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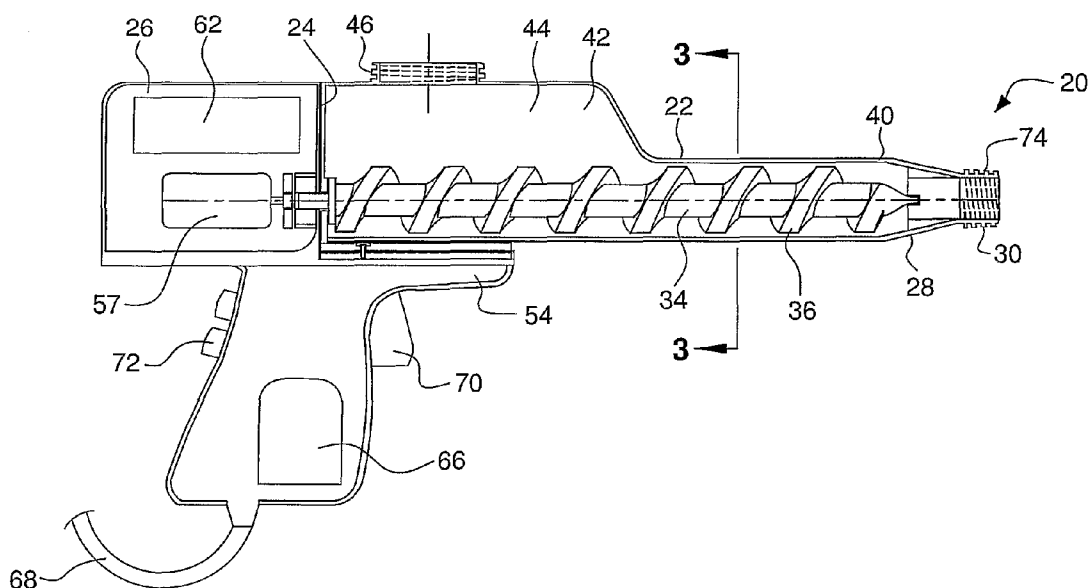
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(57) Abstract: An embodiment of a hand-held mixing and dispensing device has a mixing barrel. At least one mixing screw extends along the barrel. The device has an inlet for material to be mixed into the barrel, and an outlet at an end of the barrel to which mixed material can be delivered by rotation of the at least one mixing screw. A motor is provided for rotation of the at least one mixing screw. The device can be held with one hand by a grip while the motor is rotating the at least one mixing screw.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

MIXER

Field of the Invention

[0001] The invention relates to a mixer, and especially to a device that both mixes and dispenses cement or other material, and can be held and operated with one hand.

Background

[0002] Poly-Methyl-Meth-Acrylate (PMMA) is a two-part polymer that is used as a cement in a number of orthopedic procedures. PMMA is prepared by mixing a powder component and a liquid component. Once the components have been mixed, they react to form a solid cement. It is therefore necessary to mix the components immediately before the cement is to be used, and to apply the cement, which is in the form of a highly viscous fluid, before it sets. The reaction between the powder and liquid components gives off unpleasant gases, which it is desirable to remove from the work area. Various mixers have been proposed to perform the two required functions of mixing and dispensing.

[0003] One simple mixer consists essentially of a container with a mixing paddle inside the container and a handle that can be rotated to agitate the paddle. The container may be of various shapes, such as cylindrical or "U shape," which is a cylinder with a hemispherical bottom end, giving it a U shape in axial cross-section, and a removable lid at the top end. An optional connection may be provided on the mixing container lid for a vacuum line to remove the off-gasses formed during mixing. The vacuum line, by maintaining a slightly sub-atmospheric pressure in the mixing vessel, also reduces the undesirable formation of air bubbles in the mix.

[0004] The completed mixture may be manually transferred to the application site by scooping from the container. The simplicity of that approach is attractive to some users because it gives the user a high level of control over the application of the cement. That is a personal preference for some users, and may be a practical requirement for some applications. In addition, the simple approach is economical,

especially for sterile procedures or procedures with quick-setting cements, where any equipment that comes in contact with the cement may be disposable.

[0005] Alternatively, the completed mixture may be loaded into a dispensing cartridge. Where the mixing device is adapted to transfer the mixed material directly to the cartridge, it eliminates intervention of hands and tools, the possibility of contamination or waste is reduced, and manual intervention is reduced to loading the cartridge onto the mixing device. The mixing chamber is otherwise fairly similar to the simple mixer mentioned above. The level of ease or complexity of cartridge installation varies, as some devices have an integrated cartridge. The full cartridge is typically placed in a device very similar to a caulk gun for application to the site. A degassing feature may be included.

[0006] An automated mixing unit may receive packed raw material with a specific bulk shape and packaging, and perform the process of opening the packages and dispensing into the mixing housing by a powered and automated cycle of operation. The unit may then mix the cement by controlled and programmed cycles. At the end of the mixing, the mixture is transferred into a cartridge, as such automated mixing units are typically table-mounted devices stationed far away from the application site. An example of such a device is shown in U.S. Patent No. 5,531,519 (Earle). The capital cost of such equipment is high, and operating costs may also be high, because the unit requires raw material in a particular shape of packaging, so that generic bulk raw materials may not be usable. Also, a high level of automation may be disadvantageous for some users who would like to have flexibility and controllability in changing function types and ranges.

[0007] U.S. Patent No. 5,876,116 (Barker et al.) shows a bone cement mixing and dispensing system with a U shaped mixing bowl and a dispensing tube extending from the bottom of the mixing bowl. An axial shaft carries a mixing paddle within the mixing bowl and drives a feed screw along the dispensing tube. To prevent premature dispensing, the dispensing tube can be slid axially between positions opening and closing an outlet port from the mixing bowl into the dispensing tube. The drive shaft is operated by a hand crank at its top end, or by an electric drill inserted in place of the hand crank. Whether the drive shaft is turned by hand or by a drill, one hand is needed to hold the dispensing system, and the other hand to turn the crank or operate the drill, both while mixing and while dispensing. As a result, if the user of the cement needs a

hand free to control the application of the cement or other operations at the application site, the dispensing device must be operated by an assistant.

