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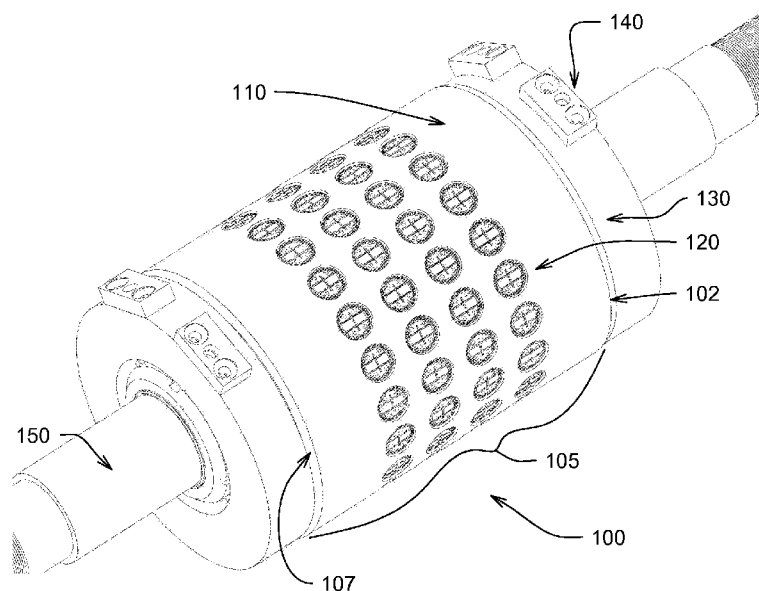


FIGURE 1

(57) Abstract: A rotary die ejection technology is disclosed. A cylindrical die roll has a rotary cylinder having internal air and regulation channels. The outer surface of the rotary cylinder includes mold cavity or cutter cavity. The cavity may be in the form of a socket capable of receiving inserts, including plugs and tool inserts. The plugs and tool inserts may be partially or entirely constructed from a porous material. The mold cavity or cutter cavity is in fluid communication with the internal air channel.

ROTARY TOOL EJECTION TECHNOLOGY

RELATED APPLICATIONS

[0001] The present patent document claims the benefit of the filing date under 35 U.S.C. §119(e) of Provisional U.S. Patent Application Serial No. 62030576, filed JULY 29, 2014, and Provisional U.S. Patent Application Serial No. 62030587, filed JULY 29, 2014, and U.S. Patent Application Serial No. 14810833, filed JULY 28, 2015, each of which is hereby incorporated by reference in its entirety, including all drawings and documents filed therewith.

BACKGROUND

[0002] Consumers increasingly rely upon the convenience of packaged food products. Convenience foods for both animals and humans have proliferated – and range from healthy to indulgent. Consumables such as but not limited to cookies, candies, crackers, and animal nourishment, come in a variety of textures, compositions, shapes, and sizes. Rotary die cutters and rotary die molds are a popular method of forming consumable food products.

BRIEF SUMMARY

[0003] A rotary die ejection technology is disclosed. A cylindrical die roll has an rotary cylinder having internal air and regulation channels. The outer surface of the rotary cylinder includes sockets capable of receiving tool inserts. The tool inserts being partially or entirely constructed from a porous material. The assembly of the tool insert with the socket creating a mold cavity or cutter cavity. The mold cavity or cutter cavity is in fluid communication with the internal air channel.

[0004] Other features and advantages of the disclosure will be, or will become, apparent to one of skill in the art upon examination of the following figures and detailed description. It is intended that all such additional advantages and features be included in the description, be within the scope of the invention, and be protected by the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG 1 is a perspective view of a first rotary tool;

- [0006]** FIG 2 is a cross section view of a first rotary tool;
- [0007]** FIG 3 is a second cross section view of a first rotary tool;
- [0008]** FIG 4 is a third cross section view of a first rotary tool;
- [0009]** FIG 5 is a fourth cross section view of a first rotary tool;
- [0010]** FIG 6 is a view of an air supply hub;
- [0011]** FIG 7 is a perspective view of a second rotary tool;
- [0012]** FIG 8 is a view of a docker pin plug;
- [0013]** FIG 9 is a cross section view of a second rotary tool;
- [0014]** FIG 10 is a second cross section view of a second rotary tool;
- [0015]** FIG 11 is a view of a plug;
- [0016]** FIG 12 is a view of a plug;
- [0017]** FIG 13 is a view of a consumable;
- [0018]** FIG 14 is a view of a second consumable;
- [0019]** FIG 15 is a view of a third rotary tool;
- [0020]** FIG 16 is a cross section view of a third rotary tool;
- [0021]** FIG 17 is an exploded assembly view of a third rotary tool;
- [0022]** FIG 18 is a view of a fourth rotary tool;
- [0023]** FIG 19 is a cross section view of a fourth rotary tool; and
- [0024]** FIG 20 is an exploded assembly view of a fourth rotary tool in cross section.

DETAILED DESCRIPTION OF THE DRAWINGS

[0025] Food products of various kinds, including cookies, crackers, candies, animal consumables, and other products, are frequently formed by high-volume automated rotary mold and/or rotary cutting devices. A rotary die is a cylinder, the surface of which is covered with shallow engraved cavities. A rotary cutter is a cylinder, the surface of which is covered with portions that rise about the face of the cylinder. Hybrid forms may also exist which include both engraved cavities and raised portions. In one exemplary process, the cylinder rotates past the opening in a hopper filled with food product (e.g., a food dough). The food product fills any engraved portions on the cylinder. Excess dough is sheared off

from the main mass by a blade. As the cylinder continues to rotate, the dough pieces are ejected onto a conveyor belt.

[0026] In another exemplary process, rotary die cutting uses a cylindrical die on a rotary press. A long sheet or web of material is fed through the rotary press into an area which holds a rotary tool, for example but not limited to, a rotary die cutter or a rotary die mold. The rotary tool may cut out shapes, make perforations or creases, impart aesthetic design, and/or cut the sheet or web into smaller parts. Rotary die cutting allows for the manufacture of multiple substantially identical formed products.

[0027] Several processes are used to release the formed product from the rotary tool. Some use fat and lard as lubricants to discourage attachment of the food product to the rotary tool. With the rising popularity of fat-free products, the industry increasingly adopted rotary tool coatings to assist release of formed shapes. Examples of rotary tool coatings include formulations of TEFLON and ceramics that are FDA and USDA approved for food contact.

[0028] Many known coatings wear out from repeated use; therefore the rotary tools require routine maintenance. As the rotary tool coatings wear out, the release fidelity decreases. Product increasingly sticks to the surface of the rotary tool. Decreases in fidelity result in considerable expense due to lost food product (e.g., through deformations, and sticking), down time, and loss of efficiency. Furthermore, the maintenance process results in downtime. Maintenance requires removing the subject machine from operation while the rotary tool is removed for reconditioning. The reconditioning process takes several days to several weeks and bears a significant expense. In an attempt to realize a large product output despite the maintenance inefficiencies, many companies are required to run several machine lines so that they can rotate production and maintenance. This requires larger more expensive facilities to house redundant machinery.

[0029] We disclose a rotary tool ejection technology that is capable of operating at high efficiency with minimal maintenance. In one variation, the rotary tool ejection technology eliminates the requirement of rotary tool coatings. In a variation, the rotary tool ejection technology eliminates the requirement of the use

of lubricants, including by increasing the fat content of the food product. In a variation, the rotary tool ejection technology features a rotary tool with no internal moving parts, further reducing maintenance concerns. The reduction of moving parts further increases the sanitation of the system, as moving parts often create additional surfaces in which food product may be trapped.

[0030] We also disclose a novel method of employing a porous material within the rotary tool system. In one variation, the porous material may be a porous metal material that has inter-connected porosity. A porous metal material may be fabricated from metal powder particles using powder metallurgy techniques. The porous material may have a range of pore sizes from about 0.5 micrometer to about 200 micrometers.

[0031] DEFINITIONS

[0032] Definitions: unless stated to the contrary, for the purpose of the present disclosure the following terms shall have the following definitions:

[0033] A reference to "another variation" in describing an example does not imply that the referenced variation is mutually exclusive with another variation unless expressly specified.

[0034] The terms "a," "an" and "the" mean "one or more," unless expressly specified otherwise.

[0035] The phrase "at least one of" when modifying a plurality of things (such as an enumerate list of things) means any combination of one or more of those things, unless expressly specified otherwise.

[0036] The term "represent" and like terms are not exclusive, unless expressly specified otherwise. For example, the term "represents" does not mean "represents only," unless expressly specified.

[0037] The term "e.g." and like terms means "for example, but not limited to" and thus does not limit the term or phrase it explains.

[0038] The term "porous material" refers to a material that has inter-connected porosity. A porous material may be fabricated from metal powder particles using powder metallurgy techniques. The porous material may comprise synthetic materials, ceramics, or combinations and composites thereof. The porous material may be a sintered material or

may be a micro-drilled material. The porous material may have a range of pore sizes (whether created by a sintering process or by micro-drilling) from about 0.05 micrometer to about 300 micrometers. For example, the porous material may have a pore size in the range in micrometers of about 0.05 -300, 0.5-300, 0.2 – 100, 5.0-30, 20-40, or any individual value or range falling in between the listed ranges. Additionally or alternatively, the pore size within a porous material may vary throughout the material or the porous material may include pores of more than one pore size within the disclosed ranges. A porous insert is an insert, which may be a plug, a machined insert, or otherwise that is made of porous material and machined to be fit and/or retained in a mold cavity or socket.

[0039] Figure 1. A rotary tool **100** may include a rotary cylinder **105**, one or more air supply hub **130** and a central shaft **150**. The rotary cylinder **105** and the air supply hub **130** may be assembled on the central shaft **150**. The central shaft **150** may adapt the rotary tool **100** to placement into any rotary manufacturing system. The supply of ejection air is attached to the rotary tool by the air supply hub **130**. The air supply hub **130** supplies air to the rotary tool as described in more detail throughout.

[0040] The rotary cylinder **105** may have a first end **102**, a second end **107**, and a surface face **110**. The first end **102** may be parallel to the second end **107**. The surface face **110** may be the exterior portion of the rotary tool **100**. The surface face **110** may be the face of the rotary tool that comes into contact with a product dough. The surface face **110** may include a mold cavity **120**. Figure 1 provides an exemplary illustration of a rotary tool having mold cavities **120** arranged on the surface face **110**. The mold cavities **120** are shown in sets of four, however, the rotary tool **100** may include fewer or more mold cavities **120** per set. Additional or alternative arrangements may include offset pitching and nesting of mold cavities **120**, among others. Other arrangements are also possible. While mold cavities **120** are shown, the system may additionally or alternatively include cutters and/or sockets (e.g., examples provided at Figure 18).

[0041] The rotary cylinder **105** may be a one-piece construction or a multi-piece construction. The rotary cylinder **105** may be made of a non-porous material, e.g., non-porous brass, steel, metal or the rotary cylinder **105** may be made of a porous metal material.

[0042] A rotary tool **100** may include an air ejection technology. The rotary tool **100** may include an internal manifold for circulating air (shown in subsequent figures) supplied, for example, through an air port **140**. The rotary tool **100** may include one or more air supply hub(s) **130**. In the example of Figure 1, the rotary tool **100** is assembled adjacent to two air supply hubs **130**. Where two air supply hubs **130** are present, the air supply hub(s) **130** may be arranged in a book-end type arrangement with the rotary cylinder **105**. The air supply hub **130** may include one or more air ports **140**. The air ports **140** may be points of air entry and/or air exit.

[0043] Figure 2 provides a cross-section view of the rotary tool **100** of Figure 1, cut through the plane of channels **210** and **220** and orifice **230**.

[0044] The rotary tool **100** may include one or more channels. The one or more channels may accommodate the circulation of ejection air, temperature regulating fluid, or otherwise, e.g., through the rotary cylinder **105**. Figure 2 provides a cross section of an exemplary system of air channels. In this figure, a source channel **210**, which may be located on an air supply hub **130**, provides ejection air to a distribution channel **220**. The distribution channel **220** may enter the rotary cylinder **105** at one or more of the first end **102** and the second end **107**. (Figure 17 provides a view of the distribution channel opening **1710** through which the distribution channel **220** enters the rotary cylinder.) The distribution channel **220** may pass through the rotary cylinder **105** as a longitudinal channel parallel to a row of mold cavities **120**. Each mold cavity **120** is in fluid communication with the distribution channel **220**, e.g., through an orifice **230**. The mold cavity **120** may include a porous material region, which may permit the passage of air from the distribution channel **220** and the orifice **230** to contact and act upon the contents of the mold cavity **120**, e.g., product dough.

