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(19) **United States**(12) **Patent Application Publication****Ness**(10) **Pub. No.: US 2006/0185309 A1**(43) **Pub. Date: Aug. 24, 2006**(54) **MASONRY BLOCKS AND MASONRY
BLOCK ASSEMBLIES HAVING MOLDED
UTILITY OPENINGS**(52) **U.S. Cl. 52/596**(76) Inventor: **John T. Ness**, Stillwater, MN (US)

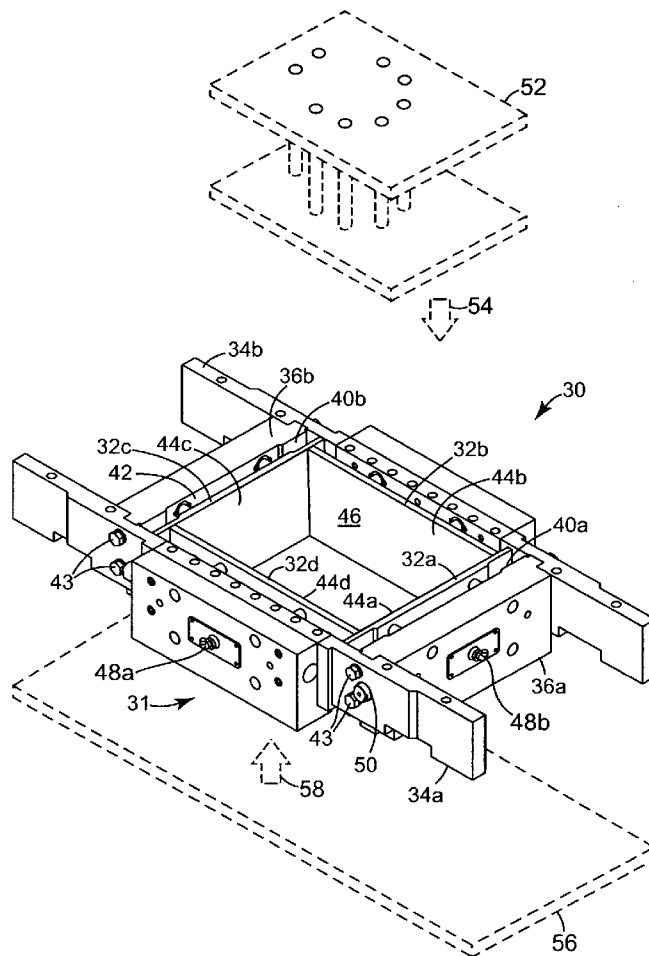
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DICKE, BILLIG & CZAJA, P.L.L.C.**FIFTH STREET TOWERS****100 SOUTH FIFTH STREET, SUITE 2250****MINNEAPOLIS, MN 55402 (US)**(21) Appl. No.: **11/330,611**(22) Filed: **Jan. 12, 2006****Related U.S. Application Data**

(60) Provisional application No. 60/644,107, filed on Jan. 13, 2005.

Publication Classification(51) **Int. Cl.**
E04C 2/04 (2006.01)(57) **ABSTRACT**

A masonry block molded by a masonry block machine employing a mold assembly having a plurality of liner plates, at least one of which is moveable. The masonry block includes a first transverse face, a second transverse face opposing the first transverse face, at least one aperture extending through the masonry block between the first and second transverse faces, a first end face joining the first and second transverse faces, a second end face opposite the first end face and joining the first and second transverse faces, a first major face joining the first end and second end faces, and a second major face opposing the first major face and joining the first and second end faces. A molded utility opening extends through the first major face to the at least one aperture and adapted to receive a utility device, wherein the first major face and molded utility opening are formed during a molding process by action of a moveable liner plate having a mold element which is a negative of the molded utility opening.



