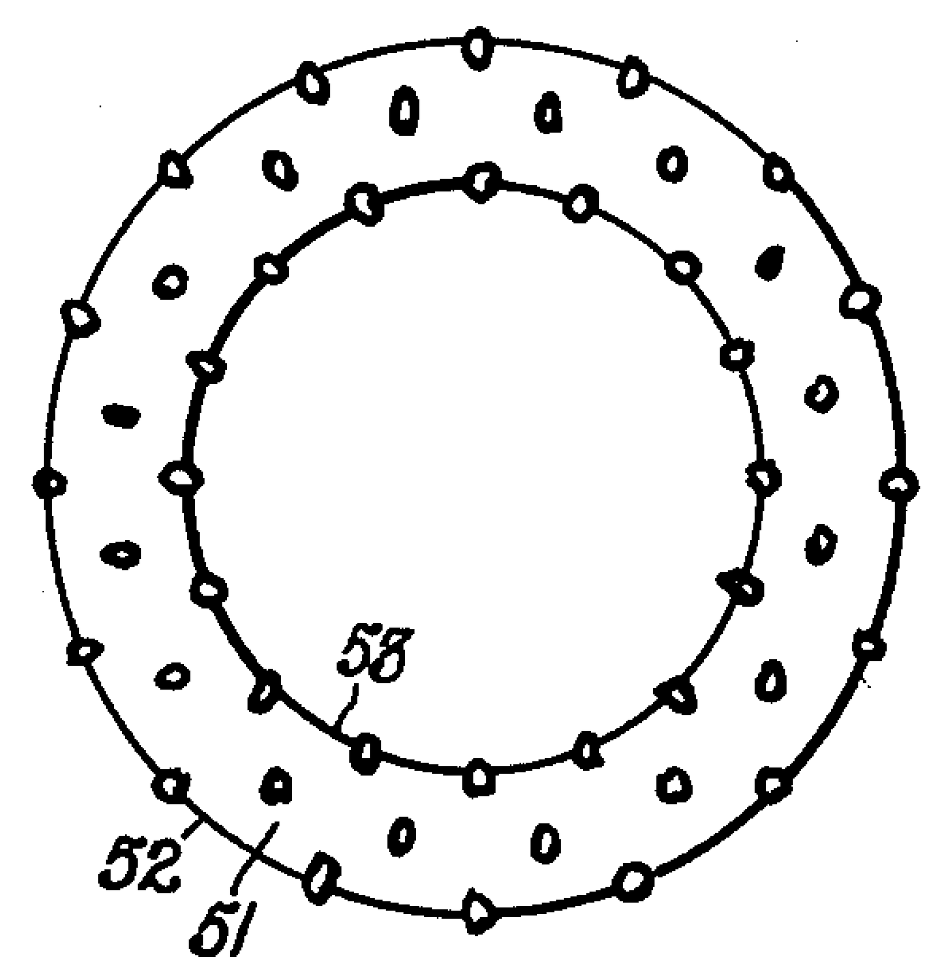


Fig. 6.

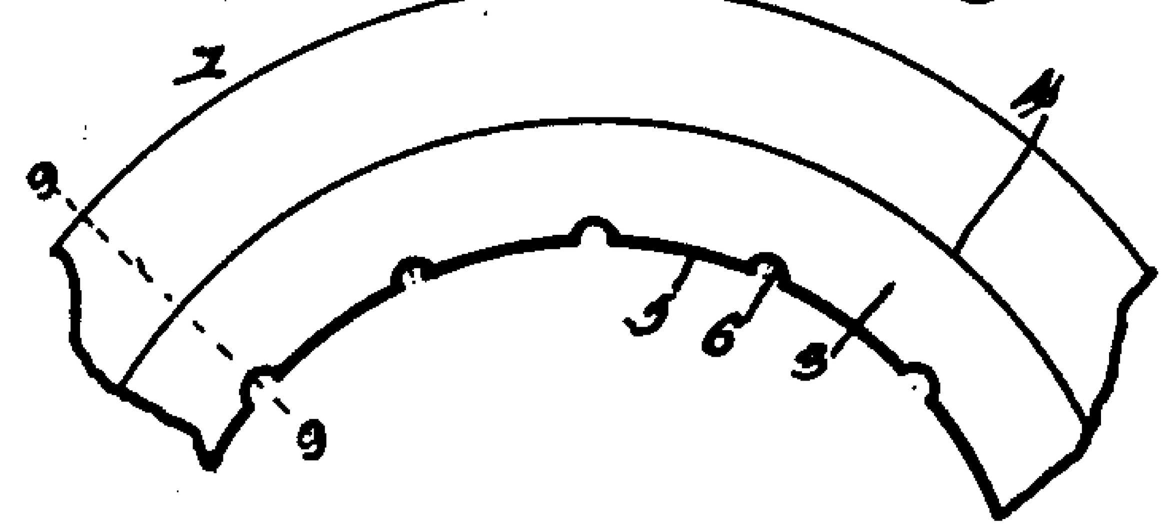


Fig. 5.

