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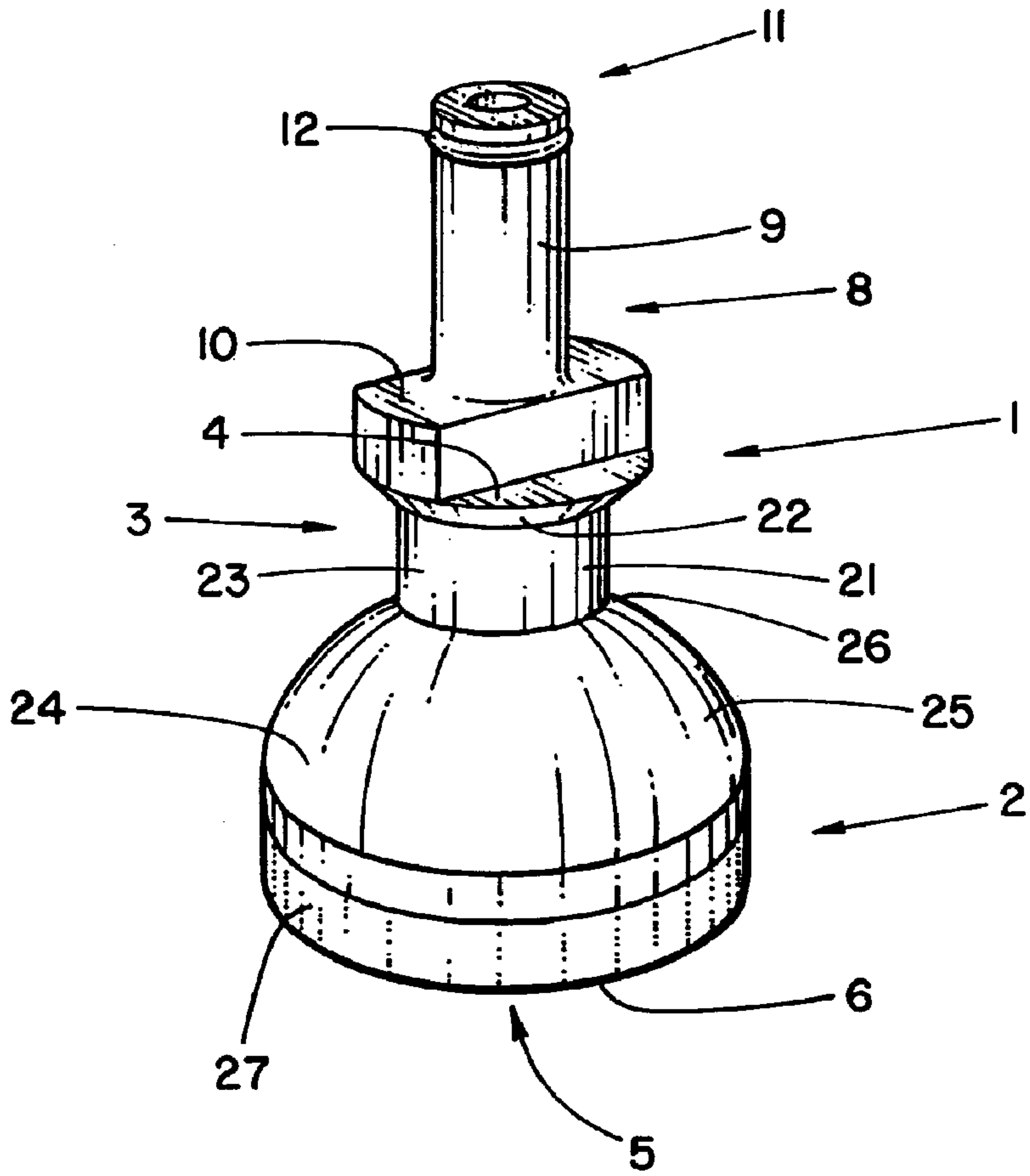

(57) Abrégé/Abstract:
The present invention provides a grinding cup (1) having a lower grinding section (2) and an upper body section (3) integrally connected to form a grinding cup having top (4) and bottom (5) surfaces. The grinding section (2) is formed from a material

(57) Abrégé(suite)/Abstract(continued):
capable of grinding the hard materials such as tungsten carbide inserts of button bits etc. A centrally disposed convex recess (7) is formed in the bottom surface (5) having the desired profile for the button to be ground. One or more passageways (15) in the upper body section (3) and grinding section permit a coolant, preferably water, optionally mixed with cutting oil or a water/air mist, to be provided to the surface of the button (5) during grinding, through outlet(s) on the bottom surface. Drive means (8) are provided on or in the upper body section that cooperate with the output shaft of the grinding machine. Retaining means (11) are provided in conjunction with the drive means (8) to releasably secure the grinding cup (1) to the output shaft of the grinding machine during use.

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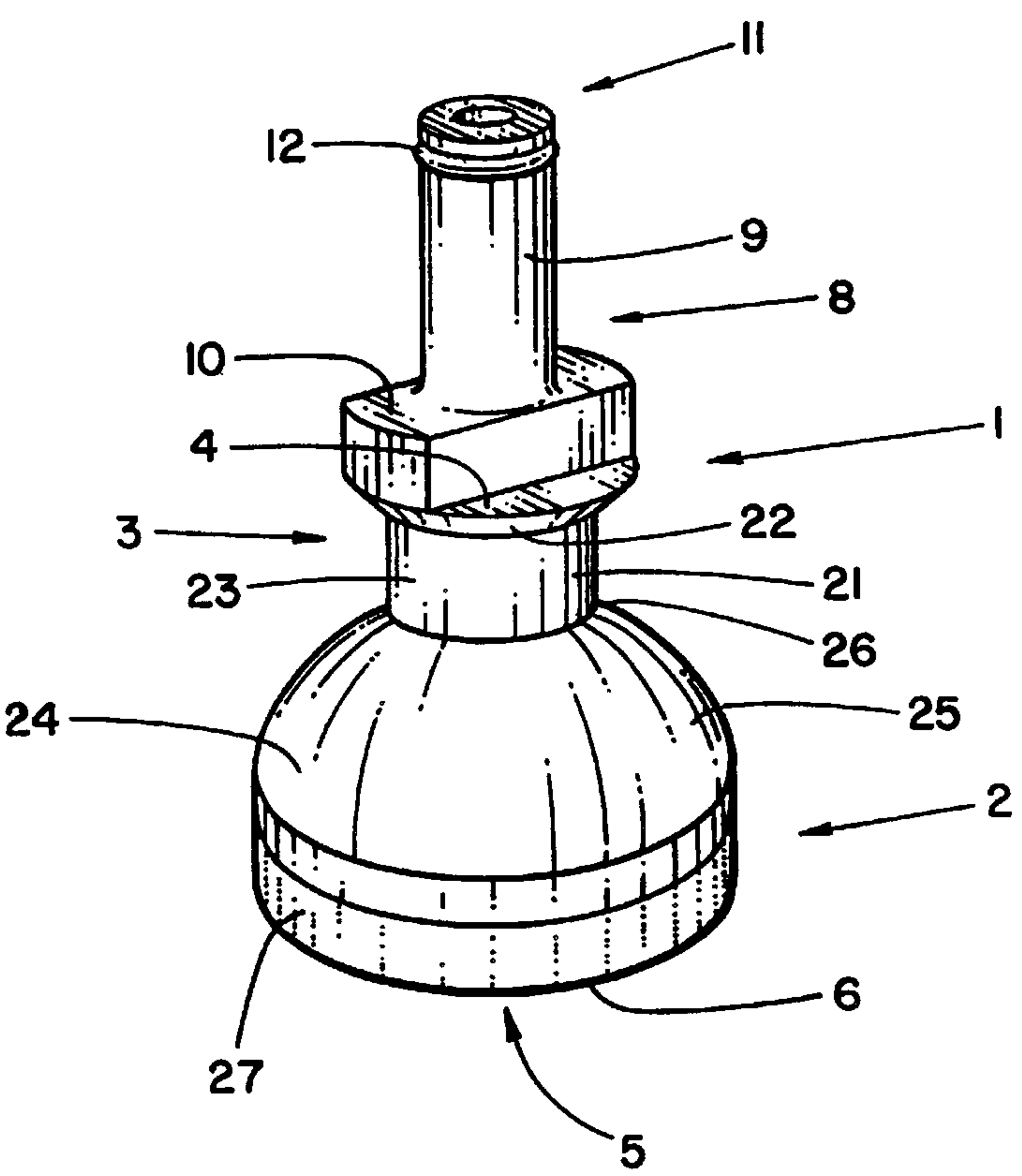
(54) Title: MASS REDUCED GRINDING CUP



(57) Abstract: The present invention provides a grinding cup (1) having a lower grinding section (2) and an upper body section (3) integrally connected to form a grinding cup having top (4) and bottom (5) surfaces. The grinding section (2) is formed from a material capable of grinding the hard materials such as tungsten carbide inserts of button bits etc. A centrally disposed convex recess (7) is formed in the bottom surface (5) having the desired profile for the button to be ground. One or more passageways (15) in the upper body section (3) and grinding section permit a coolant, preferably water, optionally mixed with cutting oil or a water/air mist, to be provided to the surface of the button (5) during grinding, through outlet(s) on the bottom surface. Drive means (8) are provided on or in the upper body section that cooperate with the output shaft of the grinding machine. Retaining means (11) are provided in conjunction with the drive means (8) to releasably secure the grinding cup (1) to the output shaft of the grinding machine during use.

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TITLE: MASS REDUCED GRINDING CUP

BACKGROUND OF THE INVENTION

The present invention relates to improvements in devices for use as grinding cups for grinding the hard metal inserts or working tips of drill bits (percussive or rotary), tunnel boring machine cutters (TBM) and raised bore machine cutters (RBM) and more specifically, but not exclusively, for grinding the tungsten carbide cutting teeth or buttons of a drill bit or cutter and the means for detachably connecting the grinding cups to the grinding machine.

In drilling operations the cutting teeth (buttons) on the drill bits or cutters become flattened (worn) after continued use. Regular maintenance of the drill bit or cutter by regrinding (sharpening) the buttons to restore them to substantially their original profile enhances the bit/cutter life, speeds up drilling and reduces drilling costs. Regrinding should be undertaken when the wear of the buttons is optimally one third to a maximum of one-half the button diameter.

Different manual and semi-automatic grinding machines are known for grinding button bits/cutters (see for example U.S. Patent No. 5,193,312; 5,070,654). In a conventional type of machine a grinding cup having the desired profile is rotated at high speed to grind the carbide button and the face of the bit/cutter surrounding the base of the button to restore the button to substantially its original profile for effective drilling.

The grinding cups conventionally consist of a cylindrical body having top and bottom surfaces. The bottom or working surface consists of a diamond/metal matrix having a centrally disposed convex recess having the desired profile for the button to be ground. A beveled rim around the recess removes steel from the face of the bit around the base of the button.