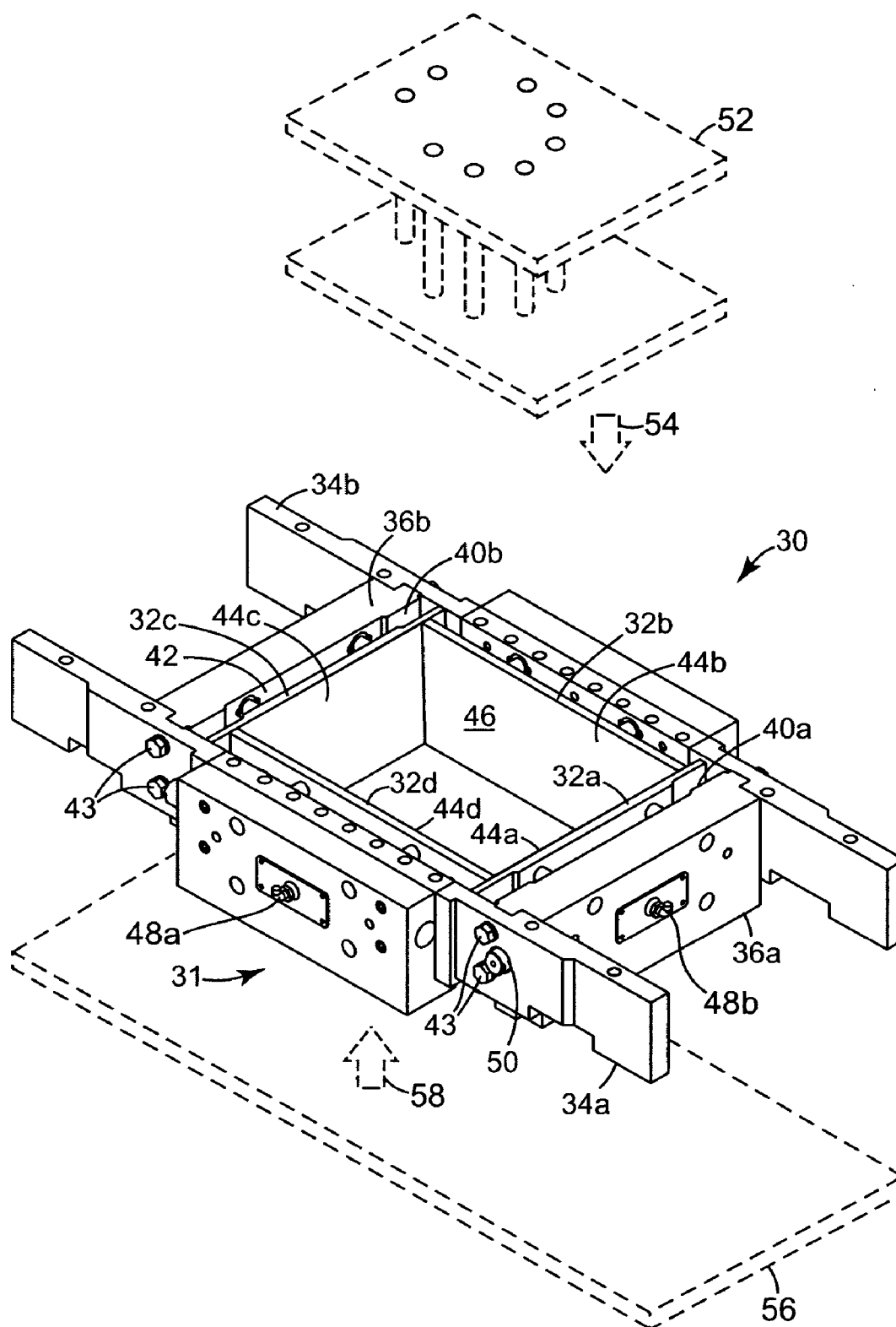


Fig. 1

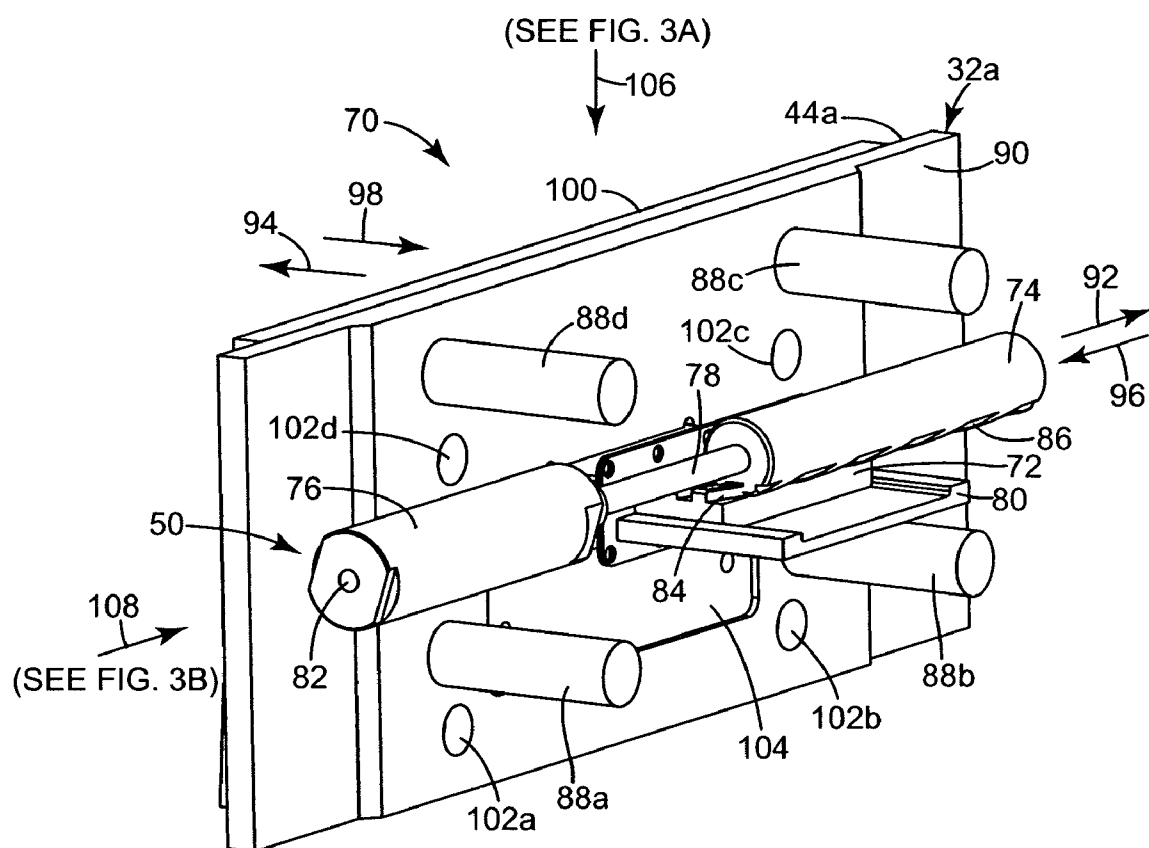


Fig. 2

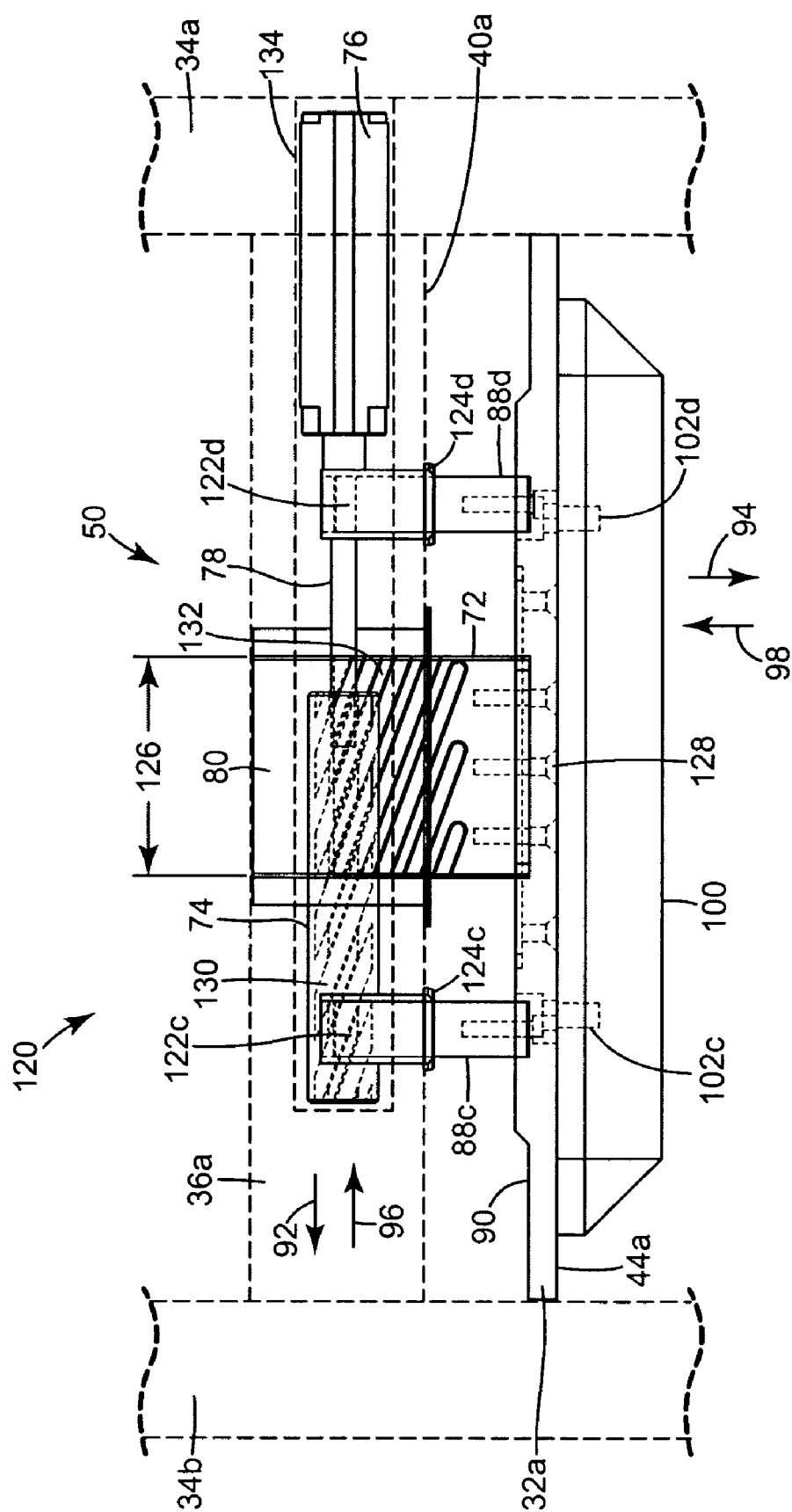


Fig. 3A

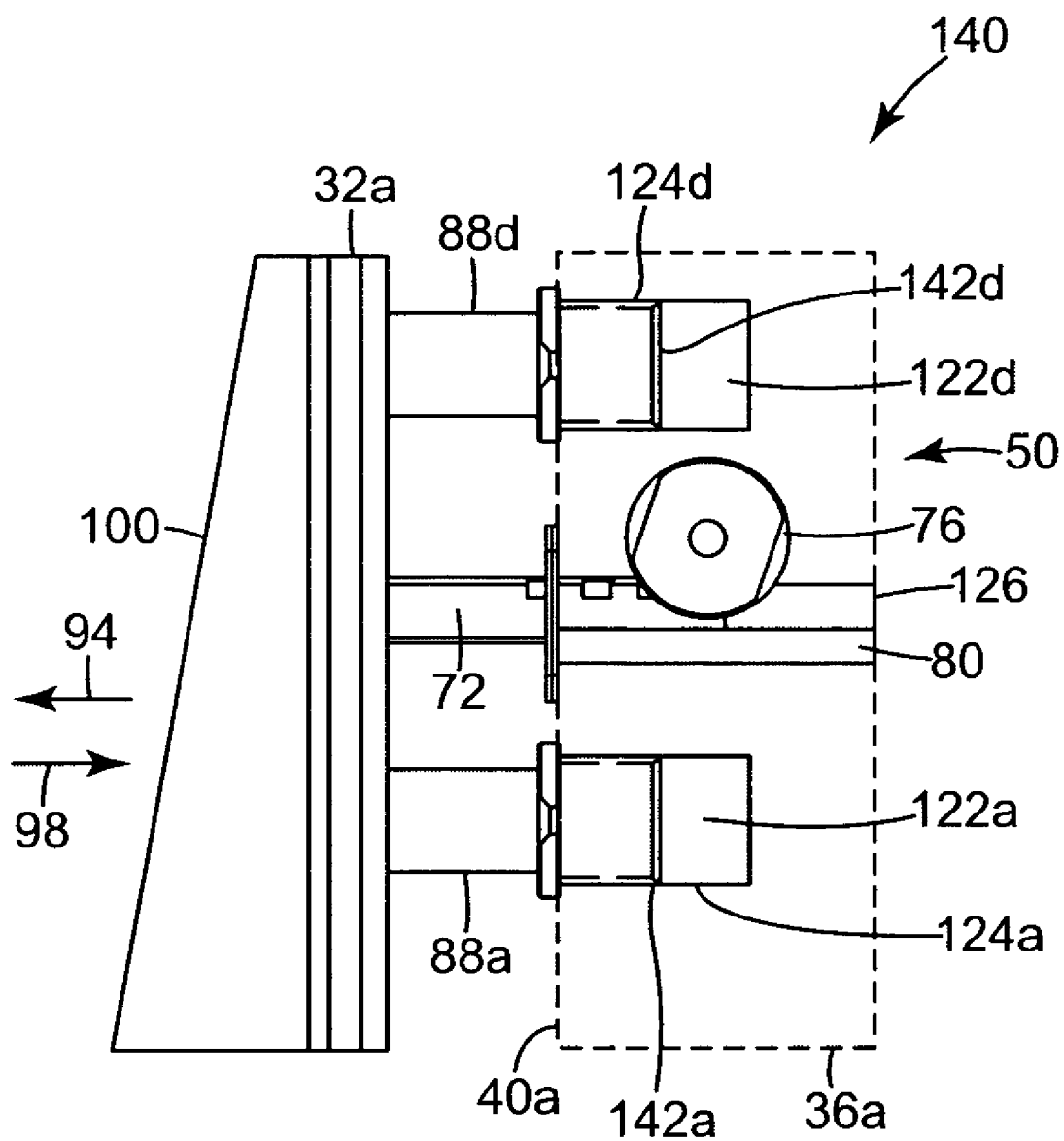


Fig. 3B

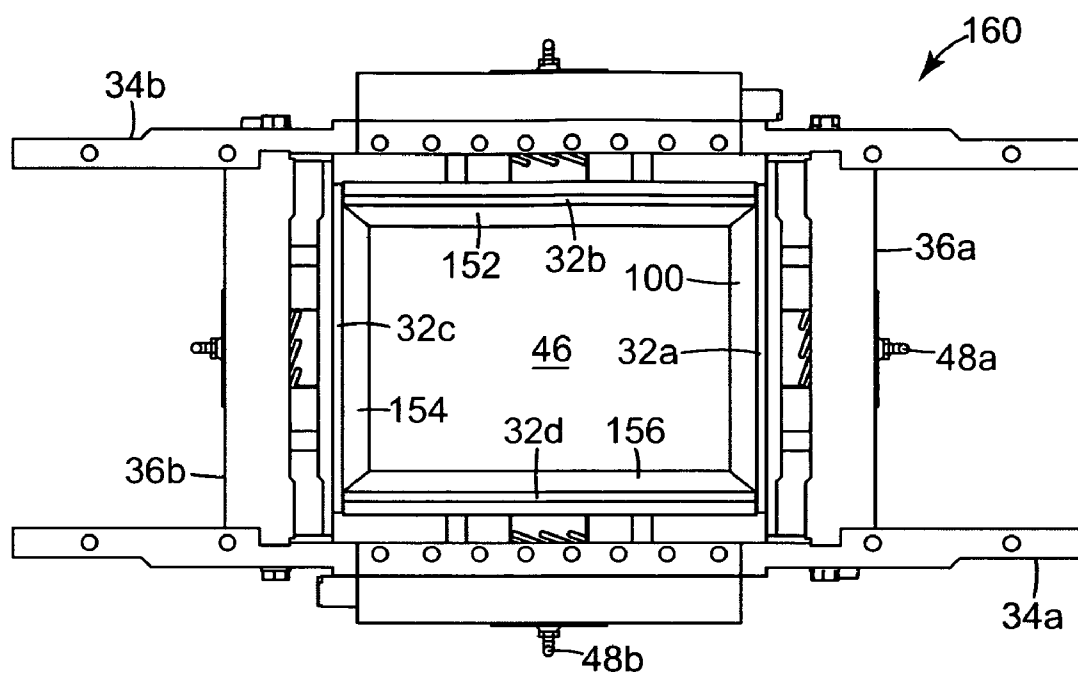


Fig. 4B

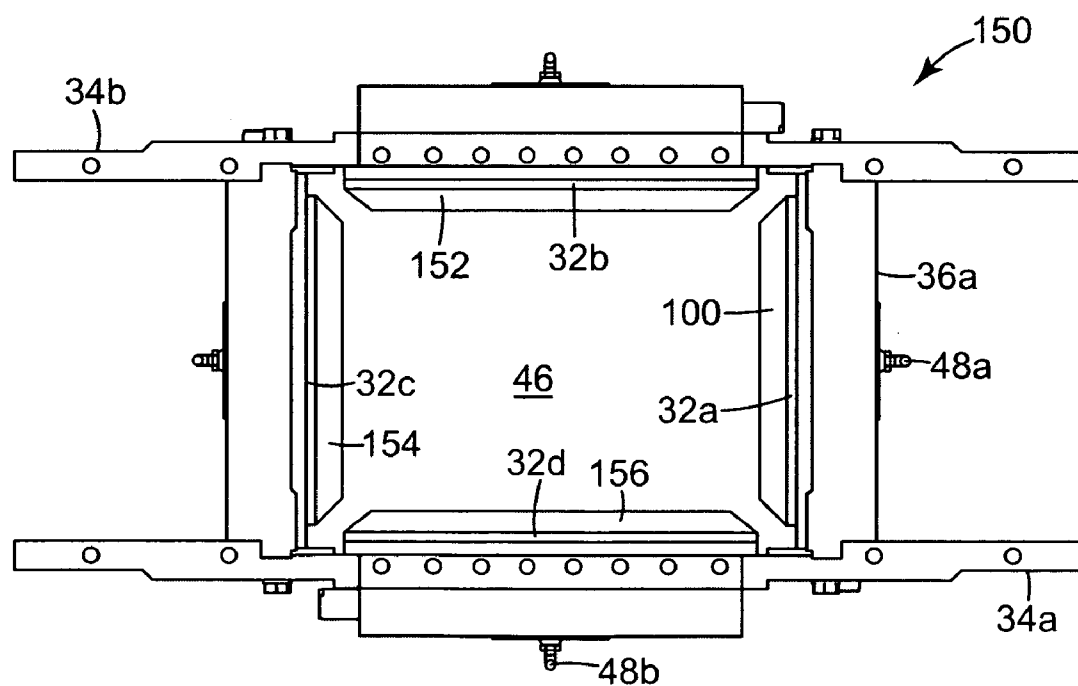


Fig. 4A

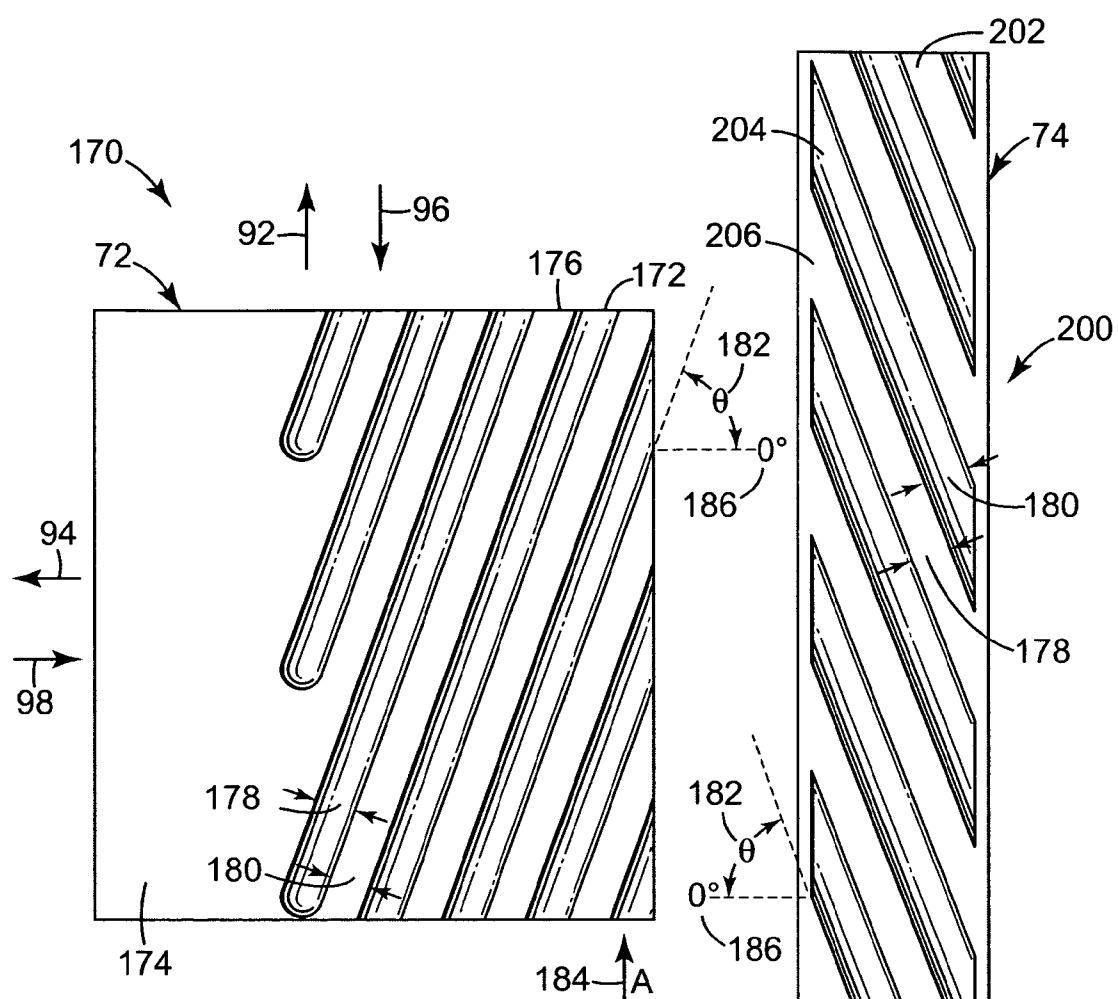


Fig. 5A

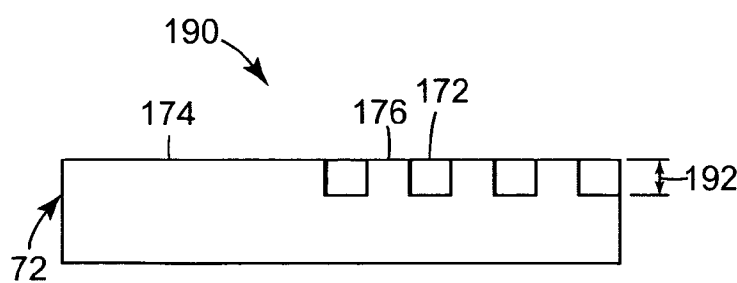


Fig. 5B

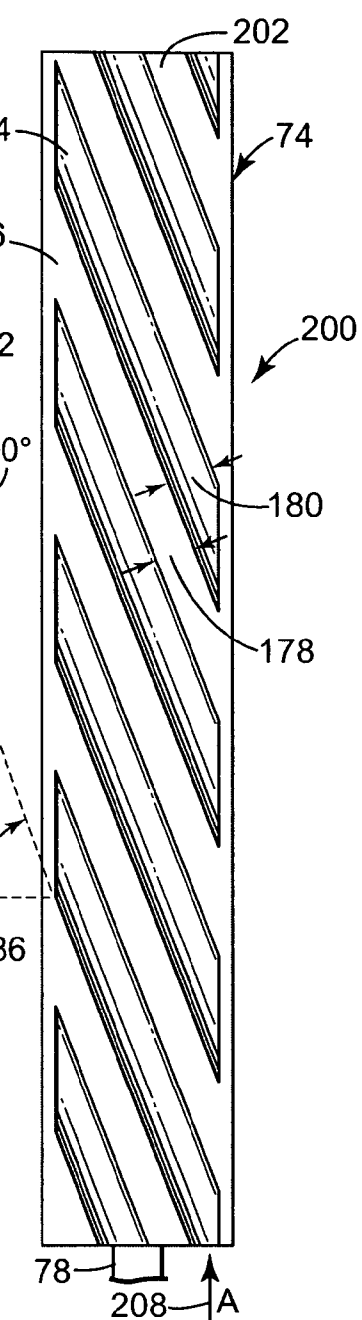


Fig. 5C

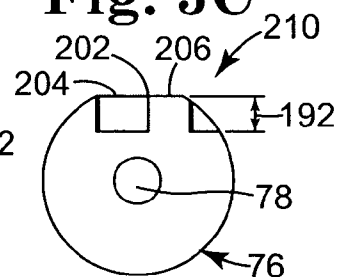


Fig. 5D

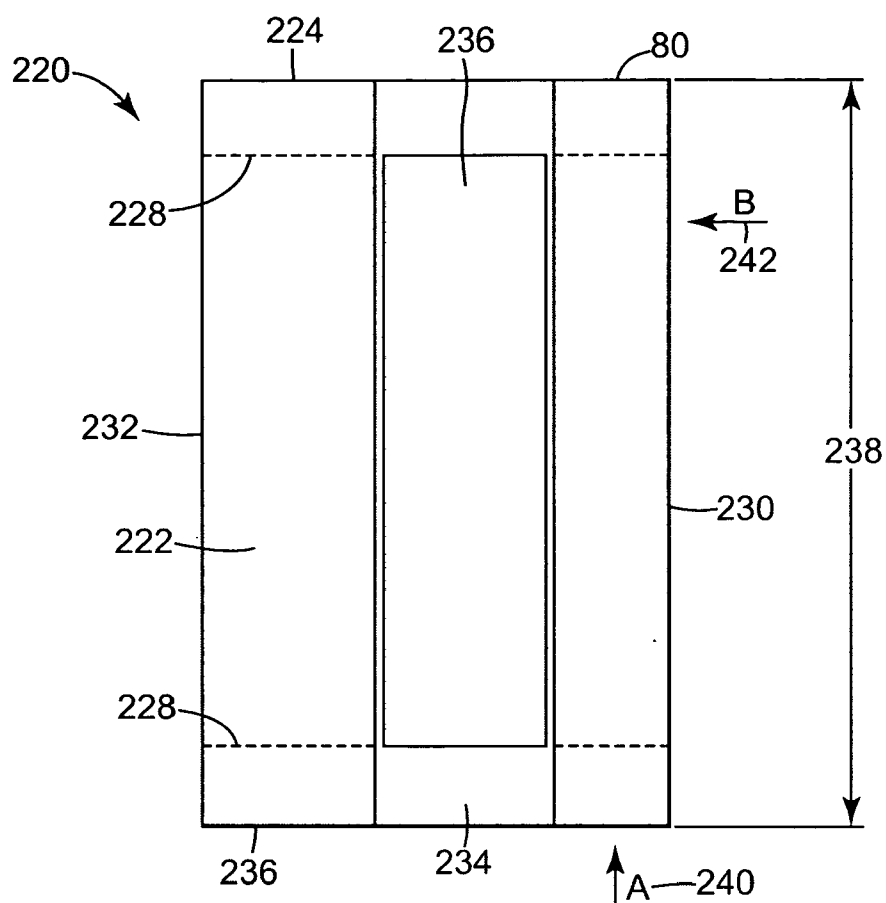


Fig. 6A

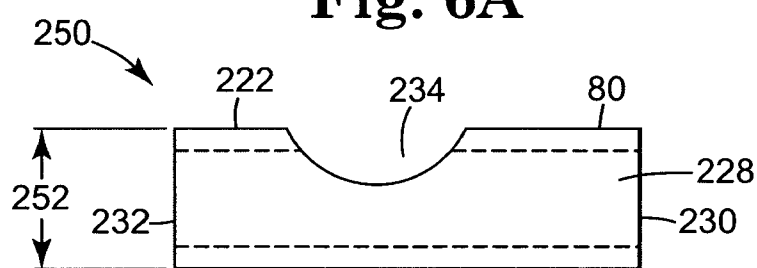


Fig. 6B