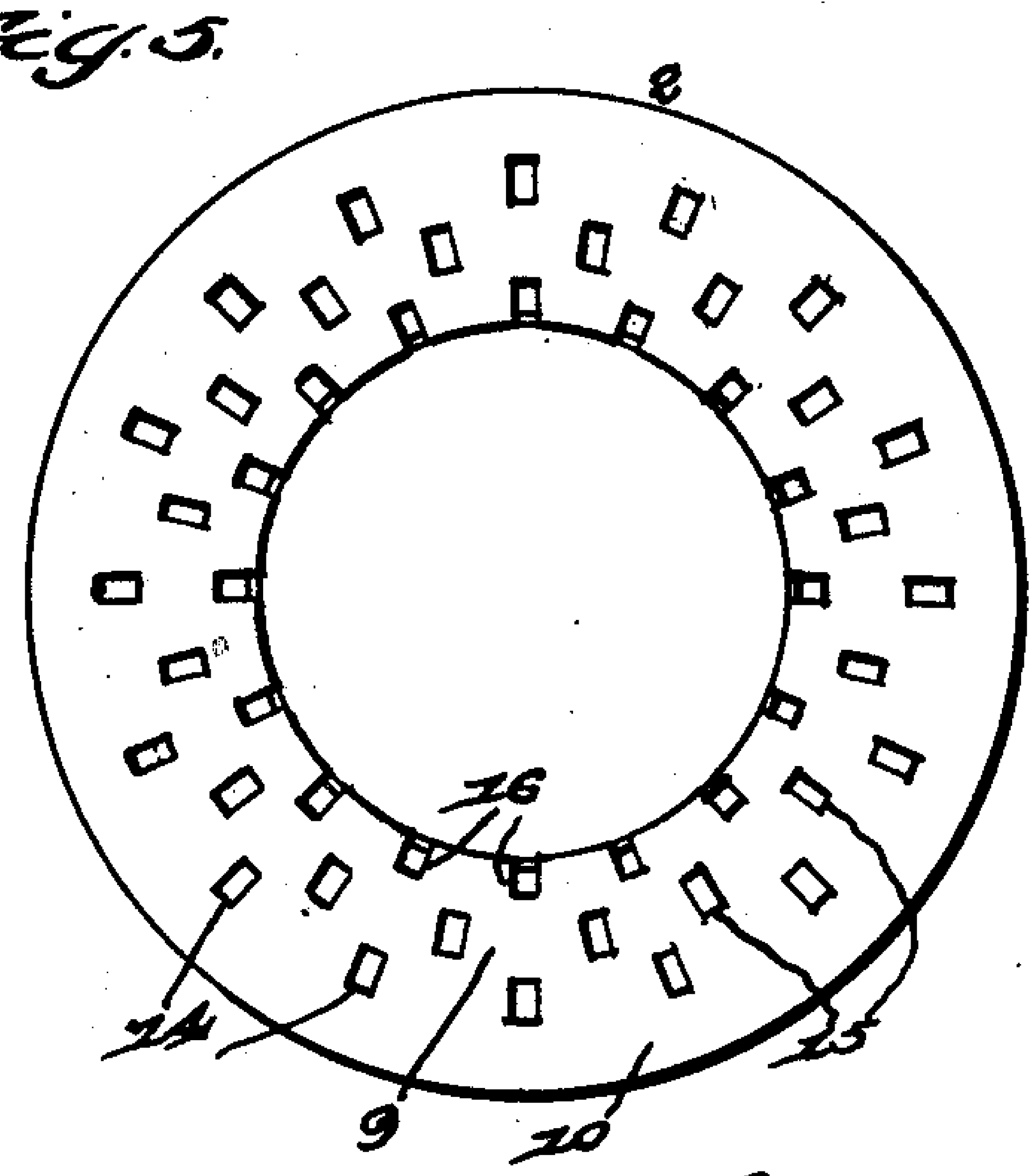


Fig. 7.

