



(51) International Patent Classification:

B29C 45/76 (2006.01) *B29C 45/40* (2006.01)
B29C 45/17 (2006.01) *B29C 45/73* (2006.01)

(21) International Application Number:

PCT/CA2011/050587

(22) International Filing Date:

22 September 2011 (22.09.2011)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/385,351	22 September 2010 (22.09.2010)	US
61/394,134	18 October 2010 (18.10.2010)	US
61/430,019	5 January 2011 (05.01.2011)	US

(71) Applicant (for all designated States except US):

ATHENA AUTOMATION LTD. [CA/CA]; 372 New Enterprise Way, Woodbridge, Ontario L4H 0S8 (CA).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **SCHAD, Robert D.** [CA/CA]; 345 Riverview Drive, Toronto, Ontario M4N 3C9 (CA). **JUNG, Daniel** [CA/CA]; 422 Lynette Crescent, Richmond Hill, Ontario L4C 2V7 (CA).

(74) Agent: **BERESKIN & PARR LLP/S.E.N.C.R.L., S.R.L.**; 40 King Street West, Suite 4000, Toronto, Ontario M5H 3Y2 (CA).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available):

ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- of inventorship (Rule 4.17(iv))

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(54) Title: POST-MOLD COOLING INJECTION MOLDED ARTICLES

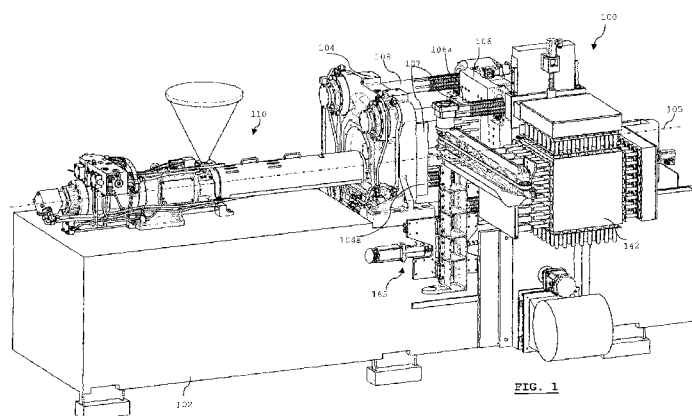


FIG. 1

(57) Abstract: An injection molding machine comprises a machine base supporting a pair of platens defining a mold area therebetween, and a cooling shell adjacent the base and disposed outside the mold area of the injection molding machine. The cooling shell includes at least first and second sides, and is rotatable about a shell axis for moving the sides between load and unload stations. The cooling shell includes a hollow interior chamber bounded at least partially by the first and second sides. The machine further includes a pressurized fluid delivery device in fluid communication with the hollow interior chamber of the cooling shell via a conduit first portion, the conduit first portion free of openable/closeable flow blocking members, wherein fluid communication between the pressurized fluid delivery device and the hollow interior chamber is continuously provided. A plurality of cooling pins are mounted to each of the sides of the cooling shell for cooling interior surfaces of molded articles loaded thereon, each cooling pin including a pin outlet in fluid communication with the hollow interior chamber via a conduit second portion, the conduit second portion including a fluid channel internal to each cooling pin, wherein fluid communication between the hollow interior chamber and the pin outlets is continuously provided.

- 1 -

TITLE: POST-MOLD COOLING INJECTION MOLDED ARTICLES

[0001] This application claims the benefit of Provisional Application Serial
5 No. 61/385,351, filed September 22, 2010, claims the benefit of Provisional
Application Serial No. 61/394,134, filed October 10, 2010, and claims the benefit
of Provisional Application Serial No. 61/430,019, filed January 5, 2011.

FIELD

[0002] The disclosure relates to injection molding machines, and methods
10 and apparatuses for post-mold cooling injection molded articles.

BACKGROUND

[0003] U.S. Pat. No. 4,836,767 (Schad) relates to an apparatus for
producing molded plastic articles which is capable of simultaneously producing
and cooling the plastic articles. The apparatus has a stationary mold half having
15 at least one cavity, at least two mating mold portions, each having at least one
core element, mounted to a movable carrier plate which aligns a first one of the
mating mold portions with the stationary mold half and positions a second of the
mating mold portions in a cooling position, a device for cooling the molded plastic
article(s) when in the cooling position, and a device for moving the carrier plate
20 along a first axis so that the aligned mold portion abuts the stationary mold half
and the second mating mold portion simultaneously brings each plastic article(s)
thereon into contact with the cooling device. The carrier plate is also rotatable
about an axis parallel to the first axis to permit different ones of the mating mold
portions to assume the aligned position during different molding cycles.

25 [0004] U.S. Pat. No. 6,299,431 (Neter) discloses a rotary cooling station to
be used in conjunction with a high output injection molding machine and a robot
having a take-out plate. A high speed robot transfers warm preforms onto a
separate rotary cooling station where they are retained and internally cooled by

- 2 -

specialized cores. The preforms may also be simultaneously cooled from the outside to speed up the cooling rate and thus avoid the formation of crystallinity zones. Solutions for the retention and ejection of the cooled preforms are described. The rotary cooling station of the present invention may be used to
5 cool molded articles made of a single material or multiple materials.

[0005] U.S. Pat. No. 6,391,244 (Chen) discloses a take-out device for use with a machine for injection molding plastic articles such as PET preforms. The take-out device has a plurality of cooling tubes that receive hot preforms from the molding machine, carry them to a position remote from the molds of the machine
10 for cooling, and then eject the cooled preforms onto a conveyor or other handling apparatus. The preforms are retained within the cooling tubes by vacuum pressure, but are then ejected by positive air pressure. A retaining plate spaced slightly outwardly beyond the outer ends of the cooling tubes is shiftable into a closed position in which it momentarily blocks ejection of the preforms during the
15 application positive air pressure, yet allows them to be dislodged slightly axially outwardly from the tubes. Such slight dislodging movement is inadequate to vent the air system to atmosphere such that sufficient dislodging air pressure remains in tubes where the preforms might otherwise tend to stick and resist ejection. After the momentary delay, the plate is shifted to an open position in which all of
20 the dislodged preforms are freed to be pushed out of the tubes by the air pressure. Preferably, the retaining plate is provided with specially shaped holes having pass-through portions that become aligned with the tubes when the plate is in its open position, and smaller diameter blocking portions that become aligned with the tubes when the plate is in its closed position. The smaller
25 diameter blocking portions exceed the diameter of the neck of the preforms but are smaller in diameter than the flanges of the preforms such that surface areas around the blocking portions overlie the flanges to block ejection of the preforms as they undergo their dislodging movement.

- 3 -

[0006] EP Pat. No. 1515829 (Unterlander) relates to a method and apparatus for cooling molded plastic articles after molding is finished. In particular, the disclosed invention relates to method and apparatus for a post mold cooling ("PMC") device having at least two opposed faces. The method and apparatus are, according to the inventors, particularly well suited for cooling injection molded thermoplastic polyester polymer materials such as polyethylene terephthalate ("PET") preforms.

SUMMARY

[0007] The following summary is intended to introduce the reader to various aspects of the applicant's teaching, but not to define any invention. In general, disclosed herein are one or more methods or apparatuses related to injection molding, and to cooling injection molded articles outside the mold area of an injection molding machine.

[0008] According to some aspects, a part handling apparatus for an injection molding machine comprises: a) a rotary cooling shell having a plurality of sides, each side rotatable together with the cooling shell about a shell axis; b) a first receiver set and at least a second receiver set of cooling receivers disposed on each side of the shell, each cooling receiver configured to be loaded with a respective injection molded article from the injection molding machine and to retain said article on the shell during rotation of the shell; and c) a take-out plate reciprocally movable between a mold and the cooling shell, the take-out plate transferring a first set of articles from the mold to the cooling receivers of the first set of a first side during a first injection cycle, and transferring a second set of articles from the mold to the cooling receivers of the second receiver set of the first side during a second injection cycle, while the first set of articles remains loaded on the cooling receivers of the first receiver set.

[0009] In some examples, the part handling apparatus may further comprise a third receiver set of cooling receivers disposed on each side of the

- 4 -

shell, the cooling receivers of the third receiver set on the first side receiving articles from a third injection cycle while the first and second sets of articles remain loaded on the cooling receivers of the first and second receiver sets. Each one of the receiver sets may have an equal quantity of individual cooling receivers. In some examples, each one of the cooling receivers may comprise a cooling pin having a base fixed to the respective side of the shell, and a tip spaced away from the base.

[0010] The take-out plate may have one or more sets of transfer tubes. In some examples, the take-out plate may have a single set of transfer tubes equal in quantity to the quantity of individual cooling receivers in each receiver set. The mold may have a quantity of mold cavities for forming molded articles during each injection cycle, and the quantity of mold cavities may be equal to the quantity of cooling tubes in the take-out plate. The tubes of the take-out plate may be spaced apart in a tube matrix pattern and the individual pins of each of the first and second receiver sets may be spaced apart in a pin matrix pattern that matches the tube matrix pattern. The take-out plate may be movable relative to the cooling shell for selectively aligning the tubes in the tube matrix pattern with the cooling pins in the pin matrix pattern of either one of the first and second receiver sets.

[0011] According to some aspects, an injection molding machine comprises: a) a mold having a quantity of mold pins, the quantity of mold pins defining a mold cavitation number; b) a take-out plate translatable between advanced and retracted positions, the take-out plate having a quantity of transfer tubes equal to the cavitation number, each transfer tube aligning with a respective one of the mold pins when the take-out plate is in the advanced position, each transfer tube receiving a molded article from the respective one of the mold pins after each injection cycle; and c) a cooling shell having at least one side, the at least one side having a quantity of cooling pins for receiving molded articles from the take-out plate, the quantity of cooling pins on the at least one

- 5 -

side being equal to an integer multiple of two or more times the cavitation number. In some examples, the cooling shell may have one, two, or four sides with pins mounted thereto.

[0012] According to some aspects, a method for cooling molded articles
5 comprises: a) rotationally orienting a cooling shell about a shell axis to position a generally planar first side of the cooling shell in a load position; b) transferring a first set of articles molded in a first injection cycle from a mold of an injection molding machine to a first set of cooling pins on the first side of the cooling shell; and c) after steps a) and b), transferring a second set of articles molded in a
10 subsequent injection cycle from the mold to a second set of cooling pins on the first side of the rotary cooling shell while the first set of articles remain on the first set of cooling pins.

[0013] In some examples, the method further comprises rotating the cooling shell to position the first side in an unload station. The method may
15 comprise removing at least one of the first and second set of articles from the first side when in the unload position. In some examples only one of, and in other examples both of, the first and second sets of articles may be removed from the first side when in the unload position.

[0014] In some examples the method may include rotating the cooling
20 shell to move a generally planar second side of the cooling shell from the unload position to the load position prior to moving the first side to the unload position, and transferring a third set of articles molded in a third injection cycle from the mold of the injection molding machine to a first set of cooling pins on the second side of the cooling shell. The method may include transferring a fourth set of
25 molded articles to a second set of cooling pins on the second side of the cooling shell while the first set of articles remains on the first set of cooling pins of the second side of the cooling shell. Rotation of the cooling shell to move the second side to the load position may simultaneously move the first side of the cooling shell to a first supplemental cooling station.

- 6 -

[0015] In some examples, step (b) may include transferring the first set of articles from a core side of the mold to a first set of transfer tubes in a take-out plate, moving the take-out plate from an advanced position to a retracted position outside the mold, and transferring the first set of articles from the first set of transfer tubes in the take-out plate to the first set of cooling pins on the first side of the cooling shell. In some examples, each set of molded articles molded in successive injection cycles may be transferred from the mold to the same first set of transfer tubes in the take-out plate. Each set of molded articles transferred to the first set of cooling pins may be transferred from the first set of transfer tubes in the take-out plate. In some examples, the take-out plate may be moved along a linear axis when moving between the advanced and retracted positions.

[0016] According to some aspects, a method of producing cooled injection molded articles comprises: a) operating an injection molding machine through repeating cycles, the injection molding machine having a mold, the repeating cycles including a first cycle followed consecutively by second, third, fourth, fifth, sixth, seventh, eighth, ninth, and tenth successive cycles, in which respective first, second third, fourth, fifth, sixth, seventh, eighth, ninth, and tenth sets of articles are made in the mold, the tenth cycle including: b) removing the first set of articles from a first set of cooling pins on a first side of a cooling shell and rotating the shell to bring the first side to a load station; c) transferring the ninth set of articles from the mold to a take-out plate outside the mold and from the take out plate to the first set of cooling pins; and d) injection molding the tenth set of articles in the mold.

[0017] In some examples, the third cycle may include transferring the second set of articles from the mold to the take-out plate and from the take-out plate to a second set of cooling pins on the first side of the shell. The third cycle may include transferring the second set of articles from the mold to the take-out plate and from the take out plate to a second set of cooling pins on a second side of the shell.

- 7 -

[0018] According to some aspects, a method for cooling molded articles comprises: a) rotationally orienting a cooling shell about an axis to position a first side of the cooling shell in a load station, the cooling shell having a second, a third, and a fourth side disposed 90 degrees, 180 degrees, and 270 degrees apart, respectively, from the first side in a direction opposite to that of rotation of the cooling shell; b) transferring a first set of articles molded in a first injection cycle from a mold of an injection molding machine to a first set of cooling pins on the first side of the cooling shell; c) transferring a second set of articles molded in a subsequent injection cycle from the mold to a second set of cooling pins on the first side of the rotary cooling shell, while the first set of articles remain loaded on the shell; d) rotationally orienting the fourth side of the cooling shell in the load position; e) transferring an eighth set of articles molded eight injection cycles after the first set of articles from the mold to one of a first and second set of cooling pins mounted on the fourth side of cooling shell; and f) before repeating step (a), unloading the first set of articles from the first set of cooling pins of the first side of the shell.

[0019] In some examples, step (b) may follow step (a) without any intervening rotation of the cooling shell. In some examples, the cooling shell may be rotated by four 90 degree increments between step (b) and step (c).

[0020] According to some aspects, an injection molding machine comprises: a) a machine base supporting a pair of platens defining a mold area therebetween; b) a cooling shell adjacent the base and disposed outside the mold area of the injection molding machine, the cooling shell having at least first and second sides, the cooling shell rotatable about a shell axis for moving the sides between load and unload stations, and the cooling shell comprising a hollow interior chamber bounded at least partially by the first and second sides; c) a pressurized fluid delivery device in fluid communication with the hollow interior chamber of the cooling shell via a conduit first portion, the conduit first portion free of openable/closeable flow blocking members, wherein fluid

- 8 -

communication between the pressurized fluid delivery device and the hollow interior chamber is continuously provided; and d) a plurality of cooling pins mounted to each of the sides of the cooling shell for cooling interior surfaces of molded articles loaded thereon, each cooling pin including a pin outlet in fluid communication with the hollow interior chamber via a conduit second portion, the conduit second portion including a fluid channel internal to each cooling pin, the conduit second portion free of openable/closeable flow blocking members, wherein fluid communication between the hollow interior chamber and the pin outlets is continuously provided.

10 [0021] In some examples, the machine may further comprise a support column having a hollow interior shaft, the cooling shell mounted to the support column by a rotary mount having a mount aperture therethrough, wherein the conduit first portion comprises at least a portion of the hollow shaft and the mount aperture. The pressurized fluid delivery device may comprise a blower, the blower having an outlet in fluid communication with the hollow shaft. The blower and the support column may be stationary relative to the base.

[0022] In some examples, the machine may further comprise a supplemental cooling station adjacent the cooling shell, the supplemental cooling station including a plurality of supplemental outlets for directing cooling fluid towards exterior surfaces of the molded articles loaded on the cooling pins.

20 [0023] In some examples, the machine may further comprise a slide along which the supplemental cooling station is translatable between advanced and retracted positions, wherein when in the advanced position, the supplemental outlets are adjacent the exterior surfaces of the molded articles and in fluid communication with the blower outlet, and when in the retracted position, the supplemental outlets are spaced away from the exterior surfaces of the molded articles and are in fluid isolation from the blower outlet.

- 9 -

[0024] According to some aspects, a method of producing cooled injection molded articles comprises: a) injection molding a first set of articles in a mold of an injection molding machine; b) after step (a), removing the first set of molded articles from the mold for transfer to a cooling shell spaced apart from the mold, 5 the cooling shell having a plurality of cooling pins mounted thereto and a hollow internal chamber therein, the plurality of cooling pins including a first set of the cooling pins equal in quantity to the first set of molded articles and affixed to a first side of the cooling shell, each cooling pin having an internal fluid channel with at least one pin outlet in fluid communication with the hollow interior chamber; c) 10 after step (b), loading the first set of molded articles onto the first set of the cooling pins, the at least one pin outlet of each cooling pin directed towards an inner surface of a respective one of the molded articles loaded thereon; d) after step (c), unloading the first set of molded articles from the first set of cooling pins; and e) continuously urging a stream of cooling fluid out of the pin outlets from a 15 fluid delivery device during a period of time from the beginning of step (a) at least until the end of step (d).

[0025] In some examples, step (e) may comprise continuously pressurizing the internal chamber of the cooling shell with the cooling fluid. The fluid delivery device may comprise a blower, and step (e) may comprises 20 continuously operating the blower, the blower having a high pressure outlet in fluid communication with the internal chamber of the cooling shell.

[0026] In some examples, the method may include prior to step (c), moving the first side of the cooling shell to position the first set of pins in a load station. Moving the first side of the cooling shell to the load station may comprise 25 rotationally indexing the cooling shell about a shell axis. The method may include after step (b), injection molding a second set of molded articles, and after step (c) but before step (d), loading the second set of molded articles onto a second set of the cooling pins mounted to the first side of the cooling shell. The cooling shell may be rotationally indexed at least once after loading the first set of

- 10 -

articles on the first set of the cooling pins but before loading the second set of articles on the second set of the cooling pins.

[0027] In some examples the method may include after step (c) but before step (d), rotationally indexing the first side from the load station to a supplemental cooling station having a housing with a plurality of supplemental cooling outlets, and directing a supplemental cooling stream towards exterior surfaces of the first set of molded articles from a first set of the supplemental cooling outlets. The method may include, after rotationally indexing the first side to the supplemental cooling station, advancing the housing toward the first side from a retracted position to an advanced position, the housing having a supplemental inlet that, when moved to the advanced position, is moved into registration with an opening in a supplemental fluid supply conduit in fluid communication with the fluid delivery device. Moving the housing to the retracted position may block the opening in the supplemental fluid supply conduit and fluidly isolate the supplemental outlets from the fluid delivery device.

[0028] According to some aspects, a multi-part tooling kit for an injection molding machine comprises: a) a first set of tooling for processing a first molded article set of first molded articles, the first set of tooling including: i) a first mold core half and a first mold cavity half mountable to opposed platens of an injection molding machine and cooperating with each other to form a first set of first mold chambers for molding the first molded article set, the first mold chambers spaced apart from each other by a first article spacing; and ii) a first take-out plate having first take-out tubes spaced and shaped to receive the first molded article set, the first take-out plate mountable to a robot disposed adjacent the platens of the injection molding machine; and iii) a first cooling shell mountable to a support remote from the mold, the first cooling shell including at least a first-shell first side with at least a first set of first cooling pins mounted to the first-shell first side, the first cooling pins spaced and shaped to receive the first molded article set from the first take-out tubes; and the tooling kit further comprising: b) at least a second

- 11 -

set of tooling for processing a second set of second molded articles, the second molded articles different in at least one of size and shape than the first set of molded articles, the second set of tooling including: i) a second mold core half and a second mold cavity half mountable to respective platens of the injection molding machine for molding the second set of second molded articles, the second molded articles of the second set spaced apart from each other by a second article spacing; ii) a second take-out plate having second take-out tubes spaced and shaped to receive the second molded article set, the second take-out plate mountable to the robot disposed adjacent the platens of the injection molding machine; and iii) a second cooling shell mountable to a support remote from the mold, the second cooling shell including at least a second-shell first side with at least one set of second cooling pins mounted to the second-shell first side, the second cooling pins spaced and shaped to receive the second molded article set from the first take-out tubes.