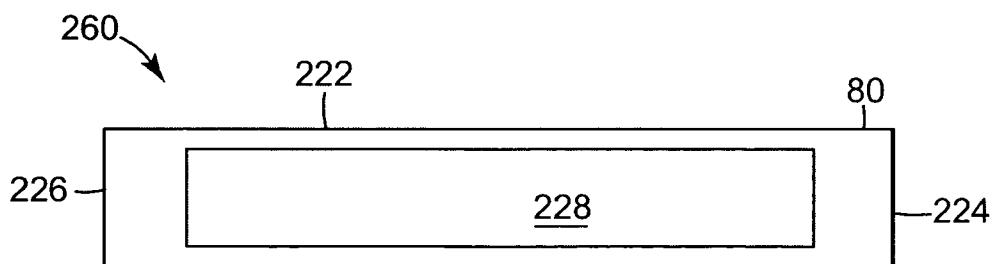


Fig. 6C

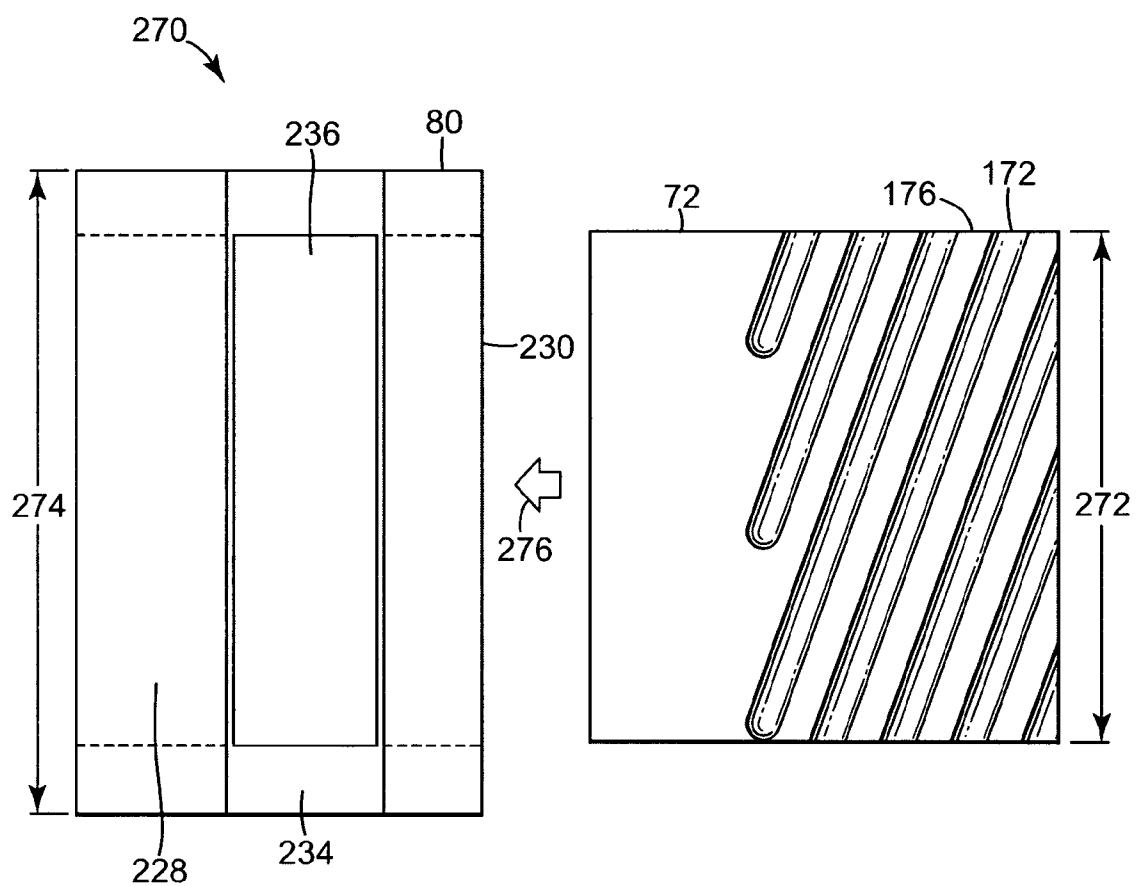


Fig. 7

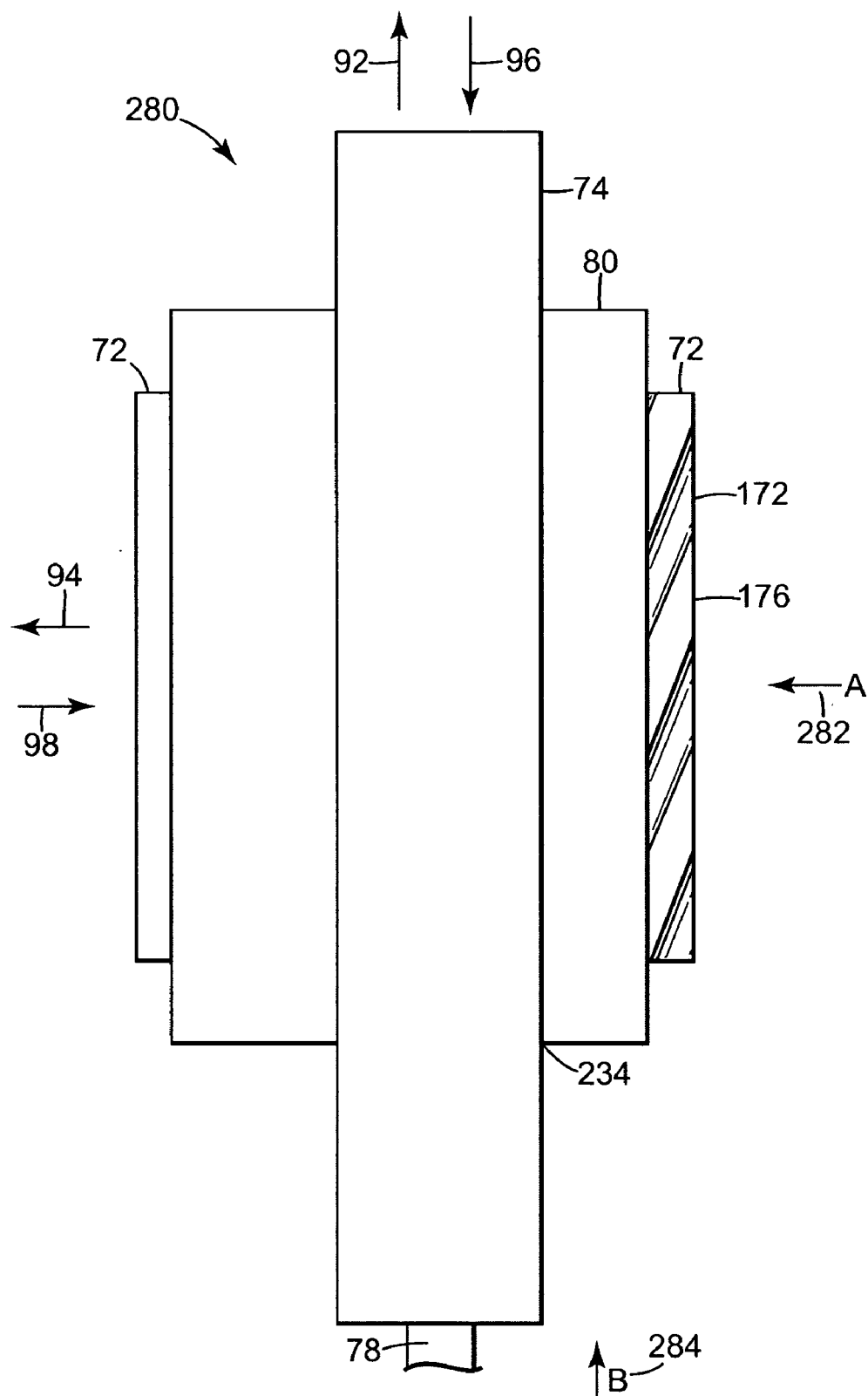


Fig. 8A

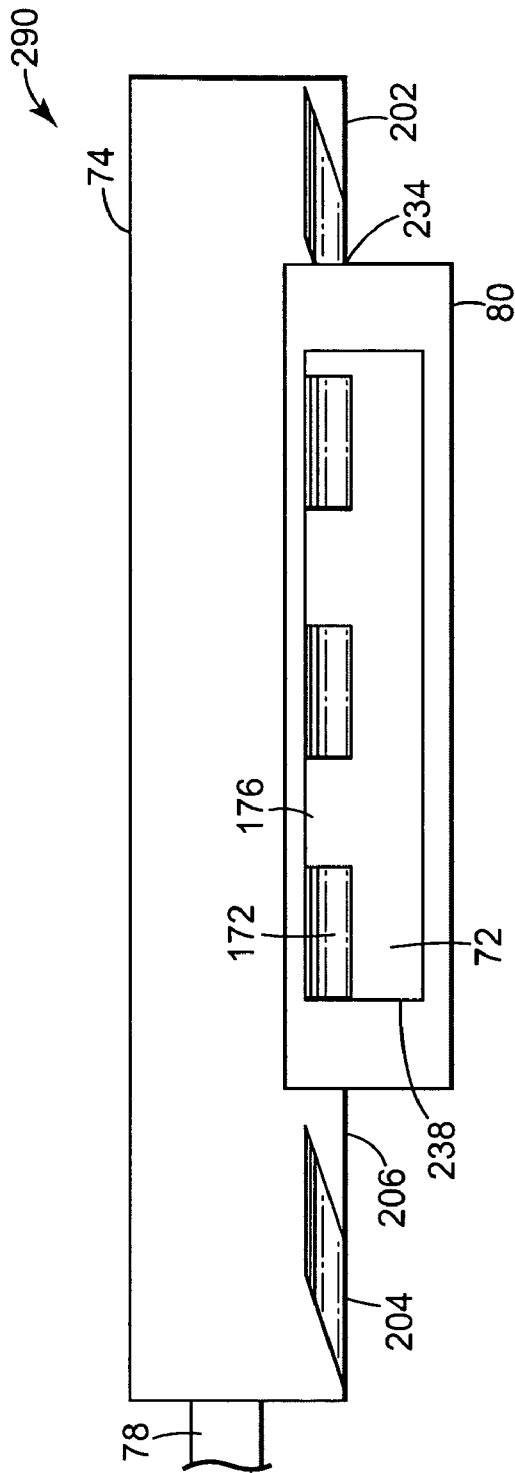


Fig. 8B

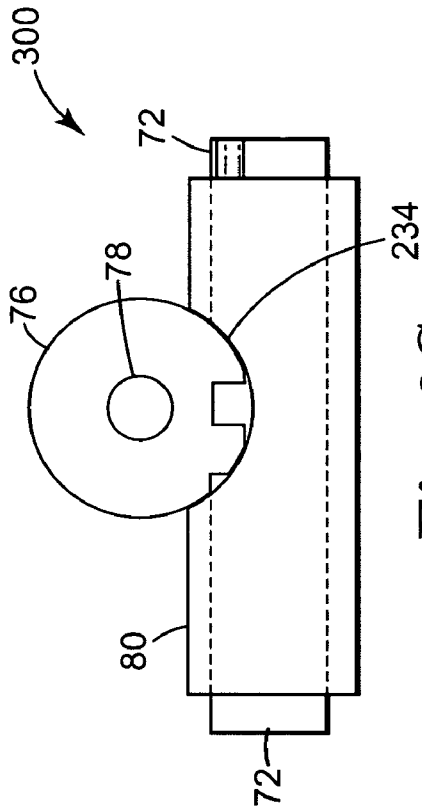


Fig. 8C

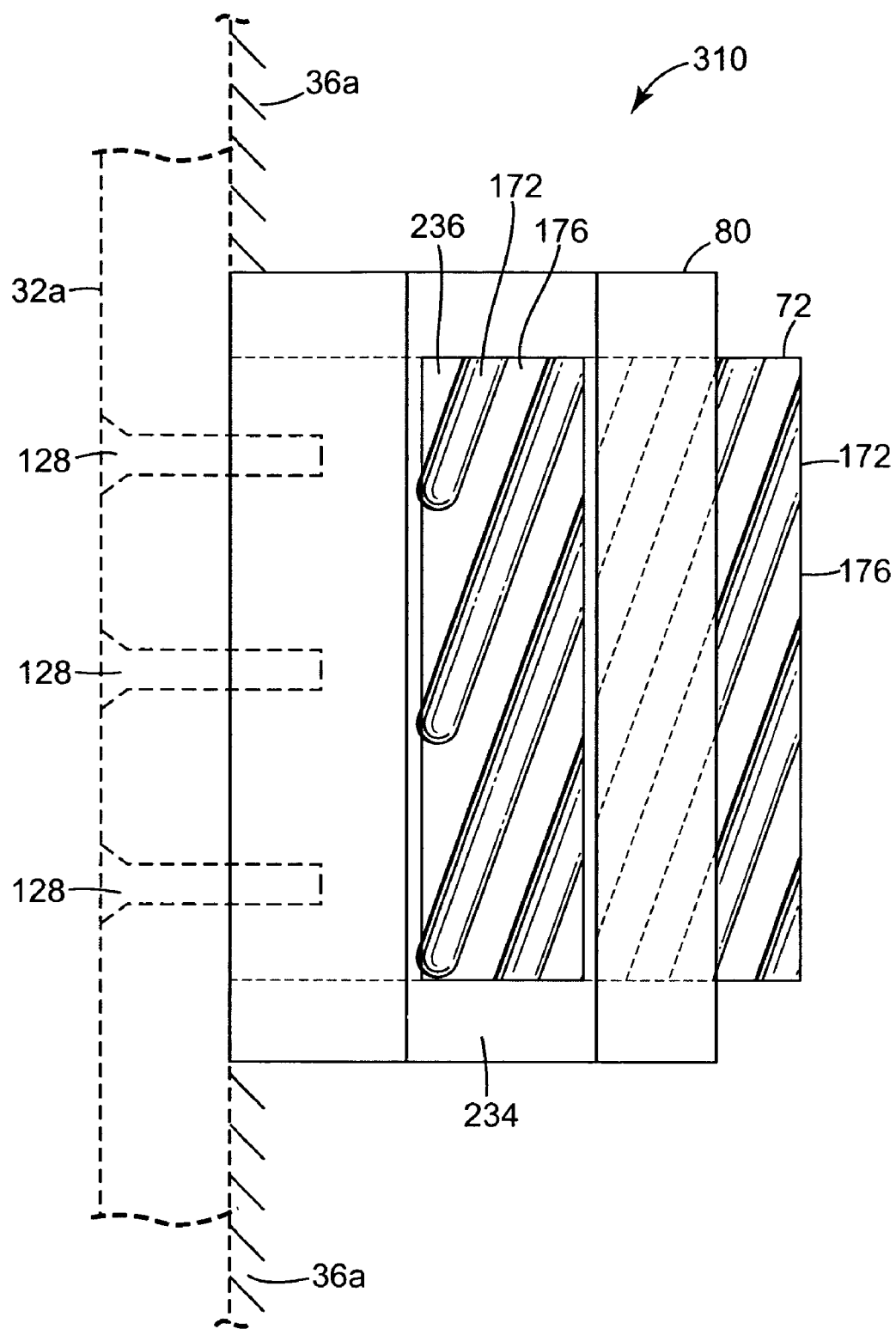


Fig. 9A

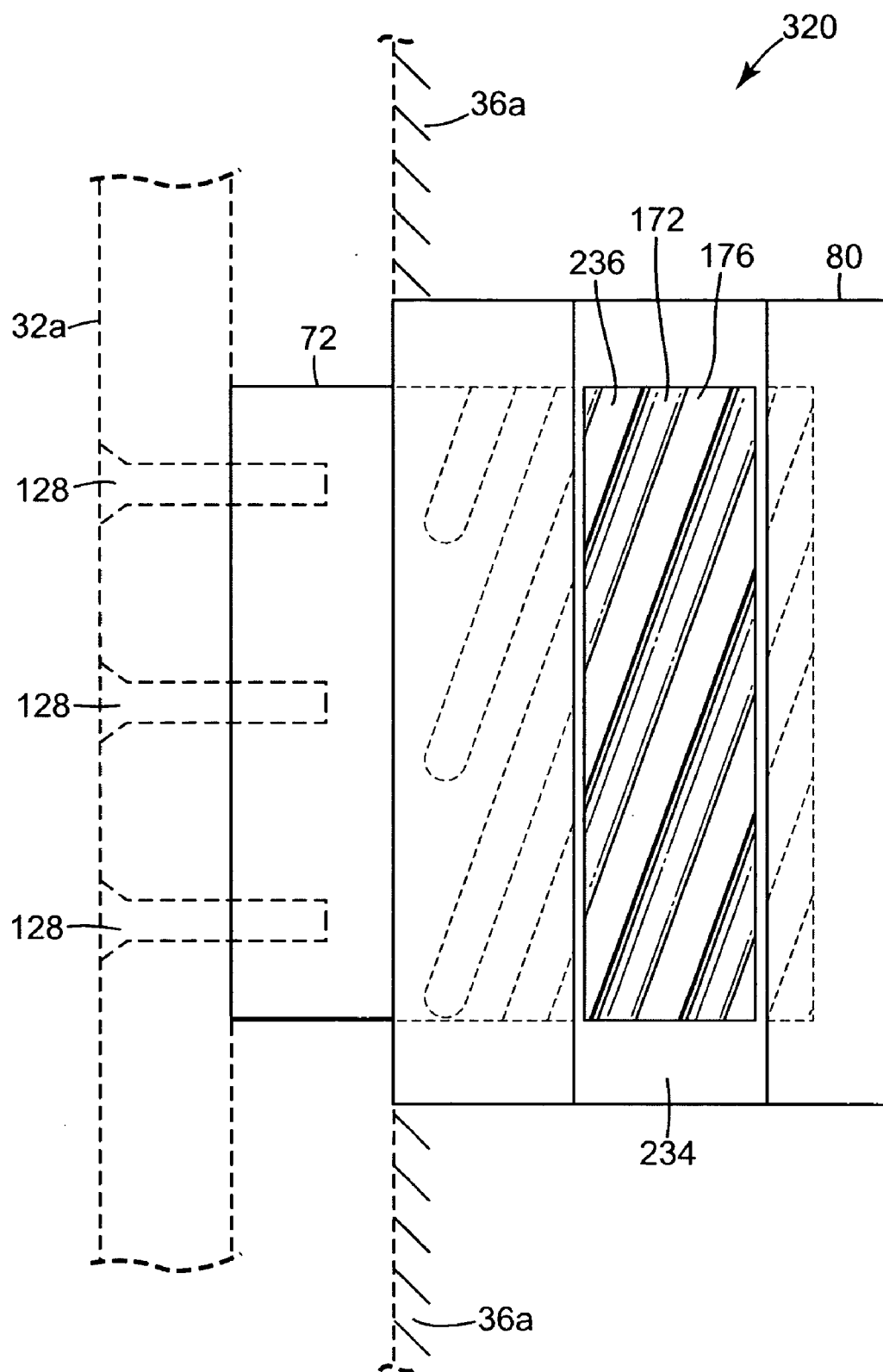


Fig. 9B

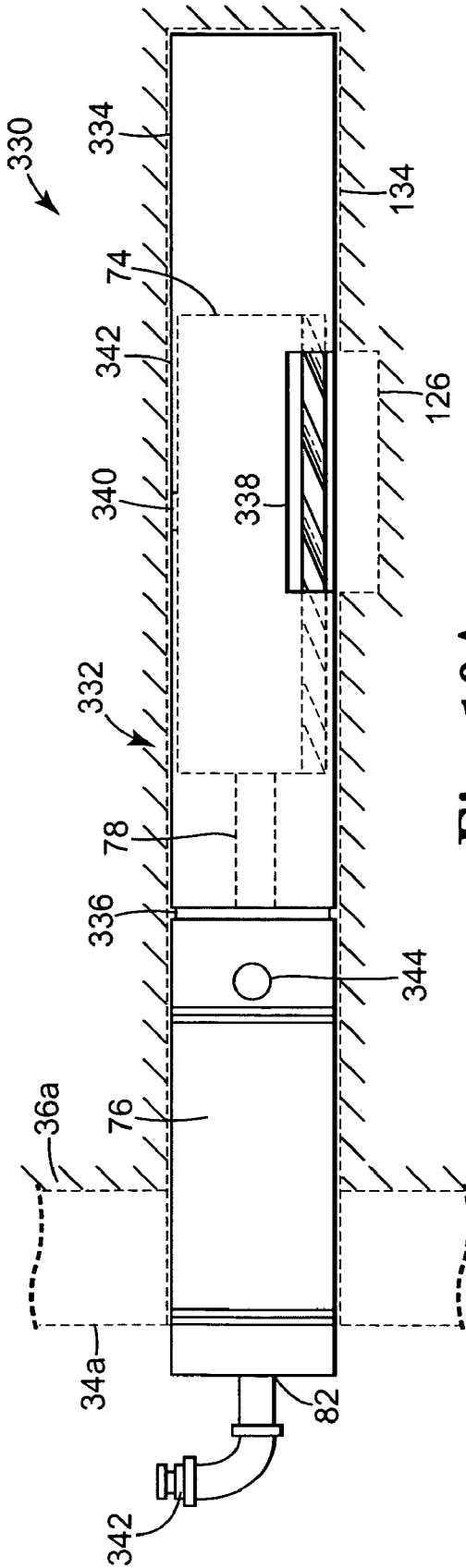


Fig. 10A

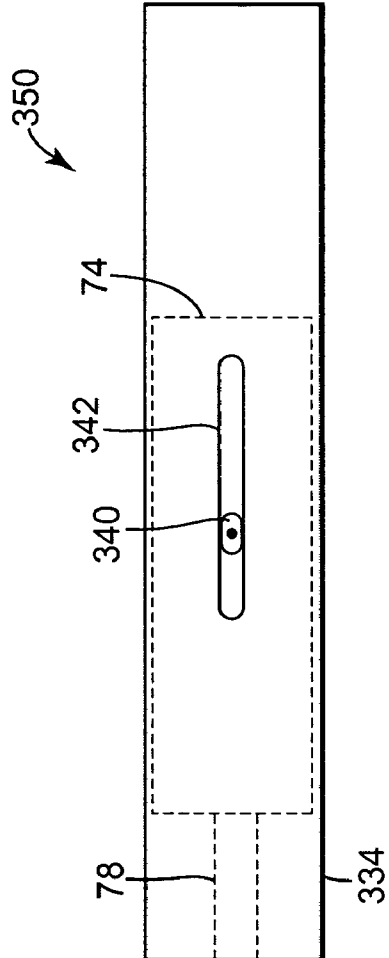


Fig. 10B

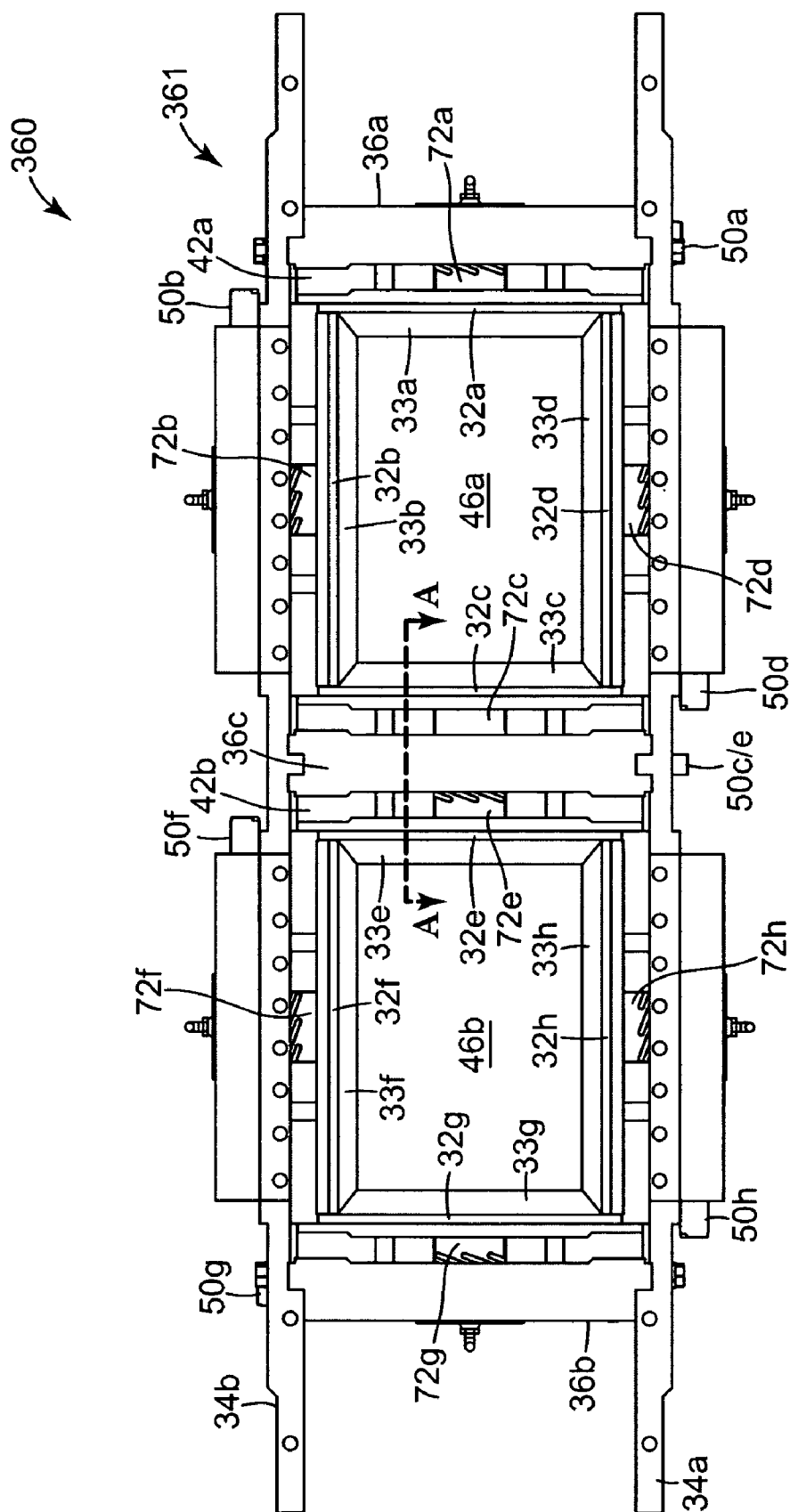


Fig. 11A

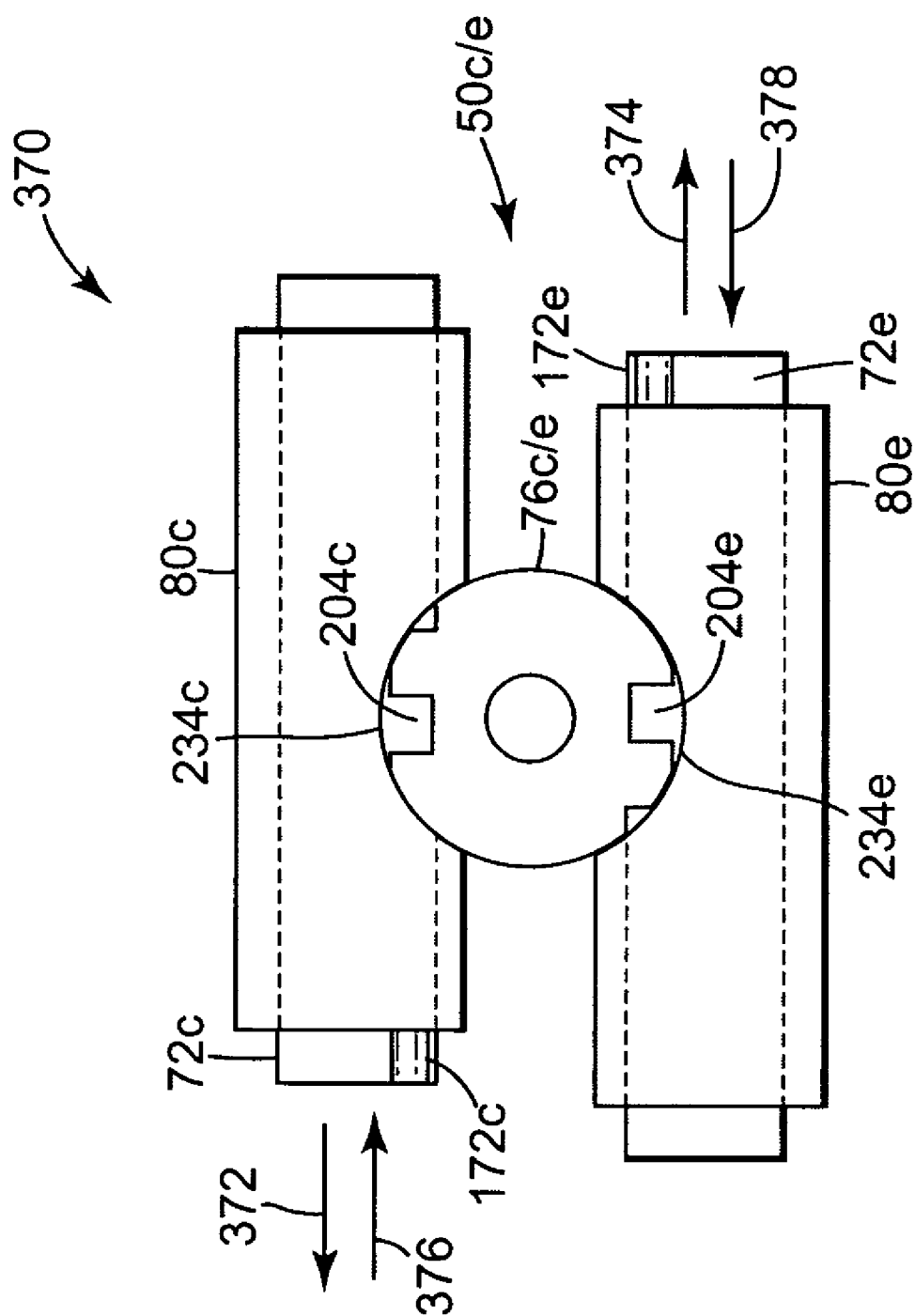


Fig. 11B

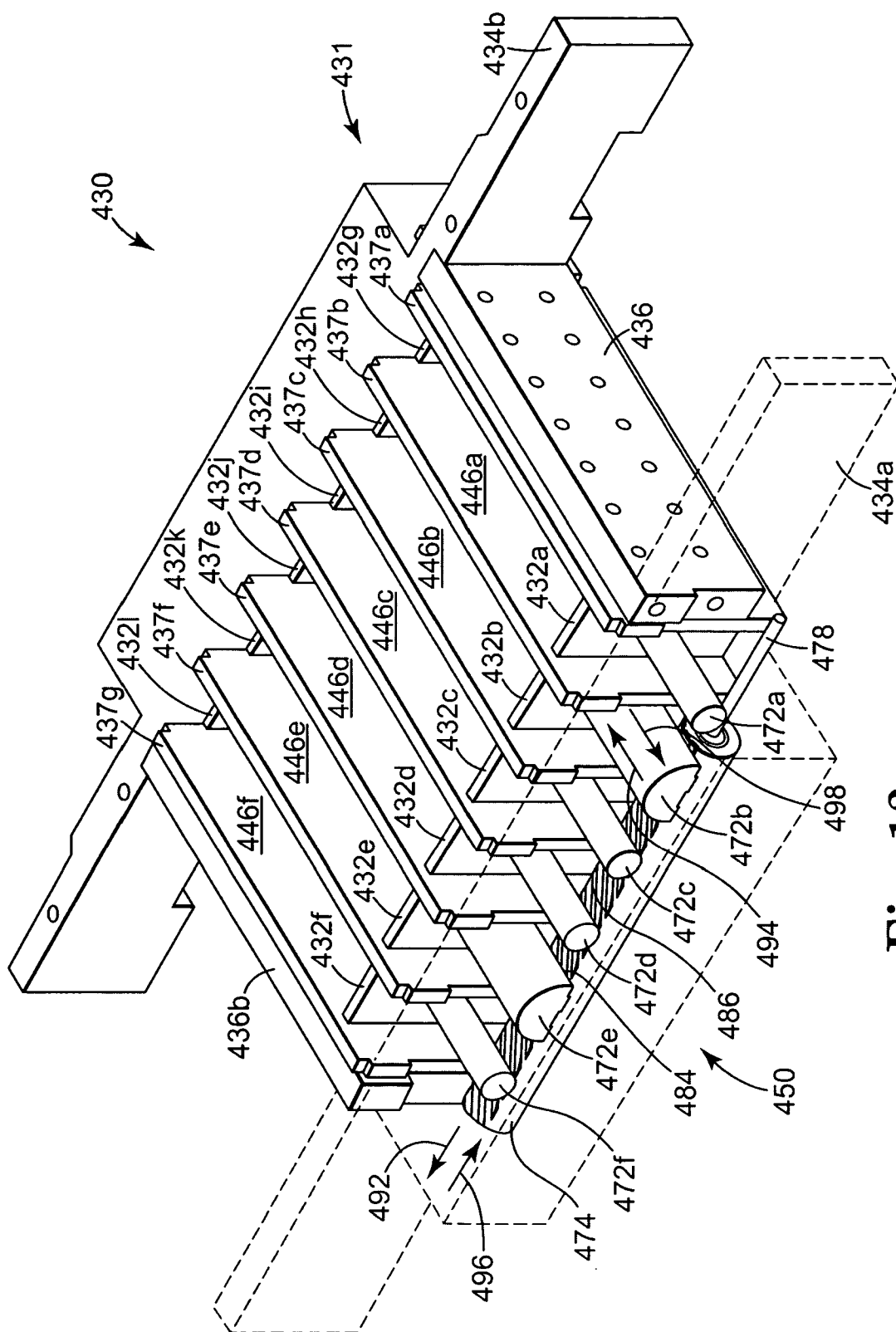
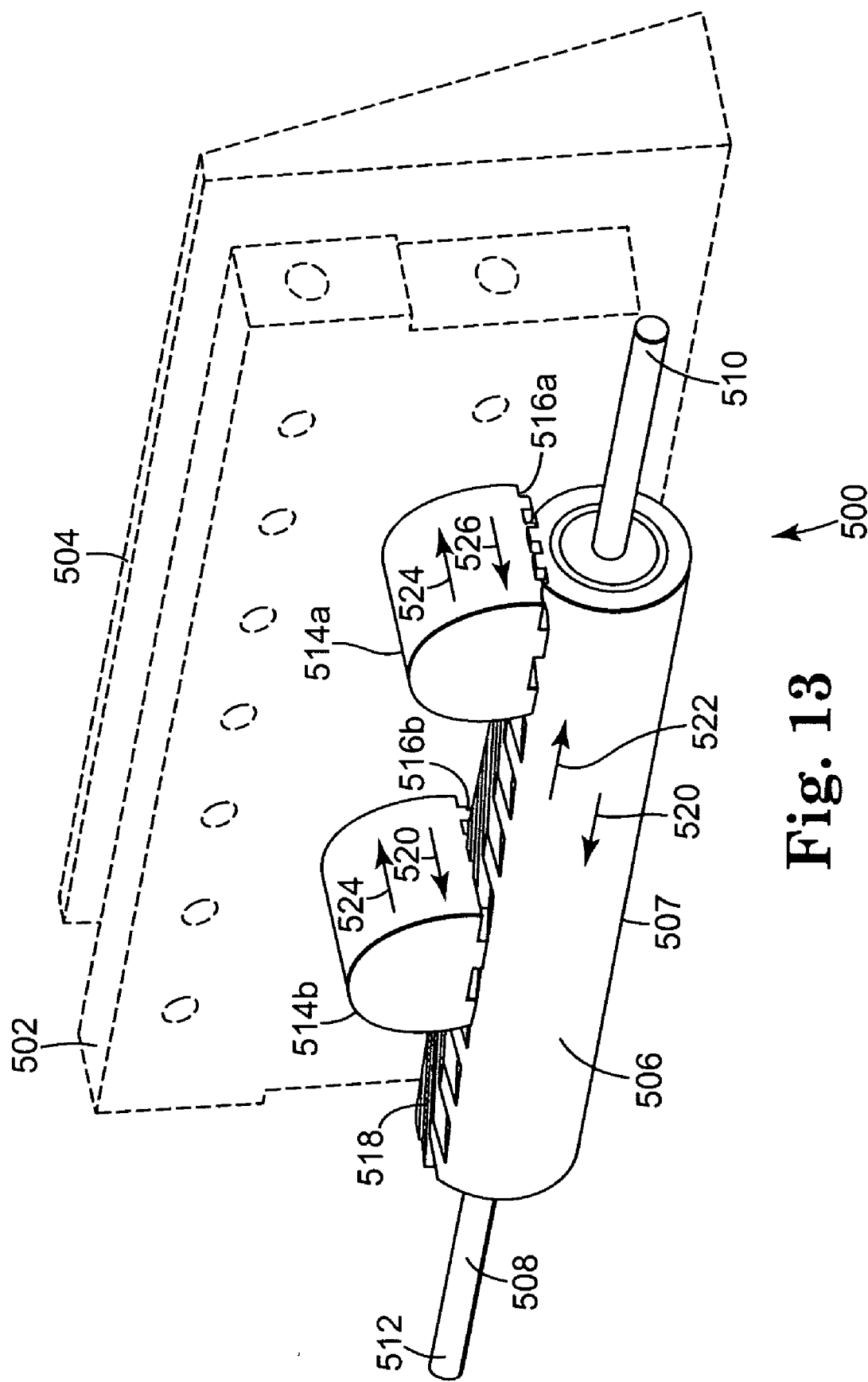