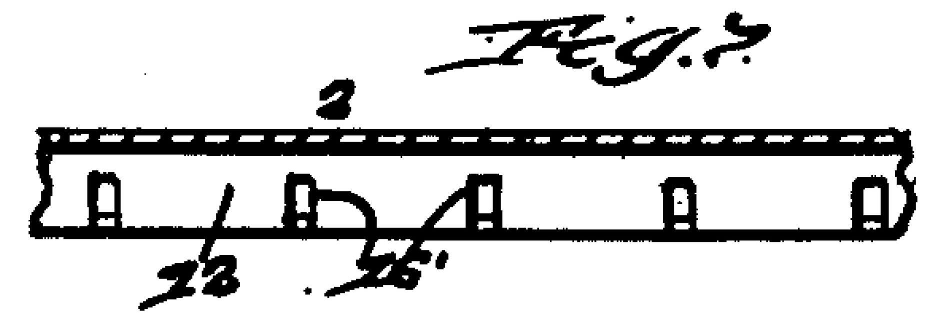


Fig. 9.

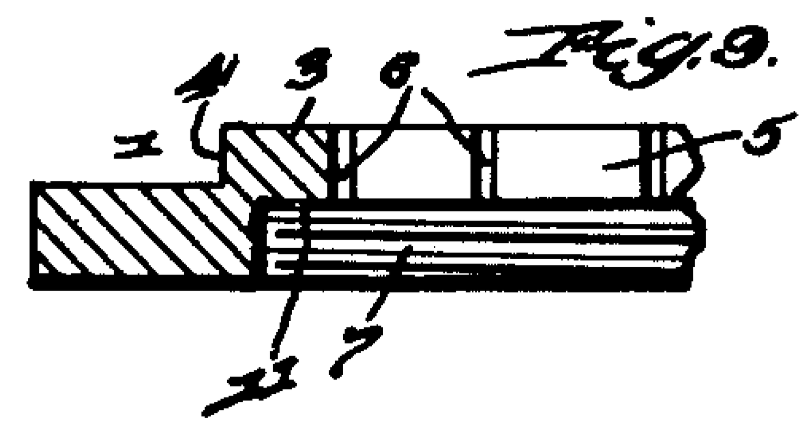
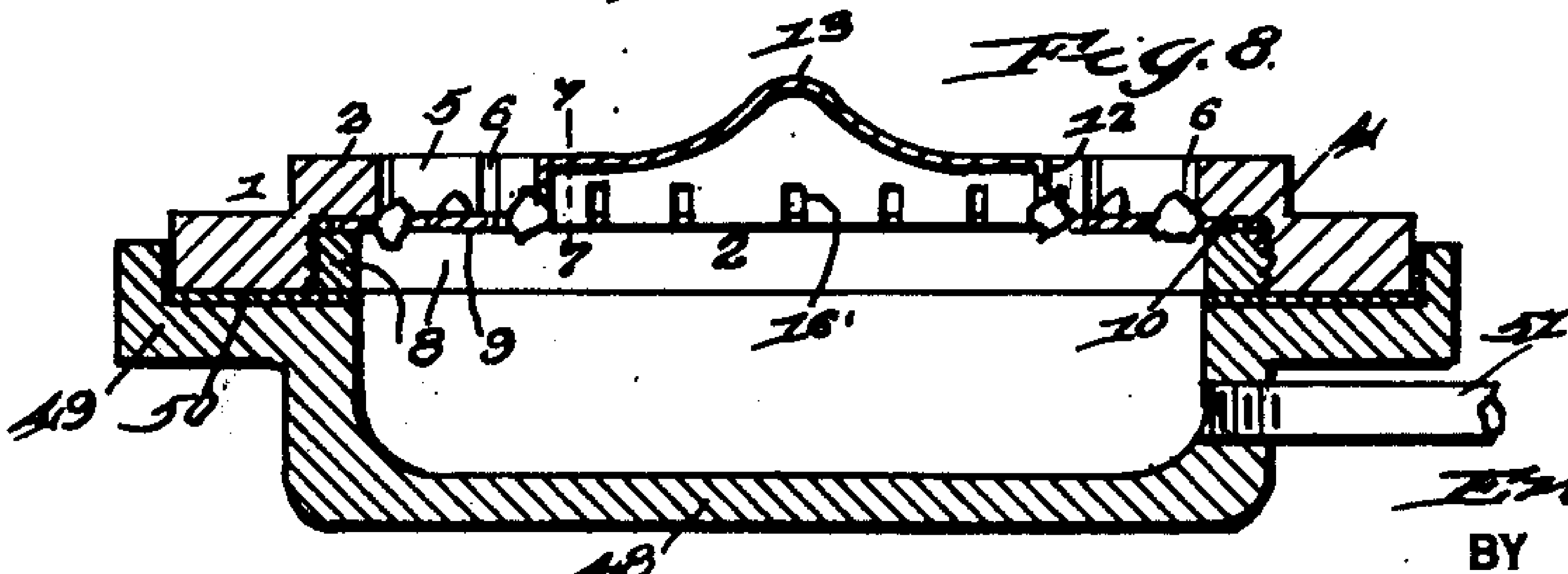