[0045] Air supply to the distribution channels **220** may be regulated or unregulated. In one example, supply of air to the distribution channels **220** may

be supplied in a periodic pattern, e.g., corresponding to a preferred product ejection position of the rotary tool **100**. Air may be supplied to the distribution channels **220** located in the rotary cylinder by the air supply hub **130**. The distribution channels **220** may supply air to the orifices **230**, e.g., creating an ejection force on material in the mold cavity **120**.

[0046] The mold cavity **120** may include a region of porous material. The porous material may be permissive to air flow, e.g., allowing air to pass from the distribution channel **220** through the mold cavity **120**.

[0047] In another example, the assembly of the rotary cylinder **105** with the air supply hubs **130** may allow for regulation of air flow into the distribution channels **220**. For example, the air supply hubs **130** may be stationary relative to the rotary cylinder **105**. As the rotary cylinder **105** rotates relative to the air supply hub **130**, each row of mold cavities **120** may receive a pulse of ejection air (e.g., from the port Fig. 6, **610** of the air supply hub **130**). The pulse of ejection air may be timed with the timing of other elements of the system, e.g., conveyor systems. Timing of the air ejection through the mold cavities **120** may be set by the selective positioning of the air supply hub **130** relative to the distribution channel **220**. For example, when the rotary cylinder **105** rotates such that a distribution channel **220** of the rotary cylinder **105** is aligned with the distribution channel **220** of the air supply hub **130**, air will pass into the distribution channel **220** of the rotary cylinder **105**. Air ejection may thus occur on a row by row basis.

[0048] The air supply hub **130** may be constructed of any suitable material. In a variation, the air supply hub **130** may be constructed of a bearing type material such as PTFE (Teflon) to permit sliding and sealing on the end surfaces of the rotary cylinder **105**.

[0049] Figure 2 also provides a cross section of a portion of an exemplary temperature control system. The temperature control system may include a source channel **240**. The source channel **240** may be located within the shaft **150**. The temperature control circuit may circulate a fluid, for example a fluid capable of being heated or cooled. The fluid may have the property of heating and/or cooling a surface of the rotary tool **100**. The fluid may have the property of

maintaining a temperature of the rotary tool **100**. The heating, cooling, and/or maintenance of a temperature may optimize ejection from the mold cavities **120**.

[0050] A temperature regulating fluid may be supplied to the rotary tool **100**. In one example, the temperature regulating fluid may be supplied to the rotary tool **100** through the shaft **150**. The temperature regulating fluid may be supplied through the shaft **150** at a selected shaft end (e.g., left side or right side), and may flow through a circulating channel (see Figure 3), and then exit out and away from the rotary cylinder **105** at the opposite end of the shaft **150**. In some variations, the temperature regulating fluid may enter and exit the same end of the shaft **150**.

[0051] Figure 3 is a cross section view, cut through the temperature control circuit. The temperature control circuit may include a source channel **240**, a radiating channel **310**, and a regulating channel **320**. The source channel **240** may be located within the shaft **150**. Temperature regulating fluid may enter the source channel **240** and then travel to the radiating channel **310** for delivery to the regulating channel **320**. The regulating channel **320** may run at an appropriate depth beneath or between the mold cavities **120**. The regulating channel may impart a desired temperature to one or more of the surface face **110**, the rotary cylinder **105**, and the mold cavities **120**. The temperature may be optimized for product release from the mold cavities **120**. For example, a cold temperature may cause the product to shrink away from the mold cavity **120** and release. A hot temperature may change the consistency of the product, encouraging release.

[0052] Figure 4 provides a cross section view cut through a diameter of the rotary cylinder **105**. The cross section bi-sects the mold cavities **120** and the orifice **230**. Mold cavities **120** may be an assembly of a socket **410** and a mold tool insert **420**. A mold tool insert **420** may have a mold tool insert surface. The mold tool insert **420** may be recessed relative to the surface face **110** of the rotary cylinder **105** such that the mold cavity **120** remains capable of receiving material (e.g., product dough) therein.

[0053] The mold tool insert **420** may be constructed of entirely of a porous material (as seen in Figure 4) or partially of a porous material (e.g., as seen in

Figures 18 and otherwise herein). The porous materials are discussed in greater detail throughout the specification. The mold tool insert **420** may define an opening **430**. The opening **430** may be defined by at least two surfaces of the mold tool insert **420**, e.g., an outer facing wall and the side walls, which side walls are inserted into the socket **410**.

[0054] The mold cavities **120** may be arranged in longitudinal rows along the surface face **110**. The mold cavities **120** may be in fluid communication with orifices **230**. The orifice **230** may be arranged in a radial formation relative to the shaft **150**. The orifice **230** may be in fluid communication with the distribution channel **220**. The distribution channel **220** may be in fluid communication with the source channel Figure 2, **210**. The distribution channel **220** and the regulating channels **320** may be arranged circumferentially around the inner region of the rotary cylinder **105**. The distribution channels **220** and the regulating channels **320** may be off set from each other.

[0055] Figure 5 is a cross section and partial view of a rotary cylinder **105** and an air supply hub **130**. The air supply hub **130** may include a port **610** and a blast channel **620**. The port **610** of the air supply hub **130** is capable of alignment with one distribution channel opening Fig. 18, **1830** of the rotary cylinder **105**. This arrangement may allow air to be supplied to the distribution channels **220** of the rotary cylinder **105** in a row-by-row fashion, e.g., when the rotary cylinder revolves into alignment with the port **610**, air will be delivered into the aligned distribution channel **220**.

[0056] The blast channel **620** is capable of alignment with a plurality of distribution channel openings Fig. 17, **1710**. In one variation, the blast channel **620** is capable of alignment with all of the distribution channel openings Fig. 17, **1710** of the rotary cylinder **105** that are not aligned with the port **610**. For example, if "n" represents the total number of distribution channel openings Fig. 17, **1710**, the blast channel **620** is capable of aligning with n-1 distribution channel openings Fig. 17, **1710**. When air is supplied to all n of the distribution channel openings Fig. 17, **1710**, then air will also travel all distribution channels **220** at once. Simultaneous air flow through all distribution channels **220** may have ejection advantages, e.g., of clearing material simultaneously from all mold

cavities **120**. Simultaneous air flow through all distribution channels **220** may have sanitary advantages, e.g., prohibiting cleaning solution from entering the air channels during wash down (described later herein).

[0057] Figure 6 is a cross section of the air supply hub **130** assembled with a shaft **150**. The air supply hub **130** has an inner face **630** and an outer face **635**. The inner face **630** of the air supply hub **130** oriented to the first end **102** or the second end **107** of the rotary cylinder **105**.

[0058] The air supply hub **130** may include a port **610**. The port **610** of the air supply hub **130** may supply air to the distribution channel Fig. 5, **220** of the rotary cylinder **105**. The configuration of the port **610** may permit controlled air release into the distribution channel Fig. 5, **220**, which may further permit controlled product release from the mold cavities **120**.

[0059] In a variation, air is supplied to the port **610** of the air supply hub **130**, e.g., through an air port **140**. As the rotary cylinder **105** rotates relative to the air supply hub **130** (which may be stationary), the distribution channel opening Fig. 17, **1710** and thus distribution channel **220** in the rotary cylinder **105** may rotate into alignment with the port **610** of the air supply hub **130**. When a port **610** is in alignment with the distribution channel opening Fig. 17, **1710** and thus distribution channel **220**, air is supplied to distribution channel **220**. The air supplied to the distribution channel **220** passes through the orifices **230** and exits through the mold cavity **120**. As the rotary cylinder **105** rotates relative to the air supply hub **130**, the distribution channel openings Fig. 17, **1710** rotate out of alignment with the ports **610** on the air supply hub **130**. When the distribution channel openings Fig. 17, **1710** rotate out of alignment with the port **610** of the air supply hub **130**, air flow to the distribution channels **220** ceases. Thus, product in the mold cavity **120** is not ejected.

[0060] The air supply hub **130** may include a blast channel **620**. The blast channel **620** may run the circumference of the air supply hub **130**. The blast channel **620** may be aligned with the distribution channel openings Fig. 17, **1710** of the rotary cylinder **105** as described above (e.g., n-1 distribution channel openings Fig. 17, **1710**). Air is supplied to the blast channel **620** of the air supply hub **130**, e.g., through an air port **180**.

[0061] Good manufacturing practices prescribe regular wash down cleaning of food production tooling. During a wash down, air may be supplied to all distribution channels **220** at once via a combination of the blast channel **620** and the port **610**. The air supplied to the distribution channels **220** may simultaneously eject from all mold cavities **120**. The simultaneous ejection of air may prevent water migration into the orifices **230** and channels **220**, **210** during wash down. Alternatively or additionally, the orifices **230** and channels **220**, **210**, may be cleaned by a supply of washdown fluid supplied through the source channel **210**, the distribution channel **220**, and/or the orifices **230**.

[0062] Figure 7 provides an example of how the ejection technology may be applied to a rotary cutter. The concepts introduced above for the rotary molder may be applied to the cutter and are incorporated herein in their entirety.

[0063] Figure 7. A rotary tool may include a rotary cylinder **105**, air supply hub **130** and a shaft **150**. The rotary cylinder **105** and the air supply hub **130** may be assembled on the shaft **150**. The shaft **150** may adapt the rotary tool **100** to placement into any rotary manufacturing system.

[0064] The rotary cylinder **105** may include a surface face **110**. The surface face **110** may be the exterior portion of the rotary tool **100**. The surface face **110** may be the portion of the rotary tool **100** capable of contacting a manufacturing raw material, e.g., product dough. The surface face **110** may include a cutter cavity **710**. The cutter cavities **710** are shown in sets of four; however, the rotary tool **100** may include fewer or more mold cavities **120** per set. Additional or alternative arrangements may include offset pitching and nesting of cutter cavities **710**, among others. Other arrangements are also possible.

[0065] A rotary tool **100** may include an air ejection technology. The rotary tool **100** may include an internal manifold for circulating air (shown in subsequent figures). The rotary tool **100** may include one or more air supply hub **130**. In the example of Figure 7, the rotary tool **100** is assembled with two air supply hubs **130**. The air supply hubs **130** may be arranged in a book-end type arrangement with the rotary cylinder. The air supply hub **130** may include one or more air ports **140**, **180**. The air ports **140**, **180** may be points of air entry and/or air exit.

[0066] The cutter cavities **710** may have raised cutter portions that raise above the plane of the surface face **110**, a lowered cavity portions that are below or continuous with the surface face **110**. The cutter cavities **710** may include a cutter side wall **715** and plugs **760**. The plugs **760** may include docker pins **730** as shown, or may not include docker pins **730**. The side walls **715** may rise out of the plane of the surface face **110** such that the side walls **715** permit the rotary tool **100** to perform a cutting function. The plugs **760** may be made of a porous material. In a variation, the entire cutter cavity **710** may be made of a porous material.

[0067] The cutter cavity **710** has a side wall **715** that is raised above the plane of the surface face **110** and a bottom wall **750** that is below the surface face **110** or continuous with the surface face **110**. The bottom wall **750** includes a socket **755** (which is configured as is socket **410** of Figure 4), which in this figure are shown assembled with a plug **760**. The cutter cavity **710** also includes docker pins **730**, both on the plug **760** and otherwise arranged on the bottom wall **750**. Docker pins **730** are placed such that they can punch holes into a product dough. The holes allow steam to escape during baking, thus helping to prevent the food stuff from over-inflating. In addition, the holes made by docker pins may connect the dough layers (e.g., or dough sheets), thereby controlling puffing and size of the product. With a cavity tool, docker pins can assist with the release of molded product, e.g., by holding the product in the cavity. Docker pins **730** may have a height higher than, e.g., the side wall **715** of the cutter cavity **710** or mold cavity **120**.