Summary of the Invention

[0008] According to one embodiment of the present invention, there is provided a hand-held mixing and dispensing device having a mixing barrel and at least one mixing screw extending along the barrel. The device has an inlet into the barrel for material to be mixed, and an outlet at an end of the barrel to which mixed material can be delivered by rotation of the at least one mixing screw. A motor is provided for rotation of the at least one mixing screw. The device can be held with one hand by a grip while the motor is rotating the at least one mixing screw.

Brief Description of the Drawings

[0009] For the purpose of illustrating the invention, there are shown in the drawings one or more forms of the invention that are presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown. In the drawings:

[0010] Fig. 1 is a longitudinal section view of an embodiment of a mixing and dispensing device according to the invention.

[0011] Fig. 2 is a top view of the device shown in Fig. 1.

[0012] Fig. 3 is an enlarged section taken along the line A-A in Fig. 1.

[0013] Fig. 4 is a side view of a funnel usable with the device of Figs. 1 to 3.

[0014] Fig. 5 is an enlarged view of detail B in Fig. 3.

[0015] Fig. 6 is an enlarged sectional view of a degassing adaptor usable with the device shown in Figs. 1 to 3.

[0016] Fig. 7 is a sectional view of the degassing adaptor shown in Fig. 6 with a vacuum pump and a dispensing hose.

[0017] Fig. 8 is an enlarged sectional view of a hose coupling usable with the device shown in Figs. 1 to 3.

Detailed Description of the Drawings

[0018] Referring now to the drawings, wherein like reference numerals indicate similar elements throughout the views, and initially to Figs. 1 to 3, a presently preferred embodiment of a mixing and dispensing device according to an embodiment of the present invention, indicated by the reference numeral 20, comprises a mixing barrel 22. As shown in Figs. 2 and 3, the mixing barrel 22 is a double barrel. The mixing barrel 22 extends from a rear end 24, where the mixing barrel 22 is attached to a motor and control unit 26, to a front end 28 with a dispensing nozzle 30. Inside the mixing barrel 22 are positioned two screws 32, 34, generally parallel and with overlapping threads 36 of opposite hands. The configuration of the threads 36 may be selected in dependence on the bulk properties of the material and the nature of the process for which the device 20 is to be used.

[0019] As shown in Fig. 3, the bottom 38 of the mixing barrel 22 is shaped to conform to the mixer screws 32, 34, and is a rounded W shape in internal cross-section. Other shapes may be used, depending on how close a clearance is desired between the threads 36 of the mixer screws 32, 34 and the inside of the mixing barrel 22. The desired clearance depends in part on the properties of the material that is to be mixed.

[0020] A front part or extrusion section 40 of the mixing barrel 22 is shaped to conform to the mixer screws 32, 34, and the upper side of the front part 40 may be of a rounded W shape in internal cross-section, matching the lower part 38. A rear part or mixing section 42 of the mixing barrel 22 has a loading chamber 44 raised above the screws 32, 34. The mixing chamber 44 has a screw-threaded opening 46 that can be closed by a cap 48 that provides a suitable seal depending on the properties of the material being mixed and the nature of the process for which the device 20 is to be used.

[0021] A funnel 50 (see Fig. 4) that screws onto the screw-threaded opening 46 may be added to the mixing section 42 to facilitate reception, maintenance, and release of components to be mixed into the mixing barrel 22. A hopper, or any suitable receptacle, may be provided instead of the funnel 50.

[0022] The shape of the mixing section 42 and the dispensing section 40 of the mixing barrel 22 may be adapted to attain optimum results for specific materials in conjunction with control of the process by adjustment of both speed and duration of mixing.

[0023] The motor and control unit 26 includes a pistol grip 52 with a bracket 54 that extends forwards under the mixing section 42 of the mixing barrel 22. As shown in Fig. 5, the mixing barrel 22 and the bracket 54 have mating dovetail formations that allow the mixing barrel 22 to be separated from the motor and control unit 26 only by disengaging spring loaded pins 56 and sliding forward. The pins 56 secure the mixing barrel 22 in the rearmost, operating position shown in Figs. 1 and 2.

[0024] The motor and control unit 26 houses one or two motors 57 driving a gear set 58 by which the two mixer screws 32, 34 are rotated. The mixer screws 32, 34 have stub shafts 60 that project through seals in the rear wall 24 of the mixing barrel 22. When the mixing barrel 22 is mounted on the bracket 54, the stub shafts 60 are shaped to suitably interlock and mate with the gear set 58. The motor and control unit 26 houses a control unit 62, including an LCD display panel 64, and a rechargeable battery 66 is located inside the pistol grip 52. An external cable cord 68 may be provided instead of the rechargeable battery 66, or a cable cord connector may be provided to recharge the rechargeable battery 66.

[0025] The pistol grip 52 is provided with controls such as a trigger 70 and push buttons 72. The controls 70, 72 are positioned so that the user can hold the unit 20 in one hand by the pistol grip 52 and use the thumb and fingers of the same hand to operate the controls 70, 72 while holding the unit. It is thus possible for the user to operate and control the unit 20 while still having one hand free for application or control of application of dispensed material to the site. Controls that are not required to be operated while dispensing material may be positioned elsewhere on the device 20, for example, as part of the display panel 64.