Water and/or air, optionally with some form of cutting oil, is provided to the grinding surface to flush and cool the surface of the button during grinding.

The grinding cups are provided in different sizes and profiles to match the standard sizes and profiles of the buttons on the drill bits or cutters. Typically the button diameter varies from 6mm up to 26mm.

The grinding cups are conventionally manufactured by first machining a blank. The blank is then pressed into a mould containing a hot diamond/metal mixture. The bottom surface of the blank is heated and bonds to the diamond/metal matrix. Alternatively the diamond/metal matrix can be formed into the grinding section and then bonded either by a shrink fit and/or with adhesives or solder to a blank.

Several different methods are used to connect and retain the grinding cups on to the grinding machine. The grinding cups were conventionally held in the grinding machine by inserting an upright hollow stem projecting from the top surface of the grinding cup into a chuck for detachable mounting of tools. Special tools such as chuck wrenches, nuts and collets are necessary to insert, hold and to remove the grinding cup into and out of the chuck.

To eliminate the need for chuck wrenches etc. the use of a shoulder drive on the grinding cups was developed. A diametrically extending recess at the free end of a hollow drive shaft of the grinding machine co-operates with a shoulder or cam means on the adjacent top surface of the grinding cup. The stem of the grinding cup is inserted into the hollow drive shaft and may be held in place by one or more O-rings either located in a groove in the interior wall of the drive shaft or on the stem of the grinding cup. See for example Swedish Patent No. B 460,584 and U.S. Patent No. 5,527,206.

An alternative to the shoulder drive is that shown, for example, in United States Patent 5,688,163. The free end of the stem of the grinding cup is machined to provide flat drive surfaces. The flat drive surfaces match the profile of a corresponding drive part in the channel of the output drive shaft into which the stem is inserted. The grinding cup is retained in place by a spring biased sleeve which forces balls mounted in the wall of the output drive shaft into an annular groove on the stem of the grinding cup.

Recent innovations are illustrated in U.S. Patent No. 5,639,273 and U.S. Patent No. 5,727,994. In these patents, the upright stem has been replaced with a centrally disposed cavity provided in the top surface of the grinding cup. The cavity is shaped and sized to permit the output drive shaft of a grinding machine to be inserted into the cavity.

Some manufacturers, in order to provide grinding cups that are compatible for use with other manufacturers' grinding machines provide adapters that connect their grinding cup to the output drive shaft of competitors' grinding machines.

Regardless of the method of connecting the grinding cup to the output drive shaft of the grinding machine, it is important to optimize the operational stability and loads forces within the chosen method of connection. Lack of operational stability, and/or the presence of excessive loads, often results in increased wear/damage, as well as vibration and resonance during grinding. Vibration and/or resonance also directly results in increased rates of wear to all moving parts such as bearings, joints, etc. of the grinding apparatus and can potentially interfere with settings within the operating control circuits of the grinding apparatus. In addition, lack of operational stability results in increased wear to all key surfaces of the output drive shaft (rotor) and grinding cup which provide consistent, proper alignment between grinding cup and/or adapter and rotor during operation. The mass of the grinding cup, particularly in larger sizes, negatively impacts operational stability, wear/damage in many areas within the grinding apparatus including wear/damage within drive/contact areas between rotor and/or adapter and grinding cup, due to mass associated loads. The mass of the grinding cup and/or adapter also greatly affects mass associated start-up forces such as increased torsion forces within the drive and/or contact surfaces due to forces such as inertia. Wear/damage has a negative impact on operational stability. Operational instability and associated vibration and/or resonance are a major contributor to the deterioration of the preferred built-in profile of the cavity in the grinding section of the grinding cup. This directly results in deterioration in the profile of the restored button. The net effect being a substantial loss in the intended overall drilling performance of the drill bit or cutter used.

SUMMARY OF THE INVENTION

It is an object of the present invention to optimize/reduce the mass of the grinding cup to reduce the negative impact of mass associated forces on operational stability, wear/damage and/or deformation of drive and/or contact surfaces, as well as other potential associated wear/damage caused by vibration and/or resonance.

It is a further object of the present invention to minimize the negative impact of mass associated start-up loads such as increased torsion forces within the drive and/or contact surfaces due to forces such as inertia.

It is a further object of the present invention to minimize the negative impact of mass associated forces on various material types used, thereby potentially allowing for the use of, for example, elastomeric materials, in various contact/drive areas in which the use of such materials may previously not have been feasible.

It is a further object of the present invention to minimize the deterioration of the preferred built-in profile of the cavity in the grinding section by reducing vibration and/or resonance.

It is a further object of the present invention to provide methods to reduce the mass of the grinding cup to optimize the wall thickness between the inner cavities, passageways, etc. and the outer structure. This results in an outside form substantially linked to the inside form with consideration given to the drive means selected and providing areas required for product identification and necessary structural strength and/or support.

It is a further object of the present invention to increase the diameter of the passageway through the stem and/or grinding cup to reduce mass of grinding cup and optimize flow and hence volume of flushing medium/coolant delivered to the grinding section under varying operational conditions.

Accordingly, the present invention provides a grinding cup having a lower grinding section and an upper body section integrally connected to form a grinding cup having top and bottom surfaces. The grinding section is formed from a material capable of grinding the hard materials such as tungsten carbide inserts of button bits etc. A centrally disposed convex recess is formed in the bottom surface having the desired profile for the button to be ground. One or more passageways in the upper body section and grinding section permit a coolant, preferably water, optionally mixed with cutting oil or a water/air mist, to be provided to the surface of the button during grinding, through outlet(s) on the bottom surface. Drive means are provided on or in the upper body section that cooperate with the output shaft of the grinding machine. Retaining means are provided in conjunction with the drive means to releasably secure the grinding cup to the output shaft of the grinding machine during use. The drive means or upper body section or grinding section or any combination thereof are adapted to reduce negative impact on operational stability, drive/contact surface wear/damage, wear/damage and/or deformation of elastomeric materials in the drive and/or contact areas, as well as other potential associated wear/damage to the grinding apparatus caused by vibration and/or resonance, and mass associated operational loads. Mass associated operational loads include start-up loads such as increased torsion loads caused by inertia. By reducing vibration and/or resonance, deterioration of the preferred built-in profile of the cavity in the grinding section is minimized.

Further features of the invention will be described or will become apparent in the course of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more clearly understood, the preferred embodiment thereof will now be described in detail by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of an embodiment of a shoulder drive, mass reduced grinding cup according to the present invention

Fig. 2 is a top plan view of the grinding cup of Fig. 1.

Fig. 3 is a cross section of the grinding cup of Fig. 2 along 3-3.

Fig. 4 is a bottom plan view of the grinding cup of Fig. 1-3.

Fig. 5 is a perspective view of another embodiment of a grinding cup according to the invention for grinding small button bits.

Fig. 6 is a top plan view of the grinding cup of Fig. 5.

Fig. 7 is a cross section of the grinding cup of Fig. 6 along 7-7.

Fig. 8 is a bottom plan view of the grinding cup of Fig. 5-7.

Fig. 9 is a perspective view of an embodiment of a hex drive, mass reduced grinding cup according to the present invention

Fig. 10 is a cross section of the grinding cup of Fig. 9 along 10-10.

Fig. 11 is a top plan view of the grinding cup of Fig. 9.

Fig. 12 is a bottom plan view of the grinding cup of Fig. 9.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The grinding cups and/or adapters of the present invention have a number of features directed to reducing the mass of the grinding cup and/or adapter to reduce negative impact on operational stability, drive/contact surface wear/damage, wear/damage and/or deformation of elastomeric materials in the drive and/or contact areas, as well as other potential associated wear/damage to the grinding apparatus caused by vibration and/or resonance, and mass associated operational loads and to increasing the diameter of the passageway through the stem and grinding cup or adapter to reduce mass of grinding cup and optimize volume of coolant delivered to the grinding section. Mass associated operational loads include start-up loads such as increased torsion loads caused by inertia.

Referring to Figs. 1-4, one embodiment of a mass reduced grinding cup according to the present invention is generally indicated at 1. The grinding cup 1 is intended for use with a grinding machine which incorporates a diametrically extending recess at the free end of a hollow drive shaft that co-operates with a shoulder or cam means on the adjacent top surface of the grinding cup such as described in U.S. Patent No. 5,527,206. The present invention is not restricted to grinding cups of this type. As will be explained, the present invention has application to all types of grinding cups regardless of the means of driving the grinding cup or attaching it to the grinding apparatus. In the illustrated embodiment, the means of driving the grinding cup would normally be an integral extension of the output shaft of rotor of the grinding machine. The means of driving the grinding cup could also consist of either a separate attachment to the output shaft of the rotor or an adapter to connect a grinding cup having one type of drive means to an output drive shaft having a different type of drive means.

For example the adapter could connect a shoulder drive grinding cup to a different output drive shaft such as the hex drive system as illustrated in U.S. Patent No. 5,639,273 or U.S. Patent No. 5,727,994 or the drive system illustrated in Canadian Patent 2,136,998.

The grinding cup 1 consists of a lower grinding section 2 and an upper body section 3 integrally connected to form a grinding cup having top and bottom surfaces 4 and 5 respectively. The grinding section 2 is formed from a material capable of grinding the tungsten carbide inserts of button bits etc.. In the preferred embodiment, the grinding section is formed from a metal and diamond matrix. The peripheral edge 6 in the bottom surface 5 is preferably beveled to facilitate the removal of steel from the face of the bit around the base of the button during grinding. A centrally disposed convex recess 7 is formed in the bottom surface 5 having the desired profile for the button to be ground.

Drive means 8 are provided on or in the upper body section 3 that cooperate with the output shaft of the grinding machine. As noted above, the drive means can be any of the methods currently being used including chuck nut and collet systems, shoulder drive systems, machined drive surfaces on the free end of the stem or hex drive systems. In Figs 1-4, the drive means 8 consists of a hollow vertical upright stem 9 centrally located on the top surface 4 of the grinding cup 1. Cam means or shoulder 10 is provided at the base of the stem 9 and is sized to engage with a diametrically extending recess at the free end of a hollow drive shaft of the grinding machine. The hollow stem 9 is inserted into the hollow drive shaft of the grinding machine.

Retaining means 11 are provided in conjunction with the drive means 8 to releasably secure the grinding cup to the output shaft of the grinding machine during use. In the preferred embodiment illustrated in Figs. 1-4, the retaining means 11 are one or more O-rings 12 located in one or more grooves 13 on the stem 9 of the grinding cup. Optionally the retaining means could also be achieved by the drive means or a combination of both working independently or cooperatively.

The passageway 14 in stem 9 connects to a corresponding passageway 15 in the body section 3 and grinding section 2 to permit a coolant, preferably water, optionally mixed with cutting oil or a water/air mist, to be provided to the surface of the button during grinding, through one or more outlets 16. As shown in Fig. 4, the outlets 16 in this embodiment consist of three slots 17,18,19 radially extending from the centre 20 of the convex recess 7. The coolant prevents excessive heat generation during grinding and flushes the surface of the button of material removed during grinding. In addition, the diameter of the passageway 15 adjacent to outlets 17-19 may be expanded to facilitate optimized flow between passageway and outlets.