Fig. 8.



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2,125,332

UNITED STATES PATENT OFFICE

2,125,332

BIT CASTING MEANS, METHOD, AND ARTICLE

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Application April 5, 1937, Serial No. 134,929

9 Claims. (Cl. 22—65)

This invention relates to an improved method and means for casting a diamond drill bit body onto the coupling of a rotary drill, and the invention also relates to various articles of manufacture.

It is a feature of the invention to provide a novel mold structure adapted to contain the drill coupling and having a bit forming cavity in which the stones are disposed, the cavity having a capacity for metal in excess of the amount necessary to form the bit body whereby a considerable movement of the metal will take place in the casting operation that effectively avoids the formation of gas pockets.

A further feature of novelty resides in an improved method and means for subjecting the molten metal to centrifugal action while the metal is being poured to thereby enhance the possibility of obtaining a solid casting throughout the cross section thereof and greatly increasing the thorough disposition of the metal about the stones to firmly anchor the latter.

It is also a feature of the invention to reduce the temperature of the molten metal sufficiently before the latter reaches the stones to avoid burning the latter and thereby rendering the same ineffective in drilling.

The invention involves the steps of rapid air passage along and past the stones as the latter are being located to insure preliminary anchorage, and subsequently, the step of applying a meltable adhesive and subjecting the same to heat to melt the same about the stones as a fixture medium until the molten metal is admitted, such adhesive or wax-like substance being disintegrated by the molten metal.

It is a further object to provide a novel means whereby stones of a wide range of shape may be effectively used and easily mounted.

A very special feature resides in means whereby the stones may be set in a manner to project beyond the bore and core faces of the bit body, as well as from the end face of the latter, whereby ample bore and core clearance may be provided in the initial drilling action of the bit body, as well as during subsequent service.

A further novel feature resides in a die structure comprising main and secondary die members, the latter being interchangeable with the former whereby secondary die members may be provided for bit bodies of a variety of size of core bore in combination with the main die member adapted to form bits of a uniform outer diameter.

The invention has many other features and objects which will be more fully described in connection with the accompanying drawings and which will be more particularly pointed out in and by the appended claims.

In the drawings:

Fig. 1 is a vertical sectional view of the complete mold structure mounted to be revolved about a vertical axis.

Fig. 2 is a sectional view on line 2—2 of Fig. 1, showing the lower portion of the structure before the metal has been poured.

Fig. 3 is a vertical sectional view of the completed bit body after it has been cast onto a drill coupling.

Fig. 4 is an end view of the bit body showing the drill end face thereof.

Fig. 5 is a bottom face view of the secondary die member.

Fig. 6 is a broken segmental view of a portion of the main die member.

Fig. 7 is a developed sectional view showing the disposition of the stone holding openings in the secondary die member taken on line 7—7 of Fig. 8.

Fig. 8 is a sectional view of the die structure mounted on a suction cup.

Fig. 9 is a sectional view on line 9—9 of Fig. 6.

Like characters of reference designate similar parts throughout the different figures of the drawings.

Reference will first be made to the die base which includes a main and a secondary die, the former being generally indicated at 1, and the latter at 2. The main die member 1 is shown of annular form the same having a radially inwardly facing die portion 3 slightly elevated with respect to the main body 1, to conveniently form an annular locating shoulder 4. The inner or die face 5 is interrupted at spaced intervals by vertically disposed recesses or grooves 6, the purpose of which will later appear.

Below the die face 5 the main member 1 is threaded at 7 for engagement by an exteriorly threaded die anchoring ring 8.