Fig. 12



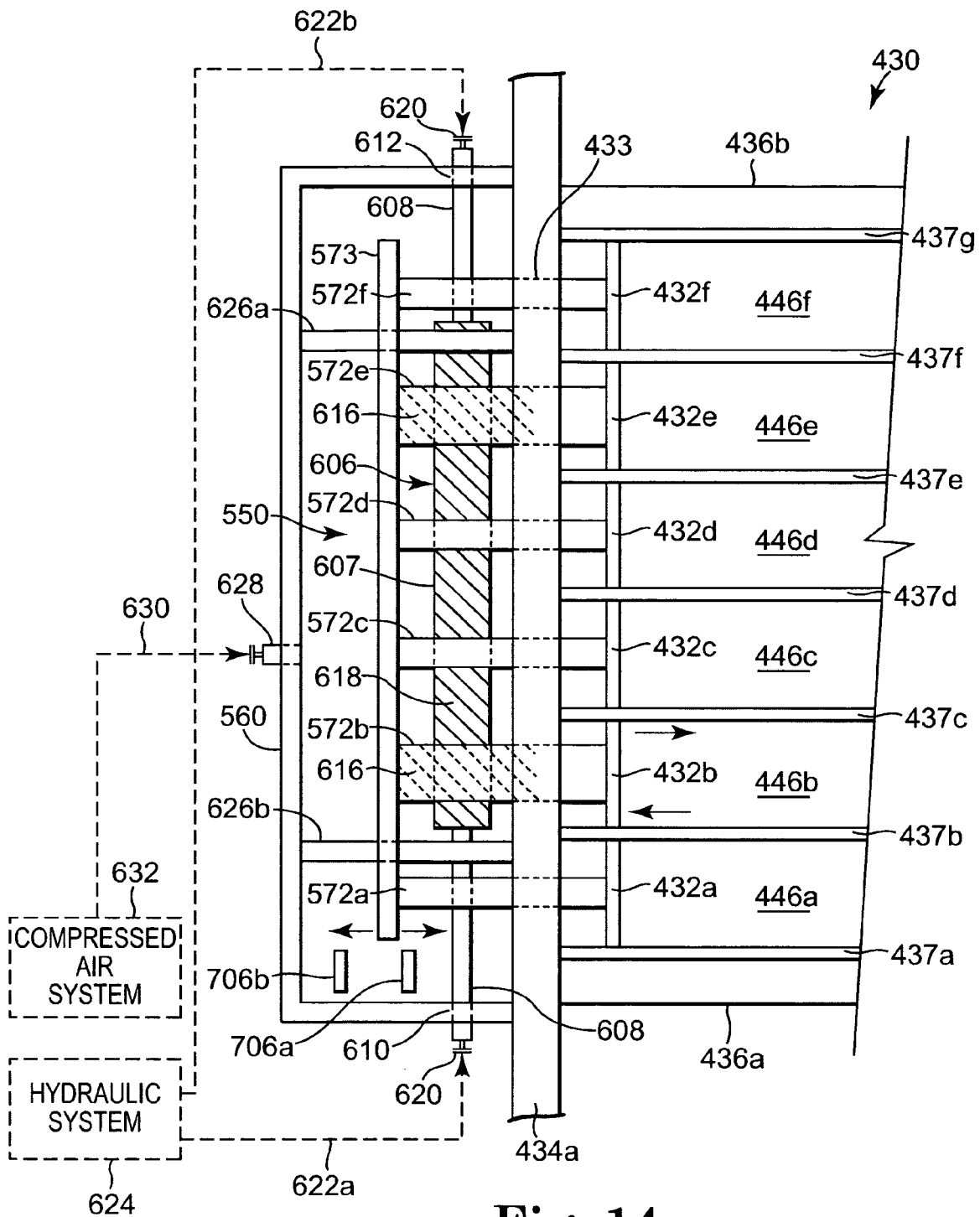


Fig. 14

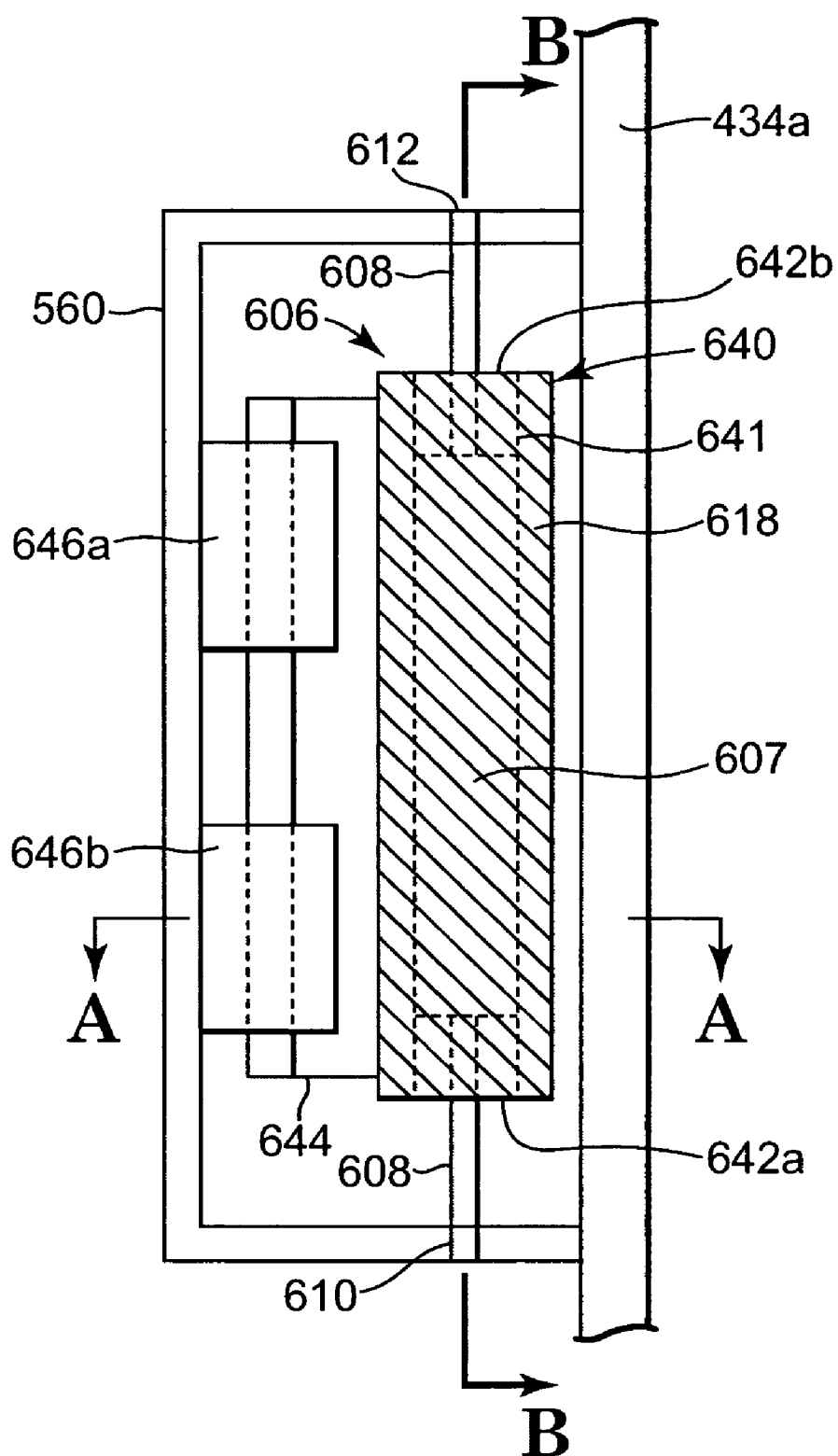


Fig. 15A

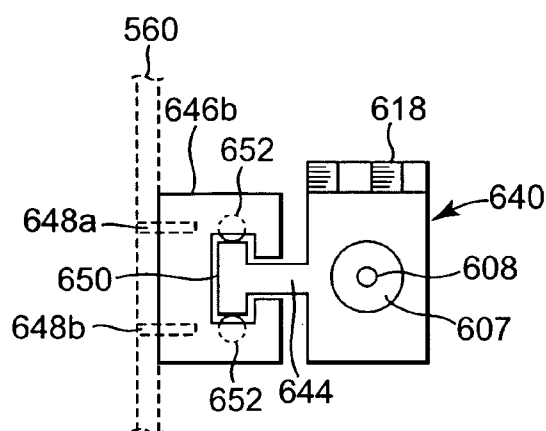


Fig. 15B

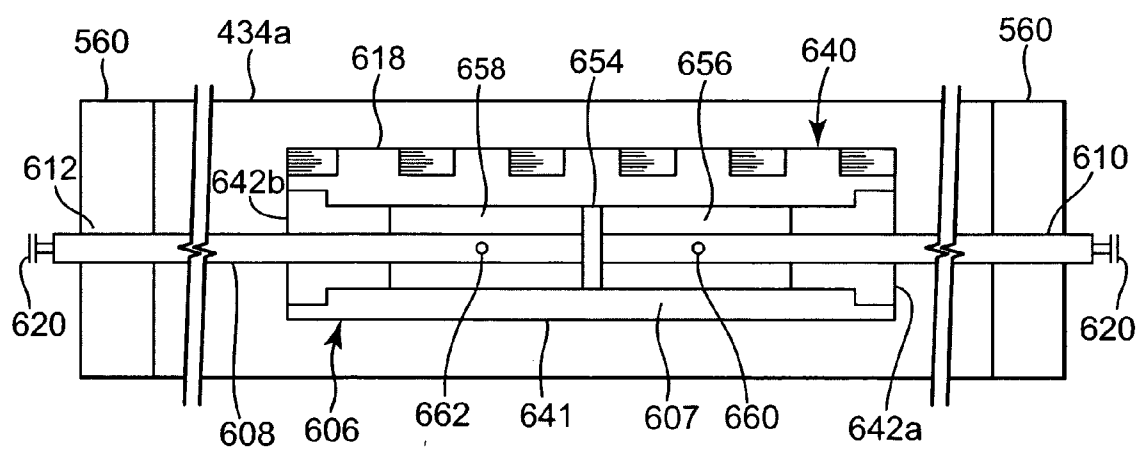


Fig. 15C

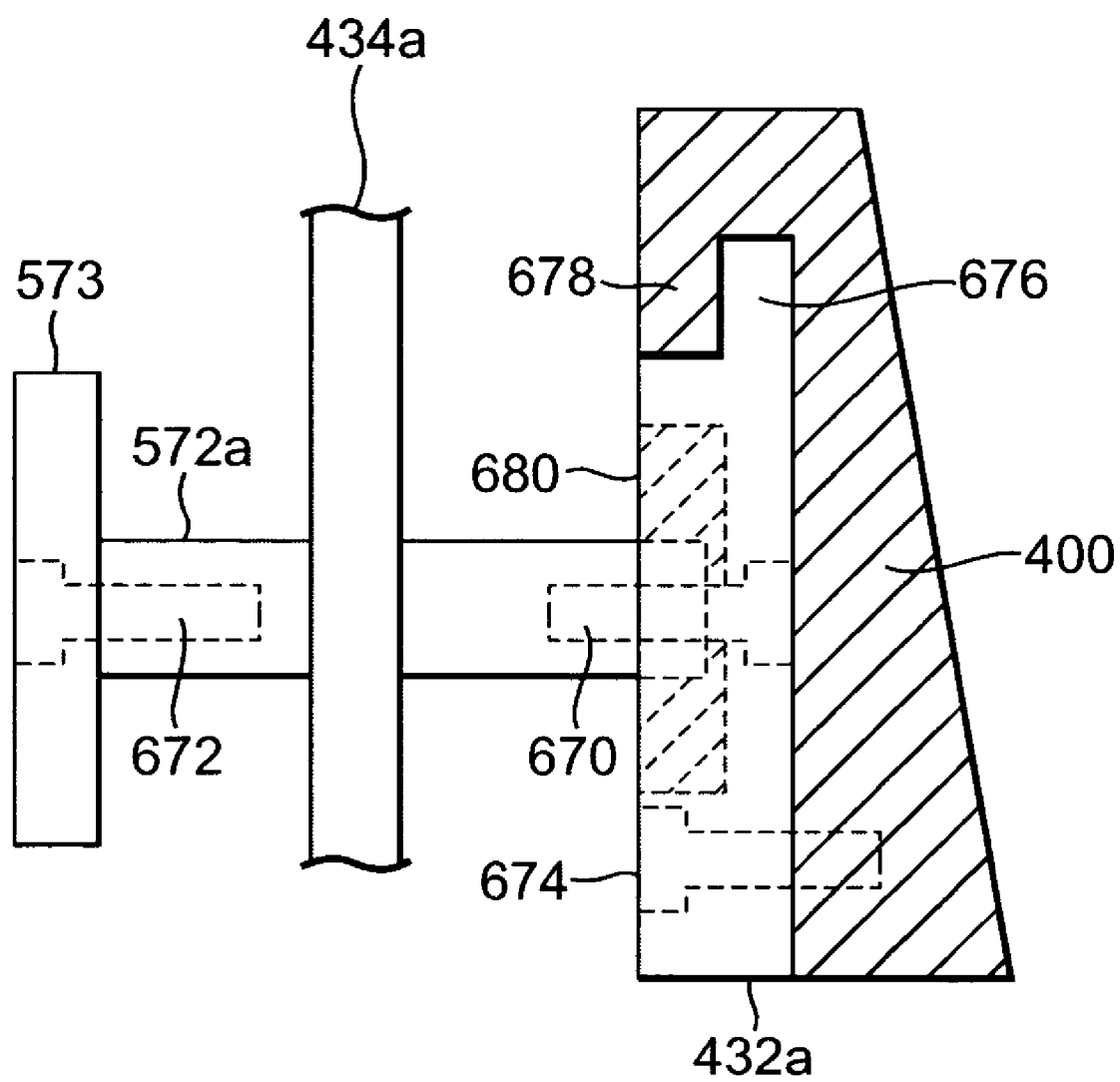


Fig. 16

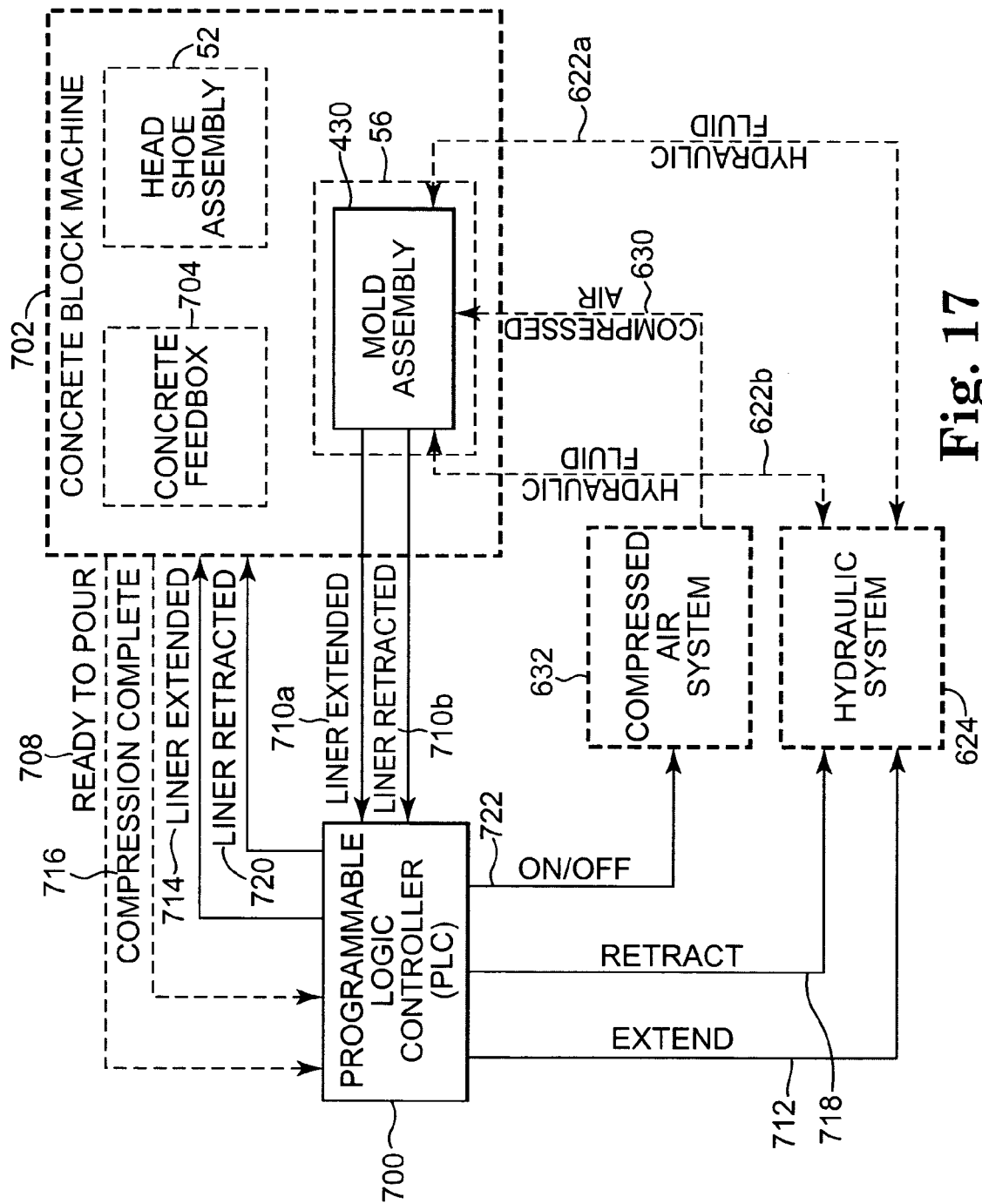


Fig. 17

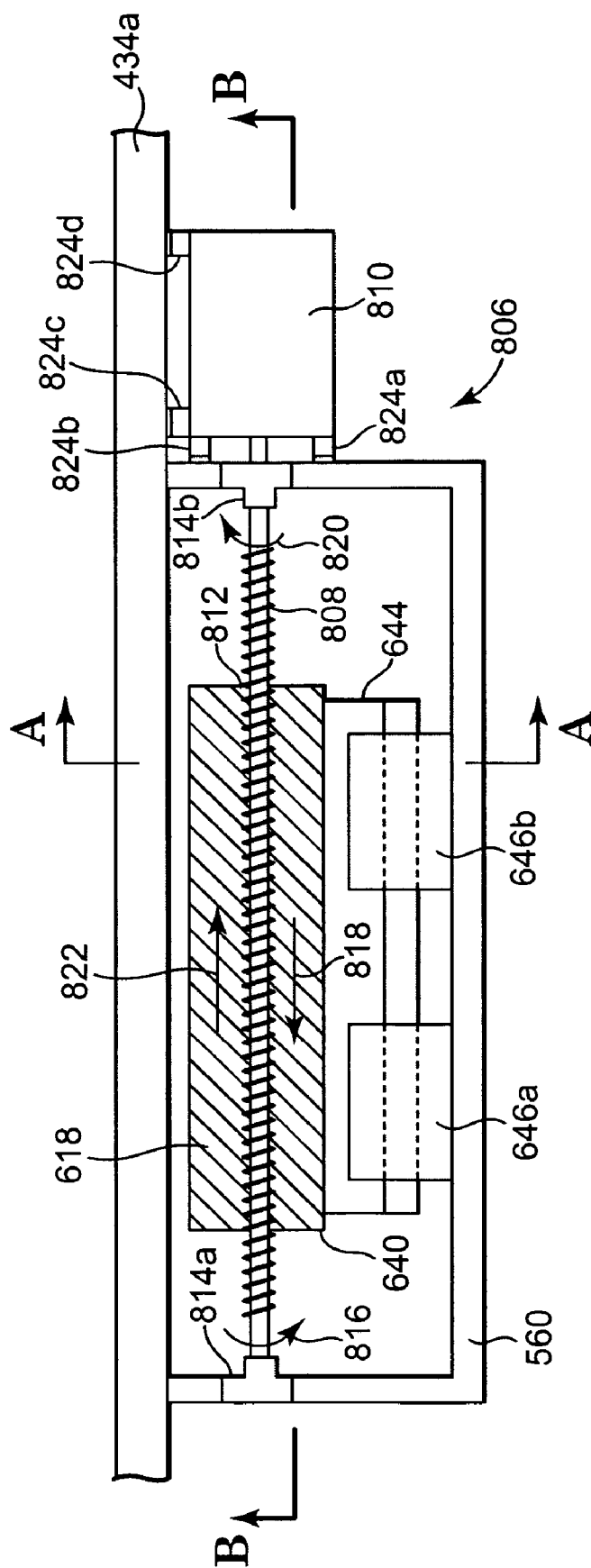


Fig. 18A

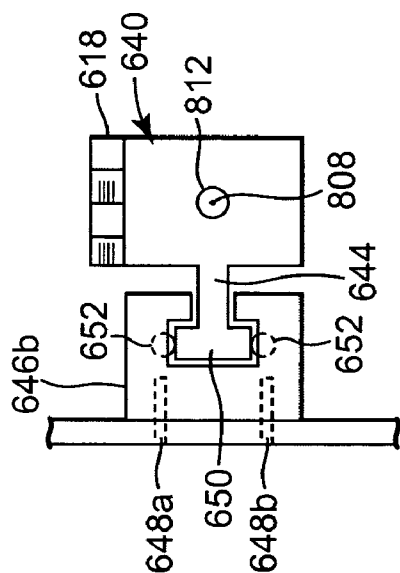


Fig. 18B

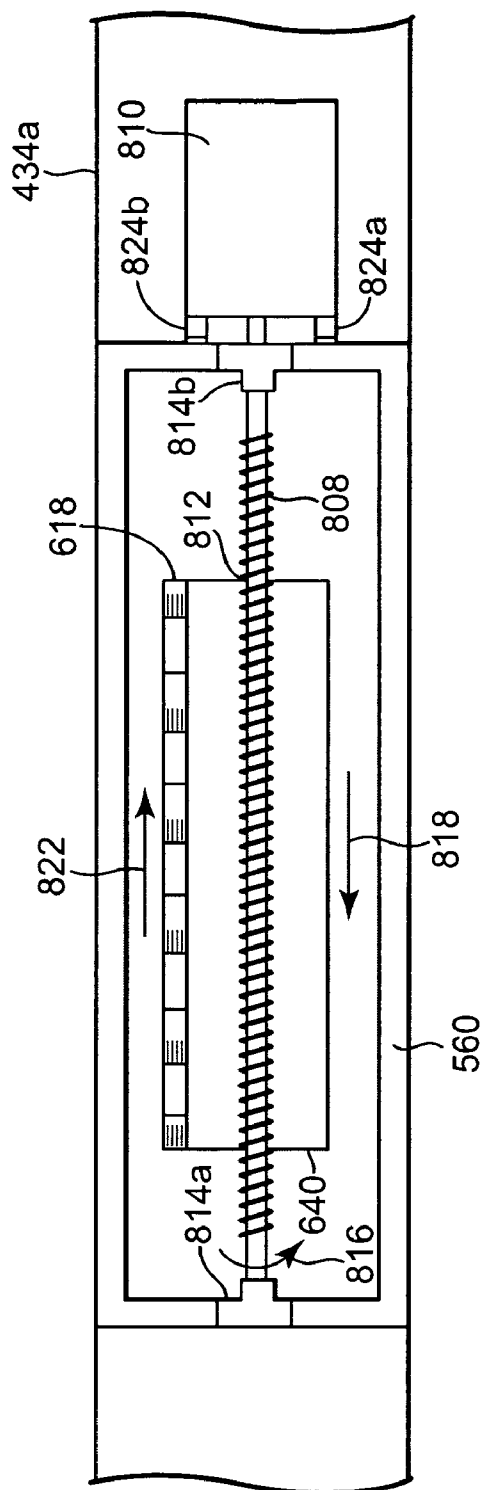


Fig. 18C

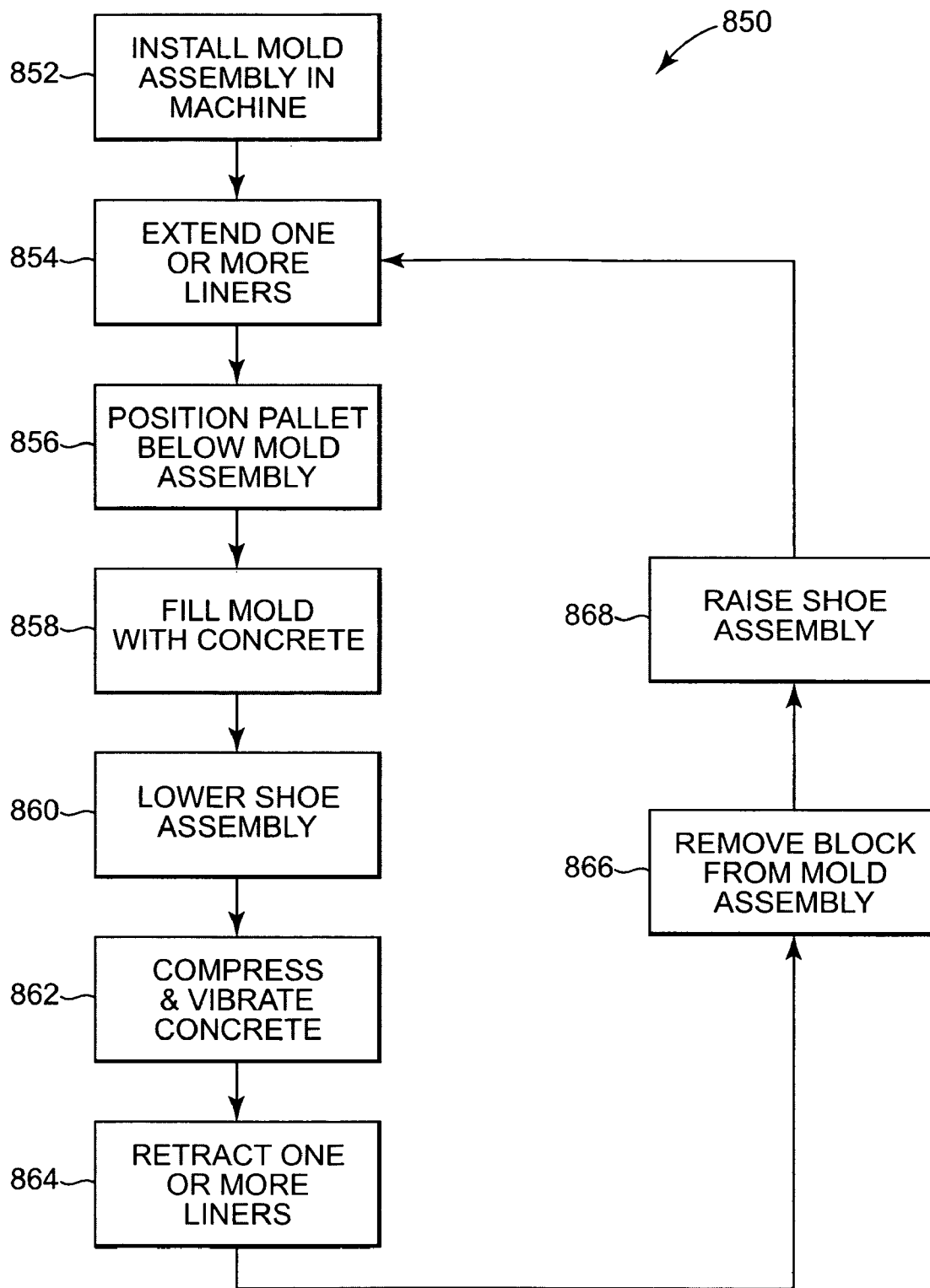


Fig. 19

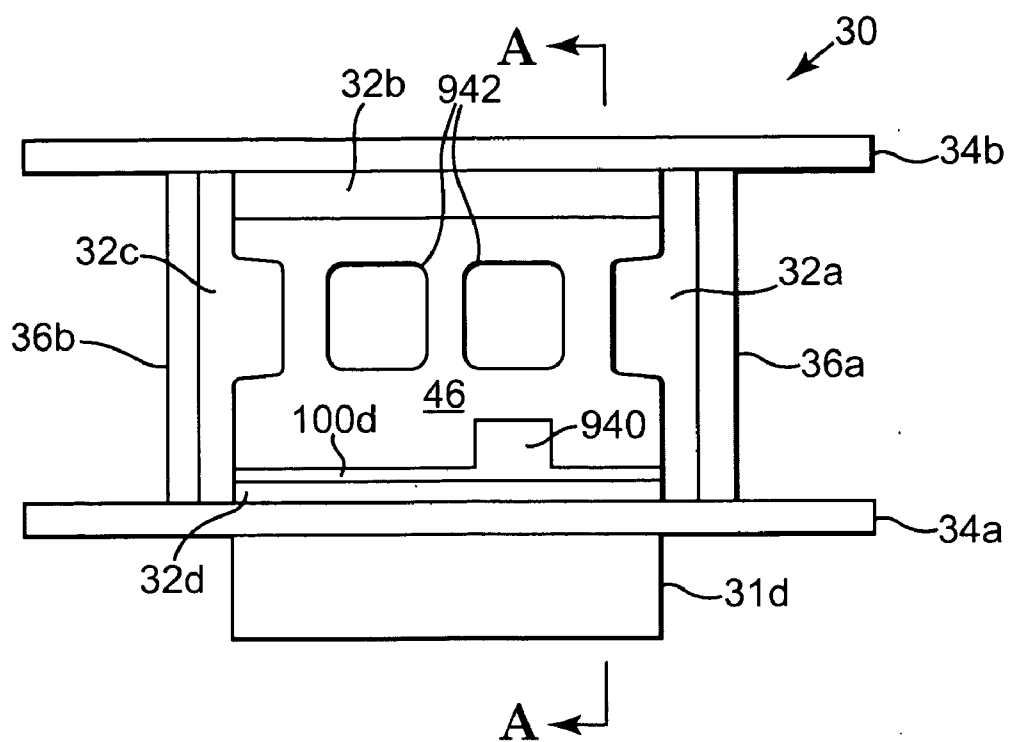


Fig. 21A

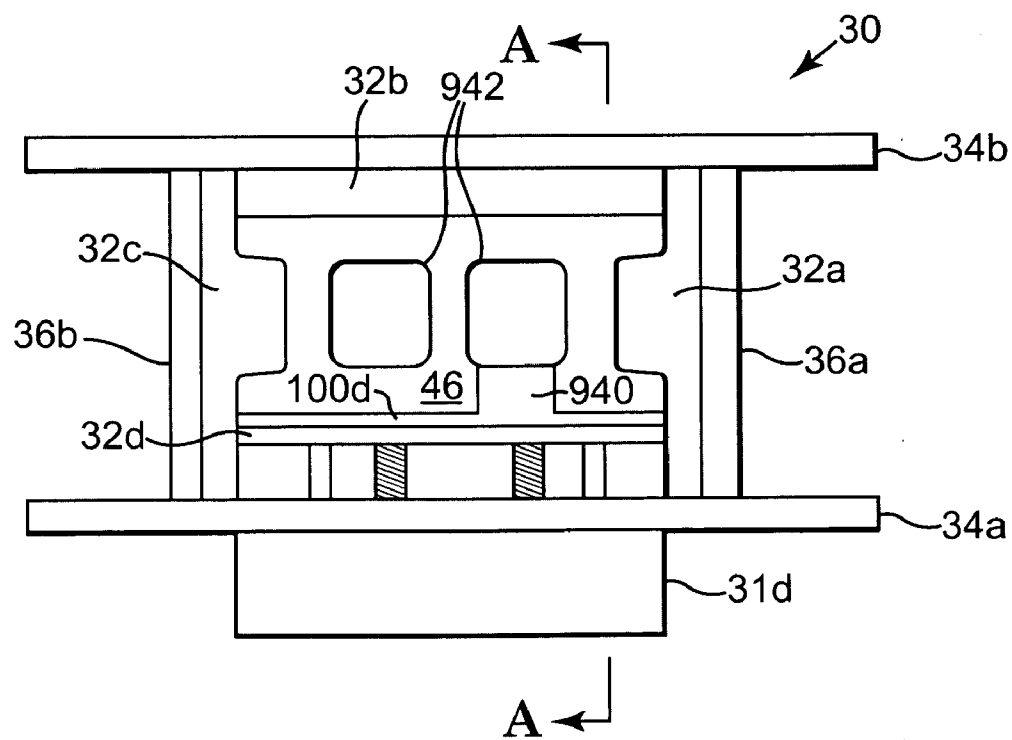


Fig. 21B

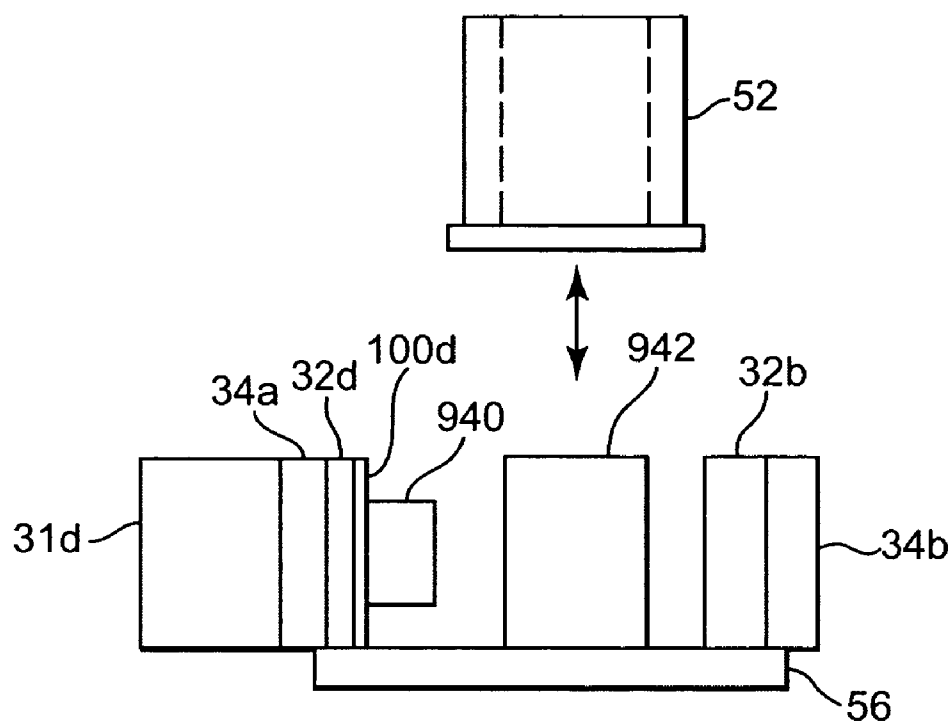


Fig. 21C

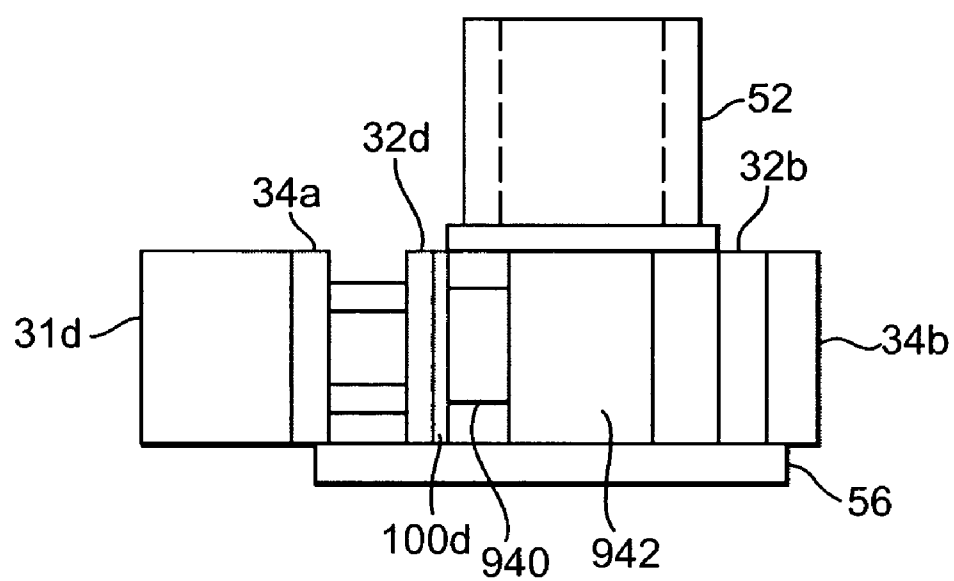


Fig. 21D

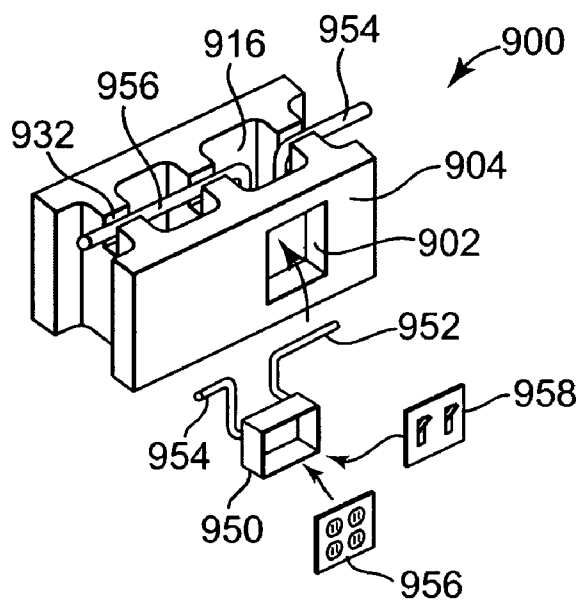


Fig. 22

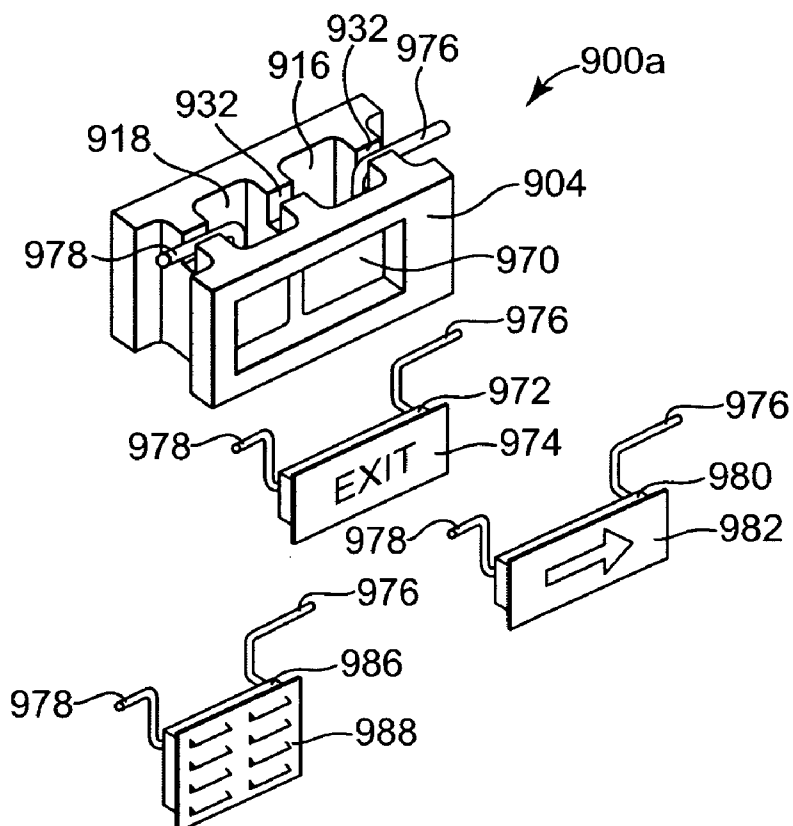


Fig. 23

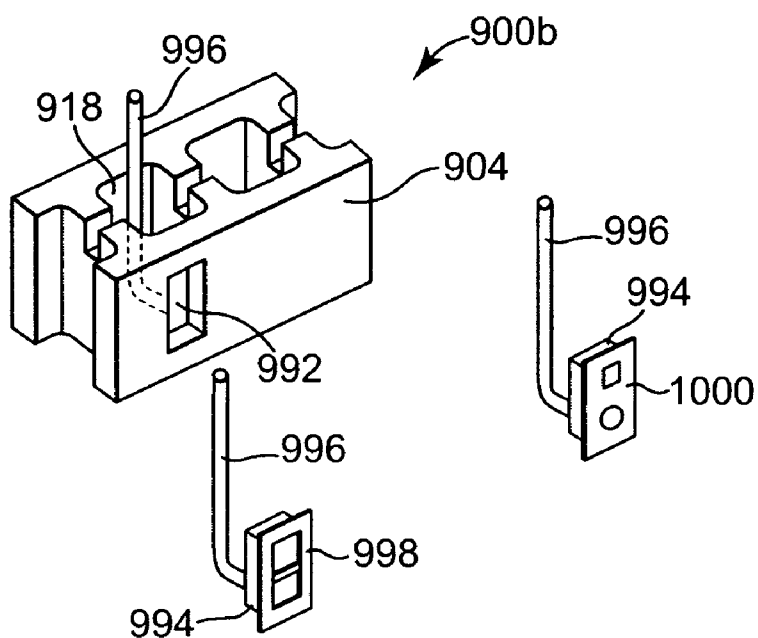


Fig. 24

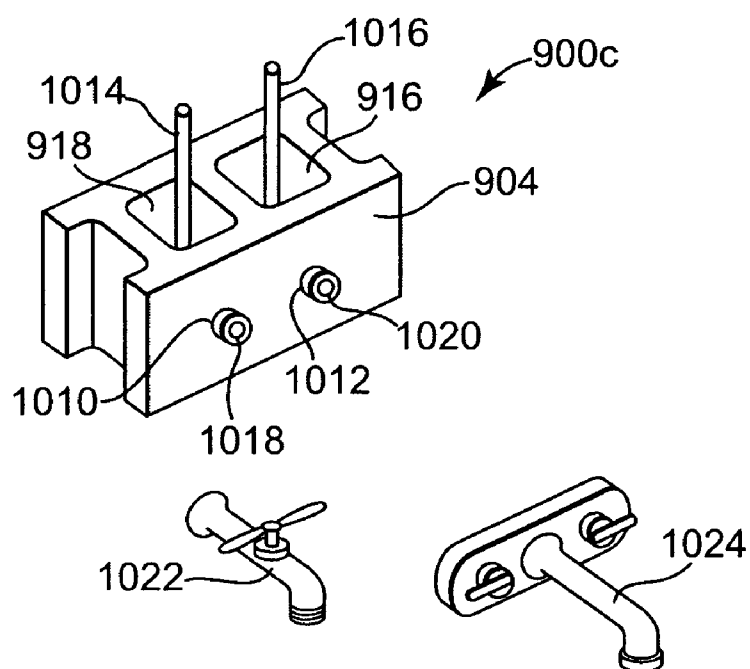


Fig. 25

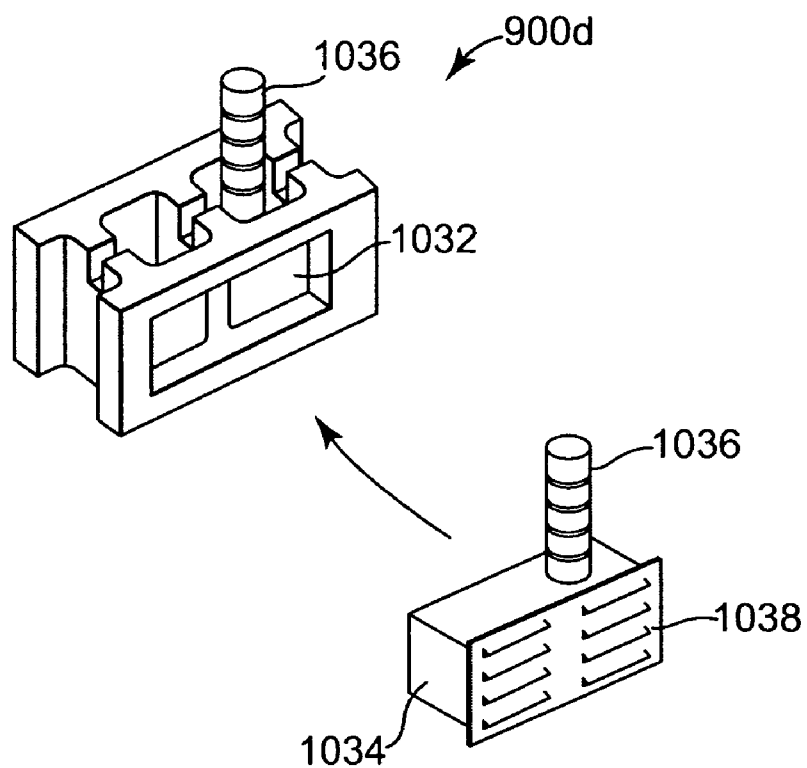


Fig. 26

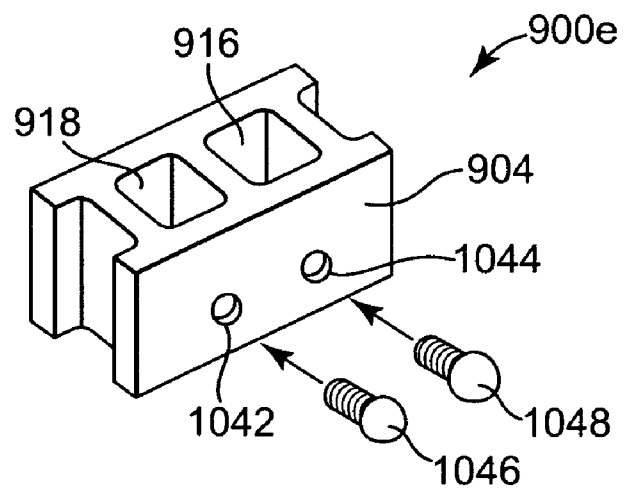


Fig. 27

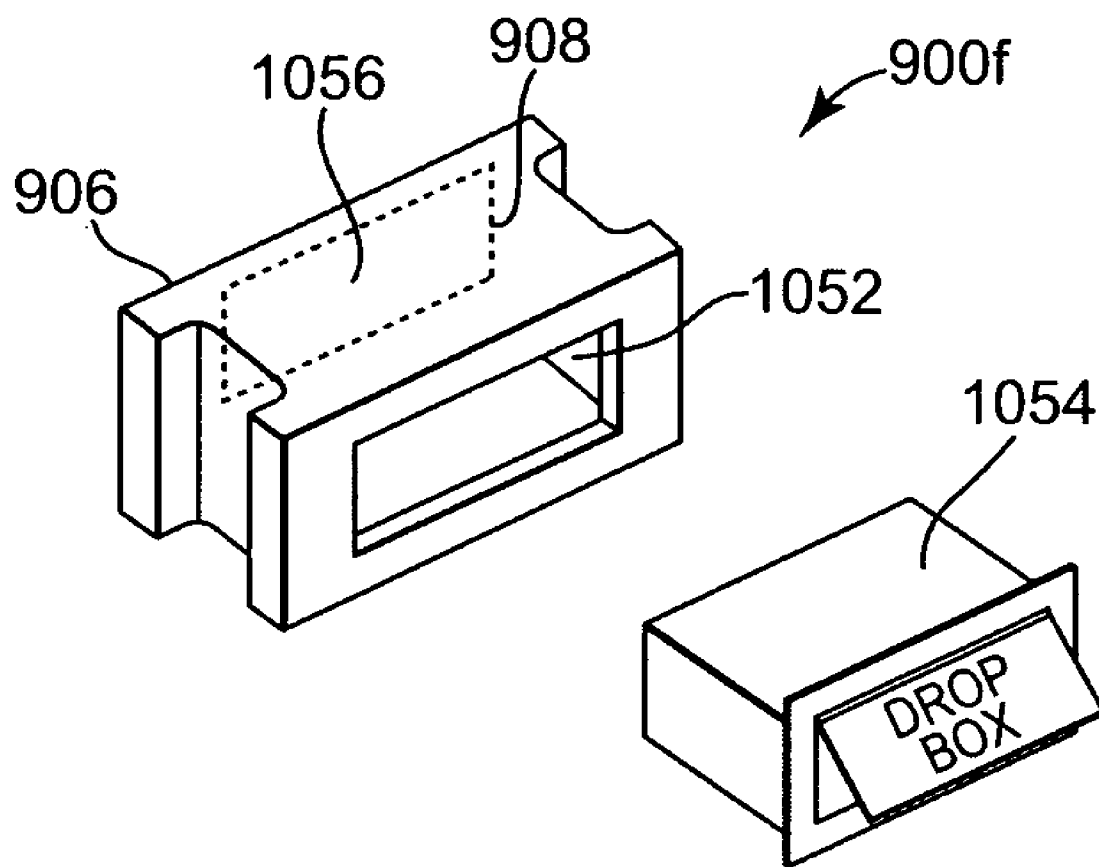


Fig. 28

MASONRY BLOCKS AND MASONRY BLOCK ASSEMBLIES HAVING MOLDED UTILITY OPENINGS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The subject matter of this application is related to the subject matter of U.S. Provisional Patent Application No. 60/644,107, filed Jan. 13, 2005, priority to which is claimed under 35 U.S.C. §119(e) and which is incorporated herein by reference.

THE FIELD OF THE INVENTION

[0002] The present invention relates generally to masonry blocks, and more particularly to masonry blocks and masonry block assemblies having molded utility openings.

BACKGROUND OF THE INVENTION

[0003] Concrete blocks, sometimes referred to as concrete masonry units, are employed to construct any number of structures. One type of concrete masonry unit, commonly referred to as a masonry "gray block", is a hollow core block that is often used to construct basement and foundation walls and in the construction of large commercial and institutional buildings. Gray blocks are easy to install and provide strength, durability, and flexibility in construction. The hollow cores also aid in keeping water and condensation from the inside wall surfaces. Furthermore, when the hollow cores are filled with insulation, gray blocks provide increased energy efficiency relative to other types of structures, such as poured concrete.