In the embodiment shown, the upper body section 3, grinding section 2 and drive means 8 of the grinding cup 1 are adapted to reduce the mass of the grinding cup to reduce negative impact on operational stability, drive/contact surface area wear/damage and/or deformation, wear/damage and/or deformation of elastomeric materials in drive and/or contact areas, as well as other potential associated wear/damage to the grinding apparatus caused by vibration and/or resonance, and mass associated operational loads. Mass associated operational loads include start-up loads such as increased torsion loads caused by inertia. In addition, minimizing the deterioration of the preferred built-in profile of the cavity in the grinding section can be accomplished by substantially reducing vibration and/or resonance.

In the preferred embodiment illustrated, the top surface 4 of the upper body section 3 has a diameter D about the same as the diameter of the diametrically extending recess at the free end of the hollow drive shaft of the grinding machine. One way to reduce the mass of the grinding cup consists of reducing the diameter of exterior surface 21 of the upper body section 3. In the grinding cup illustrated in Figs. 1-4, the diameter of the body section 3 is reduced by tapering part or all the exterior surface 21 to form a beveled portion 22. Alternatively the reduction of the diameter of the exterior surface 21 can be radial or form a reverse radius. The beveled portion 22 terminates in neck portion 23 that connects to the grinding section 2. In the embodiment illustrated in Figs. 1-4, neck portion 23 is generally cylindrical with a diameter sufficient to provide structural support for the grinding cup 1.

Another way to reduce the mass of the grinding cup is to machine the outer surface 24 of the metal portion 25 of grinding section 2 to the point of connection 26 with the neck portion 23 in a profile preferably corresponding to the mating surface 28 of metal portion 25 with the diamond matrix 27. The thickness T of the metal portion 25 of the grinding section 2 in the area should be sufficient to provide structural support for the diamond matrix 27.

To further reduce the mass of the grinding cup and optimize volume of coolant delivered to the grinding section 2, the diameters of the passageways 14, 15 through the stem 9 and grinding cup 1 are increased as wide as possible without negatively impacting the structural integrity of the components.

The above noted methods to reduce the mass of the grinding cup attempt to optimize the wall thickness between the inner cavities, passageways, etc. and the outer structure. This results in an outside form substantially linked to the inside form with consideration given to the size of the grinding cup, the drive means selected, manufacturing costs, areas required for product identification and necessary structural strength and/or support. The present invention does not require in each case all of the possible methods of reducing the mass of the grinding cup to be employed. Either the drive means, upper body section or grinding section may be adapted or any combination thereof. Further the invention is applicable to all types of grinding cups or adapters regardless of the means used to drive, connect and retain the grinding cup on the grinding machine. Further the invention is applicable to all types of grinding cups regardless of the means used to drive, connect and retain the grinding cup on the grinding machine. The invention is applicable regardless of whether the grinding cup is of the type having an upright hollow step for insertion into a chuck, has a shoulder drive as shown in Figs. 1-4, is of the type illustrated in U.S. Patent No. 5,688,163 where the free end of the stem is machined to provide the drive surfaces or is of the type illustrated in U.S. Patent Nos. 5,639,237 and 5,727,994 or is provided with an adapter that connects one type of grinding cup to an output drive shaft having a different drive system or any modifications or improvements thereon.

Cam means or shoulder 10 provided at the base of the stem 9 is preferably substantially the same size as the diametrically extending recess at the free end of a hollow drive shaft of the grinding machine. This optimizes the contact area between the drive shaft and the grinding cup.

Figs.5-8 illustrate the application of the present invention with a grinding cup 30 intended to grind small diameter buttons. As with the embodiment illustrated in Figs. 1-4, the grinding cup 30 is intended for use with a grinding machine which incorporates a diametrically extending recess at the free end of a hollow drive shaft that co-operates with a shoulder or cam means on the adjacent top surface of the grinding cup such as described in U.S. Patent No. 5,527,206. The grinding cup 30 consists of a lower grinding section 31 and an upper body section 32 integrally connected to form a grinding cup having top and bottom surfaces 33 and 34 respectively. The grinding section 31 is formed from a material capable of grinding the tungsten carbide inserts of button bits etc.. In the preferred embodiment, the grinding section is formed from a metal and diamond matrix. The peripheral edge 35 in the bottom surface 34 is preferably beveled to facilitate the removal of steel from the face of the bit around the base of the button during grinding. A centrally disposed convex recess 36 is formed in the bottom surface 34 having the desired profile for the button to be ground.

Drive means 37 are provided on the upper body section 32 that cooperate with the output shaft of the grinding machine. In Figs 5-8, the drive means 37 consists of a hollow vertical upright stem 38 centrally located on the top surface 33 of the grinding cup 30. Cam means or shoulder 39 is provided at the base of the stem 38 and is sized to engage with a diametrically extending recess at the free end of a hollow drive shaft of the grinding machine. The hollow stem 38 is inserted into the hollow drive shaft of the grinding machine. Retaining means 40 are provided in conjunction with the drive means 37 to releasably secure the grinding cup to the output shaft of the grinding machine during use. In the preferred embodiment illustrated in Figs. 5-8, the retaining means 40 are one or more O-rings 41 located in one or more grooves 42 on the stem 38 of the grinding cup. Optionally the retaining means could also be achieved by the drive means or a combination of both working independently or cooperatively.

The passageway 43 in stem 38 connects to a corresponding passageway 44 in the body section 32 and grinding section 31 to permit a coolant, preferably water, optionally mixed with cutting oil or a water/air mist, to be provided to the surface of the button during grinding, through one or more outlets 45. In addition the diameter of passageway 44 adjacent to outlet 45 may be expanded to facilitate optimized flow between passageway and outlets.

The drive means 37 and upper body section 32 of the grinding cup 30 are adapted to reduce the mass of the grinding cup to reduce negative impact on operational stability, drive/contact surface area wear/damage, wear/damage and/or deformation of elastomeric materials in drive and/or contact areas, as well as other potential associated wear/damage to the grinding apparatus caused by vibration and/or resonance, and mass associated operational loads. Mass associated operational loads include start-up loads such as increased torsion loads caused by inertia.

In this embodiment, the top surface 33 of the upper body section 32 has a diameter D* about the same as the diameter of the diametrically extending recess at the free end of the hollow drive shaft of the grinding machine. One way to reduce the mass of the grinding cup consists of reducing the diameter of exterior surface 47 of the upper body section 32. In the grinding cup illustrated in Figs. 5-8, the diameter of the body section 32 is reduced by tapering part or all the exterior surface 47 to form a beveled portion 48. Alternatively the reduction of the diameter of the exterior surface 47 can be radial or form a reverse radius. The beveled portion 48 terminates in neck portion 49 that connects to the grinding section 31. In the embodiment illustrated in Figs. 5-8, neck portion 49 is generally cylindrical with a diameter sufficient to provide structural support for the grinding cup 30.

The grinding section 31, in the embodiment illustrated in Figs. 5-8, has the same diameter as the neck portion. Due to the size of the button intended to be ground, the grinding section, as illustrated, may not have sufficient diameter to have its exterior surface 50 machined in a profile corresponding to the diamond matrix 51 as in Figs 1-4.

To further reduce the mass of the grinding cup and optimize volume of coolant delivered to the grinding section 31, the diameters of the passageways 43, 44 through the stem 38 and grinding cup 30 are increased as wide as possible without negatively impacting the structural integrity of the components. In addition, the diameter of passageway 44 adjacent to outlet 45 may be expanded to facilitate optimized flow between passageway and outlets.

The above noted methods to reduce the mass of the grinding cup optimize the wall thickness between the inner cavities, passageways, etc. and the outer structure. This results in an outside form substantially linked to the inside form with consideration given to the size of the grinding cup, the drive means selected, areas required for product identification and necessary structural strength and/or support. The present invention does not require in each case all of the possible methods to be employed. Either the drive means and the upper body section or grinding section may be adapted or any combination thereof. Where an adapter is used to connect one type of grinding cup to an output drive shaft having a different drive system the methods to reduce the mass of the grinding cup can be used to reduce the mass of the adapter, which methods are included within the present invention.

Cam means or shoulder 39 provided at the base of the stem 38 is preferably substantially the same size as the diametrically extending recess at the free end of a hollow drive shaft of the grinding machine. This optimizes the contact area between the drive shaft and the grinding cup.

The principles of the present invention can be applied to all types of grinding cups including those illustrated in U.S. Patent Nos. 5,639,237 and 5,727,994. Figs 9-12 illustrate another embodiment of a grinding cup according to the present invention intended for use with grinders as illustrated in these two patents. The grinding cup 60 consists of a lower grinding section 61 and an upper body section 62. In the preferred embodiment the grinding section 61 and body section 62 are integrally connected to form a grinding cup having top and bottom surfaces 63 and 64 respectively. The grinding section 61 is formed from a material capable of grinding the tungsten carbide button bits. In the preferred embodiment, the grinding section is formed from a metal and diamond matrix. The peripheral edge 65 in the bottom surface 64 is preferably beveled to facilitate the removal of steel from the face of the bit around the base of the button during grinding. A centrally disposed convex recess 66 is formed in the bottom surface 64 having the desired profile for the button to be ground.

Drive means 67 are provided in the upper body section 62 that cooperate with the output shaft of the grinding machine. In the embodiment illustrated in Figs. 9-12, the body section 62 has a centrally disposed cavity 68 formed in the top surface 63 of the grinding cup. This cavity 68 is shaped and sized to permit the grinding cup to be detachably connected to the output drive shaft of the grinding machine and rotated during the grinding operation. The end portion of the output drive shaft is adapted to fit within the corresponding sized centrally disposed cavity 68 in the top surface 63 of the grinding cup 60. The output drive shaft is adapted to driveably engage within the top portion 69 of cavity 68. In the preferred embodiment shown the top portion 69 of cavity 68 in grinding cup 60 has a hexagonal cross section. To provide support for the grinding cup and minimize vibration generated axial side load on the grinding cup, the free end of the output drive shaft is adapted to fit snugly within the bottom portion 70 of cavity 68 in grinding cup 60. In the shown embodiment, both the free end of the output drive shaft and the bottom portion 70 of cavity 68 have a circular cross section slightly smaller in diameter than the hexagonal drive section 69. Other arrangements are possible for example the support section of the cavity can be above the drive section located at the bottom of the cavity or the drive section can be located intermediate two support sections.

Retaining means are provided on either the output drive shaft or in the grinding cup to detachably retain the grinding cup 60 so that grinding cup 60 will not fly off during use but can still be easily removed or changed after use. In addition, retaining means can be provided by a combination of both retaining means acting concurrently, cooperatively providing improved retention. For example in the preferred embodiment shown in Fig. 10 a groove 84 is provided in the wall 85 of cavity 68 into which an O-ring 86 is placed. The O-ring 86 will co-operate with the exterior surface of the output drive shaft to assist in retaining the grinding cup in place during use and reducing vibration and resonance. Additional O-rings on the output drive shaft will co-operate with the wall 85 of the bottom portion 70 of cavity 68 and O-ring 86 to retain the grinding cup in place during use.