Reference will next be made to the secondary die member 2, which, as shown, has a flat annular stone holding section 9 and an outer inperforate clamping section 10, in the same plane as the section 9. This clamping section is adapted to be interposed between the anchoring ring 8 and the face 11 of the main die member 1, as clearly shown in Figs. 1 and 2. By this means the secondary die member 2 is not only supported but is also held in a truly centered position. Said die member 2 is shown bent inwardly at 12 to form an annular core wall for the bit body to a length slightly beyond the stones. The central portion of this section is shown of cone-like form as indicated at 13, which functions to alter the path of the molten metal and guide the same radially outwardly toward the stone holding section 9, and into the bit forming cavity, as will later appear.

It will now be clear that the face 5 of the main die member 1, and the inwardly bent wall 12 of the secondary die member 2, together with the flat annular stone-supporting section 9 of the latter, form an annular mold channel for the bit body, the face 5 forming what will be termed the bore face, stone-supporting portion 9, the end face and inwardly bent wall 12, the core face of the bit body.

At this point it is desired to point out one of the most important features of the secondary die member whereby the stones are held in a definite order of positioning prior to casting the bit body.

This stone holding section 9, Fig. 5, is provided with an outer ring of stone receiving openings 14, an intermediate ring 15, and an inner ring 16, which are shown in the form of slots or elongated openings radially disposed, the importance of which will later appear. The stone-receiving openings 14 are adapted to register with and extend into or slightly radially beyond the grooves 6 in the main die member, there being the same number of each. The inner ring of stone-receiving openings 16, extend upwardly a slight distance into core forming wall 12, as clearly shown in Fig. 7 at 16'. The shape of the secondary die member serves greatly to strengthen the same for the relatively slight stress to which it is subjected and hence it can be made of very thin material, which in some cases may be ferrous and in others, of a non-ferrous material. In any event, it is the purpose to make this die member in such a manner that after the bit body has been cast, this die member will either have become disintegrated or be peeled off or otherwise removed from the rough casting, as in the very nature of this process, this die member 2 can only serve for one casting operation whereas the main die member 1 will be of service throughout the life of the apparatus.

Reference will next be made to the mold structure of which the die structure just described forms a constituent part.

The mold body is indicated at 17 and its exterior is cylindrical and its outer end is suitably shouldered at 18 to fit about and be centered by the shoulder 4, formed by portion 3 of the main die member 1. The interior form of the mold member 17 will vary in accordance with the type of drill coupling being used, but with the type shown said body has an inward extension 19 provided with a plurality of metal releasing ports 20, and the inner face is shown threaded to engage the threaded periphery of the coupling about to be described and forms a shoulder 22 for structural engagement with a like part on the coupling.

The drill coupling has a normal body portion 23, the periphery 24 of which is flush with the bit body 21 and the drill rod to which the coupling is connected. Above this body portion the coupling is reduced at 25 and is provided with an external thread 26. The bore 27 of the coupling is of uniform diameter. The outer end of the coupling is annularly reduced to an ogee cross section to form an undulated connecting portion, as indicated at 28, and lock forming passages 29 lead from the valley through the coupling and into the bore 27, the purpose of which will be later described. The reduction described terminates short of the secondary die member 2 in an end portion 30 and hence it will be clear that one of the purposes of this reduction of the coupling is to afford mold cavity spaces for the formation of the bit body. In practice this coupling is, except for the reduction just described, a finished article of high grade steel and when it is disposed in the cast relation shown in Fig. 3, it forms with the mold body 17 and the die structure 1 and 2, an annular cavity A, more particularly shown in full outline in Fig. 2, which is relatively enlarged at *a*, and extends at *a'* annularly about the main body 23 of the coupling.

Inwardly of the coupling is disposed a pouring tube 31 which is provided with a wall 32 of relatively increased thickness inside of the coupling, but in full clearance therefrom, a flange 33 engaging the coupling near the outer end and closing the intervening annular space 34. Any form of packing 35 may close the inner end, and lugs 36, on said pouring tube, may serve to limit the extent to which said tube may be inserted lengthwise into the coupling. Said tube is provided with an ingress end 37, which extends upwardly and which is disposed to coincident relation to the vertical axis B—B, about which the mold structure is rotated, to be presently described.

The egress end of the pouring tube is flared at 38, and the outer face 39 of the flange 33 forms an annular guiding means which effectively coacts with the coned portion 13 of the die member 2, to change the direction of the molten metal from its course through the bore 40, to a direction at substantially right angles thereto and cause the metal to flow radially outwardly into the cavity A, as will now be clear.