[0026] All the components of the device 20 are designed based on powered drive using the motor 57 under control of the electronic control unit 62 and/or the controls 70, 72, powered by the battery 66 or external electrical supply. The drive system 57, 58, 62, 66 itself is specifically designed to adapt integrally to the mixing section 22, 32, 34. The power, torque and speed ranges of the motor 57 and the gearing 58 are selected for proper working ranges with respect to various materials to be mixed. The force of extrusion is typically meant to be rather high to cause compression, increased mixing mobility, and crosslinking of polymer materials. Therefore, the rotating parts 32, 34, 56, 58 are designed to withstand the radial and axial forces, deflection, and shear expected for proper mixing of the intended materials. The bearing surfaces on

which the rotating parts run are correspondingly designed to provide free motion, load support, and sealing functions.

[0027] The controls 70, 72 may control the operation, direction, and speed of the motor 57, and thus of the screws 32, 34. By rotating the screws 32, 34 in one direction, material within the mixing barrel 22 may be urged towards the dispensing nozzle 30. By rotating the screws 32, 34 in the other direction, material within the mixing barrel 22 may be urged towards the rear end 24, allowing it to be mixed without being prematurely dispensed.

[0028] Referring now also to Figs. 6 and 7, the dispensing nozzle 30 is provided with a screw thread 74. A degassing adaptor 76 may be screwed to the dispensing nozzle 30 to allow for collection and removal of the gases from the mix. A screw threaded inlet 80 of the degassing adaptor 76 has matching screw threads for the screw thread 74 on the dispensing nozzle 30. The degassing adaptor 76 has a plenum 82 surrounding a stub pipe 84 extending from the inlet 80. An outlet pipe 86 is aligned with the stub pipe 84, and is separated from the stub pipe 84 by an annular space opening into the plenum 82. One wall 90 of the plenum 82 forms a funnel merging smoothly at its outlet end into the outlet pipe 86. A gas outlet pipe 92 extends from an upstream part of the plenum 82. The degassing adaptor 76 may be connected to a vacuum pump 94 with an in-line filter 96 for the evacuation of air and off-gases from the mix.

[0029] A solid or flexible dispensing hose 98 may be attached to the outlet pipe 86 of the degassing adaptor 76. The material, structure, shape, length, and bore size of the hose 98 may be selected for a specific dispensing application. The outlet pipe 86 may be provided with any suitable arrangement for attachment of the dispensing hose 98. As shown in Fig. 6, the outlet pipe 86 has a barb 100 onto which a widened mouth 102 of the dispensing hose 98 can be pushed.

[0030] In use of the device 20, raw materials may be introduced into the mixing barrel 22 manually through the opening 46, using the funnel 50 or other receptacle. If appropriate, the funnel 50 is removed and the opening 46 is closed off using the cap 48 to prevent leakage or spillage of the medium being mixed. Alternatively, the funnel 50 may be left in place, and closed off with a cap 102 (see Fig. 4) to prevent spillage. Alternatively, if the mixing process does not require a vacuum or extraction of off-gases, the funnel or other receptacle may be left uncapped. The degassing adaptor 76

may be attached to the threaded dispensing nozzle 30. If the degassing adaptor 76 is not required, the threaded dispensing nozzle 30 may be closed off with a plain screw cap 104 (see Fig. 2), or the dispensing nozzle 30 may be left open.

[0031] A mixing process is then initiated. The mixing process may be based on the raw materials being used and relevant requirements for the mixed material. For example, the thickness or viscosity of the mixed material may be controlled by the duration and/or vigorousness of the mixing process. An automatic cycle of operations may be carried out under control of the control unit 62, either pre-programmed or set by the user at the beginning of the cycle. Mixing may be done under manual control using the controls 70 and/or 72. The cycle of mixing may include optional forward and reverse motion. Where the dispensing nozzle 30 is not capped off, the periods of forward motion may be restricted to prevent premature dispensing of the partially mixed material, or dispensing of material into the degassing adaptor 76. By alternating forward and reverse motion, the material can be effectively mixed without requiring a large mixing chamber.

[0032] Especially where one of the raw materials is a powder, the volume of the material may reduce as mixing progresses. In the device 20, the loading chamber 44 allows room for the bulky powder to be loaded, while positioning the mixing screws 32, 34 at the bottom ensures that all the material is randomly engaged by the screws for optimum mixing and moved forward for further mixing and compression. Even if the bulk of the mixture reduces as mixing progresses, the mix remains in engagement with the mixing screws.

[0033] Automatic control of the powered drive allows the user to choose a repeatable mixing and dispensing procedure. Manual control is typically less exactly repeatable, but more versatile. Even if the motor 57 is under manual control, the control unit 62 may monitor the amount of mixing that has taken place, and may provide an indication on the display unit 64 when the contents of the mixing barrel 22 are properly mixed, or an indication of the progress of mixing. The control unit 62 may monitor any one or more of the mixing time, the mixing screw speed (if the speed is not fixed by the design of the motor 57), the motor torque load, or other parameters. Where the mixing process includes pauses in the mixing, the overall mixing time and the time for which the screws are running may be monitored and displayed separately.

[0034] The process may be controlled by adjustment of both speed and duration of mixing, in conjunction with a selected shape of the mixing section 42 and the dispensing section 40 of the mixing barrel 22, to attain optimum results for specific materials.

[0035] Off-gases produced during the mixing process may be drawn off by the degassing adaptor 76 and the vacuum pump 94. Instead, or in addition, the vacuum pump 94 may extract air from the mixing barrel 22 to reduce the amount of trapped air in the mixed material. If it is desired to maintain a vacuum in the mixing barrel 22 during mixing, or to reduce the risk of contamination, the dispensing nozzle 30, or the outlet 86 of the degassing adaptor 76 if present, may be capped off during the mixing process.

[0036] Where the medium being mixed is thick, the screws 32, 34 may be able to generate a sufficient force to eject the cap or burst the barrel. To avoid such mishaps, the motor 57 may be torque limited, with the motor being slowed, stopped, or reversed before a dangerously high pressure is generated. If the motor 57 is stopped, a manual reset may be required. The mixing action of the screws 32, 34 and the force of the vacuum pump 94 are regulated so that the mix is not drawn into the plenum 82. Where the mix is runny, the device 20 may be held with the outlet end 28 sloping upwards, to hinder flow of the mix towards the outlet.