One or more passageways 71 connect cavity 68 with the recess 66 in the grinding section to permit a coolant, preferably water, optionally mixed with cutting oil or a water/air mist, to be provided to the surface of the button during grinding, through outlets 72. As shown in Fig. 12, the outlets 72 in this embodiment consist of three slots 73,74,75 radially extending from the centre 76 of the convex recess 66.

The drive means 67, upper body section 62 and grinding section 61 of the grinding cup 60 are adapted to reduce the mass of the grinding cup to reduce negative impact on operational stability, drive/contact surface area wear/damage and/or deformation, wear/damage and/or deformation of elastomeric materials in drive and/or contact areas, as well as other potential associated wear/damage to the grinding apparatus caused by vibration and/or resonance, and mass associated operational loads.

One way to reduce the mass of the grinding cup consists of reducing the diameter of exterior surface 77 of the upper body section 62. In the grinding cup illustrated in Figs. 9-12, the diameter of the body section 62 is reduced by tapering part or all the exterior surface 77 below the cavity 68 to form a beveled portion 78. Alternatively the reduction of the diameter of the exterior surface 77 can be radial or form a reverse radius. The beveled portion 78 terminates in neck portion 79 that connects to the grinding section 61. In the embodiment illustrated in Figs.9-12, neck portion 79 is preferably cylindrical with a diameter sufficient to provide structural support for the grinding cup 60.

Another way to reduce the mass of the grinding cup is to machine the outer surface 80 of the metal portion 81 of grinding section 61 to the point of connection 82 with the neck portion 79 in a profile preferably corresponding to the mating surface 87 of the metal portion 81 with diamond matrix 83. The thickness of the metal portion 81 of the grinding section 61 that has been machined should be sufficient to provide structural support for the diamond matrix 83.

To further reduce the mass of the grinding cup and optimize volume of coolant delivered to the grinding section 61, the diameter of the passageway 71 through the grinding cup 60 is increased as wide as possible without negatively impacting the structural integrity of the components.

All of the above noted methods are intended to reduce the mass of the grinding cup optimize the wall thickness between the inner cavities, passageways, etc. and the outer structure. This results in an outside form substantially linked to the inside form with consideration given to the size of the grinding cup, drive means selected, manufacturing costs, areas required for product identification and necessary structural strength and/or support.

To further reduce the mass of the grinding cup it is possible to utilize lighter weight materials such as elastomeric materials in the upper body section of the grinding cup or to form part of the drive means or retaining means.

As noted earlier, the principles of the present invention can be applied to an adapter used to connect one type of grinding cup to an output drive shaft having a different drive system. In this case the methods to reduce the mass of the grinding cup can be used to reduce the mass of the adapter, which methods are included within the present invention. The present invention does not require in each case all of the possible methods to be employed. One or more methods or any combination thereof can be utilized.

The grinding cups of the present invention can be manufactured in general by the same process conventionally used to make grinding cups: by first forming a blank for the body section by machining, casting, forging etc. The blank is then pressed into a mould preferably containing a hot diamond/metal mixture. The bottom surface of the blank is heated and bonds to the diamond/metal matrix. Several means of heating and bonding the diamond/metal matrix to the blank are known. Alternatively the diamond/metal matrix can be formed into the grinding section and then bonded either by a shrink fit and/or with adhesives or solder or other suitable method to a blank.

The blank for the grinding cup can be machined either before or after it is pressed into the mould containing the hot diamond/metal mixture. The preferred procedure would be to the extent possible pre-machine the blank before attaching the grinding matrix section. In any event some form of post-furnace machining may be required for clean up purposes. Clean up of the interior and exterior surfaces post-furnace, to remove "flash" and other matrix material which may have seeped out of the mold during furnacing/pressing, is carried out by holding the grinding cup in the chuck of a lathe and then skimming the relevant surfaces wherever needed. At this time it is also possible to remove additional material wherever suitable.

Having illustrated and described a preferred embodiment of the invention and certain possible modifications thereto, it should be apparent to those of ordinary skill in the art that the invention permits of further modification in arrangement and detail.

It will be appreciated that the above description related to the preferred embodiment by way of example only. Many variations on the invention will be obvious to those knowledgeable in the field, and such obvious variations are within the scope of the invention as described and claimed, whether or not expressly described.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A series of grinding cups for grinding working tips of rock drill bits to restore them to substantially their original profile, wherein said working tips have a diameter of about 6mm to 26mm and a desired profile, each of said grinding cups in said series having a lower grinding section and an upper body section integrally connected to form a grinding cup having top and bottom surfaces, a centrally disposed convex recess formed in the bottom surface having the desired profile of the working tip to be ground and having a diamond matrix applied to the bottom surface of a metal portion of the lower grinding section of the grinding cup, one or more passageways in the upper body section and grinding section to permit a coolant to be provided to one or more outlets on the bottom surface, drive means provided on or in the upper body section that cooperates with the output shaft of a grinding machine, retaining means provided in conjunction with the drive means for detachable connection of the grinding cup to an output shaft of the grinding machine during use wherein the upper body section, grinding section or drive means or any combination thereof are adapted to reduce the mass of the grinding cup by one or more of (1) the diameter of the upper body section is reduced by tapering part or all the exterior surface of the upper body section to form a beveled portion said beveled portion terminating in a neck portion that connects to the grinding section, (2) the outer surface of the metal portion of said grinding section is machined to the point of connection with the upper body section in a profile substantially corresponding to the mating surface of said metal portion to the diamond matrix of said grinding section or (3) the diameters of the passageways through the upper body section and grinding section are as wide as possible

without negatively impacting the structural integrity of the grinding cup

2. A grinding cup according to claim 1 wherein the mass of the grinding cup is reduced by incorporating lighter weight materials in one or more of the upper body section, the drive means or retaining means.

3. A grinding cup according to claim 1 wherein the reduction of the diameter of the exterior surface of the upper body section can be radial or form a reverse radius.

4. A grinding cup according to claim 1, 2 or 3 wherein the drive means consists of a hollow vertical upright stem centrally located on the top surface of the grinding cup.

5. A grinding cup according to claim 4 wherein cam means are provided at the base of the stem sized to engage with a diametrically extending recess at the free end of a hollow drive shaft of the grinding machine.

6. A grinding cup according to claim 1, 2 or 3 wherein the drive means comprise a centrally disposed cavity formed in the top surface of the grinding cup, said cavity shaped and sized to permit the grinding cup to be detachably connected to the output drive shaft of the grinding machine and rotated during the grinding operation wherein an end portion of the output drive shaft is adapted to fit within the corresponding sized centrally disposed cavity and driveably engage within said cavity.

7. A grinding cup according to claim 2 wherein the lighter weight material incorporated to reduce the mass of the grinding cup is an elastomeric material.