[0068] With some food stuffs, for example but not limited to, cracker dough, there is a desire that the dough never touch the bottom wall **750** of the cutter cavity **710**. In some situations, if the dough reaches the bottom wall **750** of the cutter cavity **710**, the dough may stick and lift, which leads to tearing.

[0069] Figure 8 is an enlarged view of a docker pin **730** portion of a plug **760**. The docker pin **730** includes an angled spike **810** and a base **820**. The angled spike **810** has a diameter that increases from the outermost portion of the angled spike **810** (e.g., furthest from the surface face **110**) to where it joins the base **820**. The angled spike **810** has a hollow opening **815** therein. The walls of the angled

spike **810** may have a substantially constant thickness. The angled spike **810** may be constructed of porous material as disclosed herein. The base **820** of the docker pin **730** may also be constructed of porous material. The base **820** of the docker pin **730** may be unified with the angled spike **810**, or may be a multi-piece construction. The hollow opening **815** may reduce the air resistance of the angled spike **810** over the resistance the air would encounter if the spike was made of a solid porous material. Airflow traveling from the orifice **230** and through the docker pin **730** may assist the ejection efficiency of the food stuff contacted by the cutter cavity **710**. Ejection air may exit the docker pin **730** where the base **820** forms a continuous face at the surface face **110** and through the exterior diameter of the angled spike **810** of the docker pin **730**.

[0070] The porous material may be sized by, for example but not limited to, electric discharge machining, to a precision size and shape for press fitting into the socket **755**. Docker pins **730** of many sizes and lengths are used in rotary tool design. Size is determined by the specific needs, both technical and aesthetic.

[0071] The plug **760** may be precision machine shaped material. The plug **760** may be dimensioned to press fit into the socket **755** such that the exterior portion of the plug **760** is continuous with the bottom wall of the mold cavity **120** and/or cutter cavity **710**.

[0072] If the mold cavity **120** and/or cutter cavity **710** includes a design contour the plug **760** may be placed in a portion of the mold cavity **120** or cutter cavity **710** that has no design etching. Alternatively or additionally, if the mold cavity **120** and/or cutter cavity **710** includes a design contour the exterior face of the plug **760** may also have a design contour that is continuous with the design contour of the cavity, such that there is no interruption in the pattern. Alternatively or additionally, the mold cavity **120** and/or cutter cavity **710** may include no design contour, and the exterior surface of the plug **760** may have a design contour, such that, when integrated with the mold cavity **120** and/or cutter cavity **710** and contacted with food stuff, the plug **760** imparts a design to the food stuff.

[0073] Figure 9 provides a cross-section view of the rotary tool of Figure 7, cut through the plane of channels **210** and **220** and orifice **230**. Ejection air may

be supplied through an air manifold. The air manifold may be positioned within an air supply hub **130**. In one example, ejection air may be supplied through air supply hub **130** existing on each side of the rotary cylinder **105**.

[0074] The rotary tool may include one or more channels. The one or more channels may accommodate the circulation of ejection air, temperature regulating fluid, or otherwise, e.g., through the rotary cylinder **105**. Figure 9 provides a cross section of an exemplary air channel. In this figure, a source channel **210** provides ejection air to a distribution channel **220** shown as a longitudinal channel parallel with a row of cutter cavities **710**. Each cutter cavity **710** is in fluid communication with the distribution channel **220**, e.g., through an orifice **230**.

[0075] Air may flow to the orifice **230** through the air supply hub **130**. Supply of air from the air supply hubs **130** may be selective, e.g., may be subject to regulation. In one example, supply of air from the air supply hub **130** may be supplied in a periodic pattern, e.g., corresponding to a preferred product ejection position of the die roll. The air supply hub **130** may supply air to distribution channels **220**. The distribution channels **220** may run parallel to the shaft **150**. The distribution channels **220** may supply air to the orifices **230**, e.g., creating an ejection force on material contact by a region of the cutter cavity **710**. The mold cavity **120** and/or cutter cavity **710** may be constructed of a combination of solid material (non-porous material) and porous material. Solid material (non-porous material) may be resistant to the flow of air. Porous material may be permissive to air flow. Porous material may, additionally or alternatively, be resistant to back flow of solid materials and/or liquids (but not gases). The number and arrangement of channels may be design dependent. The air supply hubs **130** may supply air on a row by row basis.

[0076] In one variation, the air supply hub **130** may be stationary relative to the rotary cylinder **105**. As the rotary cylinder **105** rotates relative to the air supply hubs **130**, each row of mold cavities **120** may receive a pulse of ejection air. The pulse of ejection air may be timed with the timing of other elements of the system, e.g., conveyor systems. Timing of the air ejection may be set by the selective positioning of the air supply hubs **130** relative to the distribution channel **220**. The air supply hubs **130** may be constructed of a bearing type material such as PTFE

(Teflon) to permit sliding and sealing on the end surfaces of the rotary cylinder **105**, and/or on the air supply hubs **130**.

[0077] Figure 9 provides a cross section of an exemplary temperature control channel. The temperature control circuit may include a source channel **240**. The source channel **240** may be located within the shaft **150**. The temperature control circuit may circulate a fluid, for example a fluid capable of being heated or cooled. The fluid may have the property of heating and/or cooling the surface of the rotary tool **100**. The fluid may have the property of maintaining a temperature of the rotary tool **100**. The heating, cooling, and/or maintenance of a temperature may optimize ejection from the cutter cavities **710**.

[0078] A temperature regulating fluid may be supplied to the rotary tool **100**. In one example, the temperature regulating fluid may be supplied to the rotary tool **100** through the shaft **150**. The temperature regulating fluid may be supplied through the shaft **150** at a selected shaft end (e.g., left side or right side), and may flow through a circulating channel, and then exit out and away from the rotary cylinder **105** at the opposite end of the shaft **150**. In some variations, the temperature regulating fluid may enter and exit the same end of the shaft **150**.

[0079] Rotary tools may be mounted in any commercial rotary machine, including single roll and dual roll machines. The rotary cutter may use either molds or cutters. The molds and cutters may be continuous with the surface face **110**. The molds may be above the plane of the surface face **110** of the rotary cylinder **105** or below the plane of the surface face **110** of the rotary cylinder **105**. Similarly, cutter cavities **710** may have portions that rise above the surface face **110** of the rotary cylinder **105**. The cutter cavities **710** may also have portions that are located below the surface face **110** of the rotary cylinder **105** (e.g., by machining or otherwise as described herein). The location of an orifice **230** is not limited to a center location within the mold cavity **120** and/or cutter cavity **710**. There may be more than one orifice **230** in a mold cavity **120** and/or cutter cavity **710**. The mold cavity **120** and/or cutter cavity **710** may have various shapes and sizes. The ejection technology may substantially improve tool performance and thereby increase efficiency and decrease cost, e.g., by reducing down time and maintenance. The ejection technology may further permit formulation changes

such as reduced fat, without losing ejection integrity. The ejection technology may also increase the range of possible shapes and sizes of product without impact on tool performance.

[0080] Figure 10 is a cross section view, cut through the temperature control circuit. The temperature control circuit may include a source channel **240**, a radiating channel **310**, and a regulating channel **320**. The source channel **240** may be located within the shaft **150**. Temperature regulating fluid may enter the source channel **240** and then travel to the radiating channel **310** for delivery to the regulating channel **320**. The regulating channel **320** may run at an appropriate depth beneath or between the cutter cavities **710**. The regulating channel **320** may impart or maintain a desired temperature to the surface face **110**, the rotary cylinder **105**, the cutter cavities **710** or both. The temperature may be optimized for product release from the cutter cavities **710**. For example, a cold temperature may cause the product to shrink away from the cutter cavity **710** and release. A hot temperature may change the consistency of the product, encouraging release.

[0081] Figures 4-6 are applicable to the rotary tool **100** of Figure 7. The difference being the form of the cavity, e.g., the mold cavity **120** may be replaced out with the cutter cavity **710**. Similarly, the plug **760** is a characteristic of the mold cavity **120**, in a manner similar to that of Figure 7 and 8. Figure 11 is a view of a plug **760** of porous material that may be incorporated into the mold cavity **120** of Figure 1 et seq. The plug **760** may have a hollow interior permitting optimized air flow from the orifice **230**. Figure 12 is a view of a plug **760** of porous material that may be incorporated with the cutter cavity **710**. The plug **760** may have a hollow interior permitting optimized channeling of air from the orifice **230**. Figure 13 is an example of a consumable **1300** that might be ejected from the cutter cavity **710**. Here one can view the surface detail of the consumable imparted by the cutter cavity **710**, including the contour of the plug **760**. Figure 14 is an example of a consumable **1400** that might be ejected from a mold cavity **120** incorporating the plug **760** of Figure 11. A surface detail may be imparted by a contour of the mold cavity **120**, including a contour of the plug Fig. 11, **760**.

[0082] Figure 15 is a variation of a rotary cylinder **105** assembled with spring pack assembly **1500** at each end. The air supply hub **130** may be loaded axially onto the ends of the rotary cylinder **105** and maintain an air seal therewith. Loading may be provided by a spring pack assembly **1500**. The spring pack assembly **1500** may apply a force, e.g., on the air supply hub **130** which may maintain a contact seal between the air supply hub **130** and the rotary cylinder **105**. While a spring pack assembly **1500** is shown, the spring pack design may be replaced by any pressure pack capable of providing a force, e.g., an air cylinder may provide the necessary force needed for sealing contact.

[0083] Figure 16 is a sectional view cut through a plane that passes through the center of the spring pack assembly **1500**. The spring pack assembly **1500** may be positioned concentrically around the shaft **150**. The spring pack assembly **1500** may apply a force on the air supply hub **130** and the roller bearing **1610**. The roller bearing **1610** may allow the spring pack assembly **1500** to remain in contact (e.g., stationary contact) with the air supply hub **130** while the rotary cylinder **105** rotates with the shaft **150**. In one variation, only the side of the air supply hub **130** that is directly in contact with the end of the rotary cylinder **105** has a sliding motion. The sliding motion may produce a tangential force which must be matched and applied to the air supply hub **130** for the air supply hub **130** to maintain a stationary position. In a variation, the rotary cylinder **105** and the shaft **150** may rotate together while the spring pack assembly **1500** and the air supply hubs **130** remain stationary. The face of the air supply hub **130** closes to the rotary cylinder **105** may abut the rotary cylinder **105** and may be in sealed sliding contact with the rotary cylinder **105**.

[0084] Figure 17 provides an exploded assembly view of a variation of the system. While the cutter system **1700** is shown, the figure equally applies to the molder system.

[0085] Figure 18 provides a variation of the rotary tool. A rotary tool may be multi-functional. In a variation, the system is provided with a rotary cylinder **105**. The concepts introduced above in Figures 1-17 are incorporated herein in their entirety.

[0086] A rotary tool **100** may include a rotary cylinder **105**, air supply hub **130** and a shaft **150**. The rotary cylinder **105** and the air supply hub **130** may be assembled on the shaft **150**. The shaft **150** may adapt the rotary tool **100** to placement into any rotary manufacturing system.

[0087] The rotary cylinder **105** may include a surface face **110**. The surface face **110** may be the exterior portion of the rotary tool **100**. The surface face **110** may include a socket **1810**. The sockets **1810** are shown in sets of four, however, the rotary tool **100** may include fewer or more sockets **1810** per set. Additional or alternative arrangements may include offset pitching and nesting of sockets **1810**, among others. Other arrangements are also possible.

[0088] A rotary tool **100** may include an air ejection technology. The rotary tool **100** may include an internal manifold for circulating air (shown in subsequent figures). The rotary tool **100** may include one or more air supply hub **130**. In the example of Figure 18, the rotary cylinder **105** is assembled with two air supply hub **130**. The air supply hub **130** may be arranged in a book-end type arrangement with the rotary cylinder **105**. The air supply hub **130** may include one or more air ports **140**, **180**. The air ports **140**, **180** may be points of air entry and/or air exit. The temperature regulating channel opening **1840** may be points of temperature regulating fluid entry and/or exit.