Conventional means is shown for subjecting the mold structure to centrifugal force and this takes the form of a power driven shaft 41, journalled in a fixed bearing 42. An arm 43 mounted on said shaft and supported by said bearing has a notch 44 adapted to receive a peripheral portion of the main die member 1. A set screw 45 threaded in said arm 43 is adapted to engage the mold body 17 to securely but removably mount the mold structure on said arm, as will now be clear. This permits the mold structure to be revolved by shaft 41 about axis B—B and renders the ingress end 37 of the pouring tube accessible for pouring the molten metal while the apparatus is in rotary motion.

A metal catching apron 46 is removably attached at 47 to catch metal escaping from the openings 14 to 16, as will be later described.

Reference will next be made to Fig. 8, which illustrates a means whereby the stones may be secured in place while they are being inserted in the various openings previously described, and before the die structure is assembled with the mold structure, as shown in Figs. 1 and 2.

A chambered or like suction cup 48 is flanged in shape to fit about the main die member 1, as indicated at 49, and a suitable packing 50 may be interposed therebetween to prevent ingress or leakage of air. A connection 51 leads from the cup to any suitable source of suction and air is drawn with great rapidity through the various openings 14 to 16 so that as the stones are inserted into said openings they are retained in place temporarily. It will be understood that these stones are of irregular shape in most instances, and that only a relatively small portion of each can enter an opening and hence if it were not for some means for retaining the placed stones they would tilt out of position almost as fast as they were being positioned.

After the stones have been positioned, suction is either shut off or greatly reduced and then a suitable wax-like or meltable substance is sprinkled over the positioned stones in a finely divided state and to the desired depth in the casting channel, as shown at C in Fig. 2. This is done before the die structure is assembled with the mold structure. Then suitable heat is applied to melt the wax and the latter surrounds the stones and forms with the channel walls a kind of molded body that securely holds the stones in position while and after the die structure has been assembled with the mold structure. It will be clear from Fig. 1 that after being assembled with the mold structure, the die members assume a substantially vertical position, and this is one reason for anchoring the stones to prevent them from getting out of position.

Reference will next be made to one manner in which the process may be carried out and the apparatus successfully operated.

The die structure is first disposed on the suction cup 48, as just described, and the stones are individually disposed in separate openings 14 to 16, usually by means of tweezers, and after all the stones have been placed or set, suction is shut off or reduced and wax-like particles are distributed over the stones and in the casting channel to any desired depth necessary. Heat is applied to melt the wax and the latter embeds the stones and adheres to the channel walls as indicated at C, in Fig. 2. Thus, the stones are now anchored for preliminary purposes and also for purposes of final assemblage with the mold structure.

At this point it is desirable to point out the advantage of being able to make up a stock of waxed stones on the die plate without actually casting them into bit bodies because if the bodies are actually cast and not sold, the investment loss is considerable, whereas if different sizes are wanted, and these different sizes are already made up and waxed, then casting can proceed promptly.

It will be understood that couplings of a given exterior diameter often have internal bores of varying diameter, and that is why the die members 2 are made interchangeable with die member 1, so that the internal diameter of the casting channel can be changed by inserting a different die plate. Thus an equipment will involve a number of die plates 2 with the walls 12 thereof of the diameter shown, or reduced, or increased with respect to that shown.

A particularly novel feature resides in making the openings in die plate 2 elongated or of slot-like formation, so that stones of irregular shape can be used, which can be bought at a lower carat price than regularly shaped or pointed stones.

The low priced stones, which have all the hardness and efficiency of graded stones with points, will always at some area present a chisel-like or blunt edge which a slot will accommodate and which a circular hole will not; and further, if the stone happens to have a point the slot will accommodate it. Therefore these slot openings 14 to 16 have a universal range of adaptability for any type stone now on the market, as they can be used even when the stone edge is blunt.

A further advantage of this novel slot construction may be explained by reference to Fig. 3, wherein it will be seen that the bit body 21 has an end working face 51, a bore working face 52 and a core working face 53, all of which constitute the working surface of said bit body. This is due to the fact that the outermost stones project beyond the outer periphery of the bit body and the inner stones project into the core bore of the latter. This affords bore and core clearance for the water at the start of drilling as well as later on, which is an important feature.

Now referring to Figs. 2, 5, 6, 7 and 9, it will be seen that when the outer stones are positioned they can be placed in the outer slots 14 so as to project into grooves 6, and hence they will project beyond the periphery of the bit body as shown. Likewise, because the inner slots 16 extend up into wall 12, the inner stones can be located so that they will project into the finished bore 27.