[0029] In some examples, the first cooling shell may include at least a second set of first cooling pins mounted to the first side of the first cooling shell, and the second cooling shell may include at least a second set of second cooling pins mounted to the first side of the second cooling shell. Each first side of each cooling shell may includes at least one gripper plate slidably coupled to the respective side for selectively retaining and releasing molded articles loaded on the pins of the respective side.

[0030] According to some aspects, a method of changing-over an injection molding machine from injection molding first articles to injection molding second articles different than the first articles comprises: a) taking a first mold core half and a first mold cavity half out of position for opening and closing a first mold to injection mold a first set of articles, and placing a second mold core half and a second mold cavity half into position for opening and closing a second mold to injection mold a second set of articles; b) removing a first take-out plate from a robot and thereafter mounting a second take-out plate to the robot; and c)

- 12 -

replacing a first cooling shell positioned to receive articles from the robot with a second cooling shell.

[0031] In some examples, step c) may comprise releasing the first cooling shell from a rotary mount, and thereafter securing the second cooling shell to the rotary mount. In some examples, each of the cooling shells may include a plurality of cooling pins mounted thereto for conveying a pressurized cooling fluid between an interior chamber of the cooling shell and fluid channels extending through the cooling pins, and the step of releasing the first cooling shell from the rotary mount may disconnect the interior chamber of the first cooling shell from a blower, and securing the second cooling shell to the rotary mount may connect the interior chamber of the second cooling shell to the blower.

[0032] According to some aspects, a cooling apparatus for cooling injection molded articles having a generally hollow cylindrical body and a flange, comprises: a) a cooling shell disposed outside a mold area of an injection molding machine, the cooling shell having at least first and second side, the cooling shell moveable to move the sides between an unload station and a load station; b) a first set of first receivers and at least a second set of second receivers mounted to each one of the sides, each set of receivers configured to cool respective sets of said molded articles from respective distinct mold cycles of the injection molding machine when the cooling receivers are loaded with said articles; and c) a respective gripper assembly coupled to each respective side, each gripper assembly adjustable relative to the respective side to selectively release at least one of the loaded sets of molded articles of the respective side when positioned at the unload station; and each gripper assembly adjustable relative to the respective side to retain at least one newly loaded set of molded articles on the respective side when positioned at the load station.

[0033] In some examples, the gripper assembly of the respective side at the load station may be adjustable to allow loading of one of the first and at least second sets of molded articles while retaining the other of the first and at least

- 13 -

second sets of molded articles. The gripper assembly of the respective side at the load station may be adjustable to retain all of the first and at least second sets of molded articles prior to moving the respective sidewall away from the load station. The gripper assembly of a respective side at the unload station may be
5 adjustable to retain at least one of the other of said loaded sets of molded articles when said at least one of the loaded sets is released.

[0034] In some examples, each gripper assembly may comprise a plurality of first abutment surfaces and a plurality of second abutment surfaces, each first abutment surface positioned adjacent a respective one of the first receivers and
10 each second abutment surface positioned adjacent a respective one of the second receivers, each abutment surface moveable relative to the receiver between a holding position and a clear position for selectively retaining and releasing a molded article loaded on the respective adjacent receiver. Movement from the clear position to the holding position may reduce a lateral spacing
15 between the respective abutment surface and an axis of the receiver, in a direction generally perpendicular to the axis of the receiver. Each first abutment surface may be spaced apart from the respective side by a first axial spacing and each second abutment surface may be spaced apart from the respective side by a second axial spacing, each axial spacing extending orthogonally to the
20 respective side, and at least a portion of the flange of each respective molded article may be positioned axially between the respective side and at least a portion of each respective abutment surface when said abutment surface is in the holding position.

[0035] In some examples, each gripper assembly may comprise at least a
25 first respective gripper plate, and one or more of the first abutment surfaces may be affixed to each first respective gripper plate. Each first gripper plate may be oriented generally parallel to the respective side to which the gripper assembly is coupled. Each first gripper plate may be moveable between at least a first plate position in which the first abutment surfaces are in the clear position, and a

- 14 -

second plate position in which the first abutment surfaces are in the holding position.

[0036] In some examples, each first gripper plate may comprise a first set of first apertures, respective ones of the first abutment surfaces positioned adjacent respective ones of the first apertures. One or more of the second abutment surfaces may be affixed to each first respective gripper plate. Each first gripper plate may comprise a second set of apertures, respective ones of the second abutment surfaces positioned adjacent respective ones of the second apertures.

10 [0037] Each first gripper plate may be moveable among first, second and third positions. In the first position, molded articles supported by the first receivers may be retained on the cooling shell and molded articles supported by the second receivers may be releasable from the cooling shell. In the second position, molded articles supported by the second receivers may be retained on the cooling shell and molded articles supported by the first receivers may be releasable from the cooling shell. In the third position, molded articles supported by the first and second receivers may be retained on the cooling shell.

[0038] In some examples, each one of the first and second apertures may comprise an enlarged portion having a perimeter through which a flanged portion of the injection molded article can pass in a direction generally orthogonal to the gripper plate, and a narrowed portion adjoining the enlarged portion and extending from one side of the perimeter thereof, the flanged portion unable to pass through the narrowed portion in a direction generally orthogonal to the gripper plate. The narrowed portions of the first apertures may extend radially outwardly from a first side of the perimeter of the enlarged portions of the first apertures, the first side disposed in a first direction parallel to the slide axis, and the narrowed portions of the second apertures may extend radially outwardly from a second side of the perimeter of the enlarged portions of the second apertures, the second side disposed in a second direction parallel to the slide

- 15 -

axis and opposite the first direction. In some examples, each gripper assembly may comprise a retaining member to hold the gripper plate in the third position at least during the time each respective sidewall leaves the load station and arrives at the unload station.

5 [0039] According to some aspects, a cooling apparatus for cooling injection molded articles having a generally hollow cylindrical body and a flange comprises: a) a cooling shell disposed outside a mold area of an injection molding machine, the cooling shell having at least first and second sidewalls with a first set of first receivers and a second set of second receivers mounted to each
10 of the first and second sidewalls, the first and second sets of receivers configured to support articles from respective distinct mold cycles of the injection molding machine when the cooling receivers are loaded with said molded articles; b) a first gripper plate coupled to the first sidewall and a second gripper plate coupled to the second sidewall, c) each gripper plate having a first set of first apertures in
15 registration with the first receivers and a second set of second apertures in registration with the second receivers; d) each gripper plate slidable among first, second, and third positions for selectively retaining, on the cooling shell, molded articles supported by the first receivers, the second receivers, and both the first and second receivers, respectively.

20 [0040] In the first position, molded articles supported by the first receivers may be retained on the cooling shell and molded articles supported by the second receivers may be releasable from the cooling shell. In the second position, molded articles supported by the second receivers may be retained on the cooling shell and molded articles supported by the first receivers may be
25 releasable from the cooling shell. In the third position, molded articles supported by the first and second receivers may be retained on the cooling shell.

[0041] In some examples, each receiver may comprise a cooling pin for insertion into a hollow interior portion of the molded article associated therewith.

- 16 -

In some examples, each receiver may comprise a cooling tube for accommodating at least a portion of the molded article associated therewith.

BRIEF DESCRIPTION OF THE DRAWINGS

[0042] The drawings included herewith are for illustrating various
5 examples of articles, methods, and apparatuses of the teaching of the present specification and are not intended to limit the scope of what is taught in any way. In the drawings:

[0043] Figure 1 is a perspective view of an injection molding machine in accordance with or more aspects of the teaching disclosed herein;

10 [0044] Figure 2 is a front view of an exemplary article formed by the machine of Figure 1;

[0045] Figure 2A is a top view of the article of Figure 2;

[0046] Figure 2B is a cross-sectional view of the article of Figure 2A, taken along the lines 2B-2B;

15 [0047] Figure 3 is a perspective view of a portion of the machine of Figure 1, showing part handling features in greater detail;

[0048] Figure 4 is a front elevation view of a portion of the machine of Figure 3;

[0049] Figure 5 is a cross-sectional view of a portion of the machine of
20 Figure 3, taken along the lines 5-5;

[0050] Figure 5A is an enlarged portion of the machine of Figure 5;

[0051] Figures 6 and 7 are elevation views of a side of a cooling shell portion of the machine of Figure 1, showing first and second receiver sets thereon, respectively;

25 [0052] Figure 8 is an elevation view of a take-out plate portion of the machine of Figure 1;

- 17 -

[0053] Figures 9, 10, and 11 are perspective views of the portion of the machine similar to that of Figure 3, showing the machine at different points in an operating sequence;

[0054] Figures 12A-12C are elevation views of a portion of an alternative cooling shell apparatus for use with an injection molding machine;

[0055] Figure 12D is a perspective view of the alternative cooling shell apparatus of Figures 12A-12C;

[0056] Figure 13 is an exploded perspective view of the part handling apparatus portion of the machine of Figure 1, showing gripper assembly elements in greater detail;

[0057] Figure 14 is a perspective view of a gripper plate member of the gripper assembly of Figure 13;

[0058] Figure 15 is an enlarged portion of the plate of Figure 14;

[0059] Figures 16A, 16B, and 16C show a gripper plate member of the gripper assembly of Figure 13 in a first, second, and third position;

[0060] Figure 17 is an enlarged portion of the plate of Figure 16C;

[0061] Figure 18 is a plan view of an alternate gripper plate member;

[0062] Figure 19 is a perspective view of portions of an alternate gripper assembly;

[0063] Figure 20 is a cross-sectional view similar to Figure 5 but showing portions of a gripper assembly in use with an alternate cooling shell.

[0064] Figure 21 is a cross-sectional view of the apparatus of Figure 9, taken along the lines 21-21;

[0065] Figure 22 is similar to Figure 21, showing a housing of a supplemental cooling station in an advanced position;

- 18 -

[0066] Figure 23 is an enlarged view of a portion of the apparatus of Figure 22;

[0067] Figure 24 is a perspective view of an alternate example of a portion of a part handling/treatment apparatus; and

- 5 [0068] Figure 25 is a schematic illustration of a multi-part tooling kit including elements of the apparatus of Figure 1.

DETAILED DESCRIPTION

[0069] Various apparatuses or processes will be described below to provide an example of an embodiment of each claimed invention. No
10 embodiment described below limits any claimed invention and any claimed invention may cover processes or apparatuses that are not described below. The claimed inventions are not limited to apparatuses or processes having all of the features of any one apparatus or process described below or to features common to multiple or all of the apparatuses described below. It is possible that
15 an apparatus or process described below is not an embodiment of any claimed invention. Any invention disclosed in an apparatus or process described below that is not claimed in this document may be the subject matter of another protective instrument, for example, a continuing patent application, and the applicants, inventors or owners do not intend to abandon, disclaim or dedicate to
20 the public any such invention by its disclosure in this document.

[0070] Referring to Figure 1, an example of an injection molding machine 100 includes a base 102, with a stationary platen 104 and a moving platen 106 mounted to the base 102 and coupled together via tie bars 108. The moving platen 106 can translate towards and away from the stationary platen 104 along
25 a machine axis 105. A mold 107 is formed between the platens 104, 106, the mold 107 defined at least in part by a first mold half 104a mounted to the stationary platen 104, and a second mold half 106a mounted to the moving

- 19 -

platen 106. An injection unit 110 is mounted to the base 102 for injecting resin or other mold material into the mold 107 to form a molded article.

[0071] In the example illustrated, the injection molding machine 100 is shown set up for molding preforms that can be used as input material for subsequent processing, for example, a blow molding operation to produce beverage containers. With reference to Figure 2, an exemplary preform 112 comprises a generally elongate tubular article extending along a preform axis 114, and having opposing open and closed ends 116, 118. A threaded portion 120 for receiving a closure may be provided adjacent the open end 116. A radially outwardly extending annular flange 122 may be disposed adjacent the threaded portion 120, with the threaded portion 120 disposed axially between the open end 116 and the flange 122. The preforms have an inner surface 124 that can include a generally cylindrical inner wall portion 124a along the axial extent of the preform (between the open and closed ends), and a generally concave inner end portion 124b at the closed end. The preforms 112 have an outer surface 126 spaced apart from the inner surface 124 that can include a generally cylindrical outer wall portion 126a along the axial extent of the preform and a convex outer end portion 126b at the closed end. The spacing between the inner and outer surfaces 124, 126 generally defines a preform wall thickness 128.

[0072] With reference to Figure 3, in the example illustrated for producing the preforms, the first mold half 104a (attached to the stationary platen 104) can comprise a cavity side of the mold 107 having recesses (or mold cavities) 130 for forming the outer surface 126 of the preforms 112. The second mold half 106a can comprise a core side of the mold 107 having mold core pins 132 for insertion into the mold cavities 130 and forming the inner surface 124 of the preforms 112. In the example illustrated, the machine 100 has an equal quantity of mold cavities 130 and mold pins 132, this quantity defining the cavitation number of the mold 107. Typical mold cavitation numbers include 16, 32, 48, 96 or more. In the example illustrated, the mold cavitation number is 32.

- 20 -

[0073] The injection molding machine 100 is, in the example illustrated, provided with a part-handling apparatus 140 for handling and/or treating articles formed in the mold 107 of the machine. The part-handling apparatus 140 comprises a rotary cooling shell 142 having a plurality of sides 144, each side
5 144 rotatable together with the cooling shell 142 about a shell axis 146. In the example illustrated, the shell axis 146 is generally horizontal and perpendicular to the machine axis 105. The cooling shell 142 has (in the example illustrated) four generally planar sides 144a, 144b, 144c, and 144d (first to fourth sides, respectively), adjacent sides arranged generally perpendicular to each other and
10 joined along shell joint edges 148. The shell joint edges 148 are, in the example illustrated, parallel to the shell axis 146. The shell 142 has an interior chamber 149 bounded at least in part by the sides 144.

[0074] With reference to Figure 4, rotation of the cooling shell 142 about the shell axis 146 can move the sides 144 between various stations 150. In the
15 example illustrated, the stations 150 comprise four stations (150a-150d) spaced apart by 90 degree increments about the shell axis 146. One of the stations (e.g. first station 150a) can comprise a load station for loading articles onto the shell 142, and another station (e.g. fourth station 150d) can comprise an unload station 150d for unloading articles from the shell 142. At least one optional
20 supplemental treatment station can be provided between the load and unload stations 150a, 150d.

[0075] In the example illustrated, a side of the shell 142 is in the load station 150a when it is in a vertical orientation and nearest (along the machine axis) to the mold 107. In Figure 4, the first side 144a of the shell is in the load
25 station 150a. A side of the shell 142 is, in the example illustrated, in the unload station 150d when it is oriented in a generally horizontal plane beneath the shell axis 146. In Figures 3 and 4, the second side 144b of the shell is in the unload station 150d. At least one of the second and third stations 150b, 150c can comprise an optional supplemental treatment station. In the example illustrated,

- 21 -

the second station 150b comprises a first supplemental treatment station, opposite the unload station 150d, and the third station 150c comprises an optional second supplemental treatment station provided opposite the load station 150a.

5 [0076] In the example illustrated, the shell rotates in a clock-wise direction about the shell axis when viewed from the front as shown in Figure 4. Indexing the shell (i.e. rotating the shell 90 degrees) moves a side (e.g. first side 144a) from the load station 150a to the first supplemental treatment station 150b, and simultaneously moves another side (e.g. the second side 144b) from the unload
10 station 150d to the load station 150a. Indexing the cooling shell another 90 degrees moves the first side 144a (in the example illustrated) to the second supplemental treatment station 150c, positioned opposite the load station 150a. A further 90 degree index (i.e. a total of 270 degrees from the load station 150a) moves the first side 144a to the unload station 150d.

15 [0077] With reference to Figures 3, 6, and 7, the part-handling apparatus 140 further comprises a plurality of receiver sets 152 (including a first receiver set 152a and at least a second receiver set 152b) of individual cooling receivers 154 disposed on each side 144 of the shell 142. The first receiver set 152a comprises a plurality of cooling receivers 154 (identified here as first cooling receivers
20 154a), and the second receiver set 152b comprises another plurality of cooling receivers 154 (identified here as second cooling receivers 154b). Each one of the receiver sets 152 may have an equal quantity of individual receivers 154, and the quantity of receivers 154 in each set 152 may be equal to the cavitation number of the mold 107. In the example illustrated, each receiver set 152 has 32
25 receivers 154 (first receiver set 152a has 32 first receivers 154a—see Fig. 6; and second receiver set 152b has 32 second receivers 154b—see Fig. 7). There are two receiver sets 152 per side 144 (one first set 152a and one second set 152b), providing a total of 64 receivers per side of the cooling shell 142 and a total of

- 22 -

eight receiver sets 152 on the shell 142 (a total of 256 receivers 154 on the shell).

[0078] With reference to Figures 5 and 5A, in the example illustrated, each one of the cooling receivers 154 extends lengthwise along a receiver axis 155 and comprises an elongate cooling pin 156 with a base 158 fixed to the
5 respective side of the shell, and a tip 160 spaced away from the base 158 (along the receiver axis 155), with a pin sidewall 159 extending between the base 158 and the tip 160. A fluid channel 162 can be provided through each cooling pin 156, each fluid channel 162 having one or more inlets 162a adjacent the base
10 158 for receiving cooling fluid from the interior chamber 149 of the cooling shell, and one or more outlets 162b along the pin sidewall 159 for dispensing the cooling fluid from the channel and against the inner surface of a preform 112 loaded on the cooling pin 156.

[0079] Referring to Figures 3 and 8, a take-out plate 164 is reciprocally
15 movable between the mold 107 and the cooling shell 142 for transferring articles therebetween. The take-out plate generally transfers articles from the mold to the cooling receivers 154 of a side 144 of the cooling shell positioned in the load station. When the first side 144a is in the load station 150a, articles are transferred to one of the first and at least second sets 152a, 152b of the first side
20 144a of the cooling shell 142 during one (a first) injection cycle, and articles are transferred from the mold to the cooling receivers 154 of another one of the first and at least second sets 152a, 152b of the first side 144a during another (a second) injection cycle. In this specification, numbering of injection cycles is used to identify distinct injection cycles, and incremental numbering does not
25 necessarily define a particular order or succession of cycles (incremental numbering may define a particular order in some parts of the discussion where such ordering is expressly specified).

[0080] In the example illustrated, the take-out plate 164 is joined to a linear robot 165 that can translate the take-out plate 164 along a first robot axis 166

- 23 -

between an advanced position in which the take-out plate is disposed between the mold halves 104a, 106a, and a retracted position in which the take-out plate 164 is clear of the mold 107 (Figure 3). In the example illustrated, the first robot axis 166 is parallel to the shell axis 146. Furthermore, the cooling shell is, in the
5 example illustrated, optionally translatable along a second robot axis 168 that is parallel to the machine axis 105.