[0004] One drawback of using gray block in building construction, however, is that installation of utilities (e.g. electrical system components, plumbing, etc.) can be difficult and time consuming. For example, it is often a time consuming and costly for electricians to cut out required openings in the blocks for installation of conduit and junction boxes for light switches, receptacles, and other electrical devices.

SUMMARY OF THE INVENTION

[0005] One embodiment of the present invention provides a masonry block molded by a masonry block machine employing a mold assembly having a plurality of liner plates, at least one of which is moveable. The masonry block includes a first transverse face, a second transverse face opposing the first transverse face, at least one aperture extending through the masonry block between the first and second transverse faces, a first end face joining the first and second transverse faces, a second end face opposite the first end face and joining the first and second transverse faces, a first major face joining the first end and second end faces, and a second major face opposing the first major face and joining the first and second end faces. A molded utility opening extends through the first major face to the at least one aperture and adapted to receive a utility device, wherein the first major face and molded utility opening are formed during a molding process by action of a moveable liner plate having a mold element which is a negative of the molded utility opening.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] **FIG. 1** is a perspective view of one exemplary embodiment of a mold assembly having moveable liner plates according to the present invention.

[0007] **FIG. 2** is a perspective view of one exemplary embodiment of a gear drive assembly and moveable liner plate according to the present invention.

[0008] **FIG. 3A** is a top view of gear drive assembly and moveable liner plate as illustrated in **FIG. 2**.

[0009] **FIG. 3B** is a side view of gear drive assembly and moveable liner plate as illustrated in **FIG. 2**.