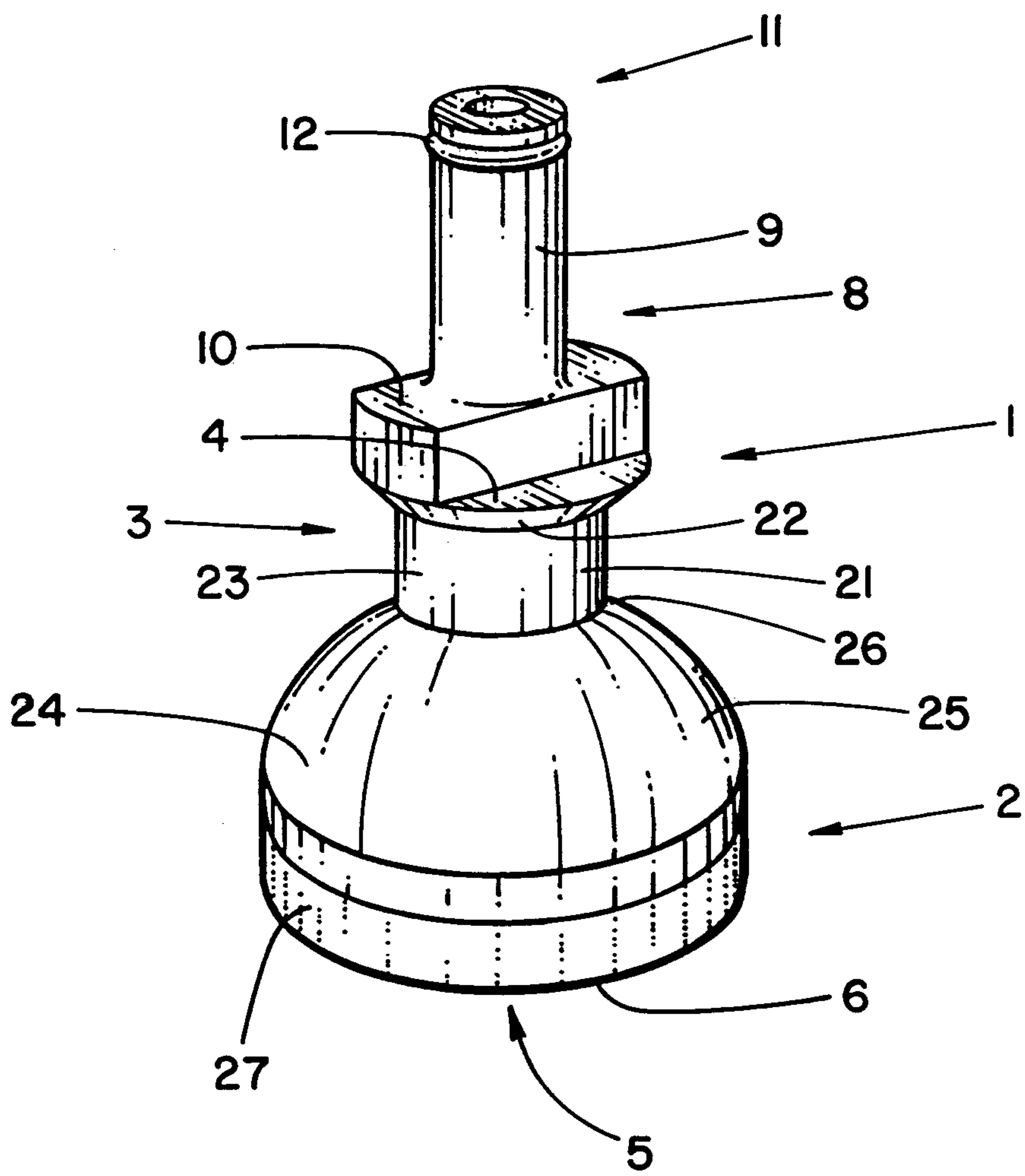


FIG. 1

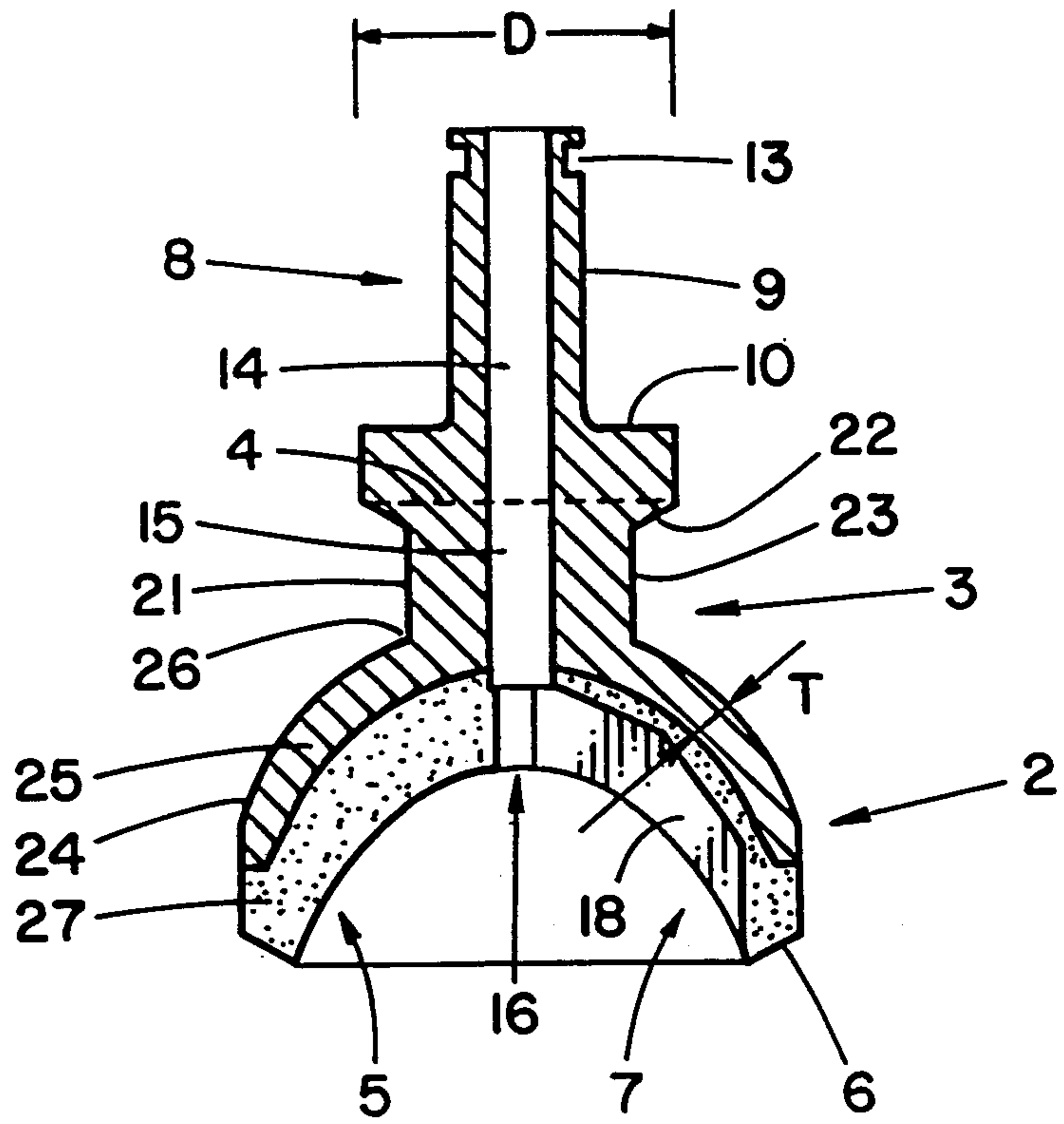
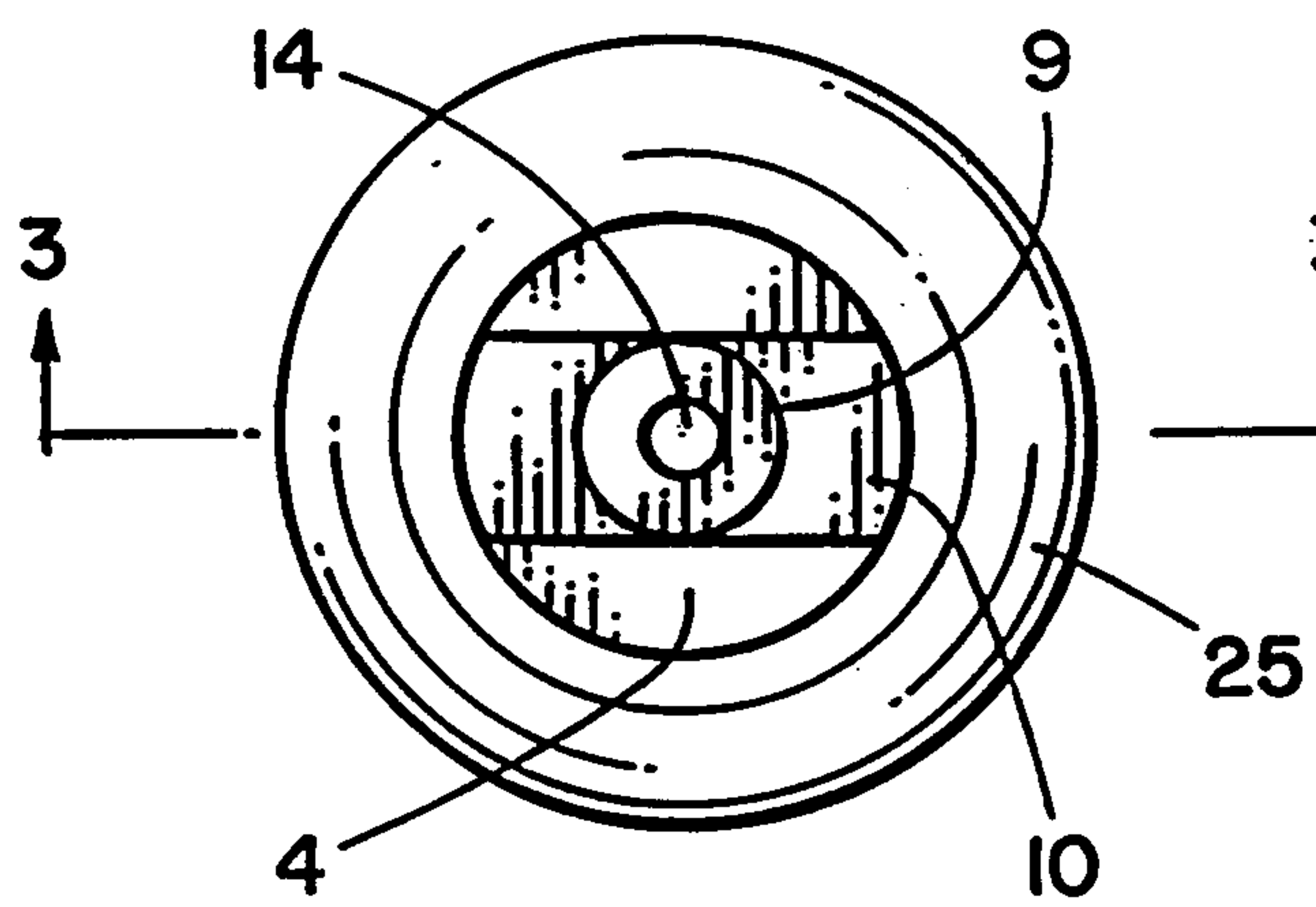