[0081] The take-out plate 164 has a quantity of transfer tubes 170 for receiving molded articles from the mold core pins 132. The quantity of transfer tubes 170 can be equal to the cavitation number of the mold 107 and can be
10 equal to the quantity of individual receivers 154 in each receiver set 152. In the example illustrated, the quantity of transfer tubes 170 provided on the take-out plate 164 is a single set of 32 tubes. In the example illustrated, equating the quantity of transfer tubes 170 with the number of mold core pins 132 provides a one-to-one correspondence between the mold core pins 132 and the transfer
15 tubes 170. When the take-out plate 164 is moved to the advanced position, each transfer tube 170 aligns with a respective one of the mold core pins 132, and each tube 170 receives a molded article (e.g. preform 112) from the same respective one of the mold core pins 132 during each successive injection cycle.

[0082] The transfer tubes 170 of the take-out plate 164 are, in the example
20 illustrated, spaced apart in a tube matrix pattern 172 (Figure 8). The tube matrix pattern 172 can include a plurality of tube rows 172a and a plurality of tube columns 172b (a total of eight tube rows 172a and four tube columns 172b in the example illustrated), with a respective one of the tubes 170 positioned at each intersection of the rows and columns 172a, 172b. The rows can be spaced apart
25 by a common tube row spacing 173a, and the columns 172b can be spaced apart by a common tube column spacing 173b.

[0083] The individual cooling receivers 154 of each of the at least two receiver sets 152 on each side 144 of the cooling shell 142 are, in the example illustrated, spaced apart in a pin matrix pattern 174 (Figure 6, 7) that matches the

- 24 -

5 tube matrix pattern 172. The pin matrix pattern 174 can include a plurality of pin rows 174a and pin columns 174b, with a respective one of the pins 156 positioned at each intersection of the pin rows and pin columns 174a, 174b. The pin rows can be spaced apart by a common pin row spacing 175a equal to the tube row spacing 173a, and the pin columns 174b can be spaced apart by a pin column spacing 175b equal to the tube column spacing 173b.

[0084] At the retracted position, the take-out plate 164 is movable relative to the cooling shell 142 for selectively aligning the tubes 170 in the tube matrix pattern 172 with the cooling pins 156 in the pin matrix pattern 174 of one of the at least two receiver sets 152. This is described in greater detail subsequently herein.

[0085] The tube matrix pattern 172 has a tube density defined by the number of tubes divided by the total surface area bounding the tube pattern. The pin pattern has a pin density defined by dividing the total number of individual receivers encompassed within the boundary of one set of pins. In examples where each face has two sets of pins, the pins of one set can be interlaced with the pins of the second set (e.g. in alternating columns or rows) so that the pin density is approximately double the tube density. Cooling shells with four sides and two sets of cooling pins on each side can provide cooling for articles (preforms) on the shell lasting about eight injection cycles.

[0086] In examples where each face has three sets of pins, the pins of each set can be interlaced so that the pin density is approximately triple the tube density. Optionally, the pins of each set can be arranged in separate, non-overlapping pin patterns so that the pin density is equal to the tube density. Cooling shells with four sides and three sets of cooling pins on each side can provide cooling for articles (preforms) on the shell lasting about 12 injection cycles.

- 25 -

[0087] In some examples, a combination of overlapping and non-overlapping pin patterns can be provided. For example, each side of the cooling shell may be provided with four sets of pins (set A, B, C, and D), with the pins of sets A and B arranged in a first interlaced, overlapping pattern arrangement, and
5 the pins of sets C and D arranged in a second interlaced, overlapping pattern arrangement, the first and second interlaced arrangements being separate from each other (e.g. positioned in side-by-side relation). This can provide each side of the cooling shell with four sets of cooling pins arranged in a density generally double that of the tube density. In this configuration, the overall size of each side
10 of the cooling shell (i.e. surface area bounding all the pins) would be about twice the size of the transfer plate (i.e. surface area bounding all the tubes). Cooling shells with four sides and four sets of cooling pins on each side can provide cooling for articles (preforms) on the shell lasting about 16 injection cycles.

[0088] Reducing the pin density of the pins on each side of the cooling
15 shell can help to reduce the spacing between adjacent pins within the same set, which can help to reduce the required size of the take-out plate. When considered from the perspective of the mold 107, the cavities in the mold can be spaced apart to provide sufficient mold wall thickness between adjacent mold cavities, while accommodating a preform having a given outer diameter and in-
20 mold cooling around the mold cavity.

[0089] With reference to Figure 9, in use the moving platen is advanced towards the stationary platen to close the mold 107 (i.e. bring mold halves 106a and 104a together). The mold 107 is clamped shut and melt is injected into the mold from the injection unit. The mold 107 remains closed until the articles are at
25 least partially cooled. Just prior to opening the mold, the take-out plate 164 can withdraw from the cooling shell 142 along the second robot axis 168. The articles on the receivers 154 of at least one receiver set 152 on the side of the cooling shell 142 in the unload station 150d (side 144a in Figure 9) can be unloaded (e.g. onto a conveyor 188) providing at least one empty set 152 of

- 26 -

cooling pins 156. The part handling device 140 is ready for the mold to open and the cooling shell 142 is ready to index.

[0090] Referring to Figure 10, once partially cooled, the mold may be opened and the take-out plate 164 can move along the first robot axis 166 to the advanced position, between the stationary and moving platens 104, 106. In the advanced position, the take-out plate 164 is positioned to receive one or more of the articles from the mold. In the example illustrated, the take-out plate 164 has a single advanced position; the take-out plate 164 moves to precisely the same advanced position relative to the mold each cycle. This can facilitate repeated accurate positioning of the take-out plate 164 with alignment of the transfer tubes 170 and mold core pins 132. In some examples, the take-out plate 164 can engage a fixed positive stop when in the advanced position.

[0091] In the example illustrated, upon opening the mold, the preforms 112 are retained on the core pins 132 of the second mold half 106a. When the take-out plate 164 is moved to the advanced position, the open ends of the cooling tubes 170 are aligned with (and face towards) the closed ends 118 of the preforms 112.

[0092] While the take-out plate 164 is in the advanced position, the cooling shell may be free to index. The take-out plate when in the retracted position is, in the example illustrated, positioned with only a slight gap 177 (Fig. 5) between the vertical plane defined by the outer surface portion 126b of the closed ends 118 of the preforms 112 on the side of the cooling shell at the load station 150a, and the vertical plane defined by the outermost ends (at the open ends) of the tubes 170 of the take-out plate 164. In this position, the take-out plate 164 invades the rotation envelope of the cooling shell. When in the advanced position (between the mold halves 104a, 106a), the take-out plate is clear of the rotation envelope of the cooling shell and can index (Figure 10) without interference.

- 27 -

[0093] Furthermore, while the take-out plate is in the advanced position, the preforms 112 may be transferred from the core pins 132 to the empty transfer tubes 170. This may be accomplished by moving the take-out plate 164 and/or the moving platen 106 towards each other. In the example illustrated, the moving
5 platen 106 advances towards the stationary platen to insert the molded, partially-cooled preforms into the transfer tubes. With reference to Figure 5A, a vacuum suction force can be applied through a suction channel 178 at each transfer tube 170, the suction channel 178 having an inlet 180 at an inner surface of each transfer tube 170. The suction force can facilitate pulling and/or holding the pre-
10 forms in the transfer tubes when the pre-forms are introduced into the tubes. An optional ejection mechanism can be provided at the mold core half 106a to facilitate transfer of the preforms 112 from the mold core pins 132 to the transfer tubes 170. The transfer tubes 170 are, in the example illustrated, water or air cooled via cooling conduits 182 and cool the outer surface 126 of the preforms
15 112 primarily by conduction. This cooling by the transfer tubes 170 can help to stabilize the physical structure of the perform 112 when removed from the mold 107.

[0094] With reference again to Figure 3, once the preforms 112 have been transferred from the mold core pins 132 to the transfer tubes 170, the take-out
20 plate 164 can be moved to its retracted position clear of the mold 107. This may include axially separating the take-out plate and the moving platen (e.g. retracting the moving platen away from the stationary platen) so the mold core pins are withdrawn from the molded articles. In Figure 3, the moving platen 106 has just withdrawn from the stationary platen 104. The mold core pins 132 are
25 empty. The take-out plate is ready to be retracted out of the mold area along the first robot axis 166. By clearing the mold halves, the mold is ready to be closed for the next injection cycle.

[0095] In Figure 11, the take-out plate 164 has cleared the mold 107, and the mold has closed to begin injection of the next set of articles. To transfer the

- 28 -

set of articles in the tubes 170 to the empty set of cooling pins 156 on the cooling shell 142, the take-out plate 164 can be moved relative to the first side 144a of the cooling shell 142 such that the empty cooling pins 156 are inserted into the preforms 112 carried by the transfer tubes 170. This may include translating the
5 take-out plate 164 to align the transfer tubes 170 with the empty pins of the pin pattern 174 of the selected pin (receiver) set 152a, 152b, and advancing the take-out plate 164 toward the cooling shell 142 along the second robot axis 168. To align the transfer tubes 170 with the pins of the pin pattern of the selected set of pins, the take-out plate may be translated to a selected retracted position (of a
10 plurality of retracted positions) along the first robot axis 166 (horizontal in the example illustrated). In Figure 5, the take-out plate is shown in phantom line at a first retracted position (along the first robot axis 166) for loading the first receivers 154a of the first receiver set 152a. In Figure 11, the take-out plate is shown at a second retracted position (along the first robot axis 166) for loading the second
15 receivers 154b of the second receiver set 152b (the receivers 154a are visible between the cooling tubes 170, and the receivers 154b are concealed within the tubes 170).

[0096] In some examples, aligning the transfer tubes 170 with a particular one of the sets 152 of receivers 154 can include translating the take-out plate
20 164 to a selected position along an optional third robot axis oriented orthogonal to the first and second robot axes 166, 168. In the example illustrated, the optional third robot axis, if provided, would be oriented generally vertically.

[0097] When the cooling pins 156 of the cooling shell 142 have been positioned inside the hollow interior of the preforms 112 (as seen in Figure 11),
25 any suction force acting on the outer surface of the preforms (to help hold the preforms in the transfer tubes 170) may be reduced or eliminated. The suction force may be switched to a positive pressure urging the preforms out of the tubes 170 and onto the cooling pins 156. A retaining force may be exerted on the preforms by the cooling shell to help hold the preforms 112 on the cooling pins

- 29 -

156. In the example illustrated, the cooling shell 142 comprises a gripper assembly for engaging the flange of the preforms 112 to exert such a retaining force. The gripper assembly can move from a disengaged position (in which the preforms 112 are free to move axially onto and off of the cooling pins) and an
5 engaged position (in which axial movement of the preforms 112 off of the cooling pins is inhibited). Further details of an exemplary gripper assembly 400 are provided hereinafter.

[0098] Once the preforms 112 have been transferred to the cooling pins 156, the take-out plate can move away from the cooling shell along the second
10 robot axis 168, towards the retraced position (in preparation to advance between the mold halves along the first robot axis 166 for receiving the next set of molded articles from the mold core pins).

[0099] In the example illustrated, when in normal operation, the injection molding machine 100 runs successive injection cycles. Sets of articles formed in
15 successive cycles are transferred to the take-out plate 164 (one set at a time) and then to the cooling shell 142 (one set at a time). Each set of molded articles molded in successive injection cycles are transferred from the core pins 132 of the mold 107 to the same single set of transfer tubes 170 in the take-out plate 164. Furthermore, in the example illustrated, each set of molded articles
20 transferred to the cooling pins 156 are transferred from the same single set of cavities 170 in the take-out plate.

[00100] At the cooling shell 142, a period of prolonged cooling can be applied by holding multiple sets of preforms on the shell. In the example illustrated, the cooling shell holds a total of eight sets of preforms.
25 Correspondingly, eight injection cycles elapse between the time that a particular set of preforms is loaded onto the cooling shell and the time that such particular set of preforms is unloaded from the cooling shell. Cooling is provided to the preforms during the entire time (eight injection cycles) that the preforms are

- 30 -

loaded on the cooling shell, by, for example, continuously directing cooling fluid to the inner surface of the preforms from the outlets 162b of the channels 162.

[00101] The sequence of the machine 100 can, in some examples, comprise indexing the cooling shell once per injection cycle, after each single set of articles is transferred from the take-out plate 164 to an empty set of pins on the cooling shell. The pins can be emptied at the unload station 150d immediately prior to the indexing step in which the shell is rotationally oriented to position the side of the shell with the empty pins in the load station 150a. For example, four successive injection cycles can include loading articles onto the first set 152a of pins of each side of the shell (indexing the shell each cycle to successively move each side to the load station), with the following four successive injection cycles including loading articles onto the second set 152b of pins of each side of the shell (again indexing the shell each cycle to successively move each side to the load station). The take-out plate 164 can move to a common first retracted position for the first four injection cycles, and to a common second retracted position for the second four injection cycles. In this sequence, only a single set of cooling pins (either the first set or the second set) is unloaded from the side of the shell positioned at the unload station.

[00102] The sequence can, in some examples, comprise indexing the cooling shell only once for every two successive injection cycles. For example, with the first side 144a at the unload station 150d, both sets 152a, 152b of pins can be emptied immediately prior to indexing the cooling shell to move the first side to the load station. When at the load station 150a, articles from one injection cycle can be loaded onto one set of empty pins (e.g. the first set 152a of pins), the shell 142 can hold its orientation, and articles from the next injection cycle can be loaded onto the second set 152b of empty pins. After the second set 152b of pins has been loaded with articles (e.g. preforms 112), the cooling shell 142 can be indexed to move the second side 144b of the cooling shell from

- 31 -

the unload station 150d (at which both sets of pins have been emptied) to the load station 150a.

- [00103] In either of the exemplary sequences described above, after a first set of articles from one injection cycle has been transferred onto the first set of pins of one side of the cooling shell, a second set of articles from a subsequent injection cycle is transferred to the second set of pins on that same side of the cooling shell while the first set of articles remain on the first set of pins. At least one set of articles is removed from each side of the shell when at the unload station 150d.
- 10 [00104] In some examples, cooled injection molded articles can be produced by operating the injection molding machine 100 through repeating cycles including a first cycle followed consecutively by second, third, fourth, fifth, sixth, seventh, eighth, ninth, and tenth successive cycles, in which respective first, second third, fourth, fifth, sixth, seventh, eighth, ninth, and tenth sets of articles are made in the mold. The tenth cycle may include: a) unloading the first set of articles from the first set of cooling pins on the first side of the cooling shell and rotating the shell to bring the first side to the load station; b) transferring the ninth set of articles from the mold to the take-out plate and from the take out plate to the first set of cooling pins on the first side of the cooling shell; and c)
- 15 20 injection molding the tenth set of articles in the mold.

[00105] In the example illustrated, the third cycle includes transferring the second set of articles from the mold to the take-out plate 164 and from the take out plate to one of a first set and a second set 152a, 152b of cooling pins 156 on the second side 144b of the shell.

- 25 [00106] The cooling shell 142 may be rotated to move the second side 144b from the unload station 150d to the load station 150a prior to moving the first side 144a to the unload station 150d, and transferring the third set of articles

- 32 -

molded in the third injection cycle from the mold of the injection molding machine to the first set of cooling pins on the second side 144b of the cooling shell 142.

[00107] Referring now to Figure 12A, another example of a cooling shell 342 is shown. The cooling shell 342 is similar to the cooling shell 142, and like features are identified by like reference characters, incremented by 200. The cooling shell 342 has four sides 344a-344d, each of which is provided with a plurality of cooling receivers 354. The cooling receivers 354 on each side 344 are, in the example illustrated, arranged in three sets 352a, 352b, and 352c of cooling receivers (see Figures 12A, 12B, 12C, respectively). The cooling receivers 354 can comprise pins 356 for insertion into the hollow interiors of the preforms 112.

[00108] The individual cooling receivers 354 (354a, 354b, 354c, respectively) of each of the receiver sets 352a, 352b, and 352c on each side 344 of the cooling shell 342 are spaced apart in a pin matrix pattern 374. In the example illustrated, the pin matrix pattern 374 matches the tube matrix pattern 172 of the take out plate 164 of the machine 100. In use, the receivers 354 of each set 352 can be loaded sequentially as described above in relation to the shell 142. The first and second sets 352a, 352b are offset from each other in a first direction, parallel to the shell axis 346. The third set 352c is, in the example illustrated, positioned between the first and second sets along the shell axis 346, and offset in a second direction generally orthogonal to the shell axis. In use, the cooling shell 342 provides uninterrupted cooling to the preforms 112 on the shell 342 for 12 injection cycles.

[00109] With reference to Figure 13, further detail of how a retaining force may be exerted on the preforms for holding the preforms on the cooling shell is provided. Using the cooling shell 142 as an example, the cooling shell 142 may be provided with a gripper assembly 400 coupled to each side 144 of the shell 142 having the receivers 154 mounted thereon. In the example illustrated, each

- 33 -

side 144a, 144b, 144c, 144d is provided with a respective gripper assembly identified as gripper assembly 400a, 400b, 400c, 400d.

[00110] With reference to Figures 14 and 15, each gripper assembly 400 includes a plurality of first abutment surfaces 402a and a plurality of second abutment surfaces 402b. In a lateral direction (generally parallel to the respective side 144), each first abutment surface 402a is positioned adjacent a respective one of the first receivers 154a and each second abutment surface 402b is positioned adjacent a respective one of the second receivers 154b (see also Figure 5A). The first and second abutment surfaces 402 can be spaced laterally apart from the respective receiver axis 155 of the adjacent receiver 154 by a first and a second lateral spacing 404a and 404b, respectively (Fig. 5A). In an axial direction (generally orthogonal to the respective side 144), each first abutment surface 402a is spaced apart from the respective side 144 by a first axial spacing 406a and each second abutment surface 402b is spaced apart from the respective side 144 by a second axial spacing 406b. The first and second axial spacings 406 are, in the example illustrated, at least large enough to accommodate the thickness 123a of the flange 122 of the preform 112 between the abutment surface 402 and the side 144.

[00111] Each abutment surface 402 is moveable relative to the respective adjacent receiver 154 between a clear position 410 and at least one holding position 412 for selectively releasing and retaining a molded article loaded on the respective adjacent receiver 154. In Figure 15, the first abutment surface 402a is shown in the clear position 410, and the second abutment surface 402b is shown in a holding position 412. In the example illustrated, movement from the clear position 410 to the at least one holding position 412 reduces the corresponding lateral spacing 406 between the respective abutment surface 402 and the receiver axis 155 of the respective adjacent receiver 154. In the example illustrated, when in the clear position 410, the lateral spacing 406 is greater than the radius 123b of the flange of the preform and when in the holding position 412,

- 34 -

the lateral spacing 406 is less than the radius 123b of the flange of the preform 112. At least a portion of the flange 122 of each respective molded article (preform 112) loaded on the cooling shell is positioned axially between the respective side 144 and at least a portion of each respective abutment surface 402 when the abutment surface is in the at least one holding position 412.

[00112] In the example illustrated, each gripper assembly 400 comprises at least a first respective gripper plate 414, and the plurality of first abutment surfaces 402 are affixed to each first respective gripper plate 414. The second abutment surfaces 402b may also be affixed to the first gripper plate 414. In the example illustrated, the first and second abutment surfaces 402a, 402b comprise spaced apart portions of an underside (inner) surface 415 of each respective gripper plate 414. Each gripper plate 414 has an outer surface 417 opposite the inner surface 415 and facing away from the shell.