[0010] **FIG. 4A** is a top view of the mold assembly of **FIG. 1** having the liner plates retracted.

[0011] **FIG. 4B** is a top view of the mold assembly of **FIG. 1** having the liner plates extended.

[0012] **FIG. 5A** illustrates a top view of one exemplary embodiment of a gear plate according to the present invention.

[0013] **FIG. 5B** illustrates an end view of the gear plate illustrated by **FIG. 5A**.

[0014] **FIG. 5C** illustrates a bottom view of one exemplary embodiment of a gear head according to the present invention.

[0015] **FIG. 5D** illustrates an end view of the gear head of **FIG. 5C**.

[0016] **FIG. 6A** is a top view of one exemplary embodiment of a gear track according to the present invention.

[0017] **FIG. 6B** is a side view of the gear track of **FIG. 6A**.

[0018] **FIG. 6C** is an end view of the gear track of **FIG. 6A**.

[0019] **FIG. 7** is a diagram illustrating the relationship between a gear track and gear plate according to the present invention.

[0020] **FIG. 8A** is a top view illustrating the relationship between one exemplary embodiment of a gear head, gear plate, and gear track according to the present invention.

[0021] **FIG. 8B** is a side view of the illustration of **FIG. 8A**.

[0022] **FIG. 8C** is an end view of the illustration of **FIG. 8A**.

[0023] **FIG. 9A** is a top view illustrating one exemplary embodiment of a gear plate being in a retracted position within a gear track according to the present invention.

[0024] **FIG. 9B** is a top view illustrating one exemplary embodiment of a gear plate being in an extended position from a gear track according to the present invention.

[0025] **FIG. 10A** is a diagram illustrating one exemplary embodiment of drive unit according to the present invention.

[0026] **FIG. 10B** is a partial top view of the drive unit of the illustration of **FIG. 10A**.

[0027] **FIG. 11A** is a top view illustrating one exemplary embodiment of a mold assembly according to the present invention.

[0028] **FIG. 11B** is a diagram illustrating one exemplary embodiment of a gear drive assembly according to the present invention.

[0029] FIG. 12 is a perspective view illustrating a portion of one exemplary embodiment of a mold assembly according to the present invention.

[0030] FIG. 13 is a perspective view illustrating one exemplary embodiment of a gear drive assembly according to the present invention.

[0031] FIG. 14 is a top view illustrating a portion of one exemplary embodiment of a mold assembly and gear drive assembly according to the present invention.

[0032] FIG. 15A is a top view illustrating a portion of one exemplary embodiment of a gear drive assembly employing a stabilizer assembly.

[0033] FIG. 15B is a cross-sectional view of the gear drive assembly of FIG. 15A.

[0034] FIG. 15C is a cross-sectional view of the gear drive assembly of FIG. 15A.

[0035] FIG. 16 is a side view illustrating a portion of one exemplary embodiment of a gear drive assembly and moveable liner plate according to the present invention.

[0036] FIG. 17 is a block diagram illustrating one exemplary embodiment of a mold assembly employing a control system according to the present invention.

[0037] FIG. 18A is a top view illustrating a portion of one exemplary embodiment of gear drive assembly employing a screw drive system according to the present invention.

[0038] FIG. 18B is a lateral cross-sectional view of the gear drive assembly of FIG. 18A.

[0039] FIG. 18C is a longitudinal cross-sectional view of the gear drive assembly of FIG. 18A.

[0040] FIG. 19 is flow diagram illustrating one exemplary embodiment of a process for forming a concrete block employing a mold assembly according to the present invention.

[0041] FIG. 20 is a perspective view of one embodiment of a masonry block according to the present invention.

[0042] FIG. 21A is top view illustrating an example implementation of a mold assembly for forming the masonry block of FIG. 20.

[0043] FIG. 21B is top view illustrating an example implementation of a mold assembly for forming the masonry block of FIG. 20.

[0044] FIG. 21C is cross-sectional view of the mold assembly of FIG. 21A.

[0045] FIG. 21D is cross-sectional view of the mold assembly of FIG. 21B.

[0046] FIG. 22 is a perspective view of one embodiment of a masonry block according to the present invention.

[0047] FIG. 23 is a perspective view of one embodiment of a masonry block according to the present invention.

[0048] FIG. 24 is a perspective view of one embodiment of a masonry block according to the present invention.

[0049] FIG. 25 is a perspective view of one embodiment of a masonry block according to the present invention.

[0050] FIG. 26 is a perspective view of one embodiment of a masonry block according to the present invention.

[0051] FIG. 27 is a perspective view of one embodiment of a masonry block according to the present invention.

[0052] FIG. 28 is a perspective view of one embodiment of a masonry block according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0053] In the following Detailed Description, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. In this regard, directional terminology, such as "top," "bottom," "front," "back," "leading," "trailing," etc., is used with reference to the orientation of the Figure(s) being described. Because components of embodiments of the present invention can be positioned in a number of different orientations, the directional terminology is used for purposes of illustration and is in no way limiting. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope of the present invention. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims.

[0054] As described herein and illustrated by FIGS. 20-28, masonry blocks and masonry block assemblies having molded utility openings are provided. Examples of mold and drive assemblies suitable to be configured for use with the present invention are described and illustrated below by FIGS. 1-19 and by U.S. patent application Ser. No. 10/629,460 filed Jul. 29, 2003, Ser. No. 10/879,381 filed on Jun. 29, 2004, and Ser. No. 11/036,147 filed on Jan. 13, 2005, each of which is assigned to the same assignee as the present invention and incorporated by reference herein.

[0055] FIG. 1 is a perspective view of one exemplary embodiment of a mold assembly 30 having moveable liner plates 32a, 32b, 32c and 32d according to the present invention. Mold assembly 30 includes a drive system assembly 31 having side-members 34a and 34b and cross-members 36a and 36b, respectively having an inner wall 38a, 38b, 40a, and 40b, and coupled to one another such that the inner surfaces form a mold box 42. In the illustrated embodiment, cross members 36a and 36b are bolted to side members 34a and 34b with bolts 37.

[0056] Moveable liner plates 32a, 32b, 32c, and 32d, respectively have a front surface 44a, 44b, 44c, and 44d configured so as to form a mold cavity 46. In the illustrated embodiment, each liner plate has an associated gear drive assembly located internally to an adjacent mold frame member. A portion of a gear drive assembly 50 corresponding to liner plate 32a and located internally to cross-member 36a is shown extending through side-member 34a. Each gear drive assembly is selectively coupled to its associated liner plate and configured to move the liner plate toward the interior of mold cavity 46 by applying a first force in a first direction parallel to the associated cross-member, and to move the liner plate away from the interior of mold cavity 46 by applying a second force in a direction opposite the first direction. Side members 34a and 34b and cross-members 36a and 36b each have a corresponding lubrication port that

extends into the member and provides lubrication to the corresponds gear elements. For example, lubrication ports **48a** and **48b**. The gear drive assembly and moveable liner plates according to the present invention are discussed in greater detail below.

[0057] In operation, mold assembly **30** is selectively coupled to a concrete block machine. For ease of illustrative purposes, however, the concrete block machine is not shown in **FIG. 1**. In one embodiment, mold assembly **30** is mounted to the concrete block machine by bolting side members **34a** and **34b** of drive system assembly **31** to the concrete block machine. In one embodiment, mold assembly **30** further includes a head shoe assembly **52** having dimensions substantially equal to those of mold cavity **46**. Head shoe assembly **52** is also configured to selectively couple to the concrete block machine.

[0058] Liner plates **32a** through **32d** are first extended a desired distance toward the interior of mold box **42** to form the desired mold cavity **46**. A vibrating table on which a pallet **56** is positioned is then raised (as indicated by directional arrow **58**) such that pallet **56** contacts and forms a bottom to mold cavity **46**. In one embodiment, a core bar assembly (not shown) is positioned within mold cavity **46** to create voids within the finished block in accordance with design requirements of a particular block.

[0059] Mold cavity **46** is then filled with concrete from a moveable feedbox drawer. Head shoe assembly **52** is then lowered (as indicated by directional arrow **54**) onto mold **46** and hydraulically or mechanically presses the concrete. Head shoe assembly **52** along with the vibrating table then simultaneously vibrate mold assembly **30**, resulting in a high compression of the concrete within mold cavity **46**. The high level of compression fills any voids within mold cavity **46** and causes the concrete to quickly reach a level of hardness that permits immediate removal of the finished block from mold cavity **46**.

[0060] The finished block is removed by first retracting liner plates **32a** through **32d**. Head shoe assembly **52** and the vibrating table, along with pallet **56**, are then lowered (in a direction opposite to that indicated by arrow **58**), while mold assembly **30** remains stationary so that head shoe assembly **56** pushes the finished block out of mold cavity **46** onto pallet **52**. When a lower edge of head shoe assembly **52** drops below a lower edge of mold assembly **30**, the conveyor system moves pallet **56** carrying the finished block away and a new pallet takes its place. The above process is repeated to create additional blocks.

[0061] By retracting liner plates **32a** through **32b** prior to removing the finished block from mold cavity **46**, liner plates **32a** through **32d** experience less wear and, thus, have an increased operating life expectancy. Furthermore, moveable liner plates **32a** through **32d** also enables a concrete block to be molded in a vertical position relative to pallet **56**, in lieu of the standard horizontal position, such that head shoe assembly **52** contacts what will be a “face” of the finished concrete block. A “face” is a surface of the block that will be potentially be exposed for viewing after installation in a wall or other structure.

[0062] **FIG. 2** is a perspective view **70** illustrating a moveable liner plate and corresponding gear drive assembly according to the present invention, such as moveable liner

plate **32a** and corresponding gear drive assembly **50**. For illustrative purposes, side member **34a** and cross-member **36** are not shown. Gear drive assembly **50** includes a first gear element **72** selectively coupled to liner plate **32a**, a second gear element **74**, a single rod-end double-acting pneumatic cylinder (cylinder) **76** coupled to second gear element **74** via a piston rod **78**, and a gear track **80**. Cylinder **76** includes an aperture **82** for accepting a pneumatic fitting. In one embodiment, cylinder **76** comprises a hydraulic cylinder. In one embodiment, cylinder **76** comprises a double rod-end dual-acting cylinder. In one embodiment, piston rod **78** is threadably coupled to second gear element **74**.

[0063] In the embodiment of **FIG. 2**, first gear element **72** and second gear element **74** are illustrated and hereinafter referred to as a gear plate **72** and second gear element **74**, respectively. However, while illustrated as a gear plate and a cylindrical gear head, first gear element **72** and second gear element **74** can be of any suitable shape and dimension.

[0064] Gear plate **72** includes a plurality of angled channels on a first major surface **84** and is configured to slide in gear track **80**. Gear track **80** slidably inserts into a gear slot (not shown) extending into cross member **36a** from inner wall **40a**. Cylindrical gear head **74** includes a plurality of angled channels on a surface **86** adjacent to first major surface **84** of female gear plate **72**, wherein the angled channels are tangential to a radius of cylindrical gear head **74** and configured to slidably mate and interlock with the angled channels of gear plate **72**. Liner plate **32a** includes guide posts **88a**, **88b**, **88c**, and **88d** extending from a rear surface **90**. Each of the guide posts is configured to slidably insert into a corresponding guide hole (not shown) extending into cross member **36a** from inner wall **40a**. The gear slot and guide holes are discussed in greater detail below.

[0065] When cylinder **76** extends piston rod **78**, cylindrical gear head **74** moves in a direction indicated by arrow **92** and, due to the interlocking angled channels, causes gear plate **72** and, thus, liner plate **32a** to move toward the interior of mold **46** as indicated by arrow **94**. It should be noted that, as illustrated, **FIG. 2** depicts piston rod **78** and cylindrical gear head **74** in an extended position. When cylinder **76** retracts piston rod **78**, cylindrical gear head **74** moves in a direction indicated by arrow **96** causing gear plate **72** and liner plate **32** to move away from the interior of the mold as indicated by arrow **98**. As liner plate **32a** moves, either toward or away from the center of the mold, gear plate **72** slides in guide track **80** and guide posts **88a** through **88d** slide within their corresponding guide holes.

[0066] In one embodiment, a removable liner face **100** is selectively coupled to front surface **44a** via fasteners **102a**, **102b**, **102c**, and **102d** extending through liner plate **32a**. Removable liner face **100** is configured to provide a desired shape and/or provide a desired imprinted pattern, including text, on a block made in mold **46**. In this regard, removable liner face **100** comprises a negative of the desired shape or pattern. In one embodiment, removable liner face **100** comprises a polyurethane material. In one embodiment, removable liner face **100** comprises a rubber material. In one embodiment, removable liner plate comprises a metal or metal alloy, such as steel or aluminum. In one embodiment, liner plate **32** further includes a heater mounted in a recess **104** on rear surface **90**, wherein the heater aids in curing

concrete within mold 46 to reduce the occurrence of concrete sticking to front surface 44a and removable liner face 100.

[0067] FIG. 3A is a top view 120 of gear drive assembly 50 and liner plate 32a, as indicated by directional arrow 106 in FIG. 2. In the illustration, side members 34a and 34b, and cross member 36a are indicated dashed lines. Guide posts 88c and 88d are slidably inserted into guide holes 122c and 122d, respectively, which extend into cross member 36a from interior surface 40a. Guide holes 122a and 122b, corresponding respectively to guide posts 88a and 88b, are not shown but are located below and in-line with guide holes 122c and 122d. In one embodiment, guide hole bushings 124c and 124d are inserted into guide holes 122c and 122d, respectively, and slidably receive guide posts 88c and 88d. Guide hole bushings 124a and 124b are not shown, but are located below and in-line with guide hole bushings 124c and 124d. Gear track 80 is shown as being slidably inserted in a gear slot 126 extending through cross member 36a with gear plate 72 sliding in gear track 80. Gear plate 72 is indicated as being coupled to liner plate 32a by a plurality of fasteners 128 extending through liner plate 32a from front surface 44a.

[0068] A cylindrical gear shaft is indicated by dashed lines 134 as extending through side member 34a and into cross member 36a and intersecting, at least partially with gear slot 126. Cylindrical gear head 74, cylinder 76, and piston rod 78 are slidably inserted into gear shaft 134 with cylindrical gear head 74 being positioned over gear plate 72. The angled channels of cylindrical gear head 74 are shown as dashed lines 130 and are interlocking with the angled channels of gear plate 72 as indicated at 132.

[0069] FIG. 3B is a side view 140 of gear drive assembly 50 and liner plate 32a, as indicated by directional arrow 108 in FIG. 2. Liner plate 32a is indicated as being extended, at least partially, from cross member 36a. Correspondingly, guide posts 88a and 88d are indicated as partially extending from guide hole bushings 124a and 124d, respectively. In one embodiment, a pair of limit rings 142a and 142d are selectively coupled to guide posts 88a and 88d, respectively, to limit an extension distance that liner plate 32a can be extended from cross member 36a toward the interior of mold cavity 46. Limit rings 142b and 142c corresponding respectively to guide posts 88b and 88c are not shown, but are located behind and in-line with limit rings 142a and 142d. In the illustrated embodiment, the limit rings are indicated as being substantially at an end of the guide posts, thus allowing a substantially maximum extension distance from cross member 36a. However, the limit rings can be placed at other locations along the guide posts to thereby adjust the allowable extension distance.

[0070] FIG. 4A and FIG. 4B are top views 150 and 160, respectively, of mold assembly 30. FIG. 4A illustrates liner plates 32a, 32b, 32c, and 32d in a retracted positions. Liner faces 152, 154, and 154 correspond respectively to liner plates 32b, 32c, and 32d. FIG. 4B illustrates liner plates 32a, 32b, 32c, and 32d, along with their corresponding liner faces 100, 152, 154, and 156 in an extended position.

[0071] FIG. 5A is a top view 170 of gear plate 72. Gear plate 72 includes a plurality of angled channels 172 running across a top surface 174 of gear plate 72. Angled channels 172 form a corresponding plurality of linear “teeth” 176

having as a surface the top surface 174. Each angled channel 172 and each tooth 176 has a respective width 178 and 180. The angled channels run at an angle (Θ) 182 from 0°, indicated at 186, across gear plate 72.

[0072] FIG. 5B is an end view (“A”) 185 of gear plate 72, as indicated by directional arrow 184 in FIG. 5A, further illustrating the plurality of angled channels 172 and linear teeth 176. Each angled channel 172 has a depth 192.

[0073] FIG. 5C illustrates a view 200 of a flat surface 202 of cylindrical gear head 76. Cylindrical gear head 76 includes a plurality of angled channels 204 running across surface 202. Angled channels 204 form a corresponding plurality of linear teeth 206. The angled channels 204 and linear teeth 206 have widths 180 and 178, respectively, such that the width of linear teeth 206 substantially matches the width of angled channels 172 and the width of angled channels 204 substantially match the width of linear teeth 176. Angled channels 204 and teeth 206 run at angle (Θ) 182 from 0°, indicated at 186, across surface 202.

[0074] FIG. 5D is an end view 210 of cylindrical gear head 76, as indicated by directional arrow 208 in FIG. 5C, further illustrating the plurality of angled channels 204 and linear teeth 206. Surface 202 is a flat surface tangential to a radius of cylindrical gear head 76. Each angled channel has a depth 192 from flat surface 202.

[0075] When cylindrical gear head 76 is “turned over” and placed across surface 174 of gear plate 72, linear teeth 206 of gear head 76 mate and interlock with angled channels 172 of gear plate 72, and linear teeth 176 of gear plate 72 mate and interlock with angled channels 204 of gear head 76 (See also FIG. 2). When gear head 76 is forced in direction 92, linear teeth 206 of gear head 76 push against linear teeth 176 of gear plate 72 and force gear plate 72 to move in direction 94. Conversely, when gear head 76 is forced in direction 96, linear teeth 206 of gear head 76 push against linear teeth 176 of gear plate 72 and force gear plate 72 to move in direction 98.

[0076] In order for cylindrical gear head 76 to force gear plate 72 in directions 94 and 98, angle (Θ) 182 must be greater than 0° and less than 90°. However, it is preferable that Θ 182 be at least greater than 45°. When Θ 182 is 45° or less, it takes more force for cylindrical gear head 74 moving in direction 92 to push gear plate 72 in direction 94 than it does for gear plate 72 being forced in direction 98 to push cylindrical gear head 74 in direction 96, such as when concrete in mold 46 is being compressed. The more Θ 182 is increased above 45°, the greater the force that is required in direction 98 on gear plate 72 to move cylindrical gear head 74 in direction 96. In fact, at 90° gear plate 72 would be unable to move cylindrical gear head 74 in either direction 92 or 96, regardless of how much force was applied to gear plate 72 in direction 98. In effect, angle (Θ) acts as a multiplier to a force provided to cylindrical gear head 74 by cylinder 76 via piston rod 78. When Θ 182 is greater than 45°, an amount of force required to be applied to gear plate 72 in direction 98 in order to move cylindrical gear head 74 in direction 96 is greater than an amount of force required to be applied to cylindrical gear head 74 in direction 92 via piston rod 78 in order to “hold” gear plate 72 in position (i.e., when concrete is being compressed in mold 46).

[0077] However, the more Θ 182 is increased above 45°, the less distance gear plate 72, and thus corresponding liner

plate 32a, will move in direction 94 when cylindrical gear head 74 is forced in direction 92. A preferred operational angle for $\Theta 182$ is approximately 70° . This angle represents roughly a balance, or compromise, between the length of travel of gear plate 72 and an increase in the level of force required to be applied in direction 98 on gear plate 72 to force gear head 74 in direction 96. Gear plate 72 and cylindrical gear head 74 and their corresponding angled channels 176 and 206 reduce the required psi rating of cylinder 76 necessary to maintain the position of liner plate 32a when concrete is being compressed in mold cavity 46 and also reduces the wear experienced by cylinder 76. Additionally, from the above discussion, it is evident that one method for controlling the travel distance of liner plate 32a is to control the angle (Θ) 182 of the angled channels 176 and 206 respectively of gear plate 72 and cylindrical gear head 74.

[0078] FIG. 6A is a top view 220 of gear track 80. Gear track 80 has a top surface 220, a first end surface 224, and a second end surface 226. A rectangular gear channel, indicated by dashed lines 228, having a first opening 230 and a second opening 232 extends through gear track 80. An arcuate channel 234, having a radius required to accommodate cylindrical gear head 76 extends across top surface 220 and forms a gear window 236 extending through top surface 222 into gear channel 228. Gear track 80 has a width 238 incrementally less than a width of gear opening 126 in side member 36a (see also FIG. 3A).

[0079] FIG. 6B is an end view 250 of gear track 80, as indicated by direction arrow 240 in FIG. 6A, further illustrating gear channel 228 and arcuate channel 234. Gear track 80 has a depth 252 incrementally less than height of gear opening 126 in side member 36a (see FIG. 3A). FIG. 6B is a side view 260 of gear track 80 as indicated by directional arrow 242 in FIG. 6A.

[0080] FIG. 7 is a top view 270 illustrating the relationship between gear track 80 and gear plate 72. Gear plate 72 has a width 272 incrementally less than a width 274 of gear track 80, such that gear plate 72 can be slidably inserted into gear channel 228 via first opening 230. When gear plate 72 is inserted within gear track 80, angled channels 172 and linear teeth 176 are exposed via gear window 236.

[0081] FIG. 8A is a top view 280 illustrating the relationship between gear plate 72, cylindrical gear head 74, and gear track 80. Gear plate 72 is indicated as being slidably inserted within guide track 80. Cylindrical gear head 74 is indicated as being positioned within arcuate channel 234, with the angled channels and linear teeth of cylindrical gear head 74 being slidably mated and interlocked with the angled channels 172 and linear teeth 176 of gear plate 72. When cylindrical gear head 74 is moved in direction 92 by extending piston rod 78, gear plate 72 extends outward from gear track 80 in direction 94 (See also FIG. 9B below). When cylindrical gear head 74 is moved in direction 96 by retracting piston rod 78, gear plate 72 retracts into gear track 80 in direction 98 (See also FIG. 9A below).

[0082] FIG. 8B is a side view 290 of gear plate 72, cylindrical gear head 74, and guide track 80 as indicated by directional arrow 282 in FIG. 8A. Cylindrical gear head 74 is positioned such that surface 202 is located within arcuate channel 234. Angled channels 204 and teeth 206 of cylindrical gear head 74 extend through gear window 236 and

interlock with angled channels 172 and linear teeth 176 of gear plate 72 located within gear channel 228. FIG. 8C is an end view 300 as indicated by directional arrow 284 in FIG. 8A, and further illustrates the relationship between gear plate 72, cylindrical gear head 74, and guide track 80.

[0083] FIG. 9A is top view 310 illustrating gear plate 72 being in a fully retracted position within gear track 80, with liner plate 32a being retracted against cross member 36a. For purposes of clarity, cylindrical gear head 74 is not shown. Angled channels 172 and linear teeth 176 are visible through gear window 236. Liner plate 32a is indicated as being coupled to gear plate 72 with a plurality of fasteners 128 extending through liner plate 32a into gear plate 72. In one embodiment, fasteners 128 threadably couple liner plate 32a to gear plate 72.

[0084] FIG. 9B is a top view 320 illustrating gear plate 72 being extended, at least partially from gear track 80, with liner plate 32a being separated from cross member 36a. Again, cylindrical gear head 74 is not shown and angled channels 172 and linear teeth 176 are visible through gear window 236.

[0085] FIG. 10A is a diagram 330 illustrating one exemplary embodiment of a gear drive assembly 332 according to the present invention. Gear drive assembly 332 includes cylindrical gear head 74, cylinder 76, piston rod 78, and a cylindrical sleeve 334. Cylindrical gear head 74 and piston rod 78 are configured to slidably insert into cylindrical sleeve 334. Cylinder 76 is threadably coupled to cylindrical sleeve 334 with an O-ring 336 making a seal. A window 338 along an axis of cylindrical sleeve 334 partially exposes angled channels 204 and linear teeth 206. A fitting 342, such as a pneumatic or hydraulic fitting, is indicated as being threadably coupled to aperture 82. Cylinder 76 further includes an aperture 344, which is accessible through cross member 36a.

[0086] Gear drive assembly 332 is configured to slidably insert into cylindrical gear shaft 134 (indicated by dashed lines) so that window 338 intersects with gear slot 126 so that angled channels 204 and linear teeth 206 are exposed within gear slot 126. Gear track 80 and gear plate 72 (not shown) are first slidably inserted into gear slot 126, such that when gear drive assembly 332 is slidably inserted into cylindrical gear shaft 134 the angled channels 204 and linear teeth 206 of cylindrical gear head 74 slidably mate and interlock with the angled channels 172 and linear teeth 176 of gear plate 72.