FIG. 3



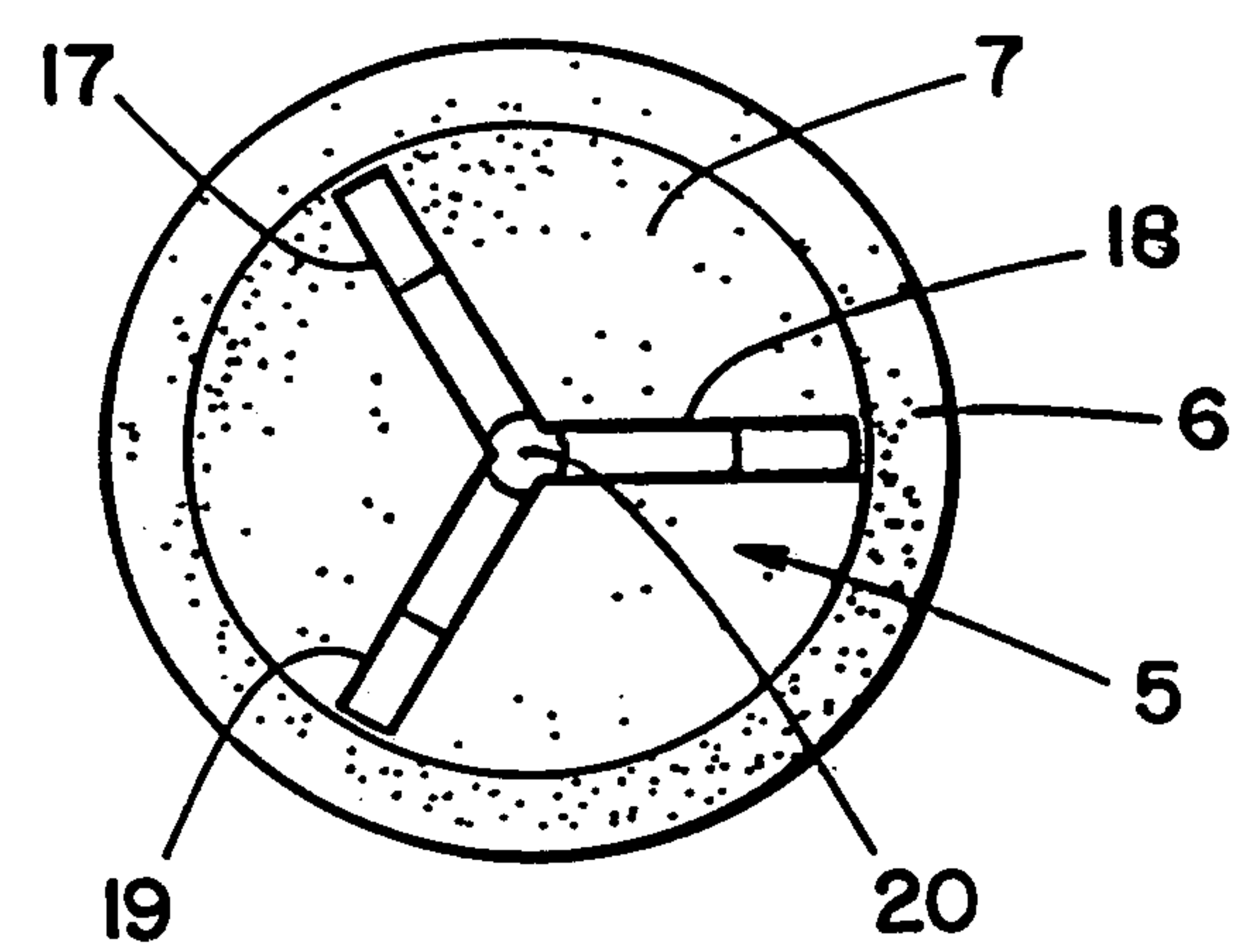


FIG. 2

FIG. 4

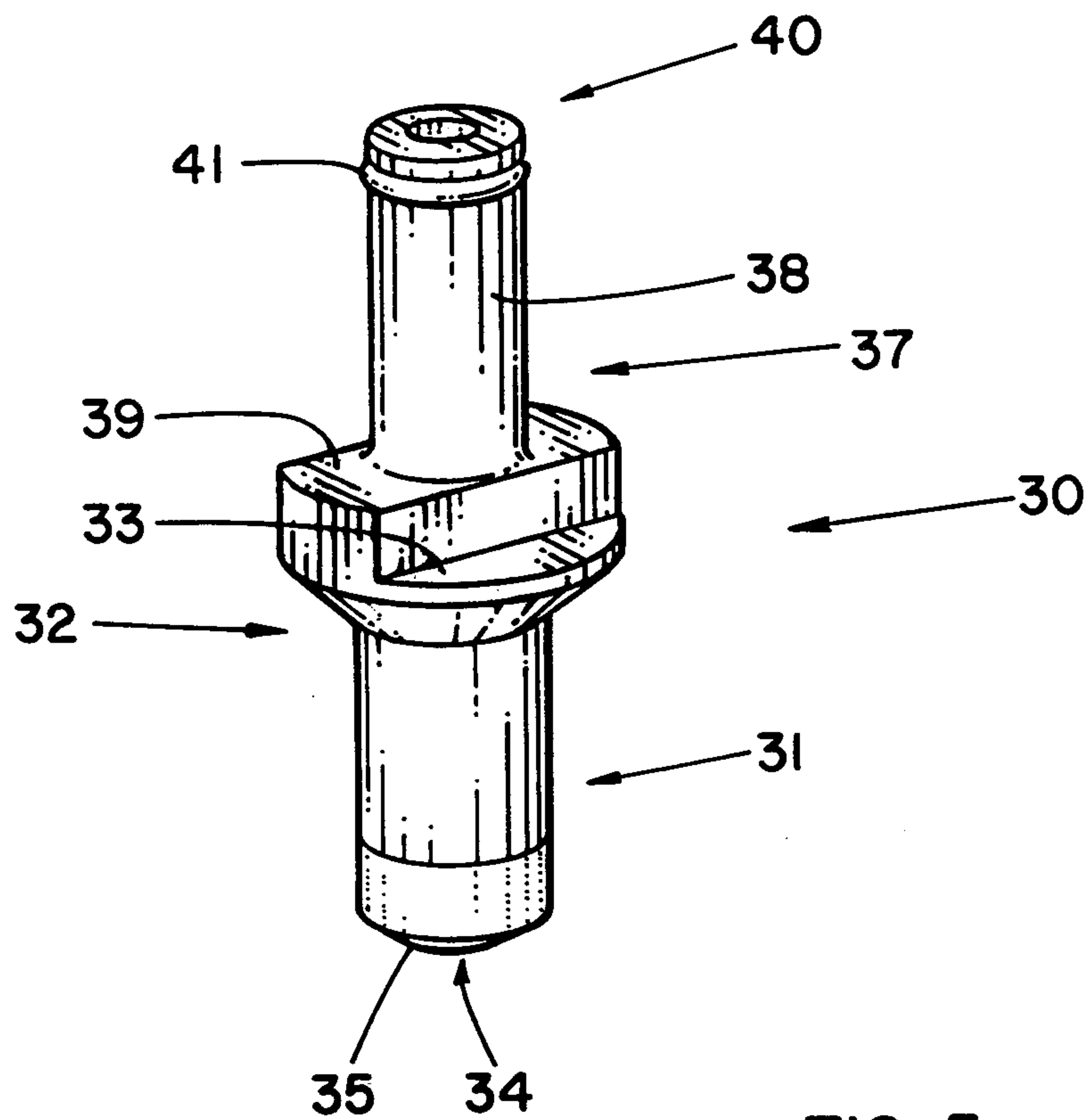


FIG. 5

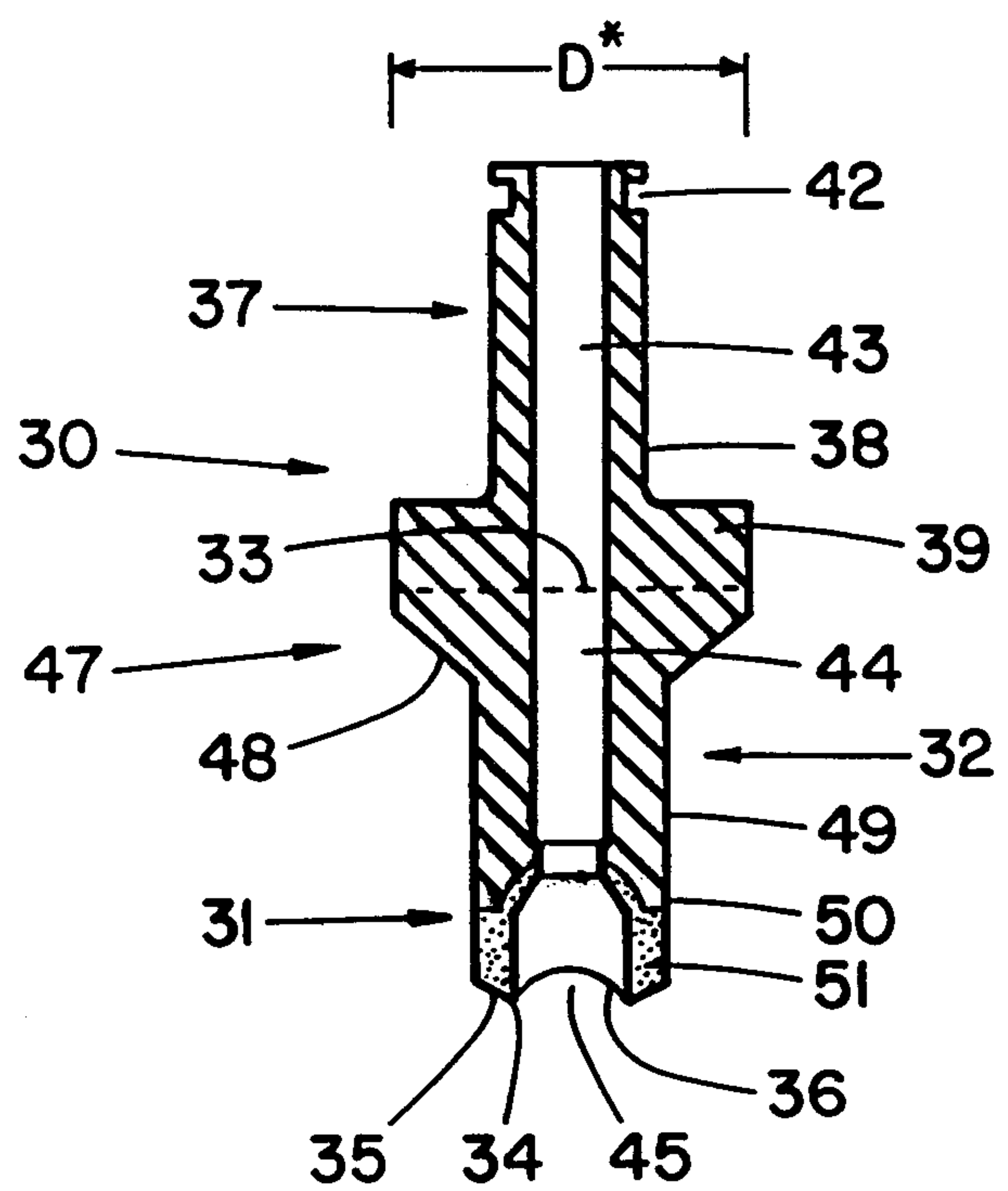


FIG. 7

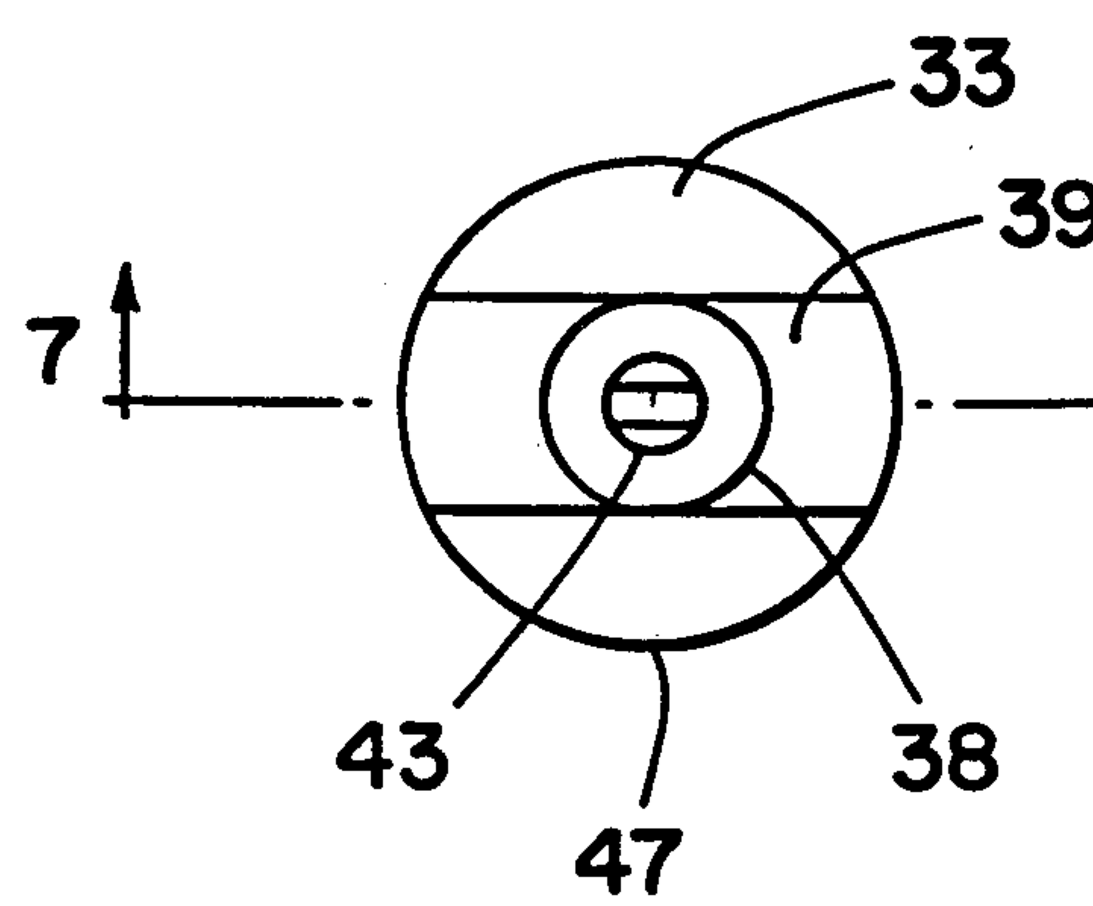