[00113] Each first gripper plate 414 is, in the example illustrated, oriented generally parallel to the respective side 144 to which the gripper assembly 400 is coupled, and is moveable between a plate first position 416 in which the first abutment surfaces 402a are in the clear position 410, and at least a plate second position 418 in which the first abutment surfaces 402b are in the at least one holding position 412.

[00114] Each first gripper plate 414 can be slidable along a respective slide axis 420 for moving between the first plate first position and the first plate second position. In the example illustrated, each first gripper plate 414 is slidable in a plane generally parallel to the respective side 144 to which it is coupled. The respective slide axis 420 of each first gripper plate 414 is, in the example illustrated, generally parallel to the shell axis 146. A respective slide support 422 can be provided for coupling each first gripper plate 414 to each respective side 144 of the shell 142. The slide support 422 can include a linear rail, a carriage coupled to a linear rail, and/or one or more of a cam or track follower.

- 35 -

[00115] In the example illustrated, the slide support 422 includes a guideway 424 provided on each gripper plate in the form of four guideway segments 424a, 424b, 424c, and 424d, each positioned adjacent a respective corner of the gripper plate 414. Four corresponding studs 426a, 426b, 426c, and 426d are affixed to each side 144 of the shell 142, each stud 426 in registration with, and received within, a respective one of the guideway segments 424. Each guideway segment 426 is elongate, with lengthwise sidewalls 428 extending along a guideway axis 430 (Figure 16A) that is parallel to the slide axis 420. Engagement of studs 426 with the inner surfaces of the sidewalls 428 helps to constrain the gripper plate 414 to move in a direction parallel to the slide axis 420. In the example illustrated, the sidewalls 428 of the guideway segments 426 protrude towards the respective side 144 of the shell 142, providing standoffs 432 (Fig. 14) that can space the gripper plate 414 away from the respective side 144 by an amount that provides the axial spacing 406a (Fig. 5A) between the first abutment surfaces and the side 144. Each stud 426 may be provided with radially protruding head adjacent an upper end of the stud 426 that may bear against the outer surface 417 of the gripper plate 414 adjacent the guideway segments 424 to inhibit orthogonal movement of the gripper plate 414 away from the respective side 144 of the shell 142.

[00116] Each gripper plate may be provided with one set of apertures for every set of receivers on each side of the shell. With reference again to Figures 14 and 15, in the example illustrated, each first gripper plate 414 comprises a set of first apertures 436a, and respective ones of the first abutment surfaces 402a are positioned adjacent respective ones of the first apertures 436a. The first apertures 436a are generally spaced apart from each other for registration with the first receivers 154a of the first receiver set 152a of the respective side 144 of the shell 142.

[00117] In the example illustrated, each first gripper plate 414 comprises a set of second apertures 436b, and respective ones of the second abutment

- 36 -

surfaces 402b are affixed to the first gripper plate 414, adjacent respective ones of the second apertures 436b. Each first gripper plate 414 is, in the example illustrated, moveable among the first, second, and third plate positions 416, 418, and 419 by sliding the gripper plate 414 in a direction parallel to the slide axis
5 420.

[00118] In the example illustrated, each aperture 436 comprises an enlarged portion 438 having a perimeter 440 through which the flange of the preform 112 can pass in a direction generally orthogonal to the gripper plate. Each aperture has a narrowed portion 442 adjoining the enlarged portion 438
10 and extending from an opening 444 along one side of the perimeter of the enlarged portion 438. The narrowed portion 442 is sized so that the cylindrical body portion 126 of the preform 112 can slide within the narrowed portion, but the flange 122 of the preform 112 is unable to pass through the narrowed portion 442 in a direction generally orthogonal to the gripper plate 414.

15 [00119] In the example illustrated, each narrowed portion 442a of the first apertures 436a extends radially outwardly from a first opening 444a in the perimeter 440a of the enlarged portion 438a of each first aperture 436a, the first opening provided along a portion of the perimeter 440a disposed in a first direction parallel to the slide axis 420 (towards the right in Figure 15). The
20 narrowed portions 442b of the second apertures 436b extend radially outwardly from a second opening 444b in the perimeter 440b of the enlarged portions 438b of the second apertures 436b, the second opening 444b provided along a portion of the perimeter 440b disposed in a second direction parallel to the slide axis and opposite the first direction (towards the left in Figure 15).

25 [00120] The enlarged portions of the first apertures are, in the example illustrated, spaced apart from each other to form an aperture matrix pattern. Similarly, the enlarged portions of the second apertures are spaced apart according to the aperture matrix pattern. The aperture matrix pattern generally

- 37 -

matches the pin matrix pattern formed by the spacing of the respective receivers in each receiver set on each side of the shell.

[00121] In use, when the gripper plate 414 is moved to the plate first position 416 (Figures 15 and 16A), the first abutment surfaces 402a adjacent the first apertures 436a are moved to the set-A clear position 410a, and the second abutment surfaces 402b adjacent the second apertures 436b are moved to a first one of the at least one set-B holding positions 412b. The first lateral spacing 404a between the first abutment surface 402a and the respective receiver axis 155a is greater than the second lateral spacing 406b between the second abutment surface 402b and the respective receiver axis 155b of the adjacent second receiver 154b. In this plate first position 416, preforms 112 can be released from or loaded on the first receivers 154a of the respective side 144 of the shell 142, while preforms already loaded on the second receivers 154b are retained on the receivers 154b of the respective side 144 of the shell.

[00122] When the plate 414 is moved to the plate second position 418 (Figure 16B), the reverse situation is provided. The first abutment surfaces 402a adjacent the first apertures 436a are moved to a first one of the at least one set-A holding positions 412a, and the second abutment surfaces 402b adjacent the second apertures 436b are moved to the set-B clear position 410b. The first lateral spacing 404a between the first abutment surface 402a and the respective receiver axis 155a is less than the second lateral spacing 406b between the second abutment surface 402b and the respective receiver axis 155b of the adjacent second receiver 154b. In this plate second position 418, preforms 112 can be released from or loaded on the second receivers 154b of the respective side 144 of the shell 142, while preforms already loaded on the first receivers 154a are retained on the receivers 154a of the respective side 144 of the shell.

[00123] When the plate 414 is moved to the plate third position 419 (Figures 16C and 17), the first abutment surfaces 402a and the second abutment surfaces 402b are moved to respective second ones of the at least one holding

- 38 -

positions 412 (referred to as first set second hold position 413a for set-A receivers and second set second hold position 413b for b-set receivers). In this position, the first and second lateral spacings 404a, 404b are generally equal (see Figure 17). Portions of the first and second abutment surfaces 402a, 402b
5 are in registration with portions of the flanges of preforms loaded on respective receivers 152a, 152b, thereby retaining the preforms thereon. In the example illustrated, the plate third position 419 is intermediate (along slide axis 420) the plate first and second positions 416, 418, and may be located approximately midway between the first and second positions 416, 418.

10 [00124] Each gripper assembly 400 may include a retaining member 450 movable between advanced and retracted positions. When in the advanced position, the retaining member 450 may hold the gripper plate 414 in the plate third position 419 at least during the time each respective side 144 (to which the respective plate 414 is coupled) leaves the load station 150a and arrives at the
15 unload station 150d. The gripper assembly 400 may include a biasing element 452 for urging the retaining member 450 towards the advanced position. The biasing element 452 may be mounted to the shell 142 and move with the shell 142 when the shell 142 is indexed to move the sides 144 of the shell 142 among the stations 150. A retraction member 454 may be provided to move the
20 retaining member to the retracted position when the respective side 144 to which the gripper assembly is coupled has been moved into the unload station and/or the load station.

[00125] In the example illustrated, a load actuator 460 (Figure 6) is provided for selectively urging the gripper plate 414 from the third position 419 to a
25 selected one of the first and second positions 416, 418 when the respective side 144 is at the load station 150a. The load actuator 460 may be fixed to the support column 462 to which the shell 142 is attached (Fig. 13), and may detachably engage the gripper plate 414 when the respective side 144 moves to the load station 150a. In the example illustrated, the load actuator 460 is

- 39 -

provided with a T-bolt 464 that, when the actuator is in a home position, is automatically engaged by a slotted bracket 466 (Fig. 14) fixed to the plate 414 as the respective side 144 rotationally arrives at the load station. The actuator 460 can then be advanced or retracted relative to the home position to move the plate
5 414 from the plate third position 419 and into a selected one of the plate first or second positions 416, 418.

[00126] In the example illustrated, an unload actuator 470 is provided for selectively urging the gripper plate 414 from the third position to a selected one of the first and second positions 416, 418 when the respective side 144 to which
10 the plate 414 is coupled is positioned at the unload station 150d. The unload actuator 470 is, in the example illustrated, fixed relative to the support column 462 to which the shell is attached. The unload actuator 470 may detachably engage the gripper plate 414 of the respective side of the shell when the respective side arrives at the unload station. The unload actuator may be
15 positioned to inter-engage with the same slotted bracket 466, but when the plate 414 is at the unload station 150d rather than the load station 150a.

[00127] Each gripper assembly 400 is, in the example illustrated, adjustable relative to the respective side 142 to selectively release at least one of the loaded sets of molded articles of the respective side 142 when positioned at the unload
20 station 150d (side 144b in Figures 11 and 13), and adjustable relative to the respective side to retain at least one newly loaded set of molded articles on the respective side when positioned at the load station 150a (side 144a in Figures 11 and 13).

[00128] The gripper assembly 400a of the respective side 144a at the load
25 station 150a is adjustable to allow loading of one of the first and at least second sets of molded articles while retaining the other of the first and at least second sets of molded articles (i.e. load preforms 112 onto one of the first and second receiver sets 152a, 152b while retaining preforms 112 on the other of the first and second receiver sets 152a, 152b). Furthermore, the gripper assembly 400a

- 40 -

of the respective side 144a at the load station 150a is adjustable to retain all of the first and at least second sets of molded articles prior to moving the respective side 144a away from the load station 150a. The gripper assembly 400b of a respective side 144b at the unload station 150d is adjustable to retain at least
5 one of the other of said loaded sets of molded articles when said at least one of the loaded sets is released.

[00129] When a respective gripper plate 414 coupled to a respective side 144 of the shell 142 is in the plate first position 416, molded articles (e.g. preforms 112) supported by the first receivers 154a are retained on the cooling
10 shell 142 and molded articles (e.g. preforms 112) supported by the second receivers 154b are releasable from the cooling shell 142. In the plate second position 418, molded articles supported by the second receivers 154b are retained on the cooling shell 142 and molded articles supported by the first receivers 154a are releasable from the cooling shell 142. In the plate third
15 position 419, molded articles supported by the first and second receivers 154a, 154b are retained on the cooling shell 142.

[00130] An alternate gripper plate 514 of an alternate gripper assembly 500 is shown in Figure 18. The gripper assembly 500 is similar to gripper assembly 400, and like features are identified by like reference characters, incremented by
20 100. The gripper plate 514 has first and second apertures 536a, 536b with narrowed portions 542a, 542b that connect with each other at their ends away from the respective enlarged portions 538a, 538b. The first abutment surfaces 502a comprise surface portions that are spaced apart from each other on opposite sides of the narrowed portions 542a, perpendicular to the slide axis 520.
25 Each first abutment surface portion is positioned adjacent the respective enlarged portion 538a of the respective aperture 536a. The enlarged portions 538a have a generally square perimeter.

- 41 -

[00131] The second abutment surfaces 538b are similarly provided in two surface portions spaced apart on opposite sides of the narrowed portion 542b of the second apertures 536b.

[00132] Referring to Figure 19, portions of another alternate gripper assembly 600 are shown, in which the gripper assembly is similar to gripper assembly 400, with like features identified by like reference characters, incremented by 200. The gripper assembly 600 is provided with two gripper plates 614a and 614b that are slidably coupled in overlapping relation onto each respective side 144 of the shell 142. The first apertures 636a having the first abutment surfaces 602a adjacent thereto are provided in the first gripper plate 614a. The first narrowed portions 642a extend in one direction (to the right along first slide axis 620a in Figure 19) from the respective enlarged portions 638a. The second apertures 636b having the second abutment surfaces 602b adjacent thereto are provided in the second gripper plate 614b. The second narrowed portions 642b extend in the opposite direction (to the left along second slide axis 620b in Figure 19) from the respective enlarged portions 638b. The first plate is provided with first clearance cut-outs 649a that are in registration with the second apertures 636b of the second plate 614b so that the first plate 614a does not interfere with the retaining/releasing operation of the second plate 614b. Similarly, the second plate is provided with second clearance cut-outs 649b.

[00133] Another alternate example of a gripper assembly 700 is shown in Figure 20, with similarities to the assembly 400 and wherein like features are identified by like reference characters, incremented by 300. The gripper assembly 700 is shown in use with receivers 854 of a cooling shell 840 in which the receivers 854 comprise cooling tubes rather than pins.

[00134] Referring to Figure 21, the part handling apparatus 140 may comprise a pressurized fluid delivery device 901 to supply pressurized fluid (e.g. air in the example illustrated) to the interior chamber 149 of the cooling shell 142. In the example illustrated, the pressurized fluid delivery device 901 comprises a

- 42 -

blower. The blower may, in some examples, be sized to deliver air at relatively moderate pressure (lower than typical shop air pressure) and at relatively high volumetric rate. In some examples, the blower may deliver air at a pressure in a range between about 70 and about 300 kPa above ambient pressure and at a volumetric rate in a range from about 3 cubic metres per minute to about 15 cubic metres per minute.

[00135] The pressurized fluid delivery device 901 may be spaced apart from the cooling shell 142 and is, in the example illustrated, disposed adjacent a lower end of the support column 462 to which the cooling shell 142 is mounted (adjacent an upper end thereof). The support column 462 has a hollow interior shaft 903 along at least a portion of its length, and the blower supplies pressurized air from the blower outlet 905 to the hollow interior shaft 903.

[00136] In the example illustrated, the cooling shell 142 is joined to the support column 462 by a rotary mount 907 (see also Fig. 13), permitting rotation of the cooling shell 142 relative to the support column 462. The rotary mount 907 comprises a mount aperture 909 that provides fluid communication between the hollow interior shaft 903 of the support column 462 and the cooling shell 142 when mounted to the support column 462.

[00137] In the example illustrated, the blower (fluid delivery device 901) and the support column 462 are stationary relative to the machine base 102. In some examples, the fluid delivery device may be affixed to the support column, and the fluid delivery device and support column may together move relative to the base 102 (for example, parallel to the X-axis 168 shown in Fig. 3). In some examples, the fluid delivery device may be affixed to, and may move with, but be stationary relative to, the cooling shell 142.

[00138] The pressurized fluid delivery device 901 is, in the example illustrated, in fluid communication with the hollow interior chamber 149 of the cooling shell via a conduit first portion 911a (identified by arrows in Fig. 21). In

- 43 -

the example illustrated, the conduit first portion 911a comprises at least at portion of the hollow interior shaft 903 of the support column 462, and at least a portion of the mount aperture 909. The conduit first portion 911a is, in the example illustrated, free of openable/closeable flow blocking members, such as, for example, valves that could be automatically closed and opened during operation of the machine to selectively interrupt and resume fluid communication between the blower and the hollow interior of the cooling shell by blocking and unblocking flow through the conduit first portion. In the example illustrated, fluid communication between the pressurized fluid delivery device 901 and the hollow interior chamber is continuously provided.

[00139] A conduit second portion 911b provides fluid communication between the outlets 162b of the cooling pins 156 and the hollow interior chamber 149 of the cooling shell 142. In the example illustrated, the conduit second portion 911b comprises the fluid channel 162 internal to each cooling pin 156. The conduit second portion 911b is, in the example illustrated, free of openable/closeable flow blocking members (e.g. controlled valves for automatically moving between opened and closed positions during operation of the machine 100), and fluid communication between the hollow interior chamber 149 and the pin outlets 162b is continuously provided.

[00140] The conduit first portion 911a and the conduit second portion 911b provide a cooling flow path 911 from the blower outlet 905 to the outlets 162b of the fluid channels 162 in the cooling pins 156. The cooling fluid flow path 911 is, in the example illustrated, free of shut-off valves or closure members (that could selectively open and close the cooling fluid flow path during operation of the machine). The cooling fluid flow path 911 is, in the example illustrated, a permanently open flow path for providing a continuous flow of cooling air from the blower to the outlets 162b of the cooling pins 154.

[00141] The part handling apparatus 140 of the machine 100 includes an optional supplemental treatment/cooling station 150b adjacent the cooling shell

- 44 -

142. The supplemental cooling station including a housing 921 having a plurality of supplemental outlets 923 for directing cooling fluid towards exterior surfaces of the molded articles (e.g. the exterior surface 126 of the preforms 112) loaded on the cooling pins 156. The supplemental cooling station may comprise a slide 925
5 along which the housing 921 of the supplemental cooling station 150b is translatable between advanced and retracted positions, wherein when in the advanced position (Fig. 22), the supplemental outlets are proximate the exterior surfaces of the molded articles and in fluid communication with the blower outlet 905, and when in the retracted position (Fig. 21), the supplemental outlets 923
10 are spaced away from the exterior surfaces of the molded articles and are in fluid isolation from the blower outlet 905.

[00142] The supplemental cooling station may include a supplemental interior chamber 927 within the housing, the supplemental interior chamber in fluid communication with a supplemental inlet 929 of the housing 921 and the
15 supplemental cooling outlets 923. The machine may include a supplemental fluid supply conduit 931 in fluid communication with the pressurized fluid delivery device 901. In the example illustrated, the supplemental fluid supply conduit comprises an upper extension of the hollow shaft 903.

[00143] In the example illustrated, the supplemental fluid supply conduit
20 931 has an opening 933 that is blocked by a portion of the housing (e.g. blocking portion 935) when the housing 921 is in the retracted position, and that (the opening 933) is in registration with the supplemental inlet 929 when the housing 921 is in the advanced position. In the example illustrated, fluid communication is provided between the fluid delivery device 901 and the supplemental outlets
25 923 when the housing 921 is in the advanced position, and the fluid delivery device 901 is fluidly isolated from the supplemental outlets 923 when the housing 921 is in the retracted position.

[00144] In the example illustrated, the apparatus 140 includes an optional second supplemental treatment/cooling station 150c. The second supplemental

- 45 -

treatment/cooling station 150c has structure similar to that of the first supplemental treatment station 150b. In the example illustrated, the second supplemental treatment station 150c has a slide that is horizontally oriented, rather than the vertically oriented slide 925 of the first supplemental treatment
5 station 150b.

[00145] In use, a method of injection molding can include injection molding a first set of articles in the mold of the injection molding machine 100. Thereafter the first set of molded articles can be removed from the mold and transferred to the cooling shell 142 via the take-out plate 164. At a point afterwards, the first
10 set of molded articles can be unloaded from the first set of cooling pins. A stream of cooling fluid can be continuously urged out of the pin outlets from the fluid delivery device during the period of time beginning with the injection molding of the first set of articles and ending no sooner than when the first set of articles are unloaded from the shell 142.

15 [00146] In some examples, the method may include continuously pressurizing the internal chamber of the cooling shell with the cooling fluid. In some examples, the fluid delivery device may include a blower, and the method may include continuously operating the blower, the blower having a high pressure outlet in fluid communication with the internal chamber of the cooling
20 shell.