[0087] In one embodiment, a key 340 is coupled to cylindrical gear head 74 and rides in a key slot 342 in cylindrical sleeve 334. Key 340 prevents cylindrical gear head 74 from rotating within cylindrical sleeve 334. Key 340 and key slot 342 together also control the maximum extension and retraction of cylindrical gear head 74 within cylindrical sleeve 334. Thus, in one embodiment, key 340 can be adjusted to control the extension distance of liner plate 32a toward the interior of mold cavity 46. FIG. 10A is a top view 350 of cylindrical shaft 334 as illustrated in FIG. 10B, and further illustrates key 340 and key slot 342.

[0088] FIG. 11A is a top view illustrating one exemplary embodiment of a mold assembly 360 according to the present invention for forming two concrete blocks. Mold assembly 360 includes a mold frame 361 having side

members 34a and 34b and cross members 36a through 36c coupled to one another so as to form a pair of mold boxes 42a and 42b. Mold box 42a includes moveable liner plates 32a through 32d and corresponding removable liner faces 33a through 33d configured to form a mold cavity 46a. Mold box 42b includes moveable liner plates 32e through 32h and corresponding removable liner faces 33e through 33h configured to form a mold cavity 46b.

[0089] Each moveable liner plate has an associated gear drive assembly located internally to an adjacent mold frame member as indicated by 50a through 50h. Each moveable liner plate is illustrated in an extended position with a corresponding gear plate indicated by 72a through 72h. As described below, moveable liner plates 32c and 32e share gear drive assembly 50c/e, with gear plate 72e having its corresponding plurality of angled channels facing upward and gear plate 72c having its corresponding plurality of angled channels facing downward.

[0090] FIG. 11B is diagram illustrating a gear drive assembly according to the present invention, such as gear drive assembly 50c/e. FIG. 11B illustrates a view of gear drive assembly 50c/e as viewed from section A-A through cross-member 36c of FIG. 11A. Gear drive assembly 50c/e includes a single cylindrical gear head 76c/e having angled channels 204c and 204e on opposing surfaces. Cylindrical gear head 76c/e fits into arcuate channels 234c and 234e of gear tracks 80c and 80d, such that angled channels 204c and 204e slidably interlock with angled channels 172c and 172e of gear plates 72c and 72e respectively.

[0091] Angled channels 172c and 204c, and 172e and 204e oppose one another and are configured such that when cylindrical gear head 76c/e is extended (e.g. out from FIG. 11B) gear plate 72c moves in a direction 372 toward the interior of mold cavity 46a and gear plate 72e moves in a direction 374 toward the interior of mold cavity 46b. Similarly, when cylindrical gear head 76c/e is retracted (e.g. into FIG. 11B) gear plate 72c moves in a direction 376 away from the interior of mold cavity 46a and gear plate 72e moves in a direction 378 away from the interior of mold cavity 378. Again, cylindrical gear head 76c/e and gear plates 72c and 72e could be of any suitable shape.

[0092] FIG. 12 is a perspective view illustrating a portion of one exemplary embodiment of a mold assembly 430 according to the present invention. Mold assembly includes moveable liner plates 432a through 432f for simultaneously molding multiple concrete blocks. Mold assembly 430 includes a drive system assembly 431 having a side members 434a and 434b, and cross members 436a and 436b. For illustrative purposes, side member 434a is indicated by dashed lines. Mold assembly 430 further includes division plates 437a through 437g.

[0093] Together, moveable liner plates 432a through 432f and division plates 437a through 437g form mold cavities 446a through 446f, with each mold cavity configured to form a concrete block. Thus, in the illustrated embodiment, mold assembly 430 is configured to simultaneously form six blocks. However, it should be apparent from the illustration that mold assembly 430 can be easily modified for simultaneously forming quantities of concrete blocks other than six.

[0094] In the illustrated embodiment, side members 434a and 434b each have a corresponding gear drive assembly for

moving moveable liner plates 432a through 432f and 432g through 432l, respectively. For illustrative purposes, only gear drive assembly 450 associated with side member 434a and corresponding moveable liner plates 432a through 432g is shown. Gear drive assembly 450 includes first gear elements 472a through 472f selectively coupled to corresponding moveable liner plates 432a through 432f, respectively, and a second gear element 474. In the illustrated embodiment, first gear elements 472a through 472f and second gear element 474 are shown as being cylindrical in shape. However, any suitable shape can be employed.

[0095] Second gear element 474 is selectively coupled to a cylinder-piston (not shown) via a piston rod 478. In one embodiment, which is described in greater detail below (see FIG. 12), second gear element 474 is integral with the cylinder-piston so as to form a single component.

[0096] In the illustrated embodiment, each first gear element 472a through 472f further includes a plurality of substantially parallel angled channels 484 that slidably mesh and interlock with a plurality of substantially parallel angled channels 486 on second gear element 474. When second gear element 474 is moved in a direction indicated by arrow 492, each of the moveable liner plates 432a through 432f moves in a direction indicated by arrow 494. Similarly, when second gear element 474 is move in a direction indicated by arrow 496, each of the moveable liner plates 432a through 432f moves in a direction indicated by arrow 498.

[0097] In the illustrated embodiment, the angled channels 484 on each of the first gear elements 432a through 432f and the angled channels 486 are at a same angle. Thus, when second gear element 474 moves in direction 492 and 496, each moveable liner plate 432a through 432f moves a same distance in direction 494 and 498, respectively. In one embodiment, second gear element 474 includes a plurality of groups of substantially parallel angled channels with each group corresponding to a different one of the first gear elements 472a through 472f. In one embodiment, the angled channels of each group and its corresponding first gear element have a different angle such that each moveable liner plate 432a through 432f move a different distance in directions 494 and 498 in response to second gear element 474 being moved in direction 492 and 496, respectively.

[0098] FIG. 13 is a perspective view illustrating a gear drive assembly 500 according to the present invention, and a corresponding moveable liner plate 502 and removable liner face 504. For illustrative purposes, a frame assembly including side members and cross members is not shown. Gear drive assembly 500 includes double rod-end, dual-acting pneumatic cylinder-piston 506 having a cylinder body 507, and a hollow piston rod 508 with a first rod-end 510 and a second rod-end 512. Gear drive assembly 500 further includes a pair of first gear elements 514a and 514b selectively coupled to moveable liner plate 502, with each first gear element 514a and 514b having a plurality of substantially parallel angled channels 516a and 516b.

[0099] In the illustrated embodiment, cylinder body 507 of cylinder-piston 506 includes a plurality of substantially parallel angled channels 518 configured to mesh and slidably interlock with angled channels 516a and 516b. In one embodiment, cylinder body 507 is configured to slidably insert into and couple to a cylinder sleeve having angled channels 518.

[0100] In one embodiment, cylinder-piston 506 and piston rod 508 are located within a drive shaft of a frame member, such as drive shaft 134 of cross-member 36a, with rod-end 510 coupled to and extending through a frame member, such as side member 34b, and second rod-end 512 coupled to and extending through a frame member, such as side member 34a. First rod-end 510 and second rod-end 512 are configured to receive and provide compressed air to drive dual-acting cylinder-piston 506. With piston rod 508 being fixed to side members 34a and 34b via first and second rod-ends 512 and 510, cylinder-piston 506 travels along the axis of piston rod 508 in the directions as indicated by arrows 520 and 522 in response to compressed air received via first and second rod-ends 510 and 512.

[0101] When compressed air is received via second rod-end 512 and expelled via first rod-end 510, cylinder-piston 506 moves within a drive shaft, such as drive shaft 134, in direction 522 and causes first gear elements 514a and 516b and corresponding liner plate 502 and liner face 504 to move in a direction indicated by arrow 524. Conversely, when compressed air is received via first rod-end 510 and expelled via second rod-end 512, cylinder-piston 506 moves within a gear shaft, such as gear shaft 134, in direction 520 and causes first gear elements 514a and 516b and corresponding liner plate 502 and liner face 504 to move in a direction indicated by arrow 526.

[0102] In the illustrated embodiment, cylinder-piston 506 and first gear elements 514a and 514b are shown as being substantially cylindrical in shape. However, any suitable shape can be employed. Furthermore, in the illustrated embodiment, cylinder-piston 506 is a double rod-end dual-acting cylinder. In one embodiment, cylinder piston 506 is a single rod-end dual acting cylinder having only a single rod-end 510 coupled to a frame member, such as side member 34b. In such an embodiment, compressed air is provided to cylinder-piston via single rod-end 510 and a flexible pneumatic connection made to cylinder-piston 506 through side member 34a via gear shaft 134. Additionally, cylinder-piston 506 comprises a hydraulic cylinder.

[0103] FIG. 14 is a top view of a portion of mold assembly 430 (as illustrated by FIG. 12) having a drive assembly 550 according to one embodiment of the present invention. Drive assembly 550 includes first drive elements 572a to 572f that are selectively coupled to corresponding liner plates 432a to 432f via openings, such as opening 433, in side member 434a. Each of the first drive elements 572a to 572f is further coupled to a master bar 573. Drive assembly 550 further includes a double-rod-end hydraulic piston assembly 606 having a dual-acting cylinder 607 and a hollow piston rod 608 having a first rod-end 610 and a second rod-end 612. First and second rod-ends 610, 612 are stationary and are coupled to and extend through a removable housing 560 that is coupled to side member 434a and encloses drive assembly 550. First and second rod ends 610, 612 are each coupled to hydraulic fittings 620 that are configured to connect via lines 622a and 622b to an external hydraulic system 624 and to transfer hydraulic fluid to and from dual-acting cylinder 607 via hollow piston rod 608.

[0104] In one embodiment, as illustrated, first drive elements 572b and 572e include a plurality of substantially parallel angled channels 616 that slideably interlock with a plurality of substantially parallel angled channels 618 that

form a second drive element. In one embodiment, as illustrated above by FIG. 12, angled channels 618 are formed on dual-acting cylinder 607 of hydraulic piston assembly 606, such that dual-acting cylinder 607 forms the second drive element. In other embodiments, as will be described by FIGS. 15A-15C below, the second drive element is separate from and operatively coupled to dual-acting cylinder 607.

[0105] When hydraulic fluid is transmitted into dual-acting cylinder 607 from second rod-end 612 via fitting 620 and hollow piston rod 608, hydraulic fluid is expelled from first rod-end 610, causing dual-acting cylinder 607 and angled channels 618 to move along piston rod 608 toward second rod-end 612. As dual-acting cylinder 607 moves toward second rod-end 612, angled channels 618 interact with angled channels 616 and drive first drive elements 572b and 572e, and thus corresponding liner plates 432b and 432e, toward the interior of mold cavities 446b and 446e, respectively. Furthermore, since each of the first drive elements 572a through 572f is coupled to master bar 573, driving first gear elements 572b and 572e toward the interiors of mold cavities 446b and 446e also moves first drive elements 572a, 572c, 572d, and 572f and corresponding liner plates 432a, 432c, 432d, and 432e toward the interiors of mold cavities 446a, 446c, 446d, and 446f, respectively. Conversely, transmitting hydraulic fluid into dual-acting cylinder 607 from first rod-end 610 via fitting 620 and hollow-piston rod 608 causes dual-acting cylinder 607 to move toward first rod-end 610, and causes liner plates 432 to move away from the interiors of corresponding mold cavities 446.

[0106] In one embodiment, drive assembly 550 further includes support shafts 626, such as support shafts 626a and 626b, which are coupled between removable housing 560 and side member 434a and extend through master bar 573. As dual-acting cylinder 607 is moved by transmitting/expelling hydraulic fluid from first and second rod-ends 610, 612, master bar 573 moves back and forth along support shafts 626. Because they are coupled to static elements of mold assembly 430, support shafts 626a and 626b provide support and rigidity to and away from mold cavities 446.

[0107] In one embodiment, drive assembly 550 further includes a pneumatic fitting 628 configured to connect via line 630 to an external compressed air system 632 and provide compressed air to housing 560. By receiving compressed air via pneumatic fitting 628 to removable housing 560, the internal air pressure of housing 560 is positive relative to the outside air pressure, such that air is continuously "forced" out of housing 560 through any non-sealed openings, such as openings 433 through which first drive elements 572 extend through side member 434a. By maintaining a positive air pressure and forcing air out through such non-sealed opening, the occurrence of dust and debris and other unwanted contaminants from entering housing 560 and fouling drive assembly 550 is reduced.

[0108] First and second rod ends 610, 612 are each coupled to hydraulic fittings 620 that are configured to connect via lines 622a and 622b to an external hydraulic system 624 and to transfer hydraulic fluid to and from dual-acting cylinder 607 via hollow piston rod 608.

[0109] FIG. 15A is a top view illustrating a portion of one embodiment of drive assembly 550 according to the present invention. Drive assembly 550 includes double-rod-end

hydraulic piston assembly 606 comprising dual-acting cylinder 607 and a hollow piston rod 608 with first and second rod-ends 610 and 612 being and coupled to and extending through removable housing 560.

[0110] As illustrated, dual-acting cylinder 607 is slideably-fitted inside a machined opening 641 within a second gear element 640, with hollow piston rod 608 extending through removable end caps 642. In one embodiment, end caps 646 are threadably inserted into machined opening 641 such that end caps 646 butt against and secure dual-acting cylinder 607 so that dual-acting cylinder 607 is held stationary with respect to second drive element 640. Second drive element 640 includes the plurality of substantially parallel angled channels 618, in lieu of angled channels being an integral part of dual-acting cylinder 607. With reference to FIG. 14, angled channels 618 of second gear element 640 are configured to slideably interlock with angled channels 616 of first gear elements 572b and 572e.

[0111] Second gear element 640 further includes a guide rail 644 that is slideably coupled to linear bearing blocks 646 that are mounted to housing 560. As described above with respect to FIG. 14, transmitting and expelling hydraulic fluid to and from dual-acting cylinder 607 via first and second rod-ends 610, 612 causes dual-acting cylinder 607 to move along hollow piston-rod 608. Since dual-acting cylinder 607 is "locked" in place within machined shaft 641 of second gear element 640 by end caps 642, second gear element 640 moves along hollow piston-rod 608 together with dual-acting cylinder 607. As second drive element 640 moves along hollow piston-rod 608, linear bearing blocks 646 guide and secure guide rail 644, thereby guiding and securing second drive element 640 and reducing undesirable motion in second drive element 640 that is perpendicular to hollow piston rod 608.

[0112] FIG. 15B is a lateral cross-sectional view A-A of the portion of drive assembly 550 illustrated by FIG. 15A. Guide rail 644 is slideably fitted into a linear bearing track 650 and rides on bearings 652 as second drive element 640 is moved along piston rod 608 by dual-acting cylinder 607. In one embodiment, linear bearing block 646b is coupled to housing 560 via bolts 648.

[0113] FIG. 15C is a longitudinal cross-sectional view B-B of the portion of drive assembly 550 of FIG. 15A, and illustrates dual-acting cylinder 607 as being secured within shaft 641 of drive element 640 by end caps 642a and 642b. In one embodiment, end caps 642a and 642b are threadably inserted into the ends of second drive element 640 so as to butt against each end of dual-acting cylinder 607. Hollow piston rod 608 extends through end caps 642a and 642b and has first and second rod ends 610 and 612 coupled to and extending through housing 560. A divider 654 is coupled to piston rod 608 and divides dual-acting cylinder 607 into a first chamber 656 and a second chamber 658. A first port 660 and a second port 662 allow hydraulic fluid to be pumped into and expelled from first chamber 656 and second chamber 658 via first and second rod ends 610 and 612 and associated hydraulic fittings 620, respectively.

[0114] When hydraulic fluid is pumped into first chamber 656 via first rod-end 610 and first port 660, dual-acting cylinder 607 moves along hollow piston rod 608 toward first rod-end 610 and hydraulic fluid is expelled from second chamber 658 via second port 662 and second rod-end 612.

Since dual-acting cylinder 607 is secured within shaft 641 by end caps 642a and 642b, second drive element 640 and, thus, angled channels 618 move toward first rod-end 610. Similarly, when hydraulic fluid is pumped into second chamber 658 via second rod-end 612 and second port 662, dual-acting cylinder 607 moves along hollow piston rod 608 toward second rod-end 612 and hydraulic fluid is expelled from first chamber 656 via first port 660 and first rod-end 610.

[0115] FIG. 16 is a side view of a portion of drive assembly 550 as shown by FIG. 14 and illustrates a typical liner plate, such as liner plate 432a, and corresponding removable liner face 400. Liner plate 432a is coupled to second drive element 572a via a bolted connection 670 and, in-turn, drive element 572a is coupled to master bar 573 via a bolted connection 672. A lower portion of liner face 400 is coupled to liner plate 432a via a bolted connection 674. In one embodiment, as illustrated, liner plate 432a includes a raised "rib" 676 that runs the length of and along an upper edge of liner plate 432a. A channel 678 in liner face 400 overlaps and interlocks with raised rib 676 to form a "boltless" connection between liner plate 432a and an upper portion of liner face 400. Such an interlocking connection securely couples the upper portion of liner face 400 to liner plate 432 in an area of liner face 400 that would otherwise be too narrow to allow use of a bolted connection between liner face 400 and liner plate 432a without the bolt being visible on the surface of liner face 400 that faces mold cavity 446a.

[0116] In one embodiment, liner plate 432 includes a heater 680 configured to maintain the temperature of corresponding liner face 400 at a desired temperature to prevent concrete in corresponding mold cavity 446 sticking to a surface of liner face 400 during a concrete curing process. In one embodiment, heater 680 comprises an electric heater.

[0117] FIG. 17 is a block diagram illustrating one embodiment of a mold assembly according to the present invention, such as mold assembly 430 of FIG. 14, further including a controller 700 configured to coordinate the movement of moveable liner plates, such as liner plates 432, with operations of concrete block machine 702 by controlling the operation of the drive assembly, such as drive assembly 550. In one embodiment, as illustrated, controller 700 comprises a programmable logic controller (PLC).

[0118] As described above with respect to FIG. 1, mold assembly 430 is selectively coupled, generally via a plurality of bolted connections, to concrete block machine 702. In operation, concrete block machine 702 first places pallet 56 below mold box assembly 430. A concrete feedbox 704 then fills mold cavities, such as mold cavities 446, of assembly 430 with concrete. Head shoe assembly 52 is then lowered onto mold assembly 430 and hydraulically or mechanically compresses the concrete in mold cavities 446 and, together with a vibrating table on which pallet 56 is positioned, simultaneously vibrates mold assembly 430. After the compression and vibration is complete, head shoe assembly 52 and pallet 56 are lowered relative to mold cavities 446 so that the formed concrete blocks are expelled from mold cavities 446 onto pallet 56. Head shoe assembly 52 is then raised and a new pallet 56 is moved into position below mold cavities 446. The above process is continuously repeated, with each such repetition commonly referred to as

a cycle. With specific reference to mold assembly 430, each such cycle produces six concrete blocks.

[0119] PLC 700 is configured to coordinate the extension and retraction of liner plates 432 into and out of mold cavities 446 with the operations of concrete block machine 702 as described above. At the start of a cycle, liner plates 432 are fully retracted from mold cavities 446. In one embodiment, with reference to FIG. 14, drive assembly 550 includes a pair of sensors, such as proximity switches 706a and 706b to monitor the position of master bar 573 and, thus, the positions of corresponding moveable liner plates 432 coupled to master bar 573. As illustrated in FIG. 14, proximity switches 706a and 706b are respectively configured to detect when liner plates 432 are in an extended position and a retracted position with respect to mold cavities 446.

[0120] In one embodiment, after pallet 56 has been positioned beneath mold assembly 430, PLC 700 receives a signal 708 from concrete block machine 702 indicating that concrete feedbox 704 is ready to deliver concrete to mold cavities 446. PLC 700 checks the position of moveable liners 432 based on signals 710a and 710b received respectively from proximity switches 706a and 706b. With liner plates 432 in a retracted position, PLC 700 provides a liner extension signal 712 to hydraulic system 624.

[0121] In response to liner extension signal 712, hydraulic system 624 begins pumping hydraulic fluid via path 622b to second rod-end 612 of piston assembly 606 and begins receiving hydraulic fluid from first rod-end 610 via path 622a, thereby causing dual-acting cylinder 607 to begin moving liner plates 432 toward the interiors of mold cavities 446. When proximity switch 706a detects master bar 573, proximity switch 706a provides signal 710a to PLC 700 indicating that liner plates 432 have reached the desired extended position. In response to signal 710a, PLC 700 instructs hydraulic system 624 via signal 712 to stop pumping hydraulic fluid to piston assembly 606 and provides a signal 714 to concrete block machine 702 indicating that liner plates 432 are extended.

[0122] In response to signal 714, concrete feedbox 704 fills mold cavities 446 with concrete and head shoe assembly 52 is lowered onto mold assembly 430. After the compression and vibrating of the concrete is complete, concrete block machine 702 provides a signal 716 indicating that the formed concrete blocks are ready to be expelled from mold cavities 446. In response to signal 716, PLC 700 provides a liner retraction signal 718 to hydraulic system 624.

[0123] In response to liner retraction signal 718, hydraulic system 624 begins pumping hydraulic fluid via path 622a to first rod-end 610 via path 622 and begins receiving hydraulic fluid via path 622b from second rod-end 612, thereby causing dual-acting cylinder 607 to begin moving liner plates 432 away from the interiors of mold cavities 446. When proximity switch 706b detects master bar 573, proximity switch 706b provides signal 710b to PLC 700 indicating that liner plates 432 have reached a desired retracted position. In response to signal 710b, PLC 700 instructs hydraulic system 624 via signal 718 to stop pumping hydraulic fluid to piston assembly 606 and provides a signal 720 to concrete block machine 702 indicating that liner plates 432 are retracted.

[0124] In response to signal 720, head shoe assembly 52 and pallet 56 eject the formed concrete blocks from mold

cavities 446. Concrete block machine 702 then retracts head shoe assembly 52 and positions a new pallet 56 below mold assembly 430. The above process is then repeated for the next cycle.

[0125] In one embodiment, PLC 700 is further configured to control the supply of compressed air to mold assembly 430. In one embodiment, PLC 700 provides a status signal 722 to compressed air system 630 indicative of when concrete block machine 702 and mold assembly 430 are in operation and forming concrete blocks. When in operation, compressed air system 632 provides compressed air via line 630 and pneumatic fitting 628 to housing 560 of mold assembly 420 to reduce the potential for dirt/dust and other debris from entering drive assembly 550. When not in operation, compressed air system 632 does not provide compressed air to mold assembly 430.

[0126] Although the above description of controller 700 is in regard to controlling a drive assembly employing only a single piston assembly, such as piston assembly 606 of drive assembly 500, controller 700 can be adapted to control drive assemblies employing multiple piston assemblies and employing multiple pairs of proximity switches, such as proximity switches 706a and 706b. In such instances, hydraulic system 624 would be coupled to each piston assembly via a pair of hydraulic lines, such as lines 622a and 622b. Additionally, PLC 700 would receive multiple position signals and would respectively allow mold cavities to be filled with concrete and formed blocks to be ejected only when each applicable proximity switch indicates that all moveable liner plates are at their extended position and each applicable proximity switch indicates that all moveable liner plates are at their retracted position.

[0127] FIGS. 18A through 18C illustrate portions of an alternate embodiment of drive assembly 550 as illustrated by FIGS. 15A through 15C. FIG. 18A is top view of second gear element 640, wherein second gear element 640 is driven by a screw drive system 806 in lieu of a piston assembly, such as piston assembly 606. Screw drive system 806 includes a threaded screw 808, such as an Acme or Ball style screw, and an electric motor 810. Threaded screw 808 is threaded through a corresponding threaded shaft 812 extending lengthwise through second gear element 640. Threaded screw 808 is coupled at a first end to a first bearing assembly 814a and is coupled at a second end to motor 810 via a second bearing assembly 814b. Motor 810 is selectively coupled via motor mounts 824 to housing 560 and/or to the side/cross members, such as cross member 434a, of the mold assembly.