FIG. 6

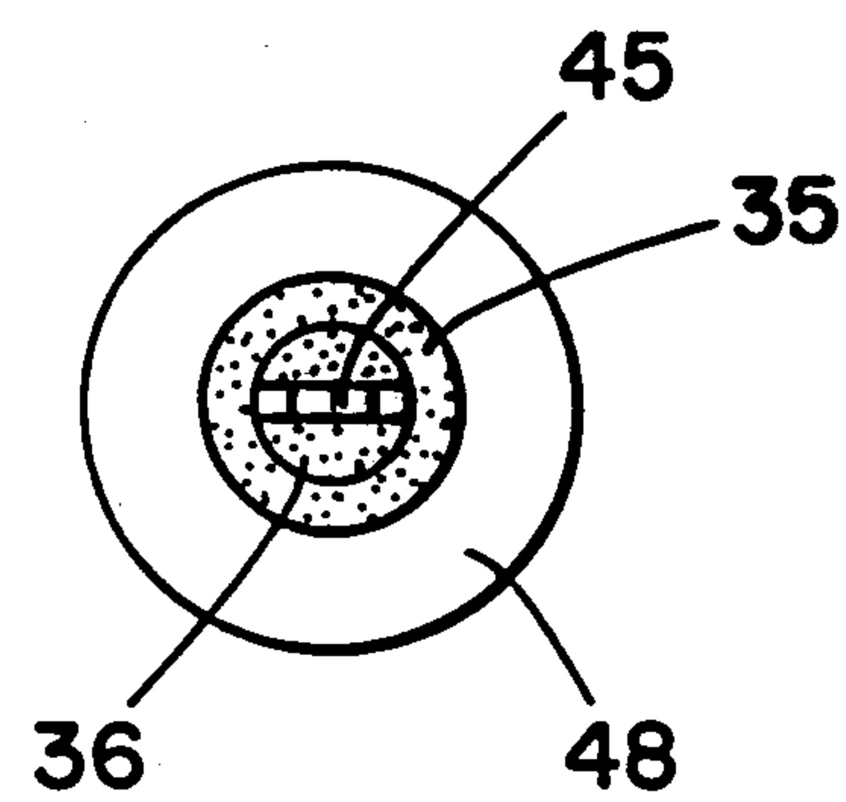


FIG. 8

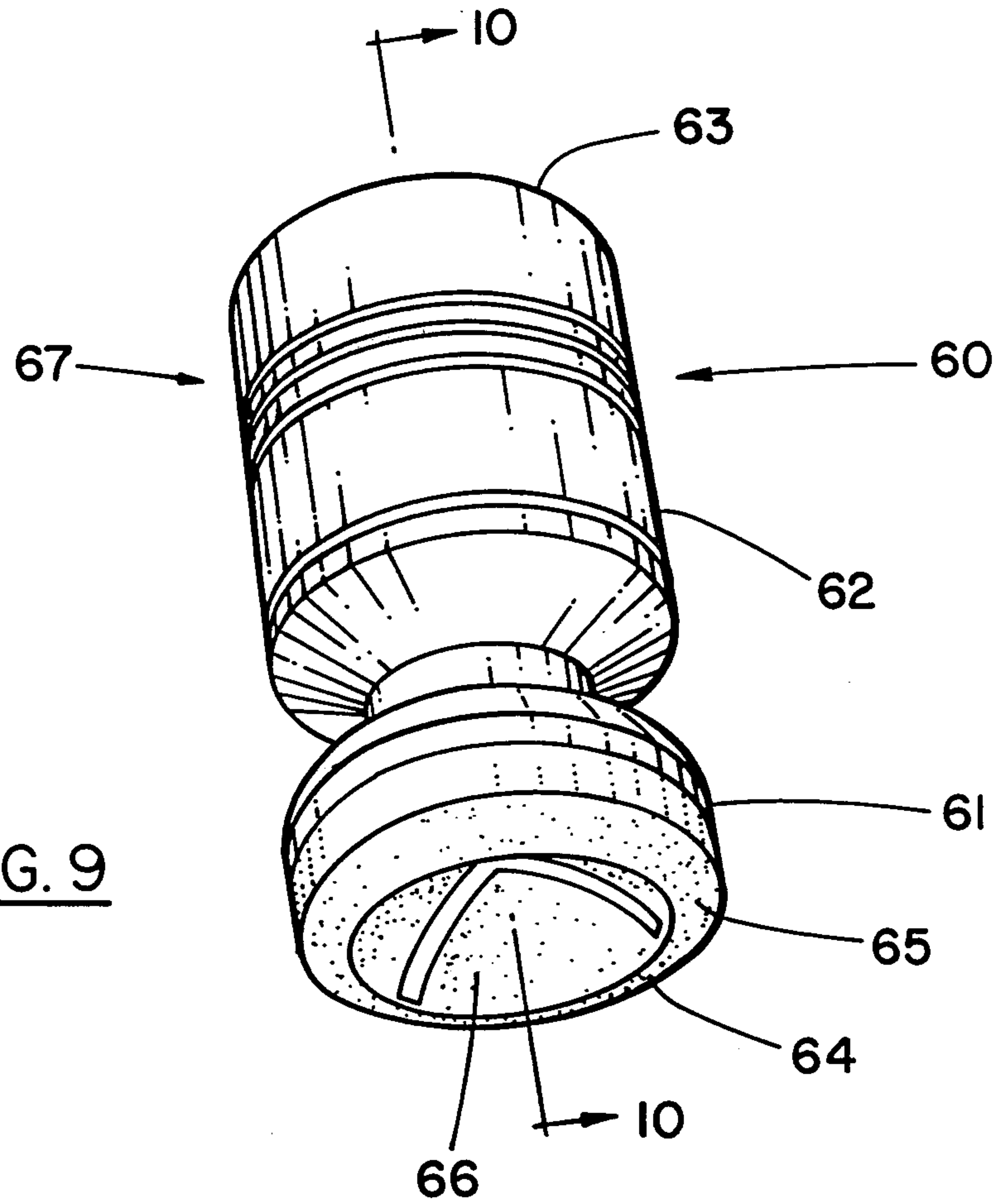


FIG. 9

FIG. 11

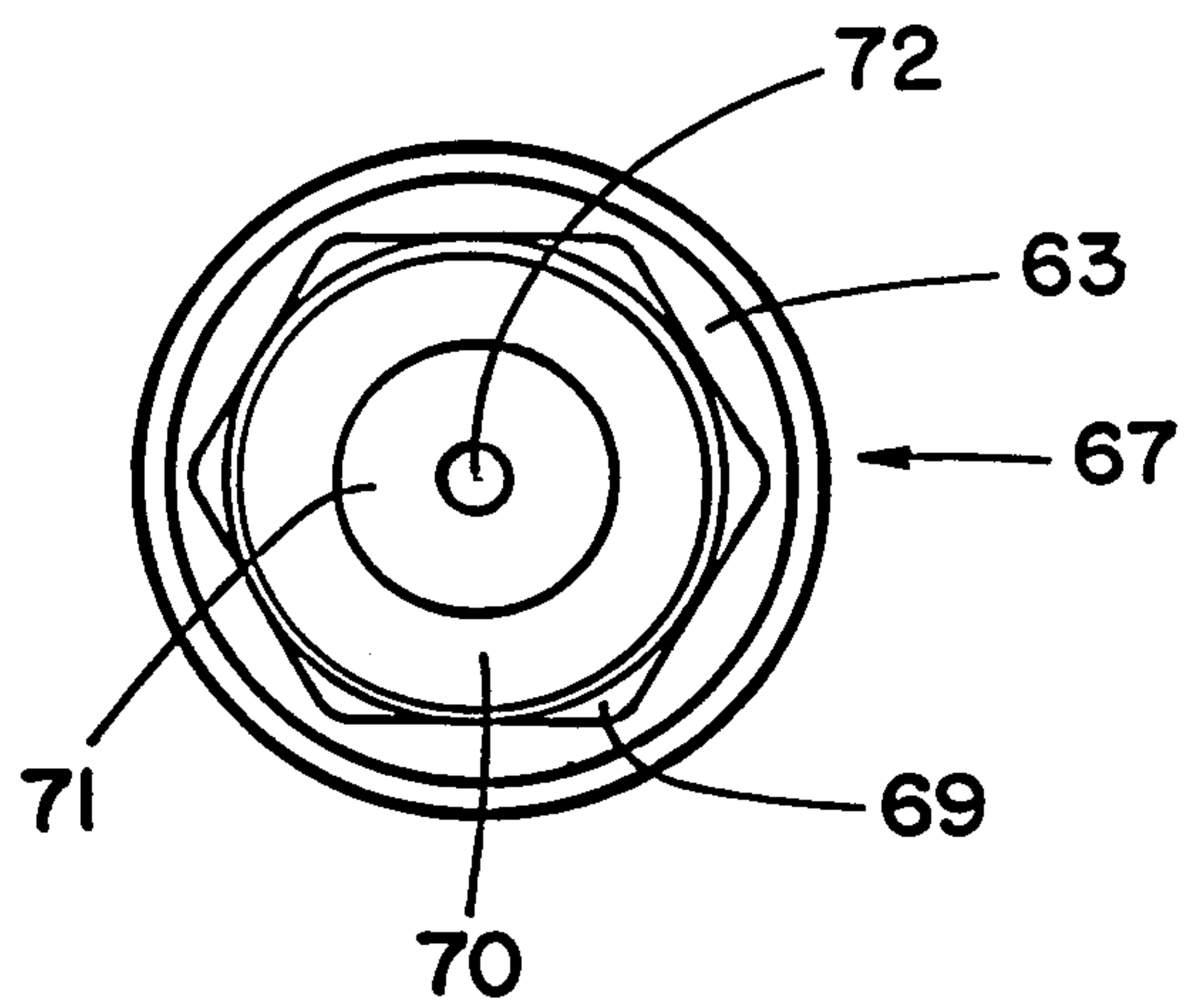
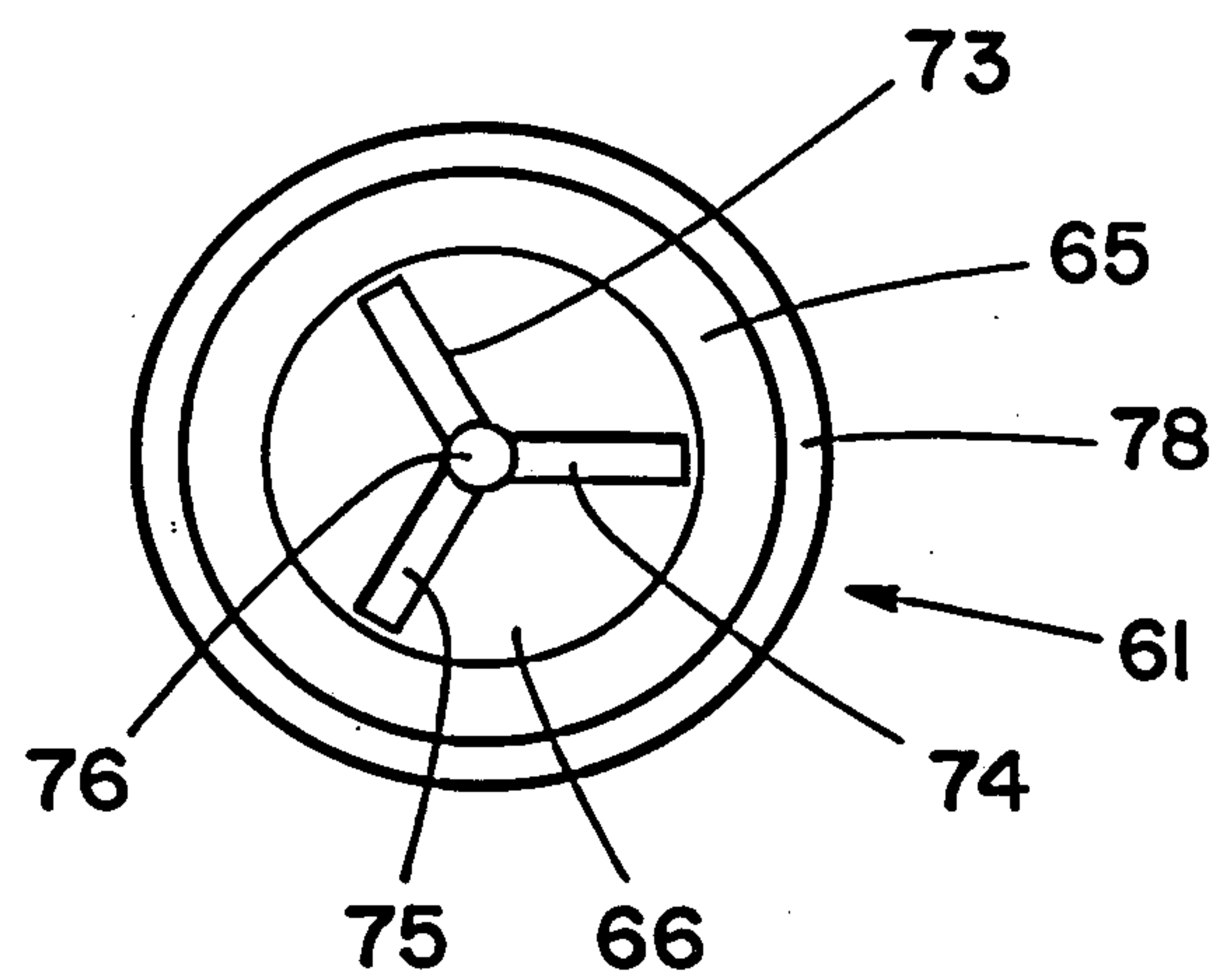