[00147] Referring to Figure 24, another embodiment of part handling apparatus 1140 is similar to the part handling apparatus 140, with like features identified by like reference characters, incremented by 1000.

[00148] The part handling apparatus 1140 includes a support column 1462
25 having an L-shaped configuration, with a horizontal portion 1462a and a vertical portion 1462b. In the example illustrated, the cooling shell 1142 is mounted generally at the intersection of the horizontal and vertical portions 1462a, 1462b, and the pressure air delivery device 1901 is mounted to an outboard end of

- 46 -

horizontal portion 1462a. The horizontal portion 1462 may house a hollow interior shaft 1903 for providing fluid communication between the fluid delivery device 1901 and the hollow interior chamber 1149 of the cooling shell 1142. The configuration of the support column 1462 and fluid delivery device 1901 can facilitate providing a clear open space beneath cooling shell 1142, and a conveyor 1188 can be positioned in the space to transport articles released from the shell to downstream handling and/or processing operations.

[00149] Referring to Figure 25, a multi-part tooling kit 2000 for an injection molding machine includes a first set of tooling 2002' for processing a first molded article set of first molded articles 112', and at least a second set of tooling 2002" for processing a second set of molded articles 112", the second molded articles different in at least one of size and shape than the first set of molded articles. In the example illustrated, the first and second molded articles 112' and 112" are preforms having attributes generally similar to that of the perform 112, but with the first preforms 112' having a different shape and size from the second preforms 112".

[00150] The tooling sets 2002' and 2002" include elements similar to those described previously herein, with like elements identified by like reference characters with a prime (') or double prime (") suffix added to denote association with the first and second tooling sets 2002', 2002", respectively.

[00151] The first tooling set 2002' includes a first mold core half 104a' and a first mold cavity half 106a' mountable to opposed platens (e.g. platens 104, 106 of the injection molding machine 100). Like the mold halves 104, 106a, the mold halves 104a' and 106a' cooperate with each other to form a first set of first mold chambers 2004 for molding sets of the first molded articles 112'. The first mold chambers 2004 are spaced apart from each other in vertical and horizontal directions by a first chamber spacing spacing.

- 47 -

[00152] The first tooling set 2002' further includes a first take-out plate 164' having first take-out tubes 170' spaced and shaped to receive the first set of molded articles 112', the first take-out plate 164' mountable to a robot disposed adjacent the platens 104, 106 of the injection molding machine 100.

5 [00153] The first tooling set 2002' further includes a first cooling shell 142' mountable to a support (e.g. support 462) remote from the mold, the first cooling shell 142' including at least two first cooling shell sides with at least one set of first cooling pins mounted to each first cooling shell side, the first cooling pins spaced and shaped to receive the first molded article set from the first take-out
10 tubes 170'.

[00154] The at least one second tooling set 2002" includes a second mold core half 104a" and a second mold cavity half 106a" mountable to opposed platens (e.g. platens 104, 106 of the injection molding machine 100). The mold halves 104a" and 106a" cooperate with each other to form a set of second mold
15 chambers 2004 for molding sets of the second molded articles 112". The second mold chambers 2004" are spaced apart from each other in vertical and horizontal directions by a second chamber spacing that may be different in at least one dimension from the first chamber spacing.

[00155] The second tooling set 2002" further includes a second take-out
20 plate 164" having first take-out tubes 170' spaced and shaped to receive the second set of molded articles 112". The second take-out plate 164" is mountable to a robot disposed adjacent the platens 104, 106 of the injection molding machine 100.

[00156] The second tooling set 2002" further includes a second cooling
25 shell 142" mountable to a support (e.g. support 462) remote from the mold, the second cooling shell 142" including at least two second cooling shell sides with at least one set of second cooling pins mounted to each second cooling shell side.

- 48 -

The second cooling pins are spaced and shaped to receive the second molded articles 112" from the second take-out tubes 170".

[00157] In some examples, the first cooling shell 142' may include at least a second set of first cooling pins mounted to each first cooling shell side. The second cooling shell 142" may include at least a second set of second cooling pins 156" mounted to each second cooling shell side. Each side of each cooling shell may include at least one gripper plate 414 slidably coupled to the respective side for selectively retaining and releasing molded articles loaded on the pins of the respective side. In some examples, the first and second cooling shells may have differing quantities of sides with pins mounted thereto. For example, the first shell may four sides, and the second shell may have only one side, or may have only two sides, with cooling pins mounted thereto.

[00158] In use, the injection molding machine 100 may be changed-over from producing a first part (e.g. first performs 112') to running a second part (e.g. second preforms 112") by taking the first mold core half and a first mold cavity half (e.g. mold halves 104a' and 106a') out of position for opening and closing a first mold to injection mold sets of first articles 112', and placing the second mold core half and a second mold cavity half (e.g. mold halves 104a" and 106a") into position for opening and closing a second mold to injection mold a second set of articles. The change-over may further include removing the first take-out plate 164' from a robot and thereafter mounting the second take-out plate 164" to the robot, and replacing the first cooling shell 142' positioned to receive articles from the robot with the second cooling shell 142".

[00159] In some examples, the change-over may include releasing the first cooling shell 142' from a rotary mount 901, and thereafter securing the second cooling shell 142" to the rotary mount 901. In some examples, each of the cooling shells 142', 142" includes a plurality of cooling pins 156 mounted thereto for conveying a pressurized cooling fluid from an interior chamber of the cooling shell to pin outlets on the pins and external to the shell. The step of releasing the

- 49 -

- first cooling shell from the rotary mount can disconnect the interior chamber of the first cooling shell from a pressurized fluid delivery device, and securing the second cooling shell 142" to the rotary mount 901 can connect the interior chamber of the second cooling shell 142" to the fluid delivery device. In some
- 5 examples, taking the mold halves out of position may include removing the first mold core half and the first mold cavity half from the respective platens, and putting the second mold halves in position may include mounting the second mold core half and the second mold cavity half to the respective platens. In some examples, taking the first mold halves out of position and putting the
- 10 second mold halves in position may include shuttling or indexing a mold half carrier from a first position to a second position, the first mold halves presented in position for molding when the carrier is in the first position, and the second mold halves presented in position for molding when the carrier is in the second position.
- 15 [00160] While the above description provides examples of one or more processes or apparatuses, it will be appreciated that other processes or apparatuses may be within the scope of the accompanying claims.

- 50 -

CLAIMS:

1. A part-handling apparatus for an injection molding machine, comprising:
 - a) a rotary cooling shell having a plurality of sides, each side rotatable together with the cooling shell about a shell axis;
 - 5 b) a first receiver set and at least a second receiver set of cooling receivers disposed on each side of the shell, each cooling receiver configured to be loaded with a respective injection molded article from the injection molding machine and to retain said article on the shell during rotation of the shell; and
 - 10 c) a take-out plate reciprocally movable between a mold and the cooling shell, the take-out plate transferring a first set of articles from the mold to the cooling receivers of the first set of a first side during a first injection cycle, and transferring a second set of articles from the mold to the cooling receivers of the second receiver set of the first side during a second injection
 - 15 cycle, while the first set of articles remains loaded on the cooling receivers of the first receiver set.
2. The apparatus of claim 1, further comprising a third receiver set of cooling receivers disposed on each side of the shell, the cooling receivers of the third receiver set on the first side receiving articles from a third injection cycle while
- 20 the first and second sets of articles remain loaded on the cooling receivers of the first and second receiver sets.
3. The apparatus of any one of claims 1-2, wherein each one of the receiver sets has an equal quantity of individual cooling receivers.
4. The apparatus of any one of claims 1-3, wherein each one of the cooling
- 25 receivers comprises a cooling pin having a base fixed to the respective side of the shell, and a tip spaced away from the base.

- 51 -

5. The apparatus of claim 4, wherein the take-out plate has a single set of transfer tubes equal in quantity to the quantity of individual cooling receivers in each receiver set.
6. The apparatus of claim 5, wherein the mold has a quantity of mold cavities
5 for forming molded articles during each injection cycle, and wherein the quantity of mold cavities is equal to the quantity of cooling tubes in the take-out plate.
7. The apparatus of claim 5, wherein the tubes of the take-out plate are spaced apart in a tube matrix pattern and the individual pins of each of the first and second receiver sets are spaced apart in a pin matrix pattern that matches
10 the tube matrix pattern.
8. The apparatus of claim 6, wherein the take-out plate is movable relative to the cooling shell for selectively aligning the tubes in the tube matrix pattern with the cooling pins in the pin matrix pattern of either one of the first and second receiver sets.
9. An injection molding machine, comprising:
15 a) a mold having a quantity of mold pins, the quantity of mold pins defining a mold cavitation number;
b) a take-out plate translatable between advanced and retracted positions, the take-out plate having a quantity of transfer tubes equal to
20 the cavitation number, each transfer tube aligning with a respective one of the mold pins when the take-out plate is in the advanced position, each transfer tube receiving a molded article from the respective one of the mold pins after each injection cycle; and
c) a cooling shell having at least one side, the at least one side
25 having a quantity of cooling pins for receiving molded articles from the take-out plate, the quantity of cooling pins on the at least one side being equal to an integer multiple of two or more times the cavitation number.

- 52 -

10. The injection molding machine of claim 9, wherein the cooling shell has four sides.

11. A method for cooling molded articles, comprising:

5 a) rotationally orienting a cooling shell about a shell axis to position a generally planar first side of the cooling shell in a load position;

b) transferring a first set of articles molded in a first injection cycle from a mold of an injection molding machine to a first set of cooling pins on the first side of the cooling shell; and

10 c) after steps a) and b), transferring a second set of articles molded in a subsequent injection cycle from the mold to a second set of cooling pins on the first side of the rotary cooling shell while the first set of articles remain on the first set of cooling pins.

12. The method of claim 11, further comprising rotating the cooling shell to position the first side in an unload station.

15 13. The method of claim 12, further comprising removing at least one of the first and second set of articles from the first side when in the unload position.

14. The method of claim 12, further comprising removing only one of the first and second set of articles from the first side when in the unload position.

20 15. The method of claim 12, further comprising removing both the first and second set of articles from the first side when in the unload position.

16. The method of any one of claims 12-14, further comprising rotating the cooling shell to move a generally planar second side from the unload position to the load position prior to moving the first side to the unload position, and transferring a third set of articles molded in a third injection cycle from the mold of the injection molding machine to a first set of cooling pins on the second side of the cooling shell.

25

- 53 -

17. The method of claim 16, further comprising transferring a fourth set of molded articles to a second set of cooling pins on the second side of the cooling shell while the first set of articles remains on the first set of cooling pins of the second side of the cooling shell.

5 18. The method of claim 16, wherein rotation of the cooling shell to move the second side to the load position moves the first side of the cooling shell to a first supplemental cooling station.

19. The method of any one of claims 11-15, wherein step (b) includes transferring the first set of articles from a core side of the mold to a first set of
10 transfer tubes in a take-out plate, moving the take-out plate from an advanced position to a retracted position outside the mold, and transferring the first set of articles from the first set of transfer tubes in the take-out plate to the first set of cooling pins on the first side of the cooling shell.

20. The method of claim 19, wherein each set of molded articles molded in
15 successive injection cycles are transferred from the mold to the same first set of transfer tubes in the take-out plate.

21. The method of any one of claims 19-20, wherein each set of molded articles transferred to the first set of cooling pins are transferred from the first set of transfer tubes in the take-out plate.

20 22. The method of claim 21, wherein the take-out plate is moved along a linear axis when moving between the advanced and retracted positions.

23. A method of producing cooled injection molded articles, comprising:

a) operating an injection molding machine through repeating cycles, the injection molding machine having a mold, the repeating cycles
25 including a first cycle followed consecutively by second, third, fourth, fifth, sixth, seventh, eighth, ninth, and tenth successive cycles, in which respective first,

- 54 -

second third, fourth, fifth, sixth, seventh, eighth, ninth, and tenth sets of articles are made in the mold, the tenth cycle including:

- b) removing the first set of articles from a first set of cooling pins on a first side of a cooling shell and rotating the shell to bring the first side to a load station;
- c) transferring the ninth set of articles from the mold to a take-out plate outside the mold and from the take out plate to the first set of cooling pins; and
- d) injection molding the tenth set of articles in the mold.

24. The method of claim 23, wherein the third cycle includes transferring the second set of articles from the mold to the take-out plate and from the take out plate to a second set of cooling pins on the first side of the shell.

25. The method of claim 23, wherein the third cycle includes transferring the second set of articles from the mold to the take-out plate and from the take out plate to a second set of cooling pins on a second side of the shell.

26. A method for cooling molded articles, comprising:

- a) rotationally orienting a cooling shell about an axis to position a first side of the cooling shell in a load station, the cooling shell having a second, a third, and a fourth side disposed 90 degrees, 180 degrees, and 270 degrees apart, respectively, from the first side in a direction opposite to that of rotation of the cooling shell;
- b) transferring a first set of articles molded in a first injection cycle from a mold of an injection molding machine to a first set of cooling pins on the first side of the cooling shell;
- c) transferring a second set of articles molded in a subsequent injection cycle from the mold to a second set of cooling pins on the first side of the rotary cooling shell, while the first set of articles remain loaded on the shell;

- 55 -

d) rotationally orienting the fourth side of the cooling shell in the load position;

e) transferring an eighth set of articles molded eight injection cycles after the first set of articles from the mold to one of a first and second set of cooling pins mounted on the fourth side of cooling shell; and

f) before repeating step (a), unloading the first set of articles from the first set of cooling pins of the first side of the shell.

27. The method of claim 26, wherein step (b) follows step (a) without any intervening rotation of the cooling shell.

28. The method of claim 26, wherein the cooling shell is rotated by four 90 degree increments between step (b) and step (c).

29. An injection molding machine, comprising:

a) a machine base supporting a pair of platens defining a mold area therebetween;

b) a cooling shell adjacent the base and disposed outside the mold area of the injection molding machine, the cooling shell having at least first and second sides, the cooling shell rotatable about a shell axis for moving the sides between load and unload stations, and the cooling shell comprising a hollow interior chamber bounded at least partially by the first and second sides;

c) a pressurized fluid delivery device in fluid communication with the hollow interior chamber of the cooling shell via a conduit first portion, the conduit first portion free of openable/closeable flow blocking members, wherein fluid communication between the pressurized fluid delivery device and the hollow interior chamber is continuously provided; and

d) a plurality of cooling pins mounted to each of the sides of the cooling shell for cooling interior surfaces of molded articles loaded thereon, each cooling pin including a pin outlet in fluid communication with the hollow interior chamber via a conduit second portion, the conduit second portion including a

- 56 -

fluid channel internal to each cooling pin, the conduit second portion free of openable/closeable flow blocking members, wherein fluid communication between the hollow interior chamber and the pin outlets is continuously provided.

30. The machine of claim 29, further comprising a support column having a hollow interior shaft, the cooling shell mounted to the support column by a rotary mount having a mount aperture therethrough, wherein the conduit first portion comprises at least a portion of the hollow shaft and the mount aperture.

31. The machine of claim 30, wherein the pressurized fluid delivery device comprises a blower, the blower having an outlet in fluid communication with the hollow shaft.

32. The machine of claim 31, wherein the blower and the support column are stationary relative to the base.

33. The machine of any one of claims 31-32, further comprising a supplemental cooling station adjacent the cooling shell, the supplemental cooling station including a plurality of supplemental outlets for directing cooling fluid towards exterior surfaces of the molded articles loaded on the cooling pins.

34. The machine of claim 33, further comprising a slide along which the supplemental cooling station is translatable between advanced and retracted positions, wherein when in the advanced position, the supplemental outlets are adjacent the exterior surfaces of the molded articles and in fluid communication with the blower outlet, and when in the retracted position, the supplemental outlets are spaced away from the exterior surfaces of the molded articles and are in fluid isolation from the blower outlet.

35. A method of producing cooled injection molded articles, comprising:
a) injection molding a first set of articles in a mold of an injection molding machine;

- 57 -

b) after step (a), removing the first set of molded articles from the mold for transfer to a cooling shell spaced apart from the mold, the cooling shell having a plurality of cooling pins mounted thereto and a hollow internal chamber therein, the plurality of cooling pins including a first set of the cooling pins equal
5 in quantity to the first set of molded articles and affixed to a first side of the cooling shell, each cooling pin having an internal fluid channel with at least one pin outlet in fluid communication with the hollow interior chamber;

c) after step (b), loading the first set of molded articles onto the first set of the cooling pins, the at least one pin outlet of each cooling pin directed
10 towards an inner surface of a respective one of the molded articles loaded thereon;

d) after step (c), unloading the first set of molded articles from the first set of cooling pins; and

e) continuously urging a stream of cooling fluid out of the pin
15 outlets from a fluid delivery device during a period of time from the beginning of step (a) at least until the end of step (d).

36. The method of claim 35, wherein step (e) comprises continuously pressurizing the internal chamber of the cooling shell with the cooling fluid.

37. The method of claim 36, wherein the fluid delivery device comprises a
20 blower, and step (e) comprises continuously operating the blower, the blower having a high pressure outlet in fluid communication with the internal chamber of the cooling shell.

38. The method of any one of claims 35-37, further comprising prior to step
25 (c), moving the first side of the cooling shell to position the first set of pins in a load station.

- 58 -

39. The method of claim 38, wherein moving the first side of the cooling shell to the load station comprises rotationally indexing the cooling shell about a shell axis.

40. The method of any one of claims 38-39, further comprising after step (b),
5 injection molding a second set of molded articles, and after step (c) but before step (d), loading the second set of molded articles onto a second set of the cooling pins mounted to the first side of the cooling shell.

41. The method of claim 40, wherein the cooling shell is rotationally indexed at least once after loading the first set of articles on the first set of the cooling
10 pins but before loading the second set of articles on the second set of the cooling pins.

42. The method of any one of claims 38-41, further comprising after step (c) but before step (d), rotationally indexing the first side from the load station to a supplemental cooling station having a housing with a plurality of supplemental
15 cooling outlets, and directing a supplemental cooling stream towards exterior surfaces of the first set of molded articles from a first set of the supplemental cooling outlets.

43. The method of claim 42, further comprising after rotationally indexing the first side to the supplemental cooling station, advancing the housing toward the
20 first side from a retracted position to an advanced position, the housing having a supplemental inlet that, when moved to the advanced position, is moved into registration with an opening in a supplemental fluid supply conduit in fluid communication with the fluid delivery device.

44. The method of claim 43, wherein moving the housing to the retracted
25 position blocks the opening in the supplemental fluid supply conduit and fluidly isolates the supplemental outlets from the fluid delivery device.

- 59 -

45. A multi-part tooling kit for an injection molding machine, comprising:

a) a first set of tooling for processing a first molded article set of first molded articles, the first set of tooling including:

5 i) a first mold core half and a first mold cavity half mountable to opposed platens of an injection molding machine and cooperating with each other to form a first set of first mold chambers for molding the first molded article set, the first mold chambers spaced apart from each other by a first article spacing;

10 ii) a first take-out plate having first take-out tubes spaced and shaped to receive the first molded article set, the first take-out plate mountable to a robot disposed adjacent the platens of the injection molding machine; and

15 iii) a first cooling shell mountable to a support remote from the mold, the first cooling shell including at least a first-shell first side with at least a first set of first cooling pins mounted to the first-shell first side, the first cooling pins spaced and shaped to receive the first molded article set from the first take-out tubes; and

20 b) at least a second set of tooling for processing a second set of second molded articles, the second molded articles different in at least one of size and shape than the first set of molded articles, the second set of tooling including:

25 i) a second mold core half and a second mold cavity half mountable to respective platens of the injection molding machine for molding the second set of second molded articles, the second molded articles of the second set spaced apart from each other by a second article spacing;

- 60 -

- 5 ii) a second take-out plate having second take-out tubes spaced and shaped to receive the second molded article set, the second take-out plate mountable to the robot disposed adjacent the platens of the injection molding machine; and
- iii) a second cooling shell mountable to a support remote from the mold, the second cooling shell including at least a second-shell first side with at least one set of second cooling pins mounted to the second-shell first side, the second cooling pins spaced and shaped to receive the second
- 10 molded article set from the first take-out tubes.