[0089] The sockets **1810** may receive tool inserts **1820**, which may be cutter inserts (shown). The socket **1810** and tool insert **1820** system may permit easy replacement of damaged tools and/or easy adaptation of the rotary tool to various different designs of tool inserts **1820**, e.g., changeover to varying product design styles for producing consumables. The easy replacement minimizes the interruption of the production process in both down time and cost.

[0090] The tool inserts **1820** may include plugs **760**. The plugs **760** may include docker pins **730** as shown, or may not include docker pins **730**. The plugs **760** may be made of a porous material described elsewhere herein.

[0091] It should be understood that in all variations, the porous material may be a micro-drilled material. The plug **760** may be precision machine shaped material. The plug **760** may be dimensioned to fit into a receiving recess of the

tool inserts **1820** such that the exterior portion of the plug **760** is continuous with, in the case of a cutter design, the surface face **110** of the rotary cylinder **105**.

[0092] If the tool insert **1820** includes a design contour the plug **760** may be placed in a portion of the tool insert **1820** that has no design etching. Alternatively or additionally, if the tool insert **1820** includes a design contour the exterior face of the plug **760** may also have a design contour that is continuous with the design contour of the cavity, such that there is no interruption in the pattern. Alternatively or additionally, the tool insert **1820** may include no design contour, and the exterior surface of the plug **760** may have a design contour, such that, when integrated with the tool insert **1820** and contacted with food stuff, the plug **760** imparts a design to the food stuff.

[0093] Ejection air may be supplied through an air manifold. The air manifold may be positioned within an air supply hub **130**. In one example, ejection air may be supplied through air supply hub **130** existing on each side of the rotary cylinder **105**.

[0094] The rotary tool **100** may include one or more channels.

[0095] Figure 19 provides a section view of the rotary tool implementing socket assembly. Figure 20 provides an exploded assembly view of the rotary tool implementing socket **1810** and tool inserts **1820**.

[0096] The component parts of the socket assembly may be identical to the parts illustrated elsewhere herein, except for the socket **1810** and tool inserts **1820**.

[0097] In one variation, the porous material may be a porous metal material that has inter-connected porosity. A porous metal material may be fabricated from metal powder particles using powder metallurgy techniques. The porous material may have a range of pore sizes from about 0.5 micrometer to about 200 micrometers. The porous material may comprise synthetic materials, ceramics, or combinations and composites thereof. The porous material may be a sintered material or may be a micro-drilled material. The pore size (whether created by a sintering process or by micro-drilling) may range from 0.2 to 100 micrometers. A porous structure may have the advantage of preventing the dough product from being caught or trapped in the mold cavity or cutter cavity.

[0098] While variations of the invention have been described, it will be apparent to those of skill in the art that many more implementations are possible that are within the scope of the claims.

CLAIMS

1. A rotary tool comprising:
 - a rotary cylinder;
 - the rotary cylinder comprising:
 - a surface face;
 - a first end; and
 - a second end;
 - the surface face having a plurality of cavities, the cavities having a porous insert;
 - the cavities each in fluid communication with a distribution channel;
 - the distribution channel passing longitudinally through the rotary cylinder and the distribution channel terminating at a distribution channel opening on at least one of the first end and the second end of the rotary cylinder;
 - an air supply hub adjacent to the rotary cylinder;
 - the air supply hub having an inner face and an outer face;
 - the inner face of the air supply hub oriented to at least one of the first end or the second end of the rotary cylinder;
 - the inner face of the air supply hub defining a port; and
 - the port capable of alignment with a distribution channel opening of the rotary cylinder.
2. The rotary tool of claim 1, the air supply hub further comprising:
 - the inner face of the air supply hub defining a blast channel; and
 - the blast channel capable of alignment with n-1 distribution channel openings of the rotary cylinder
3. The rotary tool of claim 1, further comprising:
 - the cavities are mold cavities.
4. The rotary tool of claim 1, further comprising:
 - the cavities are cutter cavities.
5. The rotary tool of claim 1, the porous insert comprising a plug situated in a bottom wall of the cavity.

6. The rotary tool of claim 1, further comprising a temperature control circuit.
7. The rotary tool of claim 1 further comprising, the air supply hub assembled with a spring pack assembly, the spring pack assembly positioned concentrically around the central shaft.
8. The rotary tool of claim 1 further comprising: the rotary mold cylinder assembled with a central shaft;
 - the central shaft defining a source channel there through;
 - the rotary mold cylinder further comprising a plurality of regulating channels; and
 - the regulating channels of the rotary mold cylinder in fluid communication with the source channel.
9. A rotary tool comprising:
 - a rotary cylinder;
 - the rotary cylinder comprising;
 - a surface face;
 - a first end; and
 - a second end;
 - the surface face having a plurality of sockets, the sockets capable of receiving a tool insert;
 - the sockets each in fluid communication with a distribution channel;
 - the distribution channel passing longitudinally through the rotary cylinder and the distribution channel terminating at a distribution channel opening on at least one of the first end and the second end of the rotary cylinder;
 - an air supply hub adjacent to the rotary cylinder;
 - the air supply hub having an inner face and an outer face;
 - the inner face of the air supply hub oriented to at least one of the first end or the second end of the rotary cylinder;
 - the inner face of the air supply hub defining a port; and
 - the port capable of alignment with a distribution channel opening of the rotary cylinder.
10. The rotary tool of claim 9, the air supply further comprising:

the inner face of the air supply hub also defining a blast channel;
and

the blast channel capable of alignment with n-1 distribution channel openings of the rotary cylinder.

11. The rotary tool of claim 9, the tool insert composed of a porous material having a pore size of about 0.5 micrometer to about 200 micrometers.

12. The rotary tool of claim 9, the tool insert further comprising a surface and side walls defining a hollow opening.

13. The rotary tool of claim 9, the tool insert composed of a non-porous material; the tool insert defining a recessed opening in an outer surface; the recessed opening capable of receiving a plug; and the plug composed of a porous material.

14. The rotary tool of claim 9, the tool insert comprising a cutter.

15. The rotary tool of claim 13, the tool insert composed of a porous metal material having a pore size of about 0.5 micrometer to about 200 micrometers.

16. The rotary tool of claim 13, the tool insert composed of a non-porous material; the tool insert defining a recessed opening in an outer face; the recessed opening capable of receiving a plug; the plug composed of a porous material.

17. The rotary tool of claim 13, wherein the plug comprises a docker pin plug, the docker pin plug comprising a base and a spike.

18. The rotary tool of claim 9, the rotary mold cylinder assembled with a central shaft;

the central shaft defining a source channel there through;

the rotary mold cylinder further comprising a plurality of regulating channels; and

the regulating channels of the rotary mold cylinder in fluid communication with the source channel.

19. The rotary tool of claim 9, further comprising, the air supply hub assembled with a spring pack assembly, and the spring pack assembly positioned concentrically around the central shaft.