[0128] In a fashion similar to that described by FIG. 15A, second gear element 640 includes the plurality of angled channels 618 which slideably interlock and mesh with angled channels 616 of first gear elements 572b and 572e, as illustrated by FIG. 14. Since second gear element 640 is coupled to linear bearing blocks 646, when motor 810 is driven to rotate threaded screw 808 in a counter-clockwise direction 816, second gear element 640 is driven in a direction 818 along linear bearing track 650. As second gear element 640 moves in direction 818, angled channels 618 interact with angled channels 616 and extend liner plates, such as liner plates 432a through 432f illustrated by FIGS. 12 and 14, toward the interior of mold cavities 446a through 446f.

[0129] When motor 810 is driven to rotate threaded screw 808 in a clockwise direction 820, second gear element 640 is driven in a direction 822 along linear bearing track 650. As second gear element 640 moves in direction 822, angled channels 618 interact with angled channels 616 and retract liner plates, such as liner plates 432a through 432f/illustrated by FIGS. 12 and 14, away from the interior of mold cavities 446a through 446f. In one embodiment, the distance the liner plates are extended and retracted toward and away from the interior of the mold cavities is controlled based on the pair of proximity switches 706a and 706b, as illustrated by FIG. 14. In an alternate embodiment, travel distance of the liner plates is controlled based on the number of revolutions of threaded screw 808 is driven by motor 810.

[0130] FIGS. 18B and 18C respectively illustrate lateral and longitudinal cross-sectional views A-A and B-B of drive assembly 550 as illustrated by FIG. 18A. Although illustrated as being located external to housing 560, in alternate embodiments, motor 810 is mounted within housing 560.

[0131] As described above, concrete blocks, also referred to broadly as concrete masonry units (CMUs), encompass a wide variety of types of blocks such as, for example, patio blocks, pavers, light weight blocks, gray blocks, architectural units, and retaining wall blocks. The terms concrete block, masonry block, and concrete masonry unit are employed interchangeably herein, and are intended to include all types of concrete masonry units suitable to be formed by the assemblies, systems, and methods of the present invention. Furthermore, although described herein primarily as comprising and employing concrete, dry-cast concrete, or other concrete mixtures, the systems, methods, and concrete masonry units of the present invention are not limited to such materials, and are intended to encompass the use of any material suitable for the formation of such blocks.

[0132] FIG. 19 is flow diagram illustrating one exemplary embodiment of a process 850 for forming a concrete block employing a mold assembly according to the present invention, with reference to mold assembly 30 as illustrated by FIG. 1. Process 850 begins at 852, where mold assembly 30 is bolted, such as via side members 34a and 34b, to a concrete block machine. For ease of illustration, the concrete block machine is not shown in FIG. 1. Examples of concrete block machines for which mold assembly is adapted for use include models manufactured by Columbia and Besser. In one embodiment, installation of mold assembly 30 in the concrete block machine at 852 further includes installation of a core bar assembly (not shown in FIG. 1, but known to those skilled in the art), which is positioned within mold cavity 46 to create voids within the formed block in accordance with design requirements of a particular block. In one embodiment, mold assembly 30 further includes head shoe assembly 52, which is also bolted to the concrete block machine at 852.

[0133] At 854, one or more liner plates, such as liner plates 32a through 32d, are extended a desired distance to form a mold cavity 46 having a negative of a desired shape of the concrete block to be formed. As will be described in further detail below, the number of moveable liner plates may vary depending on the particular implementation of mold assembly 30 and the type of concrete block to be formed. At 856, after the one or more liners plates have been extended, the concrete block machine raises a vibrating table on which

pallet 56 is located such that pallet 56 contacts mold assembly 30 and forms a bottom to mold cavity 46.

[0134] At 858, the concrete block machine moves a feedbox drawer (not illustrated in FIG. 1) into position above the open top of mold cavity 46 and fills mold cavity 46 with a desired concrete mixture. After mold cavity 46 has been filled with concrete, the feedbox drawer is retracted, and concrete block machine, at 860, lowers head shoe assembly 52 onto mold cavity 46. Head shoe assembly 52 configured to match the dimensions and other unique configurations of each mold cavity, such as mold cavity 46.

[0135] At 862, the concrete block machine then compresses (e.g. hydraulically or mechanically) the concrete while simultaneously vibrating mold assembly 30 via the vibrating table on which pallet 56 is positioned. The compression and vibration together causes concrete to substantially fill any voids within mold cavity 46 and causes the concrete quickly reach a level of hardness ("pre-cure") that permits removal of the formed concrete block from mold cavity 46.

[0136] At step 864, the one or more moveable liner plates 32 are retracted away from the interior of mold cavity 46. After the liner plates 32 are retracted, the concrete block machine removes the formed concrete block from mold cavity 46 by moving head shoe assembly 52 along with the vibrating table and pallet 56 downward while mold assembly 30 remains stationary. The head shoe assembly, vibrating table, and pallet 56 are lower until a lower edge of head shoe assembly 52 drops below a lower edge of mold cavity 46 and the formed block is ejected from mold cavity 46 onto pallet 56. A conveyor system then moves pallet 56 carrying the formed block away from the concrete block machine to an oven where the formed block is cured. Head shoe assembly 56 is raised to the original start position at 868, and process 850 returns to 854 where the above described process is repeated to create additional concrete blocks.

[0137] FIG. 20 is a perspective view illustrating one embodiment of a masonry block 900 having a molded utility opening 902, in accordance with the present invention, which is formed by action of a moveable liner plate during a block formation process and adapted to receive a utility system device. In one embodiment, as illustrated, masonry block 900 comprises what is generally referred to as a gray block and has a first major surface 904, a second major surface 906, a first transverse face 908, a second transverse face 910, a first end face 912, and a second end face 914.

[0138] A pair of apertures or hollow cores 916 and 918 extend through masonry block 900 from first transverse face 908 to second transverse face 910. Although illustrated as having a pair of hollow cores 916 and 918, masonry block 900 may include more or fewer than two hollow cores.

[0139] Masonry block 900 has a width (W) 920, a depth (D) 922, and a height (H) 924. Masonry block 900 may be formed with a plurality of dimensions, including standard dimensions such as, for example, 8"(H)×12" (D)×18"(W).

[0140] In one embodiment, as illustrated by FIG. 20, molded utility opening 902 is formed in first major face 904 and has a width (W1) 926, a depth (D1) 928, and a height (H1) 930. In one embodiment, molded utility opening 902 extends through major face 904 into hollow core 918. In one embodiment, molded utility opening 902 is formed and

positioned on major face **904** such that molded utility opening **902** extends into both hollow core **916** and hollow core **918**. Although illustrated in **FIG. 20** as being rectangular shape, as will be described in greater detail below, molded utility opening **902** may be formed to have any number of dimensions and shapes (e.g. round, square, octagonal) so as to receive a wide variety of utility system devices. For example, as will be described in greater detail below, molded utility opening **902** can be formed to have dimensions as necessary to receive a variety of electrical system devices, such as junction boxes for the mounting of electrical devices such as receptacles and light switches, and back-boxes for the mounting of electrical devices such as light fixtures and control panels. As will be described in greater detail below, conduit and wiring to such electrical devices can be routed via hollow cores **916** and **918**, and channels, such as channels **932**, formed in first and second transverse faces **908** and **910**.

[0141] Additionally, according to embodiments of the present invention, and as will be described in greater detail below, masonry blocks are provided with molded utility openings and have utility system components installed as part of a manufacturing process so as to form a masonry block assembly. The masonry block assembly is then field installed by construction personnel and coupled to facility utility systems as required. For example, in one embodiment, with reference to **FIG. 22** below, an electrical junction box or back-box is installed within a molded utility opening along with associated conduit stubs extending from the hollow cores so as to form a masonry block assembly.

[0142] By employing masonry blocks having a molded utility openings and masonry block assemblies having molded utility openings and pre-installed utility system components, construction personnel are able to save time and reduce installation costs when constructing a facility or other structure.

[0143] **FIGS. 21A-21D** are simplified illustrations of one implementation of a mold assembly **30** and a block formation process for forming masonry block **900** of **FIG. 20**. Mold assembly **30** is similar to that illustrated by **FIG. 1** and includes side members **34a**, **34b**, cross-members **36a**, **36b**, stationary liner plates **32a**, **32b**, and **34c**, and moveable liner plate **32d**. Drive assembly **31d** is coupled to and configured to extend and retract moveable liner plate **32d** toward and away from the interior of mold cavity **46**. Liner face **100d** is coupled to moveable liner plate **32d** and includes a mold element **100d** configured to form molded utility opening **902** in first major face **904** of masonry block **900**. A core bar assembly **942** is positioned in mold cavity **46** to form hollow cores **916** and **918** which extend through masonry block **900**.

[0144] **FIG. 21A** is a top view of mold assembly **30** illustrating moveable liner plate **32d** in a retracted position. **FIG. 21B** is a top view of mold assembly **30** illustrating moveable liner plate **32d** in an extended position at which point concrete is ready to be introduced to mold cavity **46**, such as described at **858** in process **850** of **FIG. 19**.

[0145] **FIGS. 21C and 21D** respectively illustrate simplified cross-sectional views of mold assembly **30** along section line A-A and section line B-B of **FIGS. 21A and 21B**, and further illustrate moveable head shoe assembly **52** and pallet **56**. **FIG. 21C** illustrates moveable liner plate **32d** and associated liner face **100d**, including mold element **940**, in

a retracted position. **FIG. 21D** illustrates moveable liner plate **32d** and associated liner face **100d**, including mold element **940**, in an extended position, and also illustrates head shoe assembly **52** positioned so as to close mold cavity **46**, such as after concrete has been introduced.

[0146] In operation, with reference to **FIGS. 21A through 21D**, and as described above by process **850** of **FIG. 19**, mold assembly **30** is coupled to a concrete block machine which, for ease of illustration, is not shown in **FIGS. 21A-21D**. Examples of such concrete block machines for which mold assembly **30** is suitable for use include models manufactured by Columbia Machine, Inc., Vancouver, Wash., USA, and Besser Company, Alpena, Mich., USA.

[0147] Initially, drive assembly **31d** extends moveable liner plate **32d** and associated liner face **100d**, including mold element **940**, into mold cavity **46**. The concrete block machine then raises a vibrating table on which pallet **56** is located such that pallet **56** forms a closed bottom for mold cavity **46**. The concrete block machine then fills mold cavity **46** with a desired concrete mixture and lowers head shoe assembly **52** so as to close the top of mold cavity **46**. The concrete block machine then compresses the concrete (e.g. hydraulically, mechanically) with head shoe assembly **52** while simultaneously vibrating mold assembly **30**. The compression and vibration together fills voids within mold cavity **46** with concrete and causes the concrete to quickly reach a level of hardness (generally referred to as "pre-curing") that permits the pre-cured block to be removed from mold cavity **46**.

[0148] To remove the pre-cured block, drive assembly **31d** retracts moveable liner **32d** and associated liner face **100d** from mold cavity **46**. Head shoe assembly **52** and pallet **56** are then lowered, while the remainder of mold assembly **30** remains stationary, until a lower edge of head shoe assembly **52** is below a lower edge of mold assembly **30**, causing the pre-cured block to be ejected from mold cavity **46** onto pallet **56**. A conveyor system then moves pallet **56** carrying the ejected block to an oven for curing (not illustrated). Head shoe assembly **52** is then raised to its initial position (see **FIG. 21C**) and the process is repeated to create additional blocks.

[0149] By extending and retracting moveable liner plate **32d** and associated liner face **100d**, including mold element **940**, in this fashion, a concrete block machine employing mold assembly **30** as described generally by **FIGS. 21A-21D** above, provides masonry blocks having a molded utility openings extending from a face to a hollow core, such as molded utility opening **902** extending to hollow core **916** of masonry block **900** of **FIG. 20**.

[0150] **FIGS. 22-28** below illustrate example embodiments of masonry blocks having one or more molded utility openings in accordance with the present invention, and various utility system devices that can be either field-installed in the molded utility openings or installed within the molded utility openings during a manufacturing process to form a masonry block assembly in accordance with the present invention.

[0151] **FIG. 22** is a perspective view illustrating one exemplary embodiment of masonry block **900** of **FIG. 20**, including molded utility opening **902**. In one embodiment, as illustrated, molded utility opening **902** is formed with

dimensions adapted to receive an electrical junction box 950. Electrical junction box 950, as illustrated, is often referred to as a “double-gang” box. In one embodiment, as part of a block manufacturing process, electrical junction box 950 is installed within molded utility opening 902 along with conduit stubs 952 and 954, which extend through hollow core 916 and routed in channels 932 so that together masonry block 900, electrical junction 950, and conduit stubs 952 and 954 form a masonry block assembly.

[0152] Electrical junction box 950 may be configured to receive a wide variety of electrical devices such as, for example, receptacles and a corresponding coverplate, as illustrated at 956, and switches and a corresponding coverplate, as illustrated at 958. In one embodiment, the additional electrical devices (e.g. receptacles/coverplate 956 and switches/coverplate 958) are included as part of the masonry block assembly.

[0153] FIG. 23 is a perspective view illustrating one exemplary embodiment of a masonry block 900a according to the present invention, which is similar to masonry block 900 of FIG. 20, but includes a molded utility opening 970 extending through first major face and into hollow cores 916 and 918. In one embodiment, molded utility opening 970 is formed with dimensions configured to receive back-boxes of various electrical devices. For example, in one embodiment, molded utility opening 970 is formed with dimensions configured to receive a back box 972 of an exit light 974. In one embodiment, as part of the block manufacturing process, back-box 972 is installed within molded utility opening 970 along with conduit stubs 976 and 978, which extend through hollow cores 916 and 918 and are routed in channels 932 so that together masonry block 900a, back-box 972, and conduit stubs 976 and 978 form a masonry block assembly. In one embodiment, exit light 974 is included as part of the masonry block assembly.

[0154] In one embodiment, molded utility opening 970 is formed with dimensions configured to receive a back-box 980 of a direction light 982. In one embodiment, as part of the block manufacturing process, back-box 980 is installed within molded utility opening 970 along with conduit stubs 976 and 978, which extend through hollow cores 916 and 918 and are routed in channels 932 so that together masonry block 900a, back-box 972, and conduit stubs 976 and 978 form a masonry block assembly. In one embodiment, direction light 982 is included as part of the masonry block assembly.

[0155] In one embodiment, molded utility opening 970 is formed with dimensions configured to receive a back-box 986 of a landscape or outdoor step/walkway light 988. In one embodiment, as part of the block manufacturing process, back-box 986 is installed within molded utility opening 970 along with conduit stubs 976 and 978, which extend through hollow cores 916 and 918 and are routed in channels 932 so that together masonry block 900a, back-box 986, and conduit stubs 976 and 978 form a masonry block assembly. In one embodiment, step light 988 is included as part of the masonry block assembly.

[0156] FIG. 24 is a perspective view illustrating one exemplary embodiment of a masonry block 900b according to the present invention, which is similar to masonry block 900 of FIG. 20, but includes a molded utility opening 992 extending through first major face and into hollow core 918.

In one embodiment, as illustrated, molded utility opening 992 is formed with dimensions adapted to receive an electrical junction box 994. Electrical junction box 994, as illustrated, is often referred to as a “single-gang” box. In one embodiment, as part of a block manufacturing process, electrical junction box 994 is installed within molded utility opening 992 along with conduit stubs 996, which extends through hollow core 918 so that together masonry block 900, electrical junction 992, and conduit stub 996 forms a masonry block assembly.

[0157] Electrical junction box 994 may be configured to receive a wide variety of electrical devices. For example, in one embodiment, junction box 994 is configured to receive a fire alarm device and a corresponding coverplate, as illustrated at 998. In one embodiment, junction box 994 is configured to receive communication system devices (e.g. a network connector or coaxial cable connector) and a corresponding coverplate, as illustrated at 1000. In one embodiment, the additional electrical devices (e.g. fire alarm/coverplate 998 and communication devices/coverplate 1000) are included as part of the masonry block assembly.

[0158] FIG. 25 is a perspective view illustrating one exemplary embodiment of a masonry block 900c according to the present invention, which is similar to masonry block 900 of FIG. 20, but includes a pair of molded utility openings 1010 and 1012 respectively from major face 904 to hollow cores 916 and 918. In one embodiment, as illustrated, molded utility openings 1010 and 1012 are circular and formed with dimensions adapted to receive plumbing pipes 1014 and 1016. Molded utility openings 1010 and 1012 may be of various diameters so as to accommodate various diameter pipes. Plumbing pipes may be of various materials, such as PVC and copper, for example.

[0159] In one embodiment, as part of a block manufacturing process, plumbing pipes 1014 and 1016 are installed within masonry block 900c and extend through molded utility openings via hollow cores 916 and 918. In one embodiment, as illustrated, a pair of sleeves/connectors 1018 and 1020 are respectively coupled the ends of plumbing pipes 1014 and 1016 as they extend through molded utility openings 1010 and 1012. As such, in one embodiment, masonry block 900c, along with plumbing pipes 1014 and 1016 extending through molded utility openings 1010 and 1020, and sleeves/connectors 1018 and 1020 form a masonry block assembly. In one embodiment, the masonry block assembly further includes plumbing fixtures such as a hose bib assembly 1022 and a faucet assembly 1024. As such, in one embodiment, plumbing pipe 1014 is adapted to couple to a cold water system and plumbing pipe 1016 to a hot water system of a facility in which the masonry block assembly is installed.

[0160] FIG. 26 is a perspective view illustrating one exemplary embodiment of a masonry block 900d according to the present invention, which is similar to masonry block 900 of FIG. 20, but includes a molded utility opening 1032 and from major face 904 to hollow cores 916 and 918. In one embodiment, as illustrated, molded utility opening 1032 is formed with dimensions adapted to receive a plenum box 1034 which comprises a portion of a ventilation system. In one embodiment, as part of a block manufacturing process, plenum box 1034 is installed within molded utility opening 1032 along with a duct stub 1036 which extends through

hollow core **916** so that together masonry block **900d**, plenum box **1034**, and duct sub **1036** from a masonry block assembly. In one embodiment, a vent cover **1038** is mounted to plenum box **1034** and included as part of the masonry block assembly. In one embodiment, the masonry block assembly may be employed as part of a supply air assembly. In one embodiment, the masonry block assembly may be employed as part of a return air assembly.

[0161] **FIG. 27** is a perspective view illustrating one exemplary embodiment of a masonry block **900e** according to the present invention, which is similar to masonry block **900** of **FIG. 20**, but includes a pair of molded utility openings **1042** and **1044** respectively extending through major face **904** to hollow cores **916** and **918**. In one embodiment, as illustrated, molded utility openings **1010** and **1012** are circular and formed with dimensions to enable expanding insulating foam to be injected into hollow cores **916** and **918**. In one embodiment, molded utility openings **1042** and **1044** are adapted to receive a pair of seal plugs **1046** and **1048** which are configured to seal molded utility openings **1042** and **1044**.

[0162] **FIG. 28** is a perspective view illustrating one exemplary embodiment of a masonry block **900f**, which is similar to masonry block **900** of **FIG. 20**, but includes a molded utility opening **1052** extending through masonry block **900f** from first major face **904** to second major surface **906**, as illustrated by dashed line **1056**. In one embodiment, as illustrated, molded utility opening **1052** is formed to receive a pass-through or drop-box **1054** which extends through masonry block **900f**. In one embodiment, masonry block **900f** is hot-cold insulated, as indicated by the absence of hollow cores through first transverse surface **908**.

[0163] It is noted that the embodiments described herein are illustrative examples and not intended to represent the full scope of all potential embodiments. As such, molded utility openings of nearly any dimensions, shape, and size can be molded in masonry blocks in accordance with the present invention. Also, multiple molded utility openings may be provided within a single masonry block and may be formed in more than one major face of a same masonry block. Additionally, any number of electrical, mechanical, plumbing, HVAC and other utility system devices and assemblies may be installed, or at least partially installed, within such molded utility openings during the block manufacturing process so as to form any number of masonry block assemblies. Furthermore, although illustrated herein with respect to what are commonly referred to as gray blocks, molded utility openings in accordance with the present invention can be formed in other types of masonry blocks, such as retaining wall blocks, for example.

[0164] Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternate and/or equivalent implementations may be substituted for the specific embodiments shown and described without departing from the scope of the present invention. This application is intended to cover any adaptations or variations of the specific embodiments discussed herein. Therefore, it is intended that this invention be limited only by the claims and the equivalents thereof.

What is claimed is:

1. A masonry block molded by a masonry block machine employing a mold assembly having a plurality of liner plates, at least one of which is moveable; the masonry block comprising:

- a first transverse face;
- a second transverse face opposing the first transverse face;
- at least one aperture extending through the masonry block between the first and second transverse faces;
- a first end face joining the first and second transverse faces;
- a second end face opposite the first end face and joining the first and second transverse faces;
- a first major face joining the first end and second end faces;
- a second major face opposing the first major face and joining the first and second end faces; and
- a molded utility opening extending through the first major face to the at least one aperture and adapted to receive a utility device, wherein the first major face and molded utility opening are formed during a molding process by action of a moveable liner plate having a mold element which is a negative of the molded utility opening.

2. The masonry block of claim 1, wherein the moveable liner plate is moved with a gear drive assembly.

3. The masonry block of claim 1, wherein the molded utility opening is formed with a desired shape and with desired dimensions.

4. The masonry block of claim 1, including a plurality of molded utility openings extending through the first major face to the at least one aperture, each molded utility opening adapted to receive a corresponding utility device and each formed by action of the moveable liner plate.

5. The masonry block of claim 1, wherein the molded utility opening is formed with a desired shape and with desired dimensions corresponding to a shape and dimensions of a standard utility device.

6. The masonry block of claim 5, wherein the standard utility device comprises an electrical system junction box.

7. The masonry block of claim 5, wherein the standard utility device comprises a heating, ventilating and air conditions system device.

8. The masonry block of claim 5, wherein the standard utility device comprises a plumbing system device.

9. An assembly comprising:

a masonry block molded by a masonry block machine employing a mold assembly having a plurality of liner plates, at least one of which is moveable; the masonry block comprising:

- a first transverse face;
- a second transverse face opposing the first transverse face;
- at least one aperture extending through the masonry block between the first and second transverse faces;
- a first end face joining the first and second transverse faces;

- a second end face opposite the first end face and joining the first and second transverse faces;
 - a first major face joining the first end and second end faces;
 - a second major face opposing the first major face and joining the first and second end faces;
 - a molded utility opening extending through the first major face to the at least one aperture, wherein the first major face and molded utility opening are formed during a molding process by action of a moveable liner plate having a mold element which is a negative of the molded utility opening; and
 - a utility assembly installed at least within the molded utility opening.
- 10.** The assembly of claim 9, wherein a portion of the utility assembly extends into and through the at least one aperture.
- 11.** The assembly of claim 9, wherein the moveable liner plate is moved by a gear drive assembly.
- 12.** The assembly of claim 9, wherein the utility assembly comprises an electrical system assembly.
- 13.** The assembly of claim 9, wherein the electrical system assembly comprises a junction box installed within the molded utility opening.
- 14.** The assembly of claim 13, wherein the electrical system assembly further includes at least one conduit stub extending from the junction through the at least one aperture.
- 15.** The assembly of claim 9, wherein the utility assembly comprises a heating, ventilating and air conditioning system assembly.
- 16.** The assembly of claim 9, wherein the utility system comprises a plumbing system assembly.
- 17.** The assembly of claim 16, wherein the plumbing system assembly comprises a pipe extending through the molded utility opening and through the at least one aperture.

18. A method of producing a masonry block having a first major face and an opposing second major face, a first transverse face and a second opposing transverse face, and a first end face and an opposing second end face, the method comprising:

providing a mold assembly having a plurality of liner plates that form a mold cavity having an open top and an open bottom and including a core bar assembly, wherein at least a first liner plate is moveable between a retracted position and an extended position and includes a mold element which is a negative of a desired molded utility opening;

moving the first liner plate to the extended position;

closing the bottom of the mold cavity with a pallet;

filling the mold cavity with dry cast concrete via the open top;

closing the top of the mold cavity with a shoe assembly;

compacting the dry cast concrete to form a procured masonry block with the second transverse face resting on the pallet, wherein the core bar assembly forms at least one aperture between the first and second transverse faces, and wherein the mold element forms the desired molded utility opening extending from the first major face to the aperture, the molded utility opening adapted to receive a utility device.

19. The method of claim 18, further comprising:

moving the first liner plate to the retracted position;

expelling the pre-cured masonry block from the mold cavity; and

curing the pre-cured masonry block.

20. The method of claim 18, wherein the first liner plate is moved between the retracted and extended positions using a gear drive assembly.

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