[0037] After mixing is completed, dispensing may follow immediately. Alternatively, the mixed material may be retained in the mixing barrel 22. The screws 32, 34 may be rotated intermittently and/or at slow speed if that is appropriate to inhibit premature hardening of the specific material.

[0038] For dispensing, a suitable dispensing hose 98 may be connected to the degassing adaptor 76. Where access to the application site is sufficiently easy, the dispensing hose 98 may be omitted and the material may be dispensed directly from the degassing adaptor 76. If degassing is not required during dispensing, the degassing adaptor 76 may be omitted and the material may be dispensed from the dispensing nozzle 30 at the end of the mixing barrel 22, either directly or through the dispensing hose 98. A threaded hose coupling 106 (see Fig. 8) with a screw coupling 80 and a hose barb coupling 100 similar to those of the degassing adaptor 76 may then be screwed onto the nozzle 30.

[0039] Where the degassing adaptor 76 is used during dispensing, the force of the screws 32, 34 drives the mix out of the dispensing nozzle 30, along the stub pipe 84 and the outlet pipe 86. The funnel shape of the wall 90 encourages the mix to flow from the stub pipe 84 to the outlet pipe 86 without escaping into the plenum 82. A viscous mix may tend to move past the gap 88 as if it were a solid mass, even if suction from the vacuum pump 94 is maintained during dispensing. In general, the shape of the tube stub 84 and plenum 82, the dispensing speed, the vacuum upstream of the filter 96, and the pressure drop across the filter 94 are coordinated to ensure clean dispensing without material being drawn out into the plenum. However, bubbles of air trapped in the mix tend to escape into the plenum 82 once they arrive at the gap 88, where there is a sudden release of external pressure, and are drawn into the filter 96 and the vacuum pump 94. The negative pressure of the vacuum facilitates flow of material along the dispensing section 40 to the dispensing area 28, preventing buildup of the material and allowing complete transfer under higher pressure.

[0040] The pistol grip handle 52 incorporates at least those controls 70, 72 that are needed during dispensing, and is ergonomically designed to allow simultaneous holding and operation with one hand. The controls 70, 72 include at least controls to start and stop dispensing. The user can thus operate the dispensing device 20 with one hand, and have the other hand free to apply or control the application of the material being dispensed, or for other actions necessary in conjunction with the application. In many cases, this means that one person, instead of two, can dispense and apply the material from the device 20. The user who is in control of dispensing flow then has improved peace of mind during the usage, as he or she need not worry about lack of coordination between application and dispensing run by two people, and the need for increased access to the application site, to allow for two people working there, is avoided. The device allows the user to maneuver freely during the application with control on the process speed, angle and amount of material applied.

[0041] Where the device is to be used for bone cement application, the device is sterilized. The barrel 22 is sealed with a high pressure packed seal where the stub shafts 60 from the screw 32, 34 passes through the back wall of the mixing section 22. The control unit 26 is then not in direct contact with the material being mixed. The control unit 26 may be hermetically sealed, and can then be sterilized, for example, by washing and chemical cleaning in accordance with applicable codes and standards. The mixing

barrel 22, the screws 32, 34, the degassing adaptor 76, the hose adaptor 106, and the dispensing hose 98 may then be disposable. In cases where the material is washable and there is no sterility requirement, the components that are exposed to the mix may be cleaned and reused.

[0042] In the mixing and dispensing device 20, the mixing and dispensing take place in the same mixing chamber 22. The user can perform the mixing and dispensing faster than with previously proposed devices in which the mixed material is transferred to fill a cartridge, and the cartridge is loaded into a caulk gun, before the mix can be applied. By avoiding lost time between mixing and application, the window of time before the mix sets can be used to maximize mixing, or to allow extra time for application. Because of the short window of time available for PMMA cement, the cement cannot be mixed until the surgeon is ready to use the cement. By reducing the time from when the surgeon is ready for the cement until the cement is ready for dispensing by the surgeon, it becomes easier to keep the bored area of the femur bone or other surgical site clean from body fluids. Mixing of PMMA with body fluids reduces the strength of the hardened cement. Mixing and dispensing in two stages, by allowing more time for recursion of body fluids into the application site, can cause great variability in the end result.

[0043] By reducing the time required for mixing and preparation, the device 20 may very well save lives as compared with previous mixing devices that require transfer to a caulk gun cartridge.

[0044] Because the extrusion mechanism is the same screws 32, 34 used for mixing, under control of the control unit 62, the extrusion mechanism is capable of optimum mixing and exerting necessary force to the mix to maximize crosslinking of the polymer. The whole mixing barrel 22 is made in a single piece, or is permanently assembled into a single whole. The mixing barrel 22 has no moving parts, and no potentially leaky joints. There is no separability between the mixing and dispensing housings 40, 42, there is no separability between the mixing and dispensing parts of the screw shafts 32, 34, there is no separability between the mixing and dispensing functions.

[0045] The use of the motor driven screws 32, 34 for extrusion allows a greater force of extrusion than a manually operated caulk gun. The greater pressure eliminates more entrapped air or off-gas bubbles, and may improve polymerization of some

materials. The higher dispensing force attainable with a powered drive can also make the unit 20 usable for cases where a high force is required for application, for example, with more viscous material, or when dispensing through a thinner or longer tube 98.

[0046] The location of evacuation of air at the gap 88, in conjunction with the design of the degassing adapter 76 that momentarily releases pressure from the mix to allow the air bubbles to be released, is well suited for degassing of the mix being dispensed.

[0047] By providing almost effortless control of dispensing and mixing speed, the powered drive 56, 58 allows the user to remain in better control of the flow of material from the dispenser, and does not cause unnecessary strain and distraction for the user.