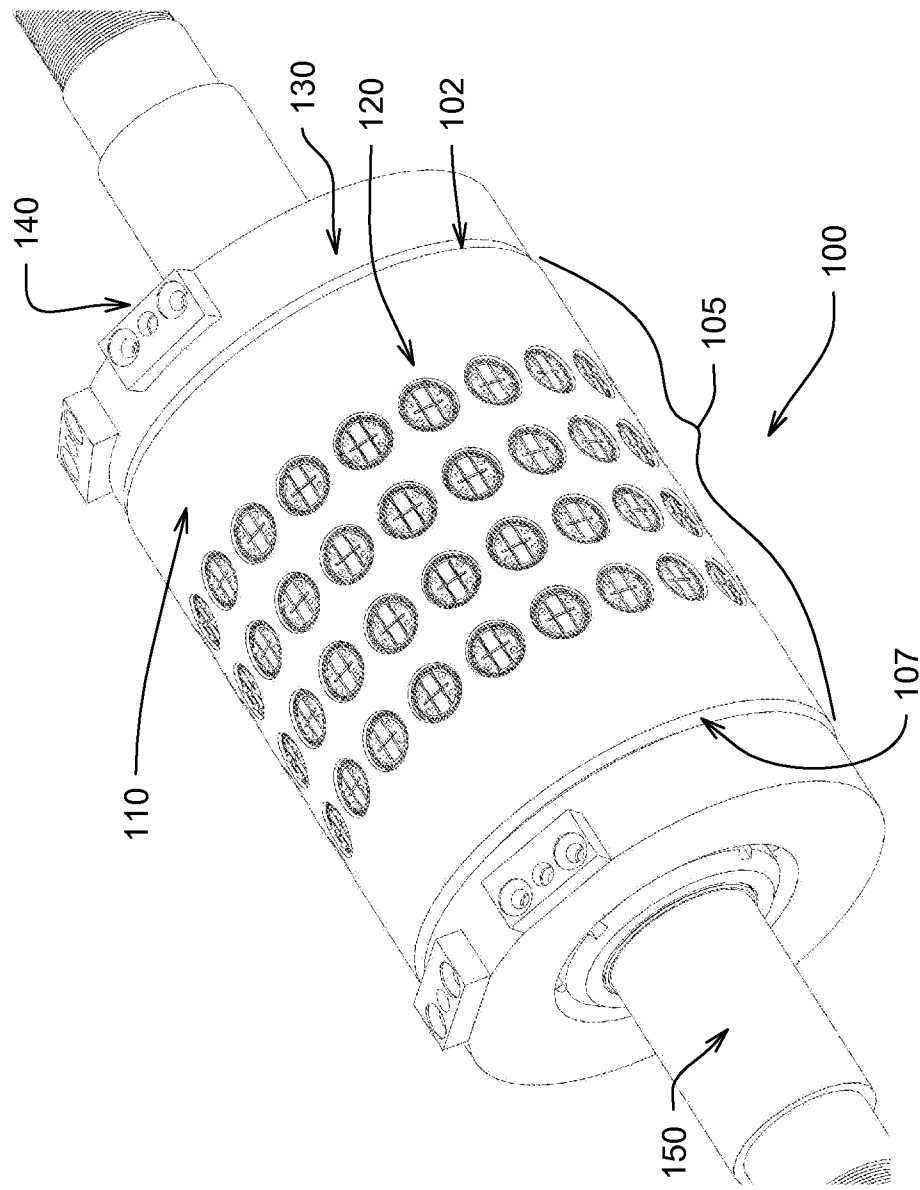


FIGURE 1

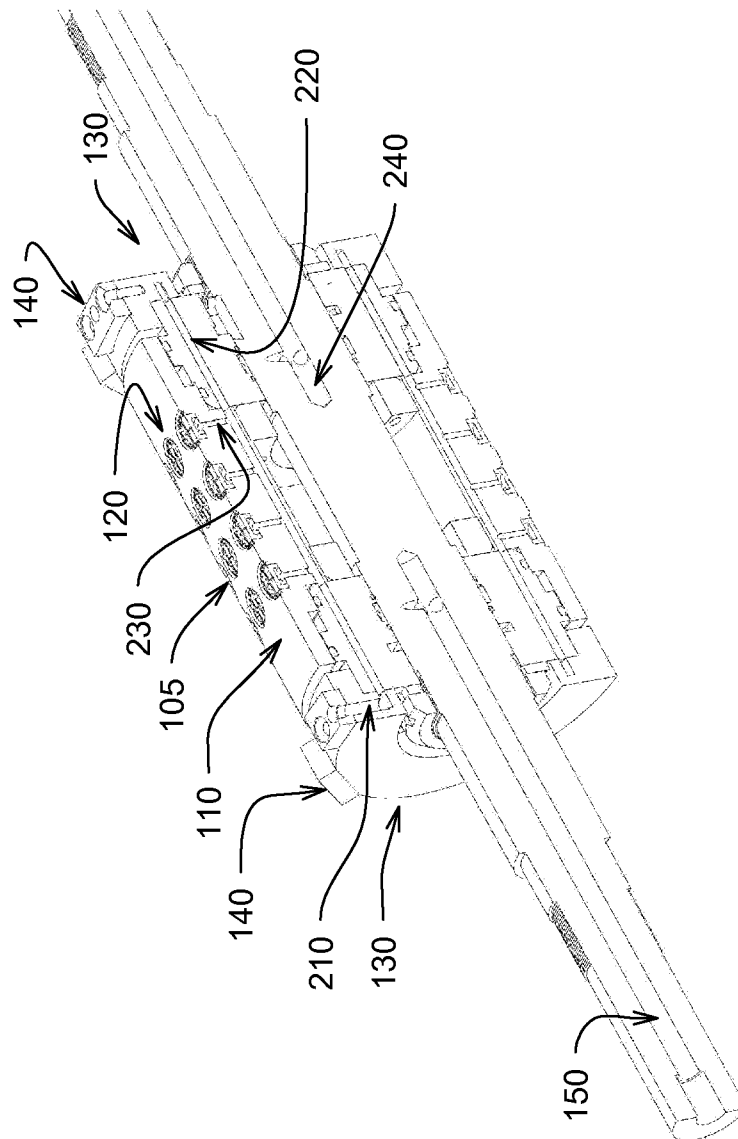


FIGURE 2

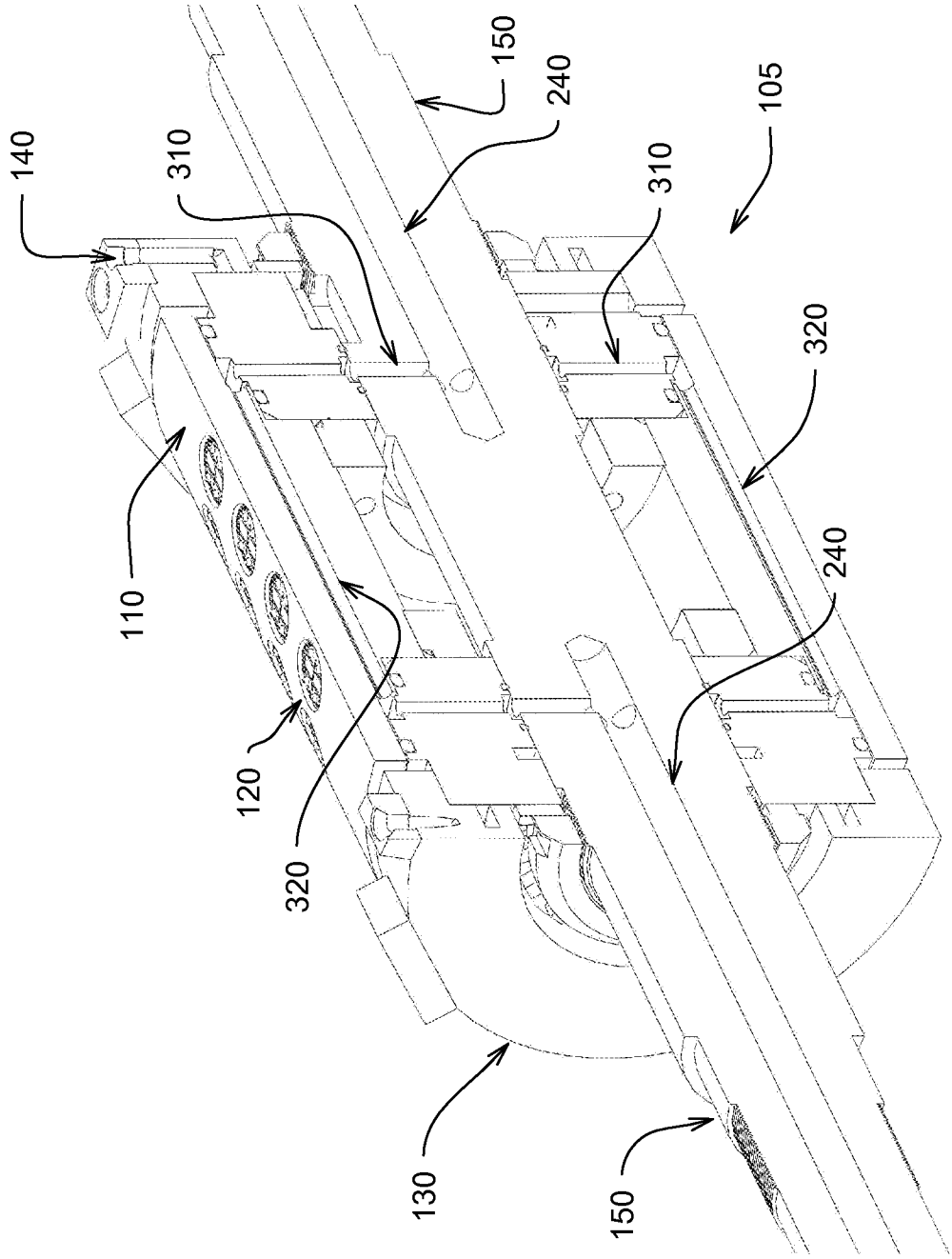


FIGURE 3

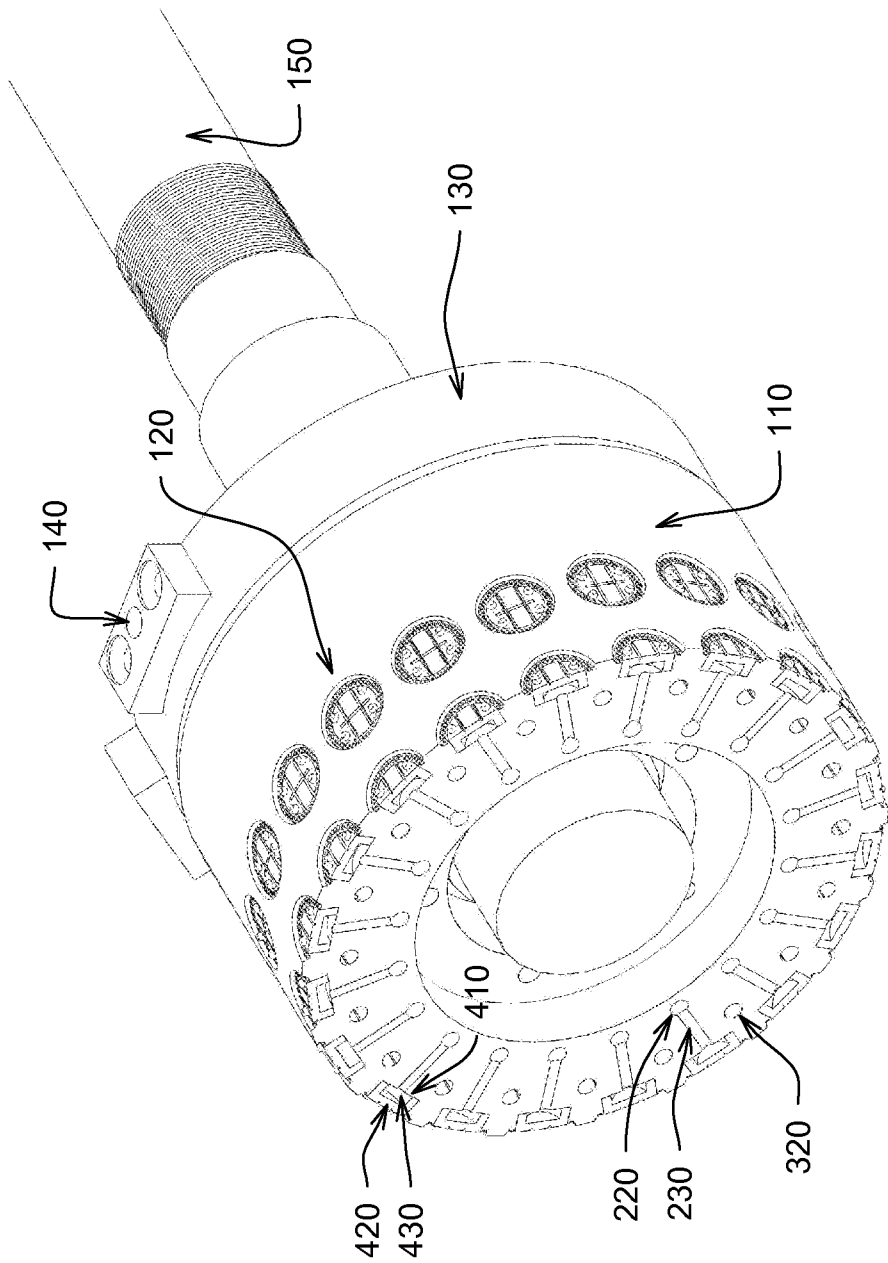


FIGURE 4

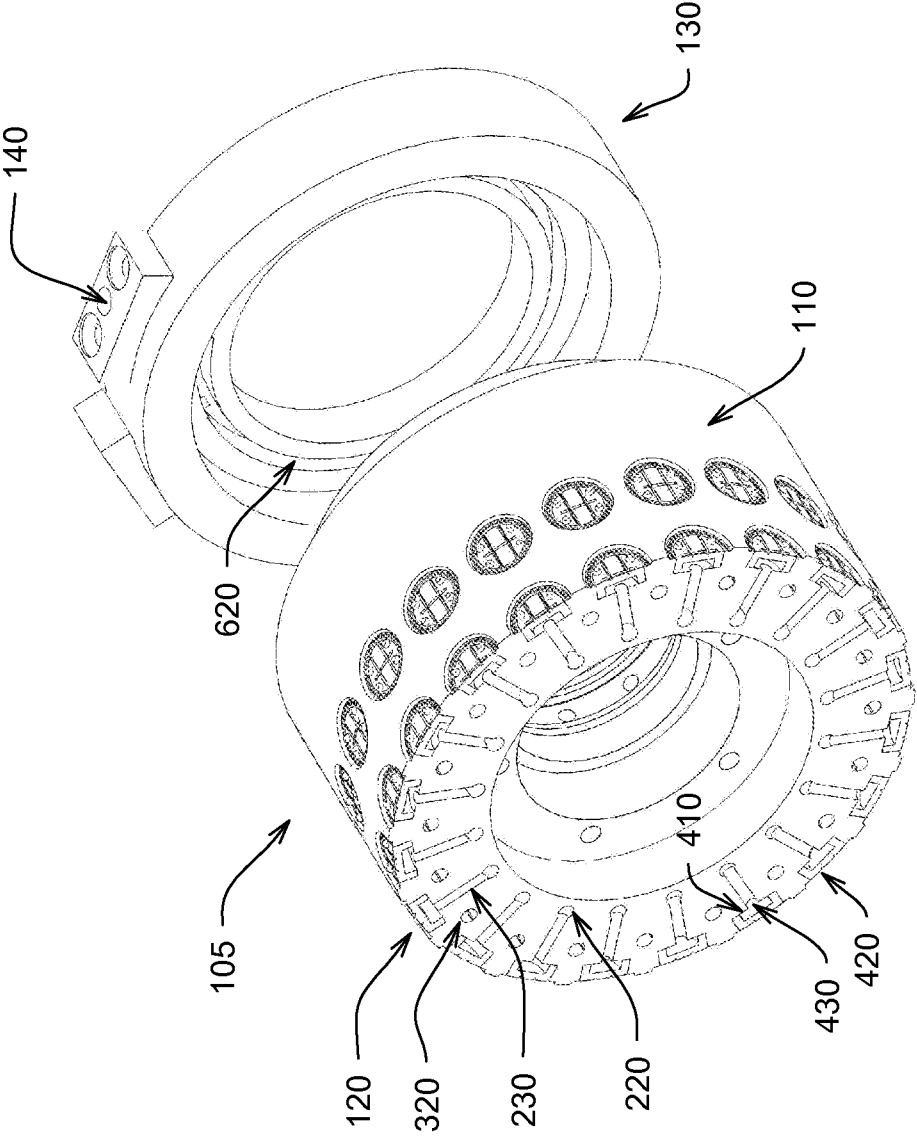


FIGURE 5

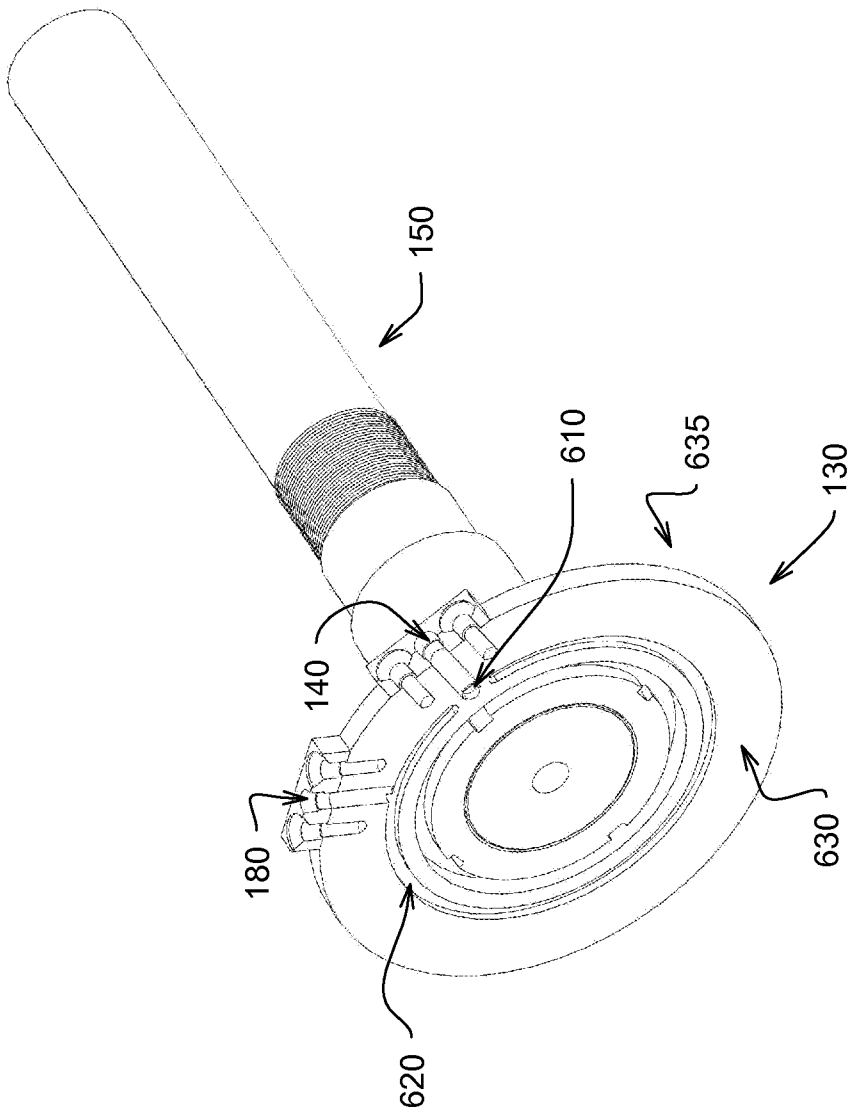


FIGURE 6

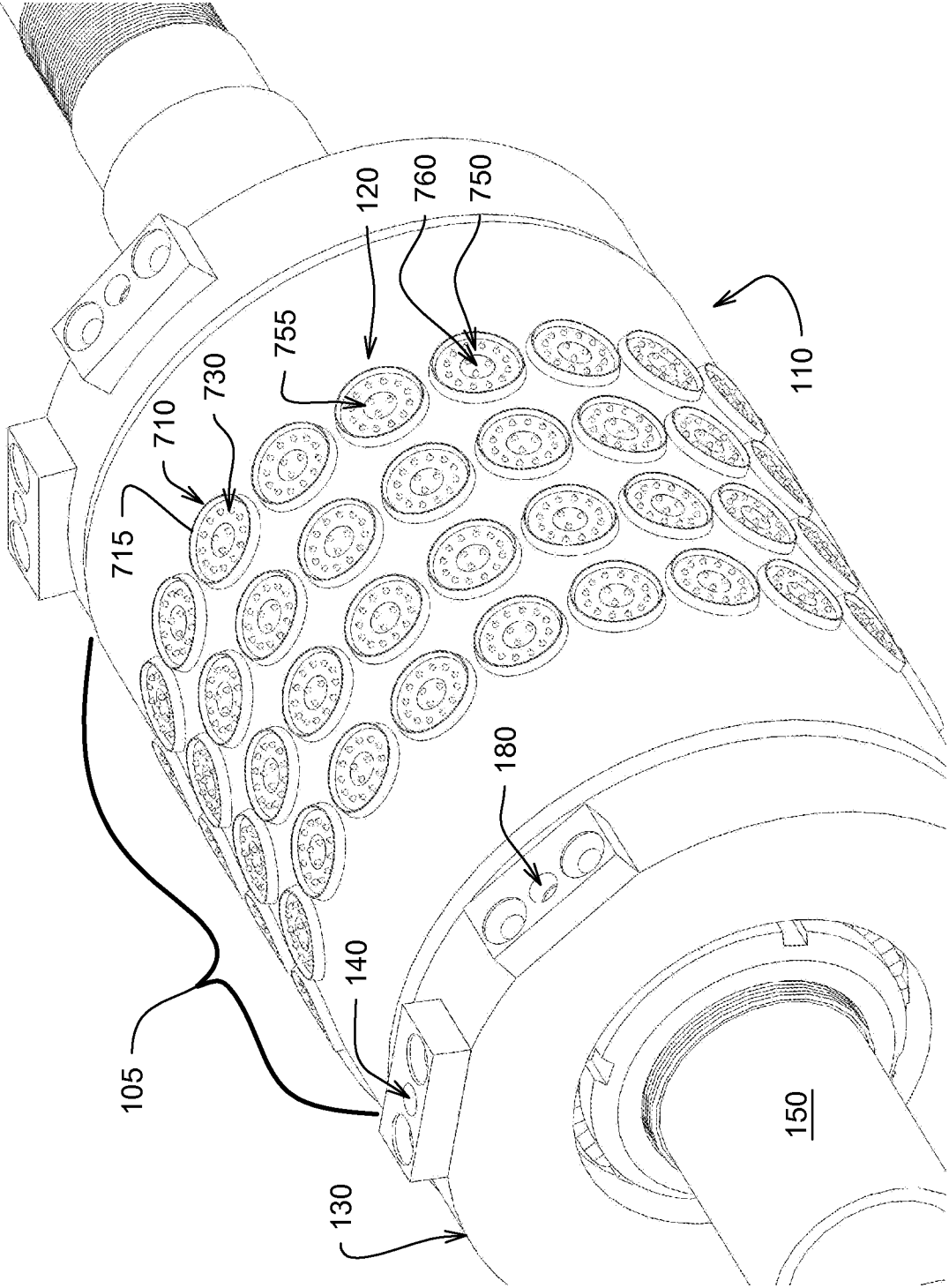


FIGURE 7

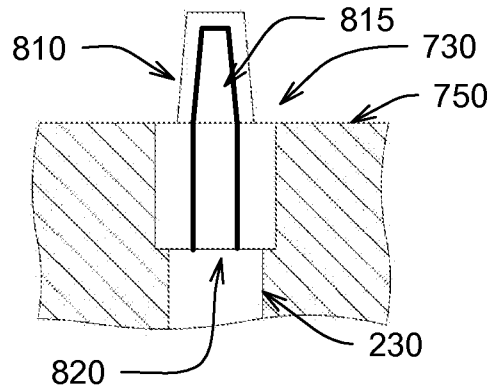


FIGURE 8

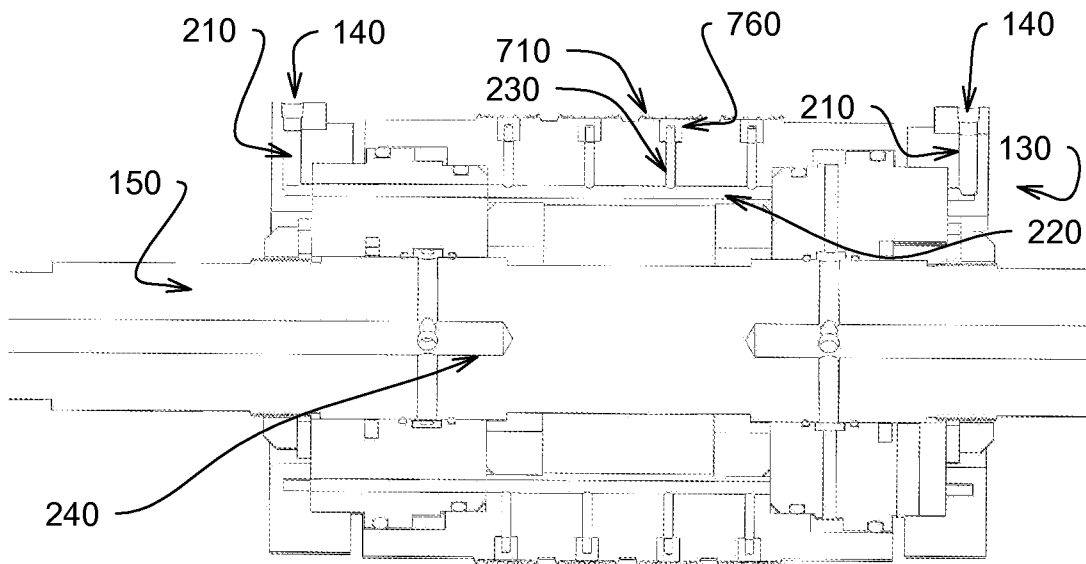


FIGURE 9

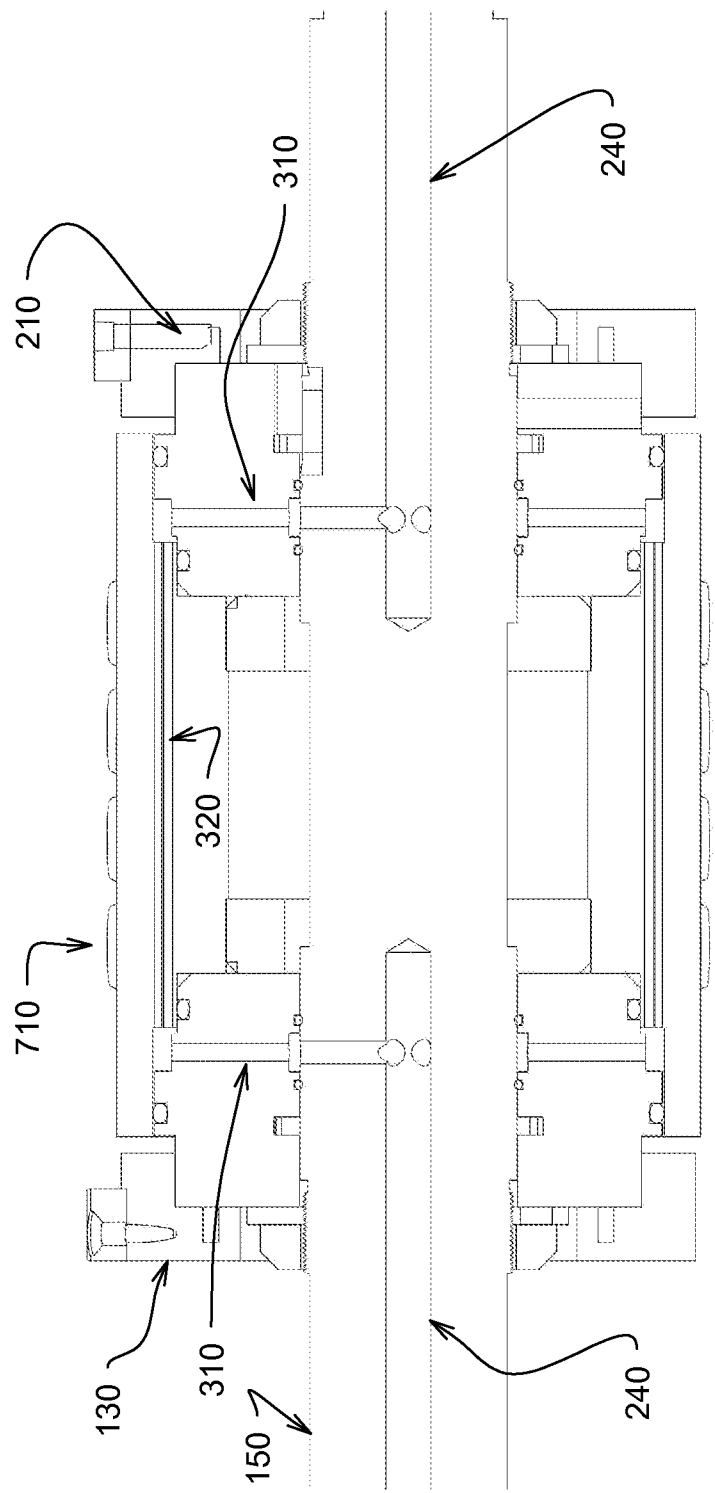


FIGURE 10

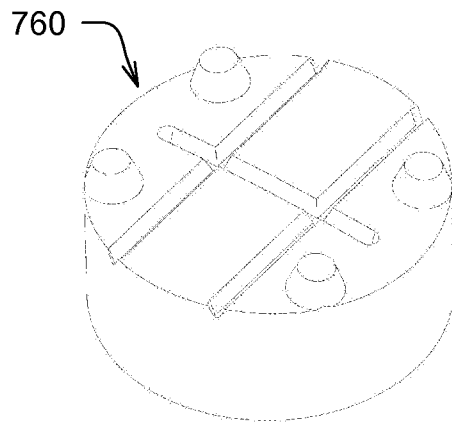


FIGURE 11

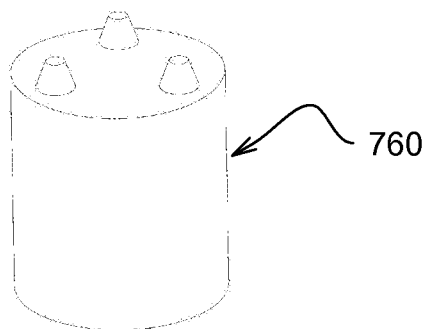


FIGURE 12

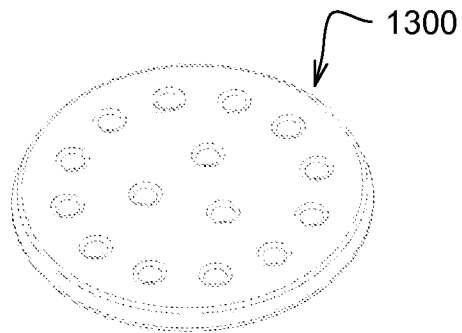


FIGURE 13