FIG. 12



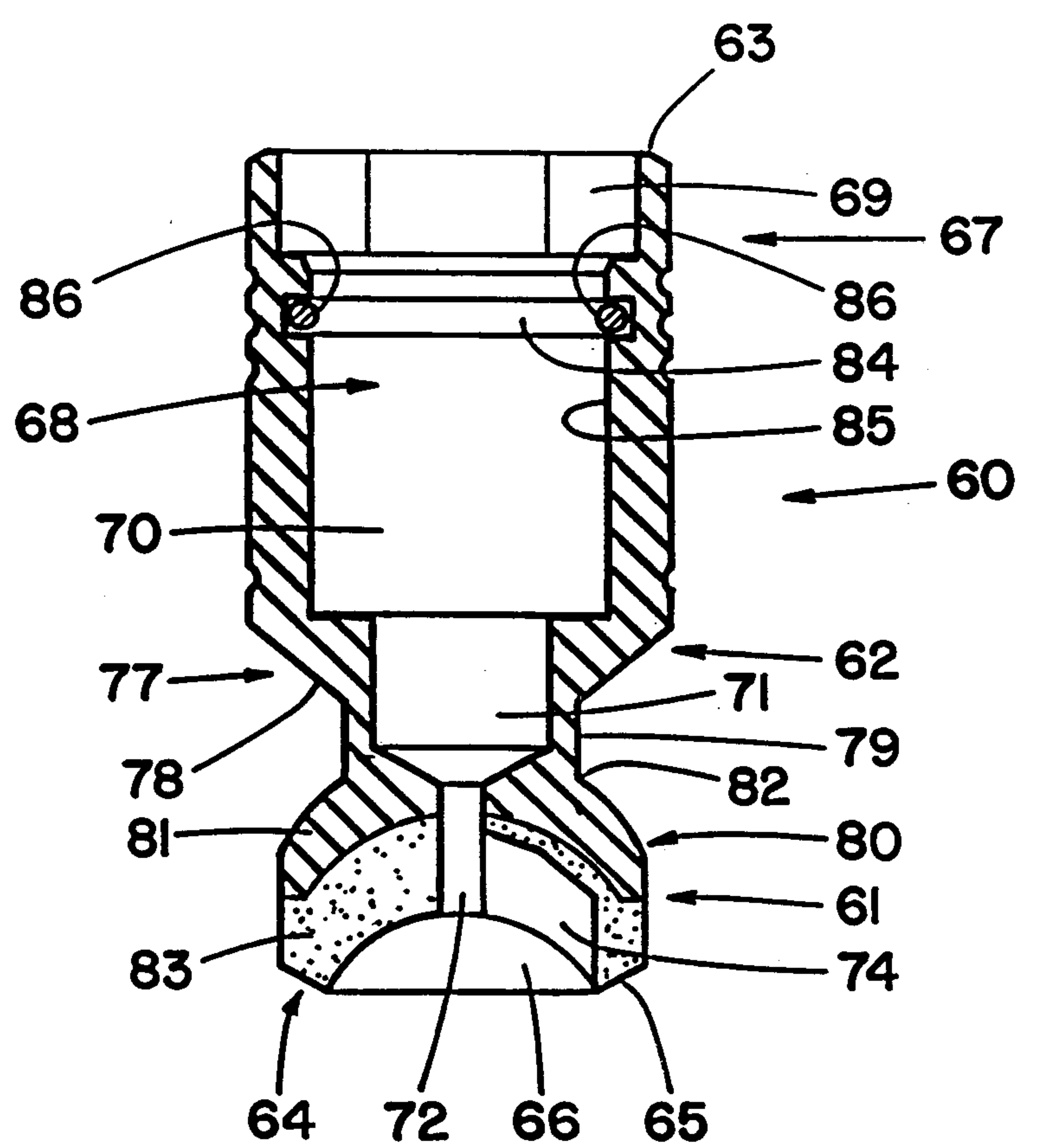
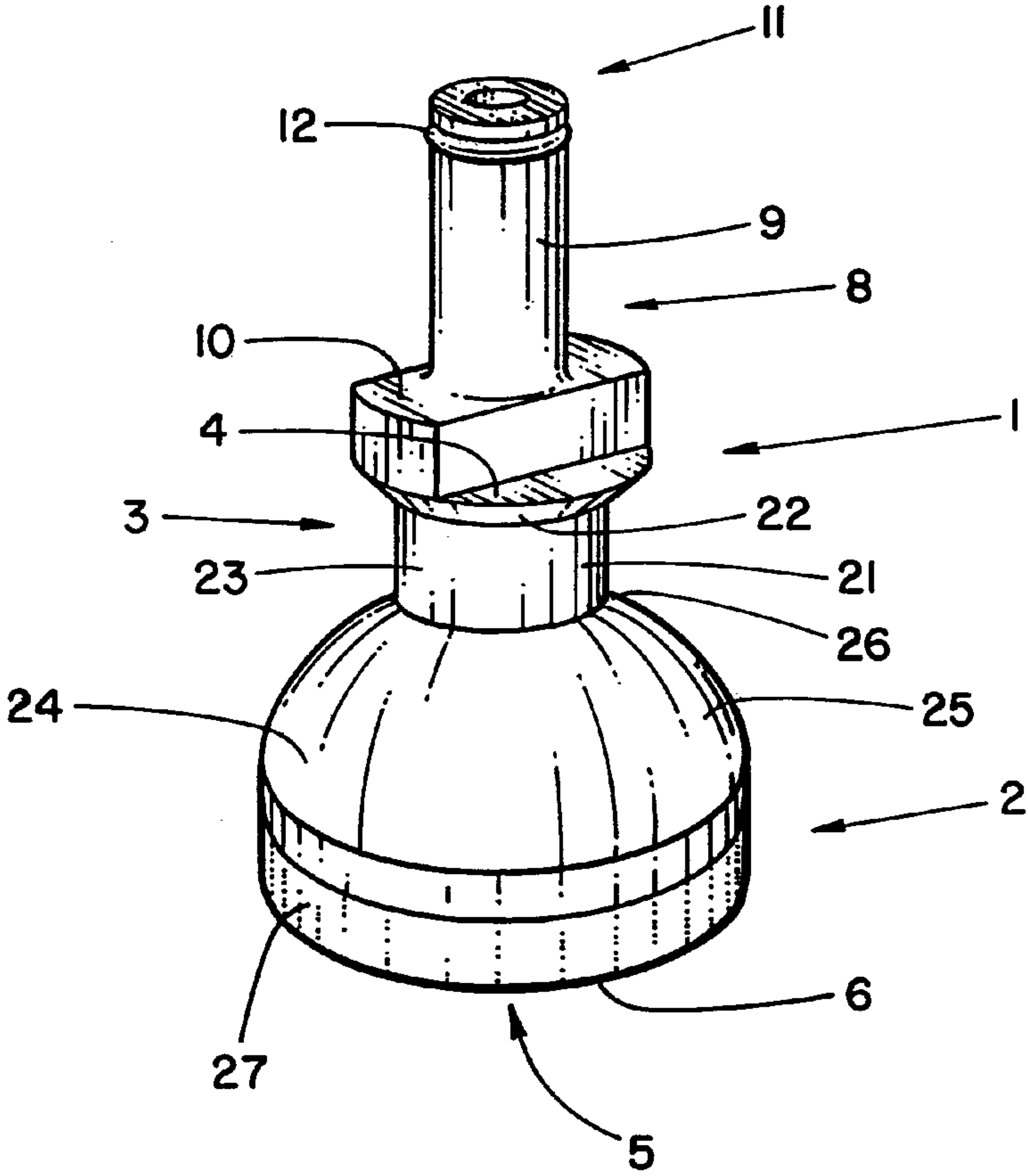


FIG. 10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