46. The tooling kit of claim 45, wherein the first cooling shell includes at least a second set of first cooling pins mounted to the first side of the first cooling shell, and the second cooling shell includes at least a second set of second cooling pins mounted to the first side of the second cooling shell.

- 15 47. The tooling kit of claim 46, wherein each first side of each cooling shell includes at least one gripper plate slidably coupled to the respective side for selectively retaining and releasing molded articles loaded on the pins of the respective side.

20 48. A method of changing-over an injection molding machine from injection molding first articles to injection molding second articles different than the first articles, comprising:

- a) taking a first mold core half and a first mold cavity half out of position for opening and closing a first mold to injection mold a first set of articles, and placing a second mold core half and a second mold cavity half into position
- 25 for opening and closing a second mold to injection mold a second set of articles;
- b) removing a first take-out plate from a robot and thereafter mounting a second take-out plate to the robot; and

- 61 -

c) replacing a first cooling shell positioned to receive articles from the robot with a second cooling shell.

49. The method of claim 48, wherein step c) comprises releasing the first cooling shell from a rotary mount, and thereafter securing the second cooling
5 shell to the rotary mount.

50. The method of claim 49, wherein each of the cooling shells includes a plurality of cooling pins mounted thereto for conveying a pressurized cooling fluid between an interior chamber of the cooling shell and fluid channels extending through the cooling pins, and wherein the step of releasing the first cooling shell
10 from the rotary mount disconnects the interior chamber of the first cooling shell from a blower, and securing the second cooling shell to the rotary mount connects the interior chamber of the second cooling shell to the blower.

51. A cooling apparatus for cooling injection molded articles having a generally hollow cylindrical body and a flange, the apparatus comprising:

15 a) a cooling shell disposed outside a mold area of an injection molding machine, the cooling shell having at least first and second side, the cooling shell moveable to move the sides between an unload station and a load station;

b) a first set of first receivers and at least a second set of second
20 receivers mounted to each one of the sides, each set of receivers configured to cool respective sets of said molded articles from respective distinct mold cycles of the injection molding machine when the cooling receivers are loaded with said articles; and

c) a respective gripper assembly coupled to each respective side,
25 each gripper assembly adjustable relative to the respective side to selectively release at least one of the loaded sets of molded articles of the respective side when positioned at the unload station;

- 62 -

each gripper assembly adjustable relative to the respective side to retain at least one newly loaded set of molded articles on the respective side when positioned at the load station.

52. The apparatus of claim 51, wherein the gripper assembly of the respective side at the load station is adjustable to allow loading of one of the first and at least second sets of molded articles while retaining the other of the first and at least second sets of molded articles.

53. The apparatus of any one of claims 51-52, wherein the gripper assembly of the respective side at the load station is adjustable to retain all of the first and at least second sets of molded articles prior to moving the respective sidewall away from the load station.

54. The apparatus of one of claims 51-53, wherein the gripper assembly of a respective side at the unload station is adjustable to retain at least one of the other of said loaded sets of molded articles when said at least one of the loaded sets is released.

55. The apparatus of any one of claims 51-54, wherein each gripper assembly comprises a plurality of first abutment surfaces and a plurality of second abutment surfaces, each first abutment surface positioned adjacent a respective one of the first receivers and each second abutment surface positioned adjacent a respective one of the second receivers, each abutment surface moveable relative to the receiver between a holding position and a clear position for selectively retaining and releasing a molded article loaded on the respective adjacent receiver.

56. The apparatus of claim 55, wherein movement from the clear position to the holding position reduces a lateral spacing between the respective abutment surface and an axis of the receiver, in a direction generally perpendicular to the axis of the receiver.

- 63 -

57. The apparatus of any one of claims 55-56, wherein each first abutment surface is spaced apart from the respective side by a first axial spacing and each second abutment surface is spaced apart from the respective side by a second axial spacing, each axial spacing extending orthogonally to the respective side, and wherein at least a portion of the flange of each respective molded article is positioned axially between the respective side and at least a portion of each respective abutment surface when said abutment surface is in the holding position.

58. The apparatus of any one of claims 55-57, wherein each gripper assembly comprises at least a first respective gripper plate, one or more of the first abutment surfaces affixed to each first respective gripper plate.

59. The apparatus of claim 58, wherein each first gripper plate is oriented generally parallel to the respective side to which the gripper assembly is coupled.

60. The apparatus of claim 58-59, wherein each first gripper plate is moveable between at least a first plate position in which the first abutment surfaces are in the clear position, and a second plate position in which the first abutment surfaces are in the holding position.

61. The apparatus of claim 58-60, wherein each first gripper plate comprises a first set of first apertures, respective ones of the first abutment surfaces positioned adjacent respective ones of the first apertures.

62. The apparatus of claim 61, wherein one or more of the second abutment surfaces are affixed to each first respective gripper plate.

63. The apparatus of claim 62, wherein each first gripper plate comprises a second set of apertures, respective ones of the second abutment surfaces positioned adjacent respective ones of the second apertures.

- 64 -

64. The apparatus of claim 63, wherein each first gripper plate is moveable among first, second and third positions.

65. The apparatus of claim 64, wherein in the first position, molded articles supported by the first receivers are retained on the cooling shell and molded
5 articles supported by the second receivers are releasable from the cooling shell.

66. The apparatus of any one of claims 64-65, wherein in the second position, molded articles supported by the second receivers are retained on the cooling shell and molded articles supported by the first receivers are releasable from the cooling shell.

10 67. The apparatus of any one of claims 64-66, wherein in the third position, molded articles supported by the first and second receivers are retained on the cooling shell.

68. The apparatus of any one of claims 63-67, wherein each one of the first and second apertures comprises an enlarged portion having a perimeter through
15 which a flanged portion of the injection molded article can pass in a direction generally orthogonal to the gripper plate, and a narrowed portion adjoining the enlarged portion and extending from one side of the perimeter thereof, the flanged portion unable to pass through the narrowed portion in a direction generally orthogonal to the gripper plate.

20 69. The apparatus of claim 68, wherein the narrowed portions of the first apertures extend radially outwardly from a first side of the perimeter of the enlarged portions of the first apertures, the first side disposed in a first direction parallel to the slide axis, and wherein the narrowed portions of the second apertures extend radially outwardly from a second side of the perimeter of the
25 enlarged portions of the second apertures, the second side disposed in a second direction parallel to the slide axis and opposite the first direction.

- 65 -

70. The apparatus of claim 69, wherein each gripper assembly comprises a retaining member to hold the gripper plate in the third position at least during the time each respective sidewall leaves the load station and arrives at the unload station.

5 71. A cooling apparatus for cooling injection molded articles having a generally hollow cylindrical body and a flange, the apparatus comprising:

a) a cooling shell disposed outside a mold area of an injection molding machine, the cooling shell having at least first and second sidewalls with a first set of first receivers and a second set of second receivers mounted to each
10 of the first and second sidewalls, the first and second sets of receivers configured to support articles from respective distinct mold cycles of the injection molding machine when the cooling receivers are loaded with said molded articles;

b) a first gripper plate coupled to the first sidewall and a second gripper plate coupled to the second sidewall,

15 c) each gripper plate having a first set of first apertures in registration with the first receivers and a second set of second apertures in registration with the second receivers;

d) each gripper plate slidable among first, second, and third positions for selectively retaining, on the cooling shell, molded articles supported
20 by the first receivers, the second receivers, and both the first and second receivers, respectively.

72. The apparatus of claim 71, wherein in the first position, molded articles supported by the first receivers are retained on the cooling shell and molded articles supported by the second receivers are releasable from the cooling shell.

25 73. The apparatus of any one of claims 71-72, wherein in the second position, molded articles supported by the second receivers are retained on the cooling shell and molded articles supported by the first receivers are releasable from the cooling shell.

- 66 -

74. The apparatus of any one of claims 71-73, wherein in the third position, molded articles supported by the first and second receivers are retained on the cooling shell.

75. The apparatus of any one of claims 71-74, wherein each receiver
5 comprises a cooling pin for insertion into a hollow interior portion of the molded article associated therewith.

76. The apparatus of any one of claims 71-74, wherein each receiver comprises a cooling tube for accommodating at least a portion of the molded article associated therewith.

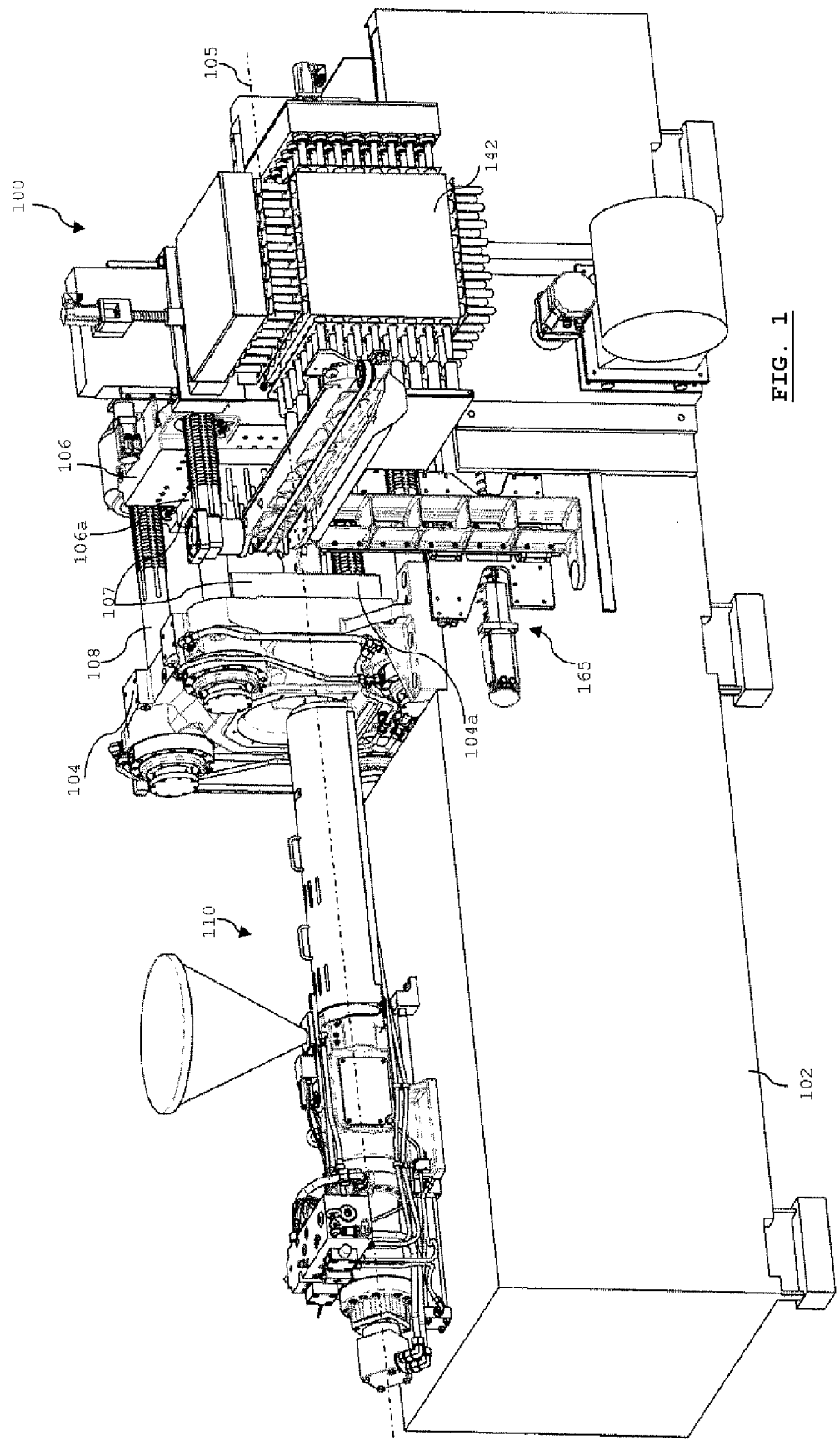
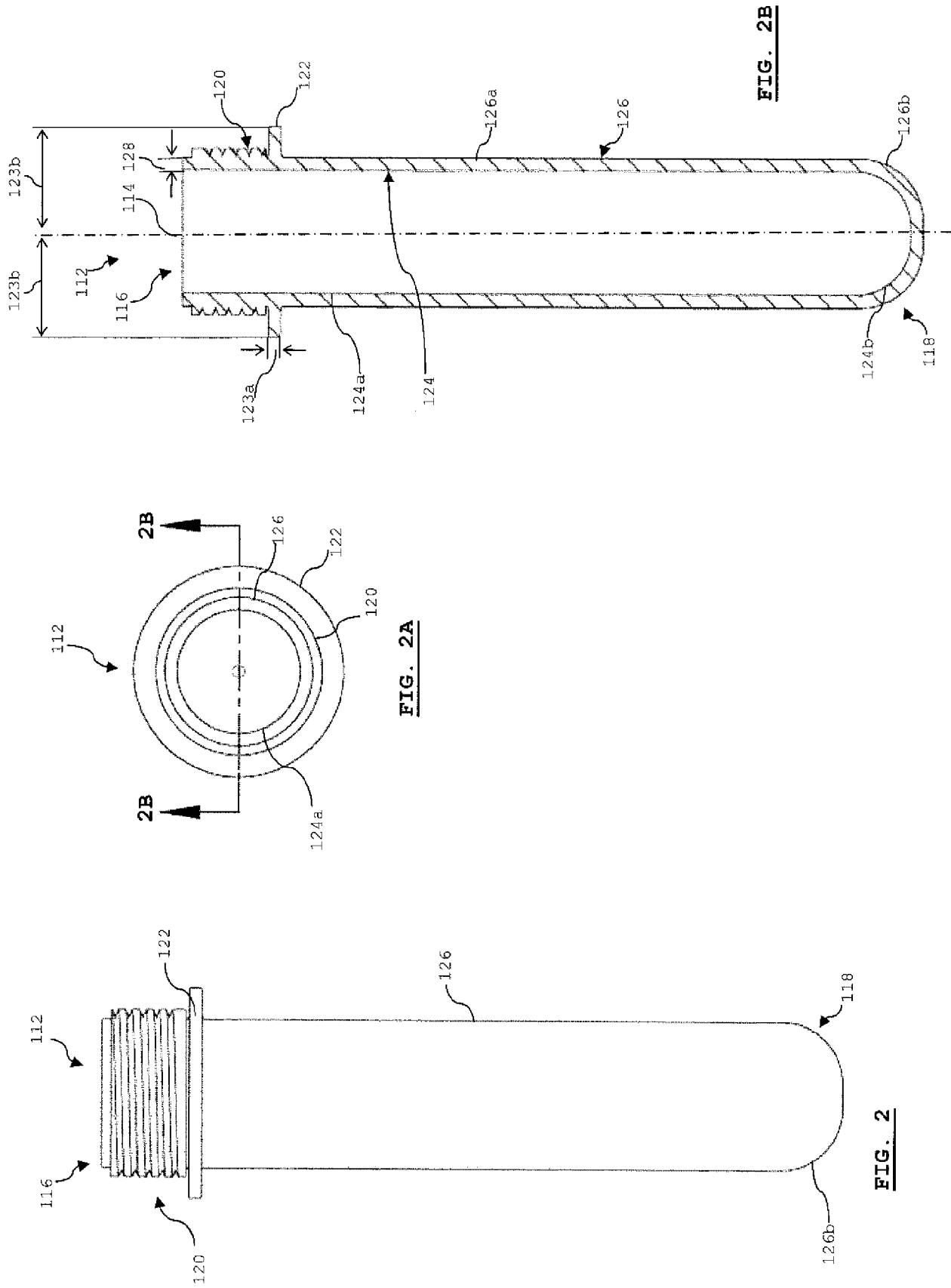