The next step in the operation of casting will now be described.

The mold structure may be assembled upon the die structure with the latter in the horizontal position shown in Fig. 2, the mold body 17 being disposed onto member 1, in flanged and centered engagement therewith and secured in any desired manner, not shown. The coupling will first have been disposed in the mold body 17. The pouring tube 31 may next be inserted and the stop arms 36, engaging the upper end of the mold body, will limit insertion of the tube 31 so that the lower face thereof will be flush with the lower end of the coupling. In cases where the coupling is exteriorly threaded, as shown, the interior of the mold body may have coacting threads, as shown, so that the coupling will be very accurately held in its inserted position.

The structure thus assembled, is then disposed on arm 43, and the set screw 45 is turned home to frictionally connect the structure with arm 43 so as to cause the latter to rotate said structure about axis B—B when shaft 41 is rotated. While the structure is being rotated, molten metal is poured into ingress 37 and centrifugal action causes it to flow lengthwise of bore 40 and against the cone-like part 13, of die plate 2. This serves to slightly chill or sufficiently reduce the temperature of the molten metal so as not to burn the stones with which it later contacts. Because of the opposing guiding surfaces consisting of parts 38 and 39 of the pouring tube, and the top center wall 13 of the die plate 2, the metal is caused to change its path of travel to an angle substantially at right angles from that path which it took through bore 40, and pass radially outwardly into cavity A.

As the molten metal engages the wax C, it will disintegrate and destroy the same as it flows into the casting channel of the die structure and about the stones. As the metal advances in cavity A, and passes the annular curved portions 28 of the coupling it will enter lock-forming passages 29, and any gas pockets that might otherwise form would thus be eliminated during the formation of such locking means, and the gas could escape through said passages into space 34. It will be clear that as the metal enters said passages 29 it will chill and by this means I effectively lock the cast bit body against rotative movement on the coupling, in addition of course to the resistance of the cast metal against such rotative movement.

The metal will of course fill cavity A and form an excess thickness about portion 23 of the coupling, and finally the molten metal will enter indicator ports 20 and when the plugs 20′ thereof are forced out the operator will know that the casting of the bit body has been completed.

A very important feature is the fact that molten metal will leak through openings 14 to 16 during casting of the bit body, and that is why I provide the apron 46 for catching this escaping metal. In practice some of this escaping metal will chill and project from the die plate in the form of what may be termed very thin "whiskers" which are often one-half inch in length, and often tubular in cross section. Now this escape of metal, together with the excess area of the cavity, insures a sufficient movement of the metal so that gas pockets are not only avoided, but centrifugal action is most effective in forcing the metal against the die plate and about the stones in such a manner that they will be rigidly anchored to the resulting casting. This is most important for efficient drilling as gas pockets adjacent the stones would soon cause the latter to become loose and be lost, with obvious disadvantages attending drilling operations.

It will thus be seen that the openings 14, 15 and 16, not only afford air passage past the stones for temporarily holding them before they are embedded by the molten metal, but they also form leakage means for release of portions of the molten metal and gases to prevent the formation of voids, especially voids near the embedded stones.

It will be understood that the casting operation will join the die plate 2 to the resulting casting, and this die plate will of course be removed whether it is of ferrous or nonferrous material. However, its loss will not be of consequence because it can be produced very cheaply.

After casting the parts are dis-assembled and the combined coupling and bit body is removed, and the bore and also the excess material is suitably machined off until the interior and exterior are flush, as shown in Fig. 3. However, the casting channel forms the working surface to the true size and hence this portion need not be reduced.

It will be understood that the step of initially positioning the stones, as shown in Fig. 8, is a very useful and valuable step in the process since in actual practice, this step is performed by low cost labor and is completed before the casting operation is started, and it is of great value because a stock of die plates with stones all located can be made up in advance, and of course temporarily anchored, as by wax, and will thus afford an advance supply to meet a rush order for a plurality of bits.

It will be understood that these couplings are relatively costly and of high grade steel, while in most instances the bit body is formed of a nonferrous alloy, which is much softer than the steel. Hence, when the bit body becomes worn it can be hack-sawed off or otherwise removed from the coupling and the latter becomes serviceable for a new bit body.