[0048] The handheld device 20 offers a high degree of mobility for direct application of the mix to a surgery site.

[0049] The overall size and weight of the mixing and dispensing device 20 may be limited to what can be easily usable without tiring out the user. The sizes of the entire assembly should remain as small as possible, and below a certain size limit. The capacity of the device can be increased by using a bigger barrel 40 and loose tolerance between screws 32, 34 and the barrel 40, although, a high force of extrusion calls for tighter tolerance and reduced output.

[0050] Although the invention has been described and illustrated with respect to the exemplary embodiments thereof, the foregoing and various other changes, omissions and additions may be made therein and thereto, without parting from the spirit and scope of the present invention.

[0051] For example, the mixing barrel 22 can be a single barrel or a double barrel. Inside the mixing barrel one screw shaft 32 or two screw shafts 32, 34 may be used. The choice of a single or double barrel may depend on the bulk properties of the dry raw material and/or the viscous mixed material. Where two screw shafts 32, 34 are used, they may be co-directional, that is to say, with threads of the same hand, to achieve a different mixing effect. The screw shaft or shafts 32, 34 may be cylindrical or tapered.

[0052] Other shaped of mixing barrel 22 may be used. For example, a mixing barrel 22 for a single screw shaft 32 may have a U shape in cross section instead of the rounded W shape shown in Fig. 3. The mixing barrel 22 may be straight or tapered. By tapering the screw shafts differently from the mixing barrel 22, or by tapering one and

not the other, the clearance between the screw threads 36 and the mixing barrel 22, and thus the compression applied to the mix, may vary along the length of the device. Where the mix is of low cohesiveness, the bottom 38 of the mixing barrel 22 may be a close fit to the screw or screws 32, 34, so that the screws sweep the mix along the bottom of the mixing barrel. With a more cohesive mix, a larger gap may be acceptable.

[0053] Various shapes and sizes of dispensing hose 98 may be used, depending on the material to be dispensed and the application of that material. A relatively short, rigid or semi-rigid and conforming hose 98 may provide a customized access to the application site by positioning and aiming the device 20 using the hand holding the pistol grip 52. A longer, more flexible hose 98 may be controlled with the other hand. The internal diameter of the delivery hose 98 may be selected in view of the quantity of mixed material to be applied, the rate of application, the viscosity of the material, and so on. The device 20 may be supplied with a delivery hose 98 optimized for a specific use, with a delivery hose 98 that can be adapted by the user to a specific use, or with a selection of delivery hoses 98.

[0054] The mixing barrel and the screw or screws may be disposable or reusable, depending on the properties of the materials being mixed and other relevant criteria. The choice may depend on how easily the set or partly set mixed material can be removed from the mixing barrel or screws, and on the standards of cleanliness required. For example, disposable barrels and screws may be preferred for sterile surgical procedures.

[0055] The mixing barrel may be made with various materials such as polymers or metals. The choice may depend on the materials to be mixed, the use of those materials, and whether the mixing barrel is to be reusable or disposable.

[0056] To provide for the necessary torque for the screws 32, 34, suitable high torque motors 56 may be used. Alternatively, motors of higher speed and lower torque may be used with reduction gearing.

[0057] The seal formed by the cap 48 or 102 may be sufficiently water-tight to prevent leakage of liquid material. For sterile processes, a sufficiently close seal to prevent incursion of contaminants may be desirable. For mixing under vacuum to extract air and off-gases, the seal may be sufficiently close to enable the desired level of vacuum to be pulled easily. However, an airtight seal may hinder dispensing of the

mixed material by causing a vacuum to form in the space vacated behind the material as the material is dispensed.

[0058] Although the device 20 has been described as being entirely hand-held, the device may be placed on a support when hand-holding is not required either for maneuverability or for operation of the controls 62, 64, for example, during a pre-programmed mixing sequence. By way of example, for convenient handling the device 20 might have a maximum overall length of about 16 inches (40 cm), not including the hose 98, and a maximum weight of about 5 lb (2.25 kg) including a full load of mix. However, larger, smaller, lighter, or heavier devices 20 may be used, depending on the circumstances.

[0059] Although the device 20 has been described primarily with reference to the application of PMMA bone cement in surgical procedures, the device may be used for mixing and dispensing cements other than PMMA, materials other than cement, and in other surgical procedures and for purposes other than surgery.