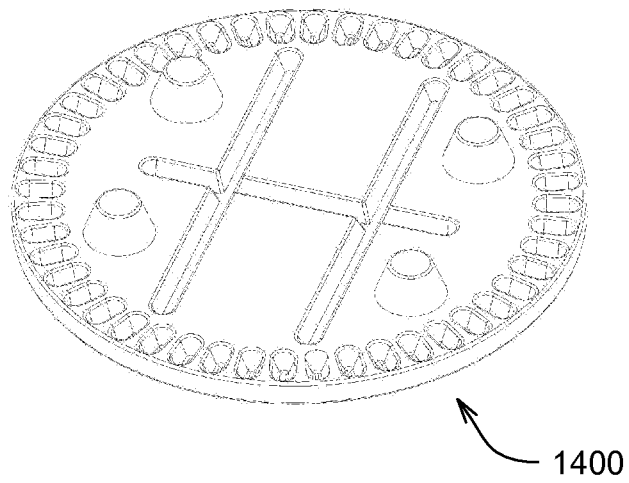


FIGURE 14

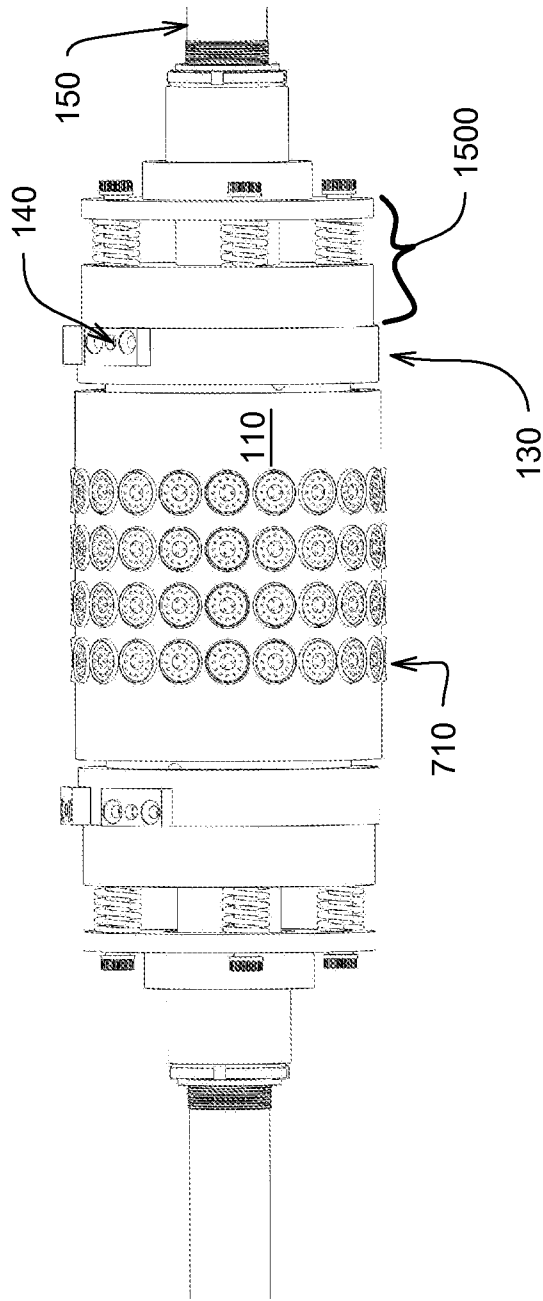


FIGURE 15

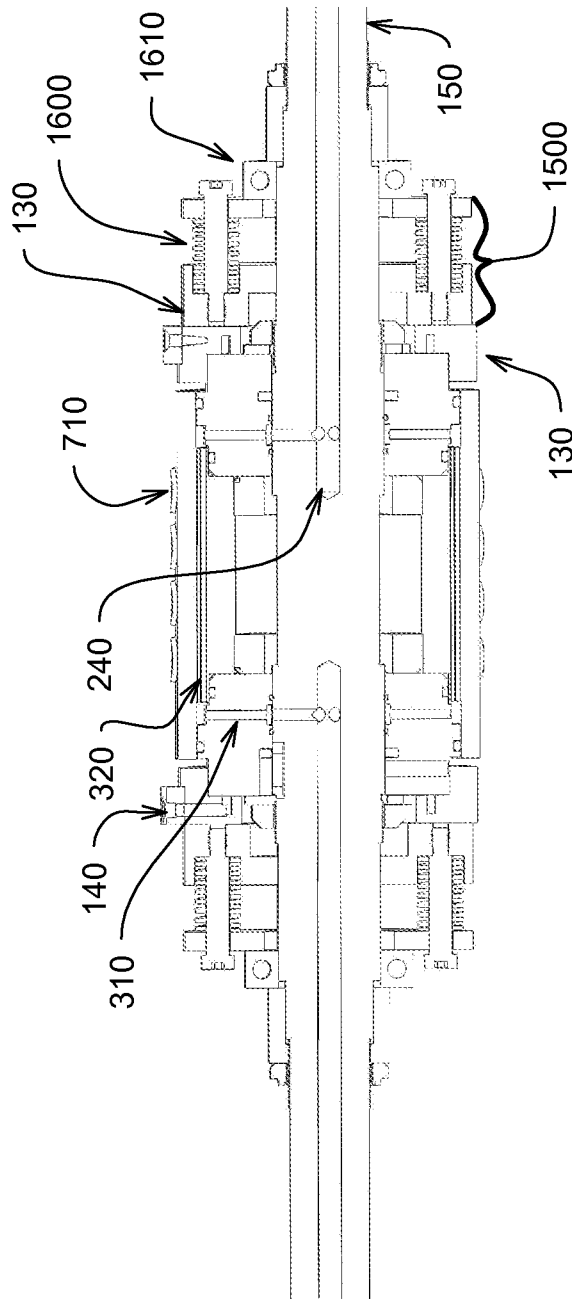


FIGURE 16

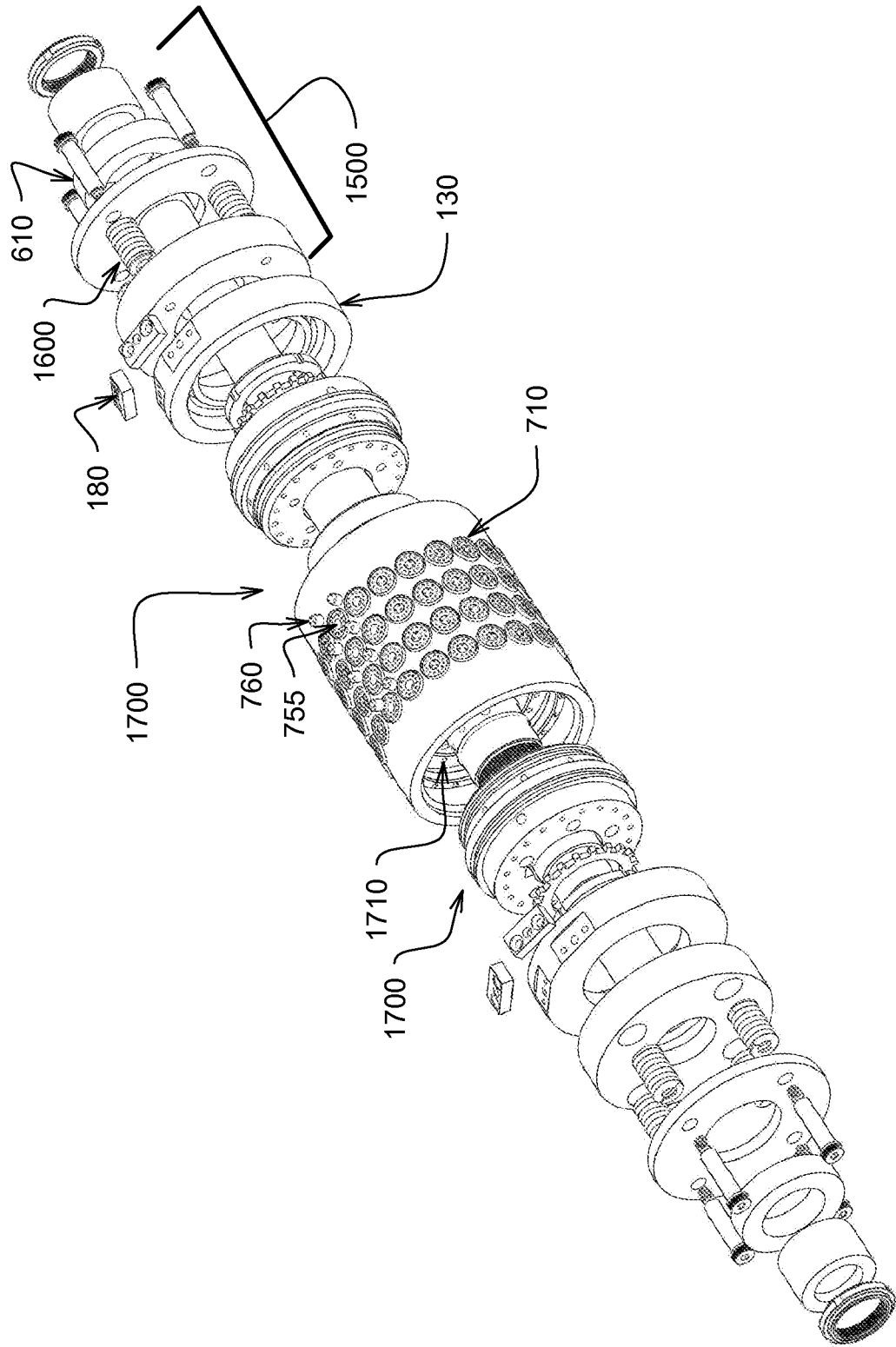


FIGURE 17

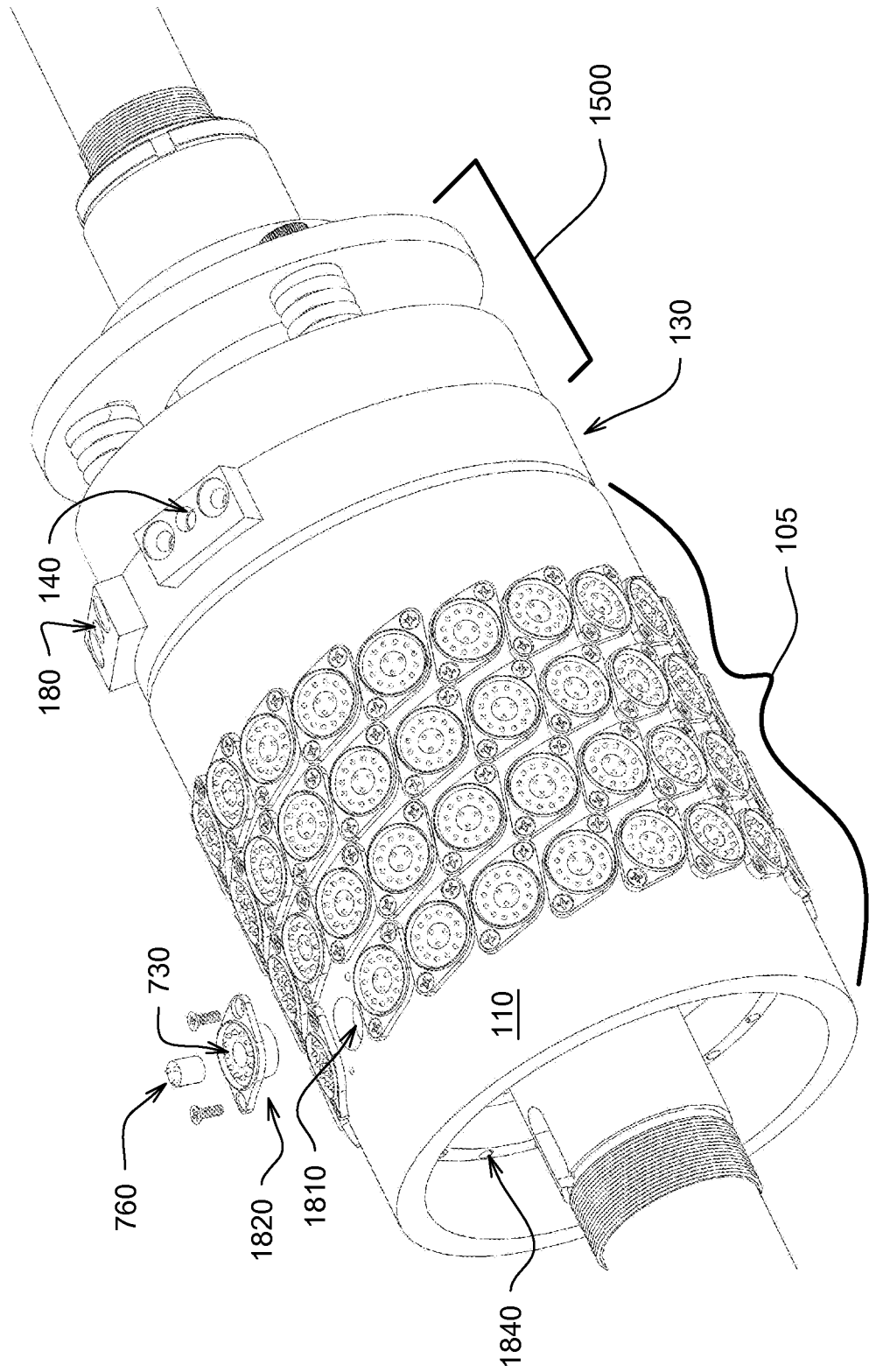


FIGURE 18

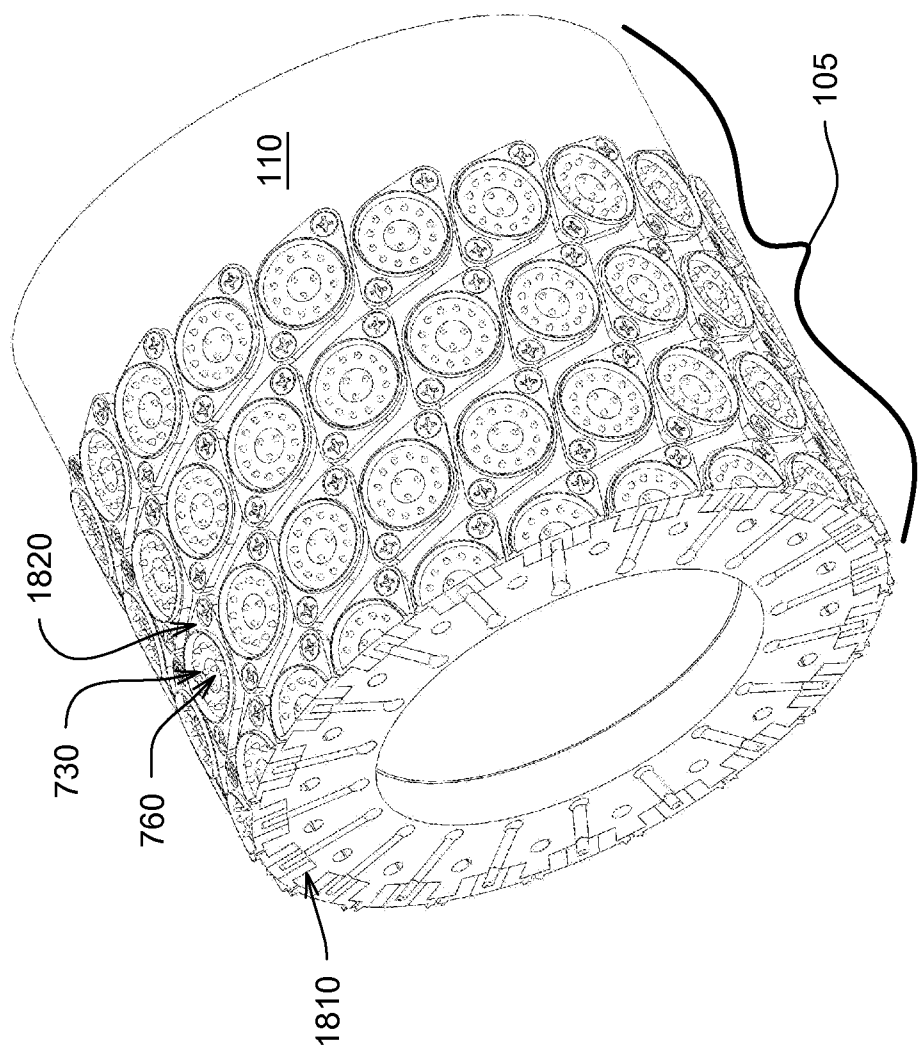


FIGURE 19

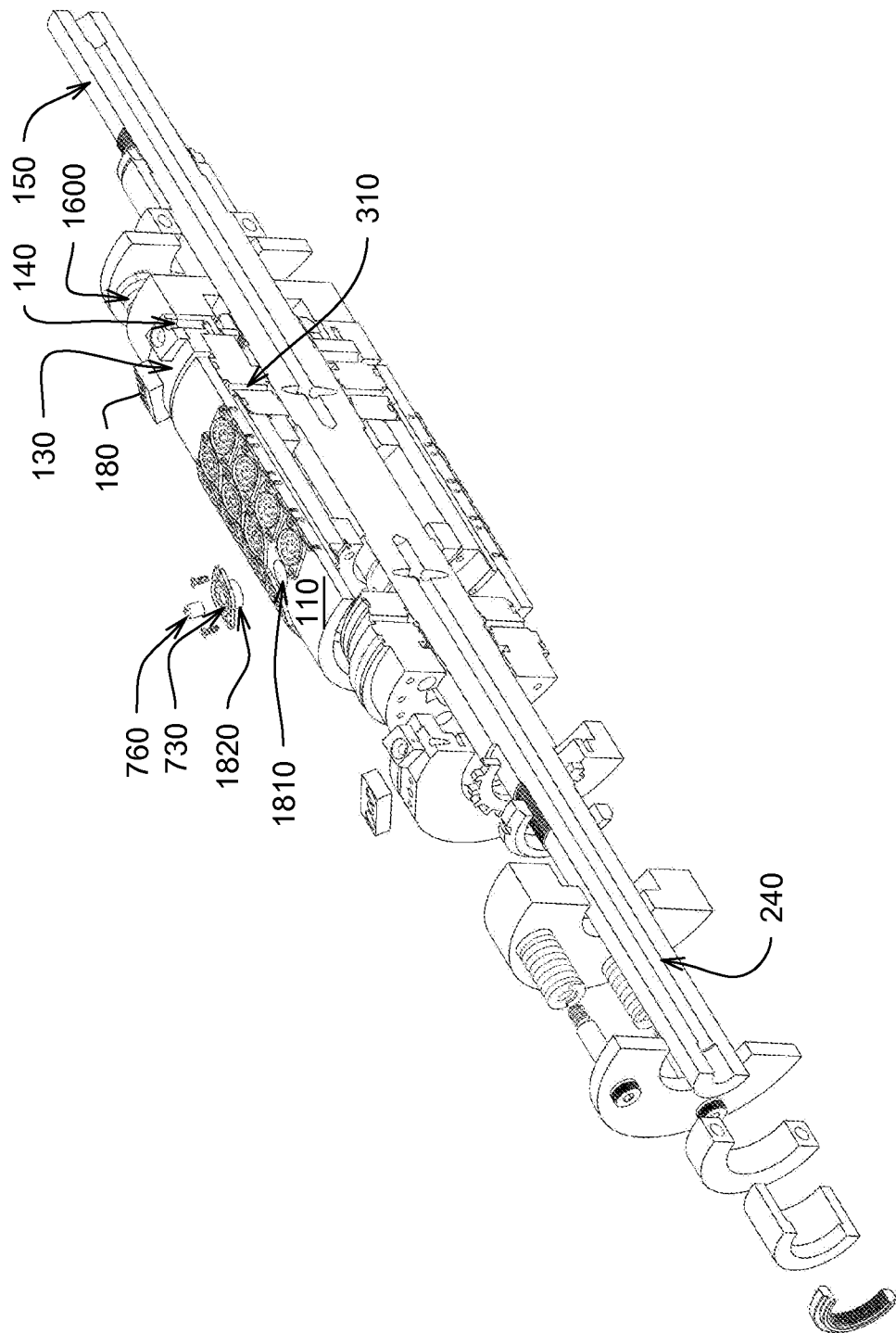


FIGURE 20

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2015/042400

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A21C 11/10 (2015.01)

CPC - A21C 11/10 (2015.09)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - A21C 11/10; A23P 1/10; B23P 11/00; B29C 43/04 (2015.01)