The importance of slightly chilling the molten metal before it reaches the stones has made it possible for me to cast bortz diamonds, which are an African product, as well as the black or carbonado diamond, which is a Brazilian product, without burning either type. This, to my knowledge, has never been successfully done heretofore. The slight chilling of the metal to prevent burning of the stones is not objectionable even though the metal may be slightly less fluid, since this is overcome by the efficiency of centrifugal action in positively advancing the metal. Further, the thrust of the molten metal is against the die plate, and this greatly reduces the danger of dislocating the stones when the metal later reaches the casting channel.

It is believed the invention will be clearly understood from the foregoing description and I do not wish to be limited to the specific form shown except for such limitations as the claims may import.

I claim:—

1. The method which comprises inserting irregularly shaped cutting stones into engagement with the walls of openings of a different shape while applying suction to the openings to induce a sustained passage of air through the openings while the stones are being inserted, partially or fully releasing the suction after the stones have been inserted in said openings, depositing a meltable adhering substance about the inserted stones, and then applying heat to melt such substance to temporarily anchor the stones in their set position in said openings.

2. The method which comprises inserting cutting stones irregular in shape into engagement with the walls of openings of a different shape while causing a sustained passage of air through said openings, reducing or releasing such air passage after the stones have been inserted, depositing a meltable adhering substance about the inserted stones, applying heat to melt such substance temporarily to anchor the stones in said openings, and then pouring molten metal about the stones to disintegrate said melted substance and permanently to embed the stones in partial projected relation to the final drilling surface of the metal body thus produced.

3. The method which comprises inserting irregularly shaped cutting stones into engagement with the walls of openings of a different shape while inducing a sustained passage of air through said openings, depositing an adhering substance about the stones temporarily to retain them in said openings, and then pouring molten metal about said stones while subjecting the metal to centrifugal action to force the metal against and around the stones, thereby to provide a metal mass with the cutting stones embedded therein.

4. In a mold for casting the working surface of a bit body for diamond drills, a two-part die comprising in combination an annular main die member, a secondary die plate member removably connected thereto, said main die member having an annular wall for forming the periphery of the bore working face of the bit body, said annular wall being provided with diamond-receiving grooves permitting projection of the cutting stones or diamonds radially outwardly of said bore working face, said secondary die plate member forming the end working face and the core working face of said bit body and being provided with a row of stone or diamond-receiving slots in registry with the grooves in the annular wall of the main die member, said secondary die plate member also being provided with a row of stone or diamond-receiving slots extending through that part of said die plate member which is to form the core working face of the bit body to permit projection of the stones radially inwardly of the core face of said bit body.

5. In a mold for casting a bit body onto the coupling of a rotary diamond drill, the combination of a mold structure for holding the coupling therein, said mold structure being provided with a bit-body-forming cavity of a size in excess of the size of the bit body to be cast, a die-plate

forming part of said cavity, said die-plate being provided with openings for receiving the cutting stones of the drill, said openings being of a shape other than that of the cutting stones so as to provide for leakage of metal past the stones during the casting operation, and means for revolving said mold structure during the casting operation, whereby the movement of the molten metal into said cavity and the passage of some of the metal through said openings by centrifugal action will cause the stones to be effectively gripped and gas pockets avoided in the cast body.

6. As a new and useful article of manufacture of the class described, a die-plate having an outer annular imperforate clamping section and an inner annular stone-receiving section in the same plane as the clamping section, said stone-receiving section having an inner and outer series of stone-receiving openings of elongated form extending radially of the section in which they are formed.

7. As a new and useful article of manufacture of the class described, a secondary die member having an annular stone-supporting section provided with outer and inner rows of stone-receiving openings, and said die member having a central core-forming annular wall provided with slots registering with the said inner row of stone-receiving openings.

8. As a new and useful article of manufacture of the class described, a secondary die member having an annular stone-supporting section provided with an outer and inner series of stone-receiving openings, the center of said die member being extended out of the plane of the die member to provide a core-forming annular wall having slots registering with the said inner series of stone-receiving openings, said central extension of the die member being shaped to form a cone-like metal-temperature-reducing and deflecting center for said die member.

9. In a centrifugal mold for casting a bit body onto a rotary drill coupling and uniting drilling stones with the bit body, a mold structure for holding the coupling and having a bit-forming cavity surrounding the coupling, a pouring tube extending through the coupling into said mold structure and having a flared terminal extending radially from the bore of said tube, and a die-plate for supporting stones in said cavity and extending abreast of and coacting with said flared terminal of the pouring tube for taking the initial impact of the metal and guiding the latter radially outwardly into said cavity to form the bit body and unite the latter with the coupling and partially embed the stones.

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