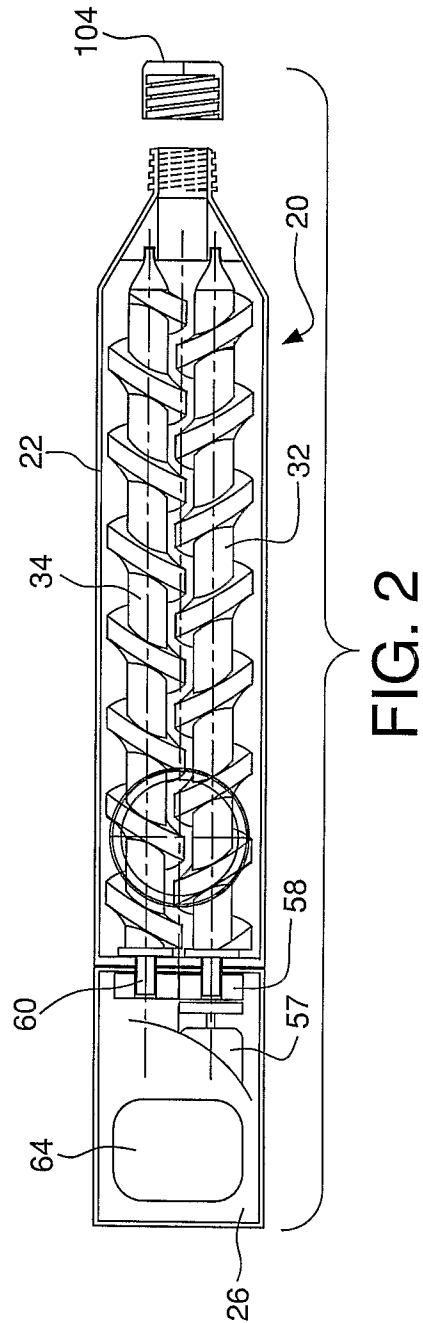
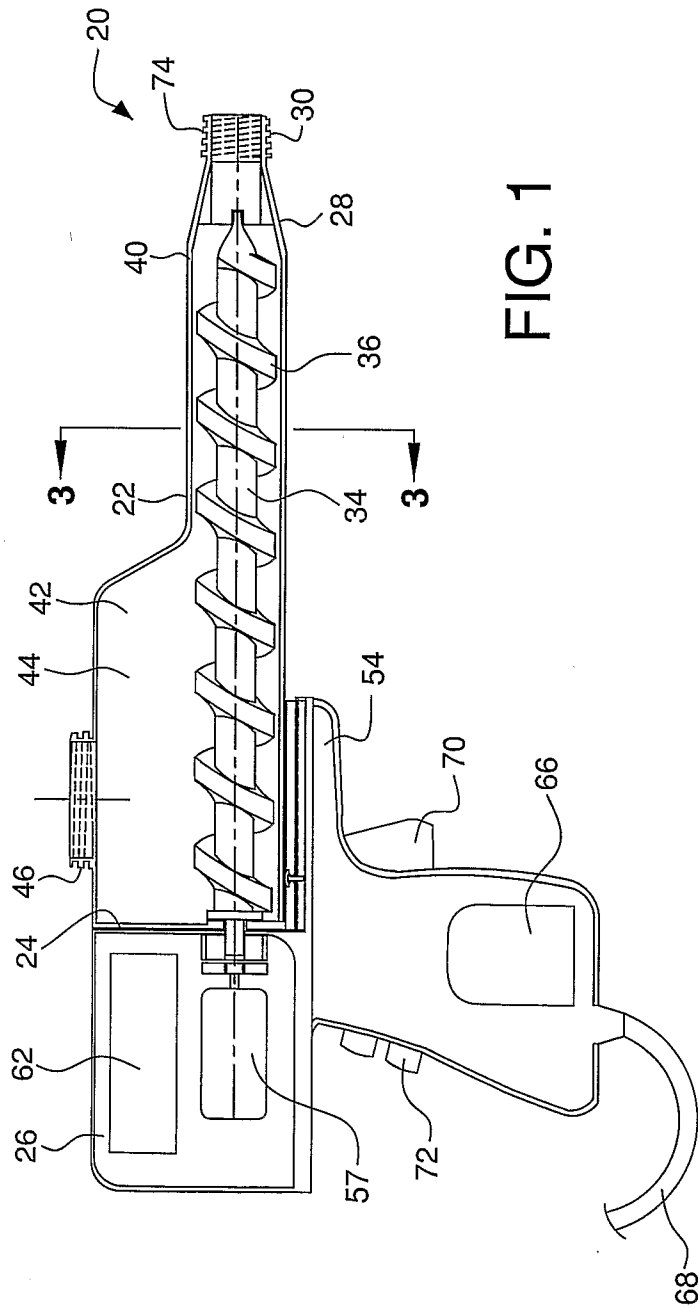
[0060] Accordingly, reference should be made to the appended claims, rather than to the foregoing specification, as indicating the scope of the invention.

Claims

What is claimed is:

1. A hand-held mixing and dispensing device comprising:
a mixing barrel;
at least one mixing screw extending along the barrel;
an inlet for material to be mixed into the barrel;
an outlet at an end of the barrel to which mixed material can be delivered by rotation of the at least one mixing screw;
a motor for rotation of the at least one mixing screw; and
a grip by which the device can be held with one hand while the motor is rotating the at least one mixing screw.
2. A device according to claim 1, wherein the at least one mixing screw is a single mixing screw.
3. A device according to claim 1, wherein the at least one mixing screw is two mixing screws, side by side with overlapping threads, and the motor is arranged to rotate the screws in opposite directions.
4. A device according to claim 1, wherein the at least one mixing screw is two mixing screws, side by side with overlapping threads, and the motor is arranged to rotate the screws in the same direction.
5. A device according to claim 1, wherein the mixing barrel comprises an extrusion section towards the outlet end and a primary mixing section away from the outlet end, wherein the extrusion section has a smaller cross-section than the primary mixing section, and wherein the inlet opens into the primary mixing section.
6. A device according to claim 1, further comprising controls arranged to be operated by the hand holding the grip.

7. A device according to claim 6, wherein the grip is a pistol grip, and the controls arranged to be operated by the hand holding the grip comprise at least one control selected from the group consisting of triggers and thumb-operated controls.
8. A device according to claim 1, further comprising a degassing adapter attachable to the outlet for collection and removal of the gases from the mix.
9. A device according to claim 8, wherein the degassing adaptor comprises a passage for material being dispensed from the outlet of the mixing barrel, an annular gap in a wall defining the passage, a plenum encircling the passage into which the gap opens, and an outlet for gas from the plenum.
10. A device according to claim 9, further comprising a vacuum pump to draw gas from said outlet for gas.
11. A device according to claim 9, further comprising a dispensing hose for delivering material from the outlet of the passage of the degassing adaptor to a site where the material is to be applied.
12. A device according to claim 1, further comprising a dispensing hose for delivering material from the outlet of the mixing barrel to a site where the material is to be applied.