CPC - A21C 11/10; A22C 7/00; A23G 1/28; A23J 1/00; A23P 1/10 (2015.09)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

USPC - 83/561; 425/235, 241, 294, 298, 316, 365, 512, 518; 426/88 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatBase, Google Patents, Google Patent/Scholar, Google.

Search terms used: Manifold, channel, cylinder, cavities, porous, rotary tool, docker pin, insert, surface, blast channel, spring pack

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005/0220932 A1 (VAN DER EERDEN et al) 06 October 2005 (06.10.2005) entire document	1,3,5,9,11-13,15,16
Y		4,6-8,14,17-19
Y	US 2010/0173052 A1 (SUSKI et al) 08 July 2010 (08.07.2010) entire document	4,14
Y	US 2008/0166442 A1 (BALBONI et al) 10 July 2008 (10.07.2008) entire document	6
Y	US 3,891,823 A (DULUDE et al) 24 June 1975 (24.06.1975) entire document	7,19
Y	US 2013/0259991 A1 (FORMAX, INC.) 03 October 2013 (03.10.2013) entire document	8,18
Y	US 2,887,964 A (GRINER) 26 May 1959 (26.05.1959) entire document	17
A	US 3,427,649 A (FAY) 11 February 1969 (11.02.1969) entire document	1-19
A	US 8,747,934 B2 (MESKENDAHL et al) 10 June 2014 (10.06.2014) entire document	1-19
A	US 2009/0134308 A1 (VAN DER EERDEN et al) 28 May 2009 (28.05.2009) entire document	1-19



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search

23 September 2015

Date of mailing of the international search report

16 OCT 2015

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