FIG. 1



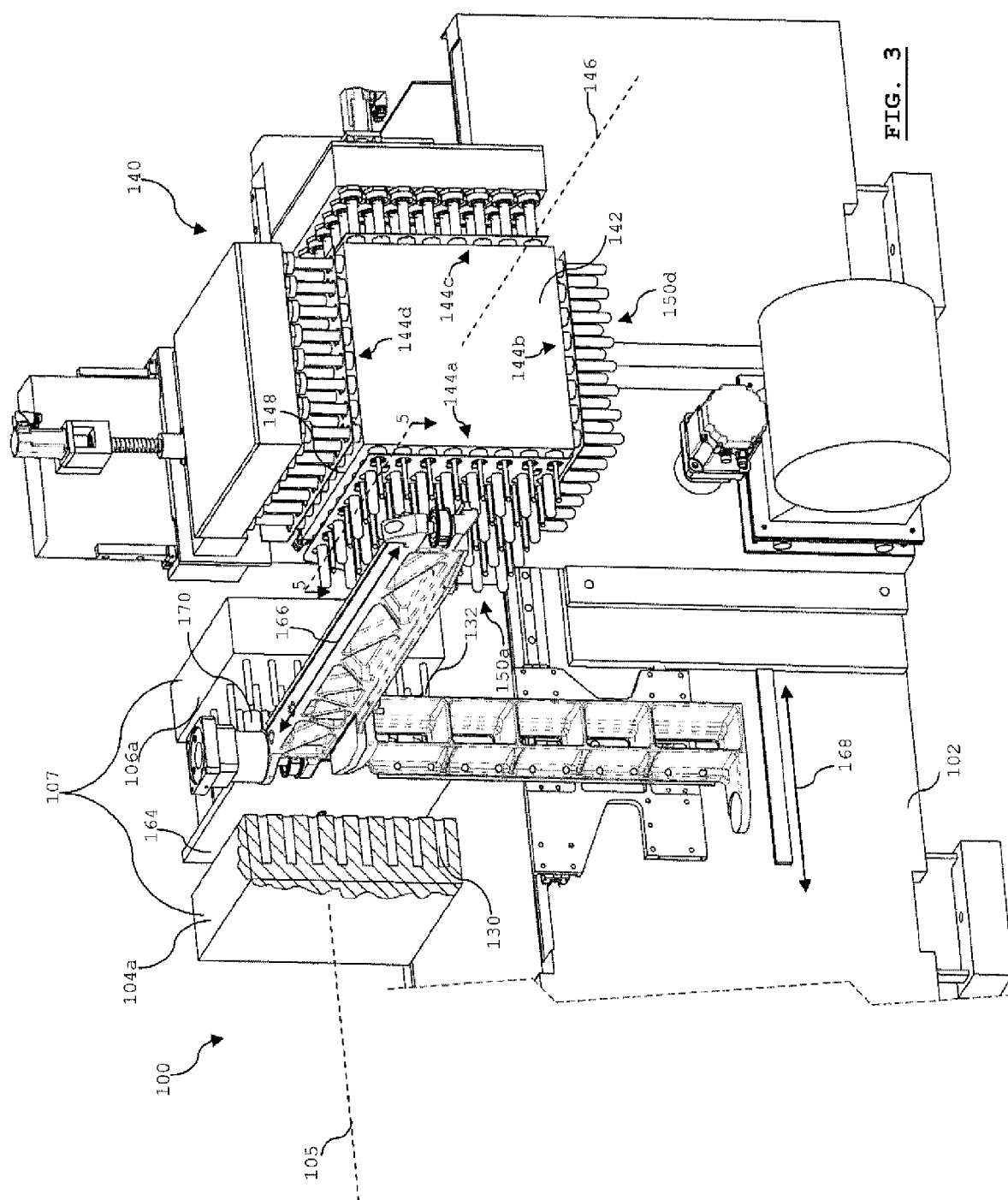


FIG. 3

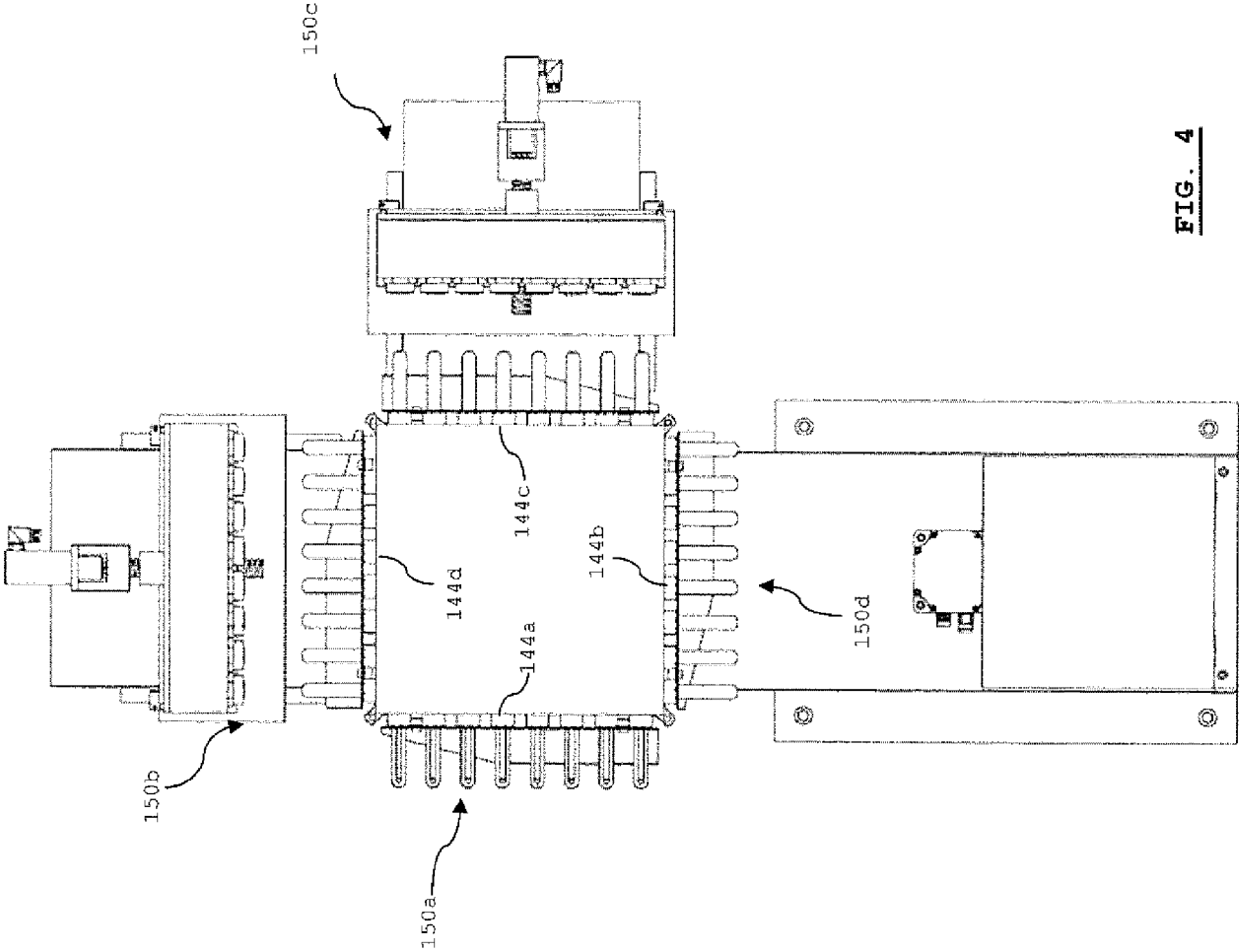


FIG. 4

5/28

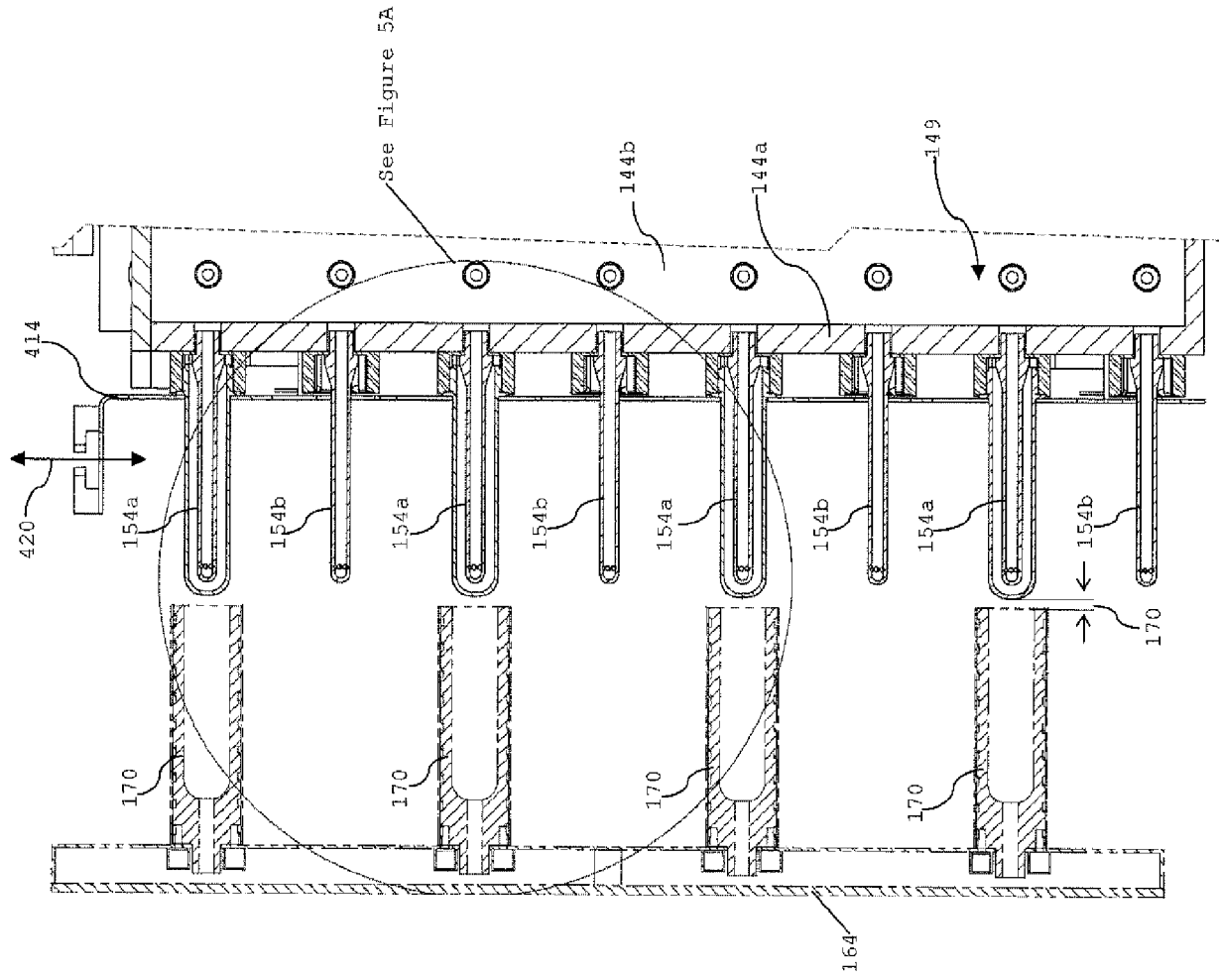


FIG. 5

6/28

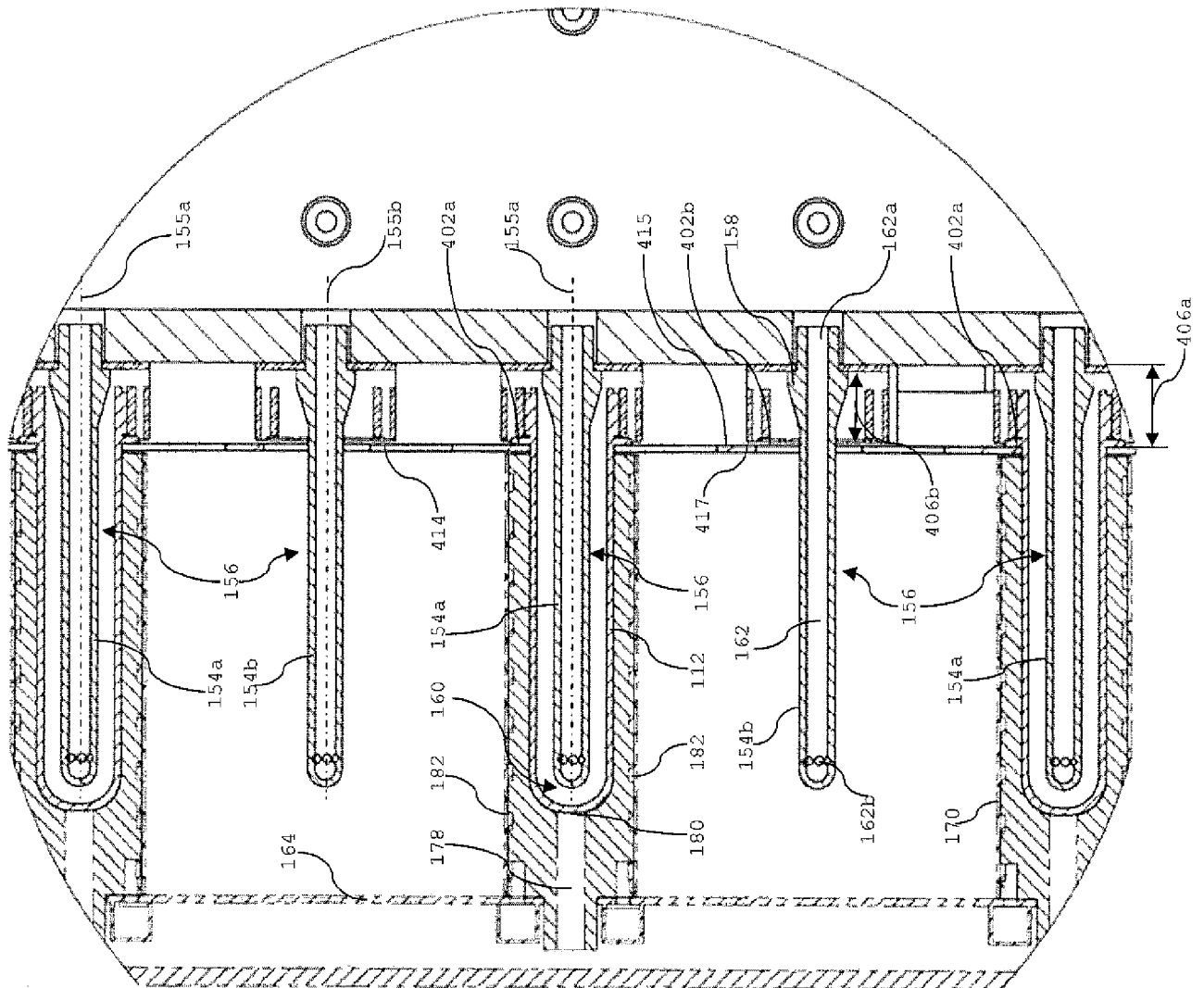


FIG. 5A

7/28

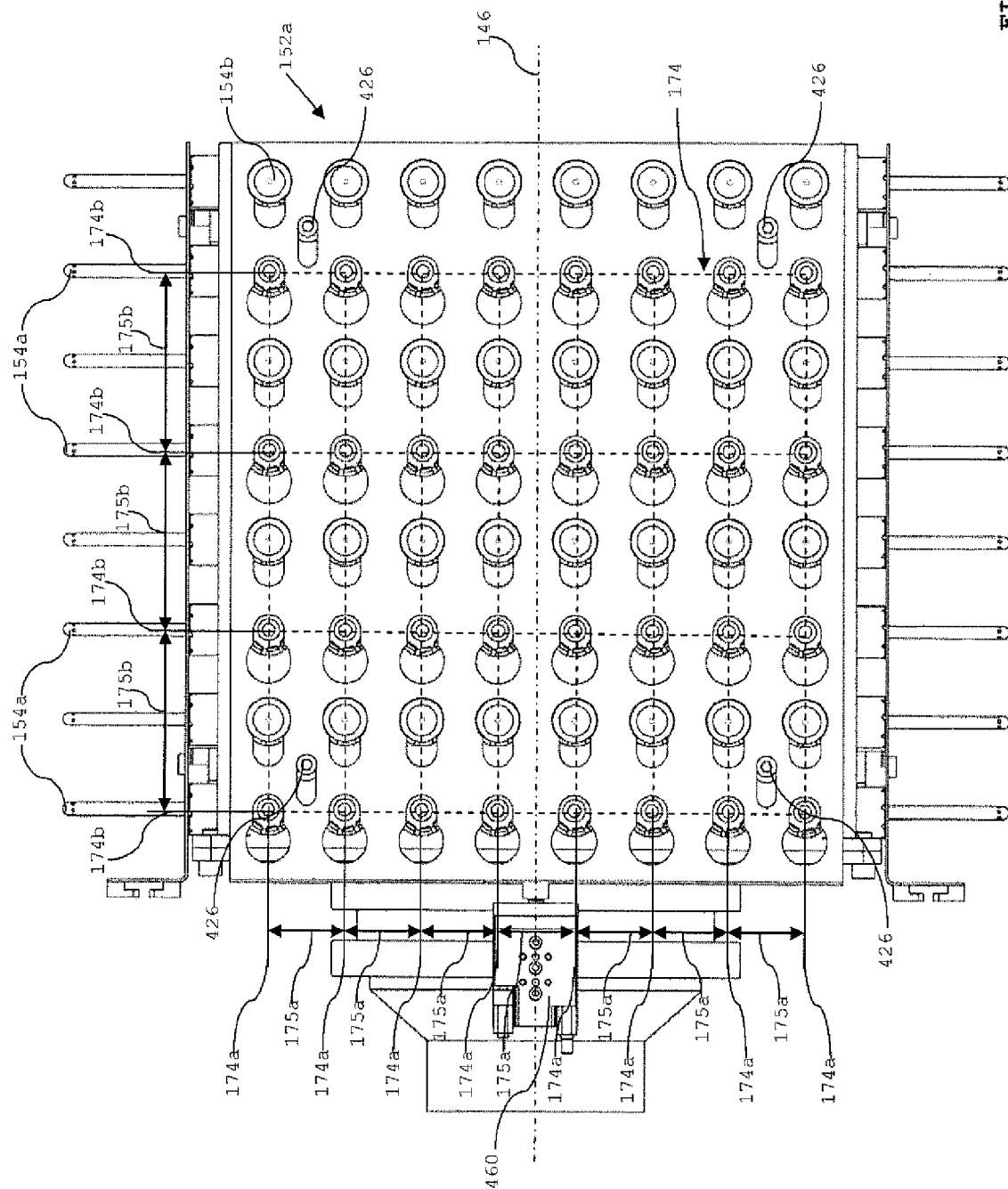
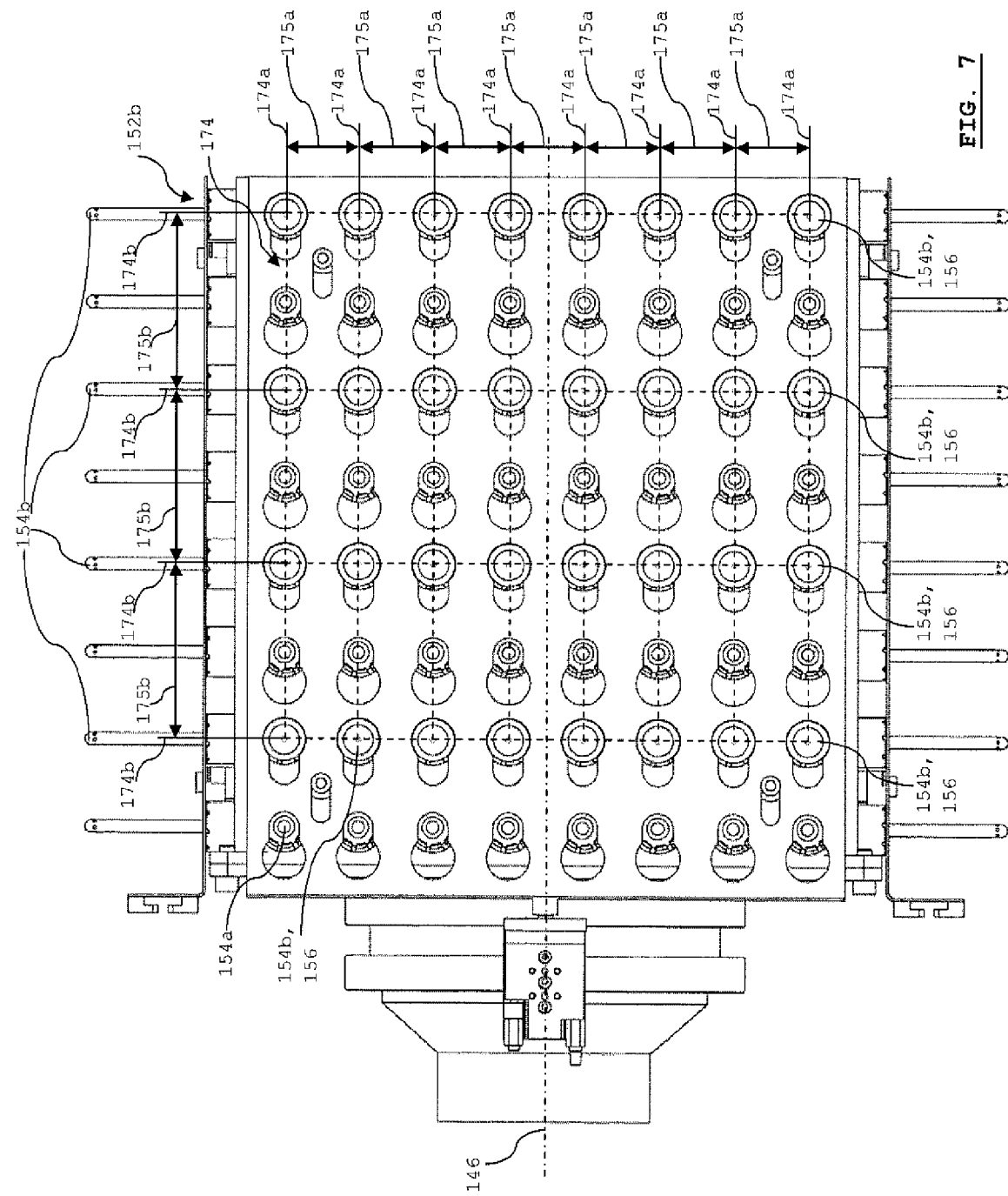