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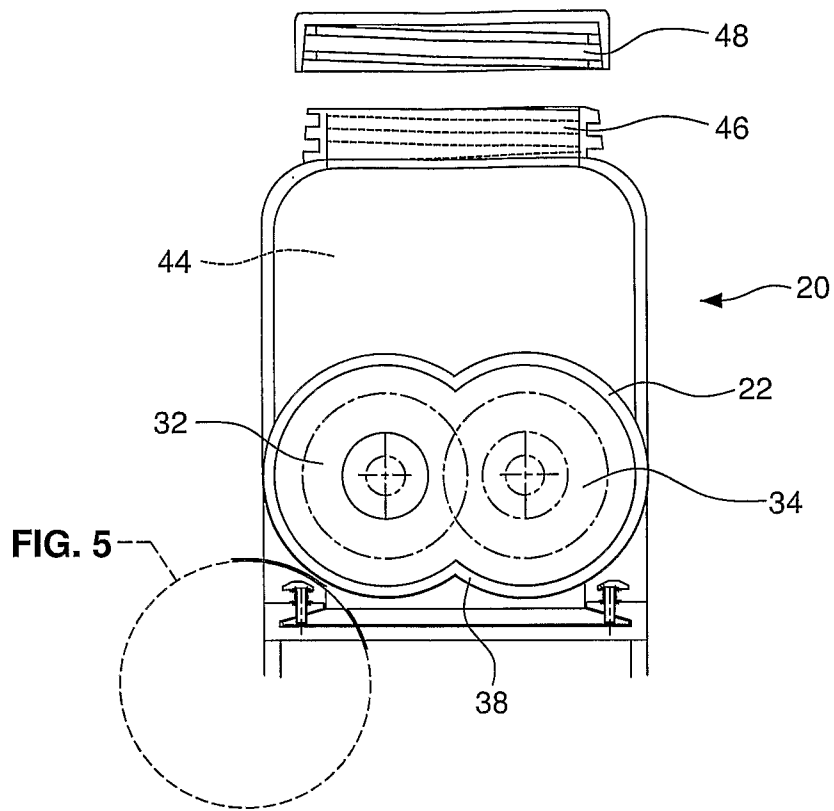


FIG. 3

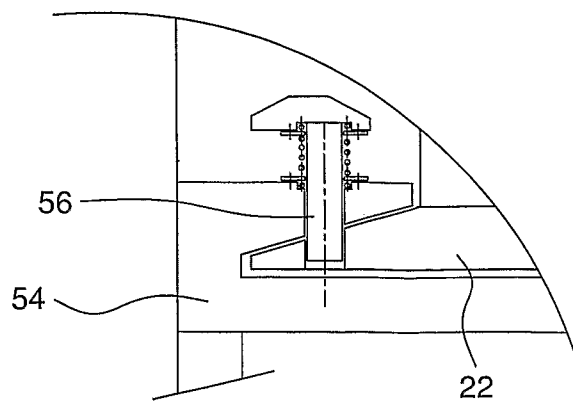


FIG. 5

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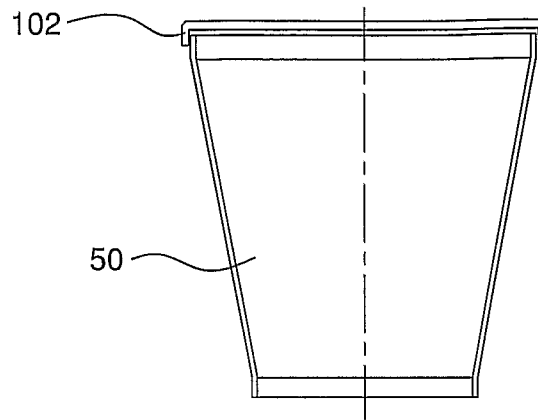


FIG. 4

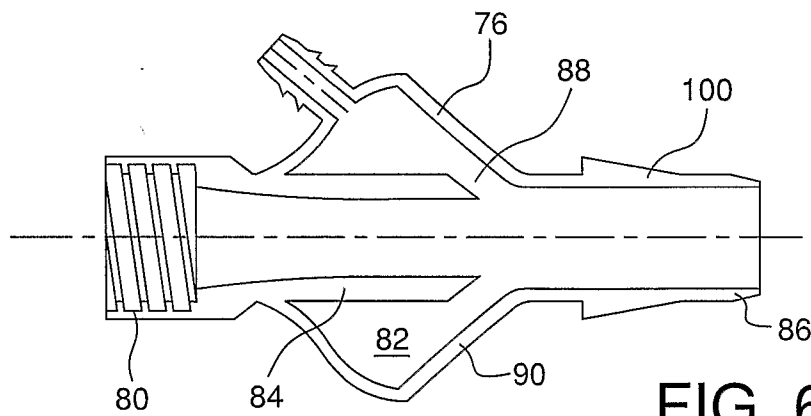


FIG. 6

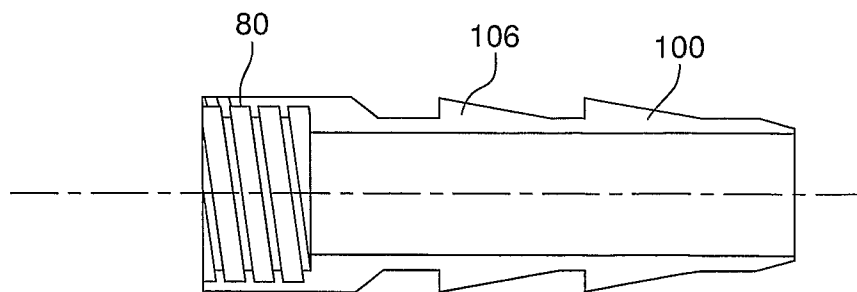
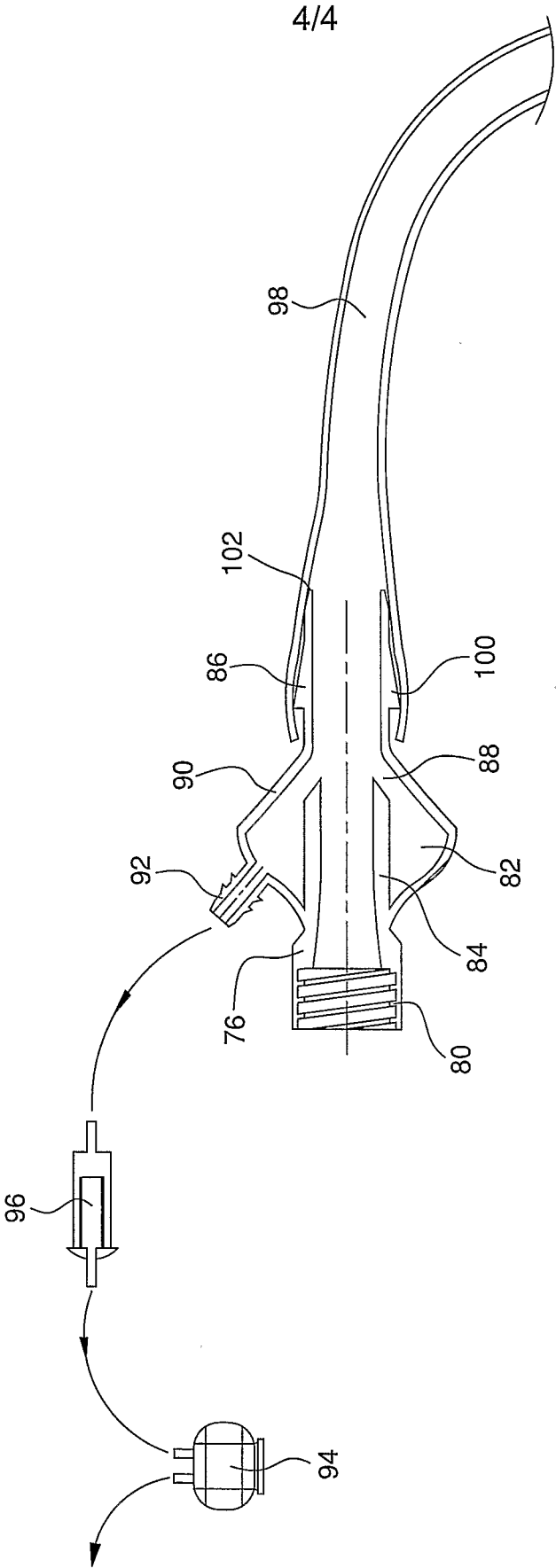


FIG. 8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US06/45121

A. CLASSIFICATION OF SUBJECT MATTER IPC: G01F 11/00 (2006.01) A61F 5/00 (2006.01) USPC: 366/85,139;222/238 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) U.S. : 366/83, 84, 85, 139; 222/238, 240, 241, 413, Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EAST: search terms screw, screws, motor, helix helixes, cement, paste, epoxy, nozzle, outlet, pistol, grip, handheld																										
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category *</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>US 5,244,123 A (BENEDICT) 14 Sept 1993 (14.09.1993), see entire document.</td> <td>1,2, 5-7,</td> </tr> <tr> <td>--</td> <td></td> <td>-----</td> </tr> <tr> <td>Y</td> <td></td> <td>3-4, 8-12</td> </tr> <tr> <td>Y</td> <td>US 3,879,150 A (BROWN et al) 22 April 1975 (22.04.1975), see elements 24, 25, column 3, line 45-54.</td> <td>3-4</td> </tr> <tr> <td>Y</td> <td>US 6,648,499 A (JONSSON) 18 Nov 2003 (18.11.2003), see elements 4 and 5, column 3, lines 46 through column 4, lines 25.</td> <td>8-12</td> </tr> <tr> <td>A</td> <td>US 2004/0193170 A1 (KEMPPAINEN et al) 20 Sept 2004 (20.09.2004), see entire document.</td> <td>1-12</td> </tr> </tbody> </table>			Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	US 5,244,123 A (BENEDICT) 14 Sept 1993 (14.09.1993), see entire document.	1,2, 5-7,	--		-----	Y		3-4, 8-12	Y	US 3,879,150 A (BROWN et al) 22 April 1975 (22.04.1975), see elements 24, 25, column 3, line 45-54.	3-4	Y	US 6,648,499 A (JONSSON) 18 Nov 2003 (18.11.2003), see elements 4 and 5, column 3, lines 46 through column 4, lines 25.	8-12	A	US 2004/0193170 A1 (KEMPPAINEN et al) 20 Sept 2004 (20.09.2004), see entire document.	1-12			
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☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.																										
<table border="0"> <tr> <td colspan="2">* Special categories of cited documents:</td> <td>"T"</td> <td>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</td> </tr> <tr> <td>"A"</td> <td>document defining the general state of the art which is not considered to be of particular relevance</td> <td>"X"</td> <td>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</td> </tr> <tr> <td>"E"</td> <td>earlier application or patent published on or after the international filing date</td> <td>"Y"</td> <td>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</td> </tr> <tr> <td>"L"</td> <td>document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"&"</td> <td>document member of the same patent family</td> </tr> <tr> <td>"O"</td> <td>document referring to an oral disclosure, use, exhibition or other means</td> <td></td> <td></td> </tr> <tr> <td>"P"</td> <td>document published prior to the international filing date but later than the priority date claimed</td> <td></td> <td></td> </tr> </table>			* Special categories of cited documents:		"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	"A"	document defining the general state of the art which is not considered to be of particular relevance	"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	"E"	earlier application or patent published on or after the international filing date	"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	"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family	"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		
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Date of the actual completion of the international search 03 February 2007 (03.02.2007)		Date of mailing of the international search report 02 MAR 2007																								
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201		Authorized officer Tony G. Soohoo Telephone No. 571-272-1700 Jacqueline A. Whitfield Special Project Asst.																								