FIG. 6



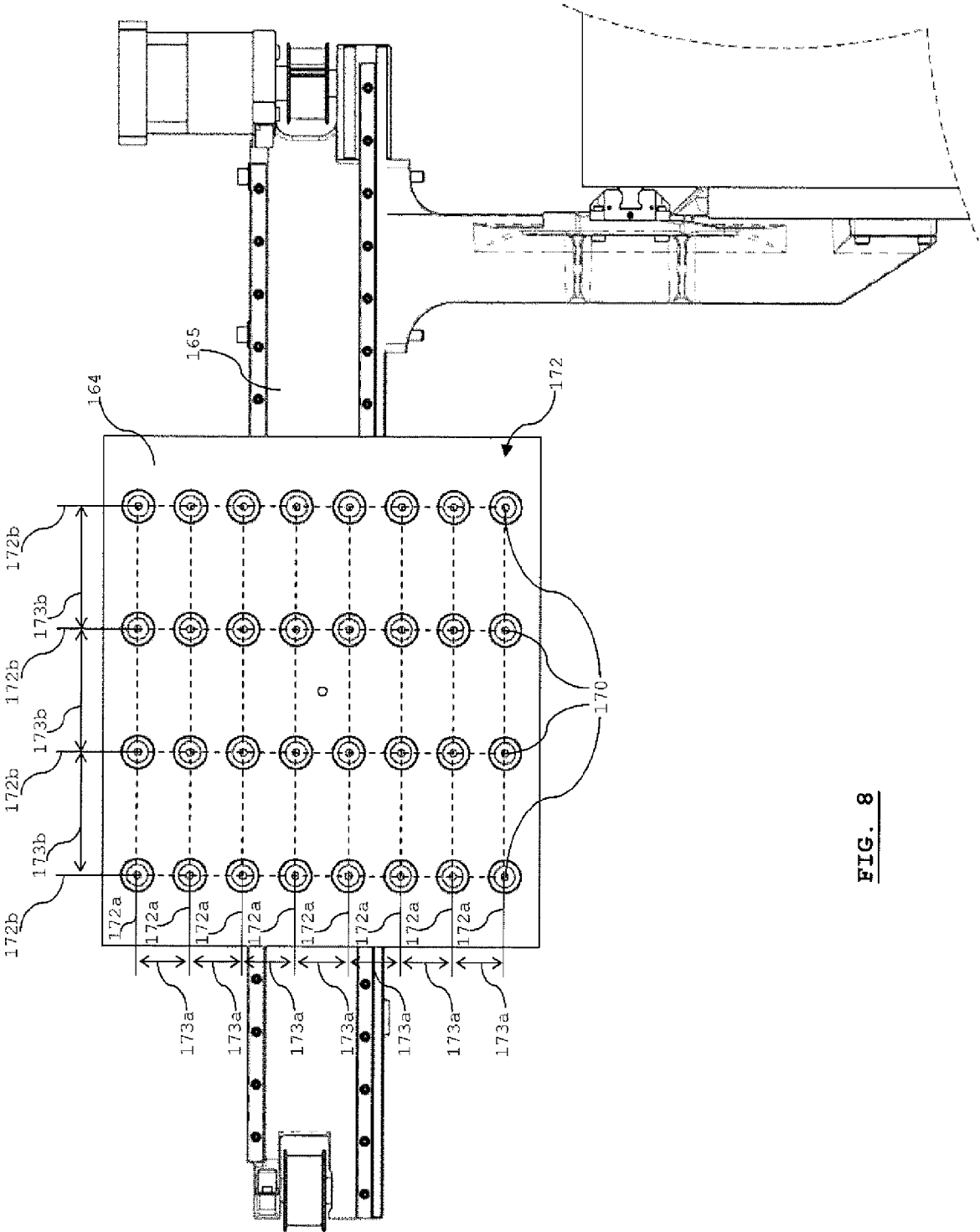


FIG. 8

10/28

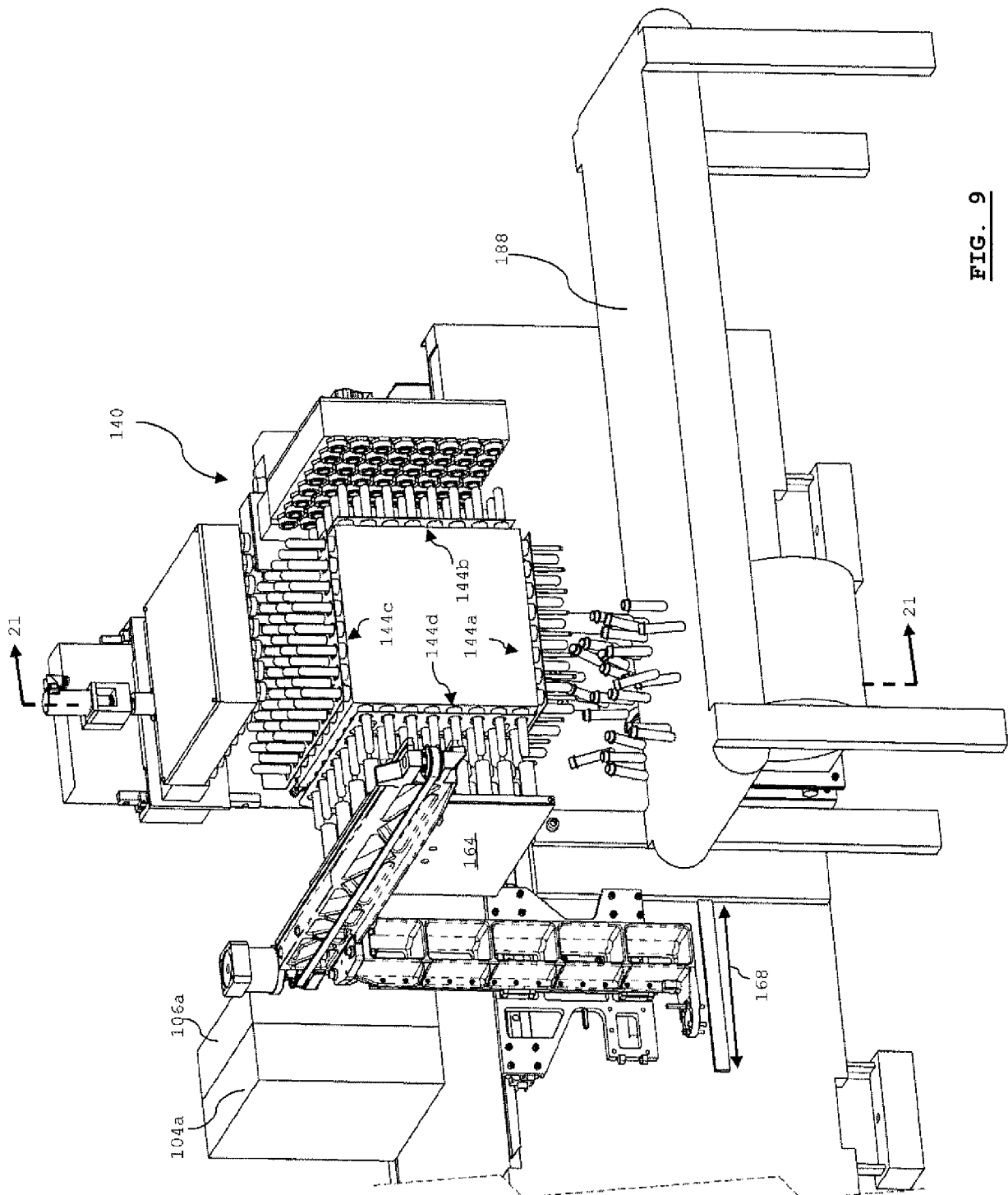


FIG. 9

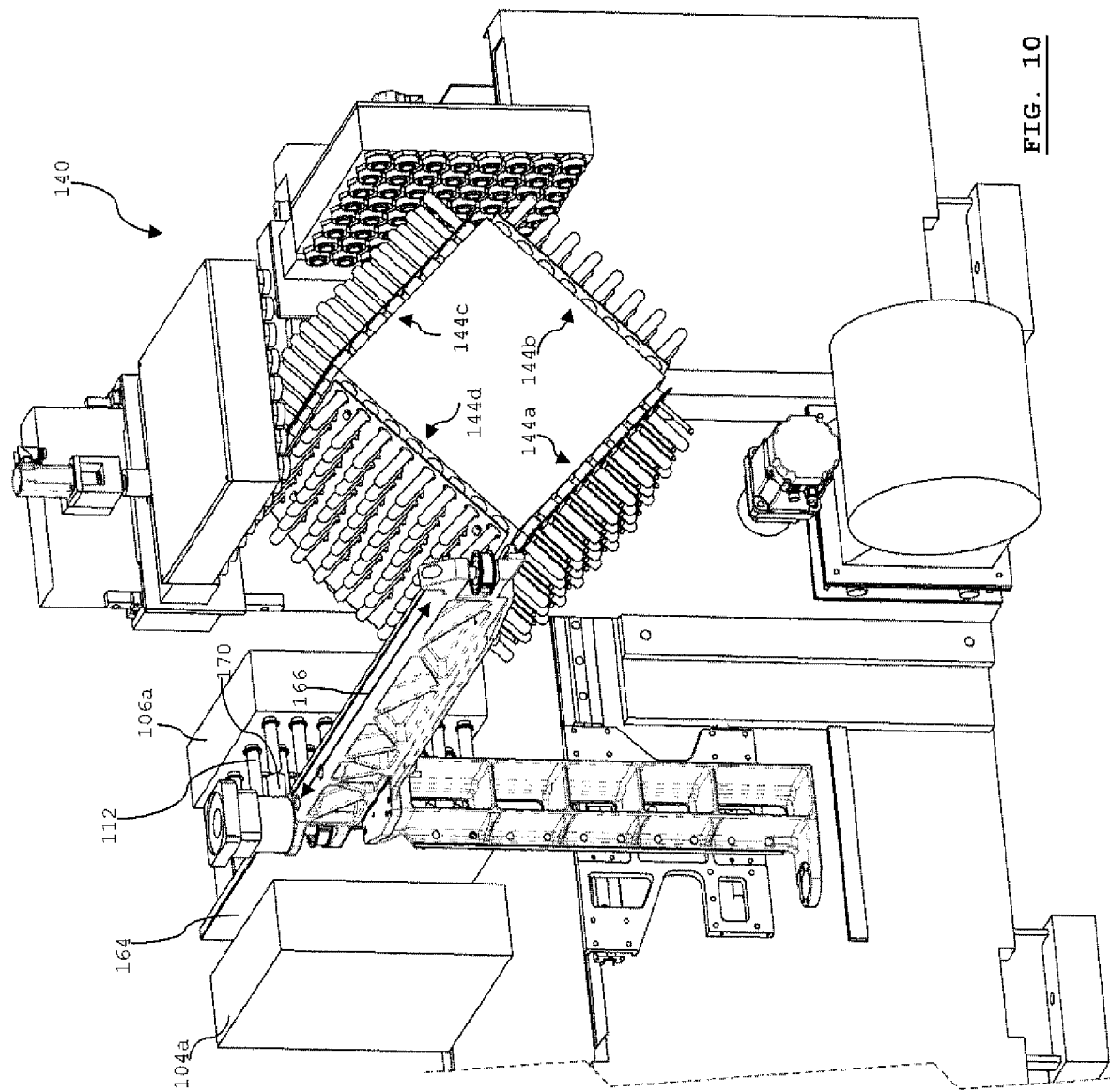


FIG. 10

12/28

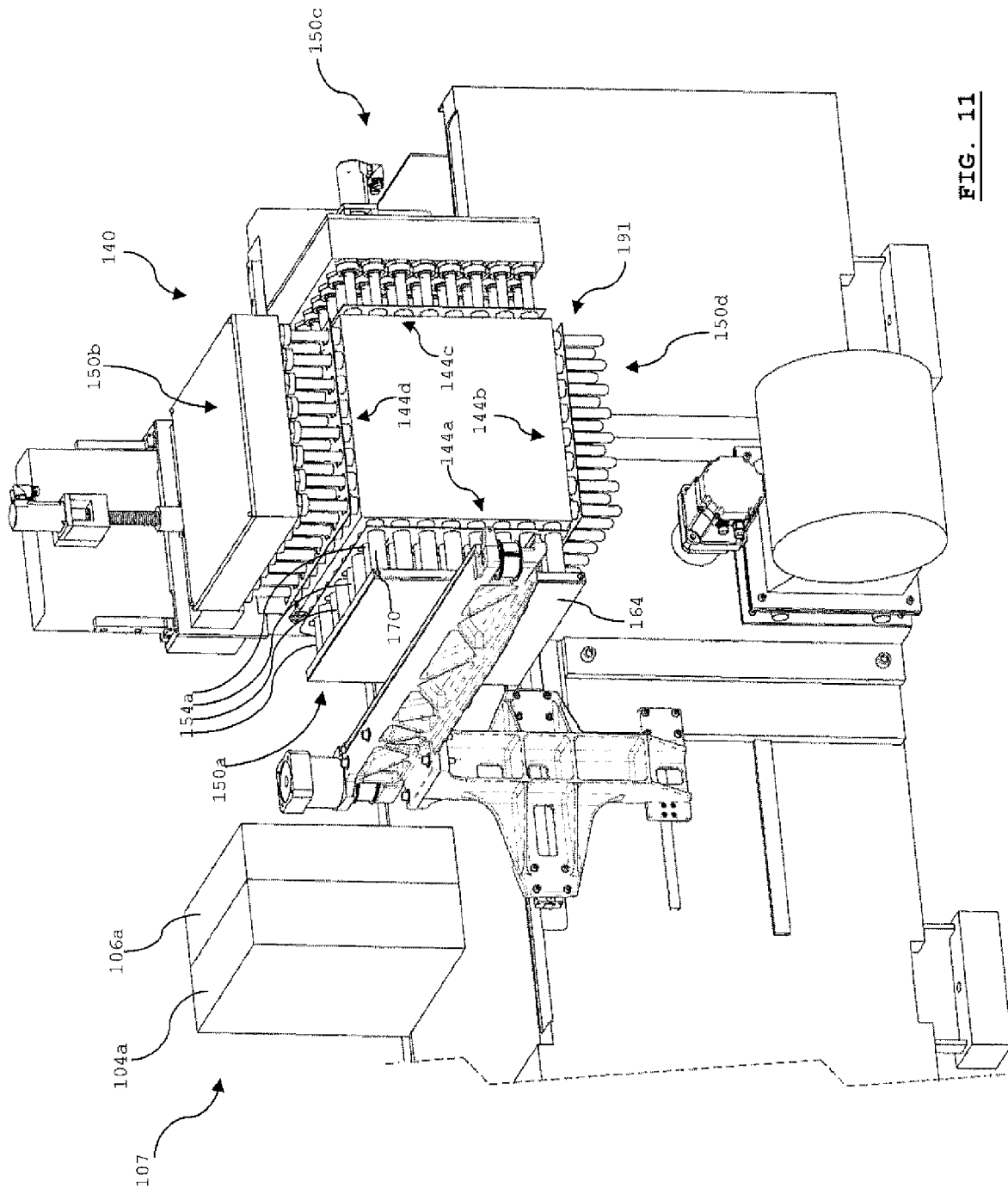


FIG. 11

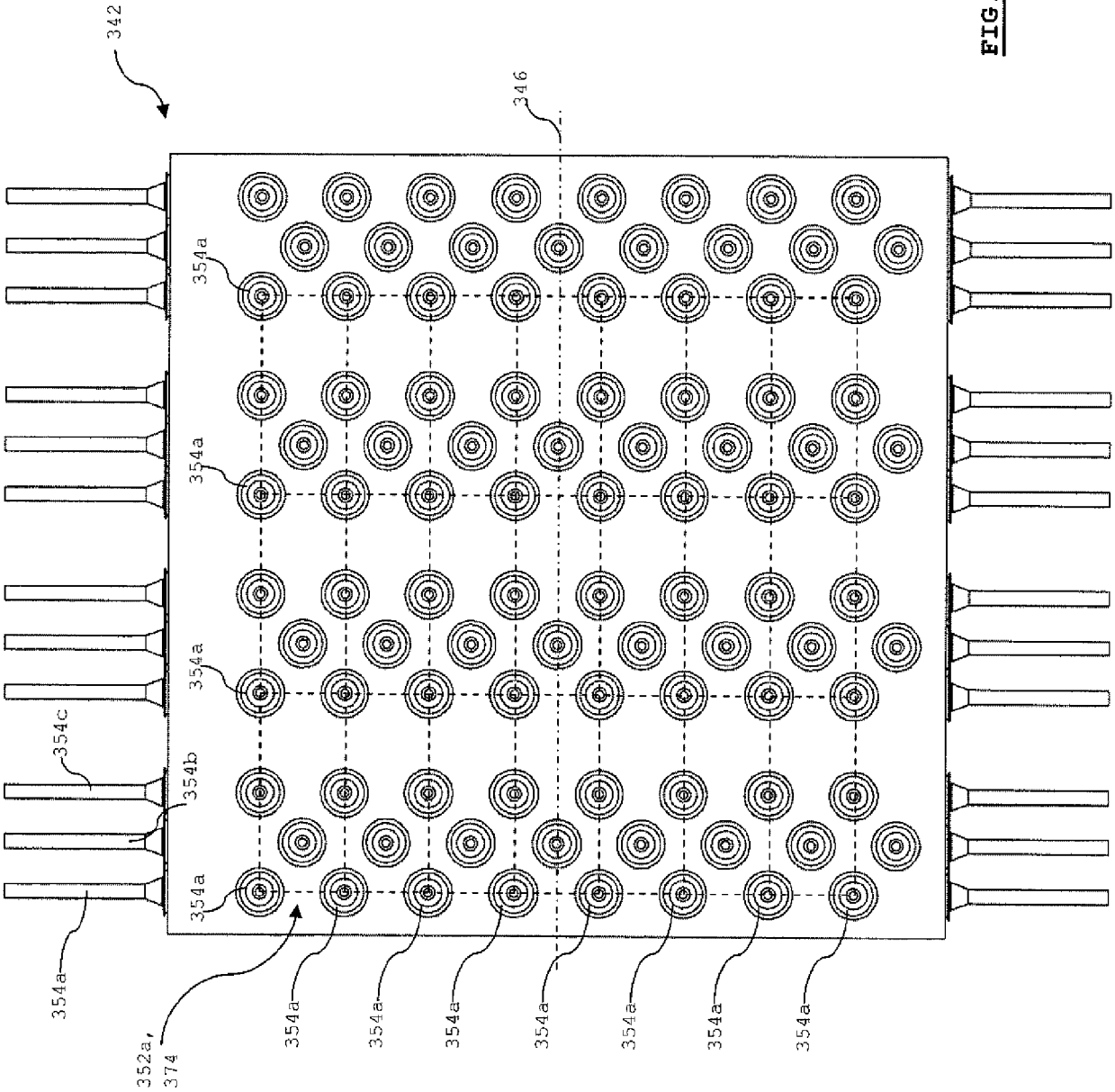


FIG. 12A

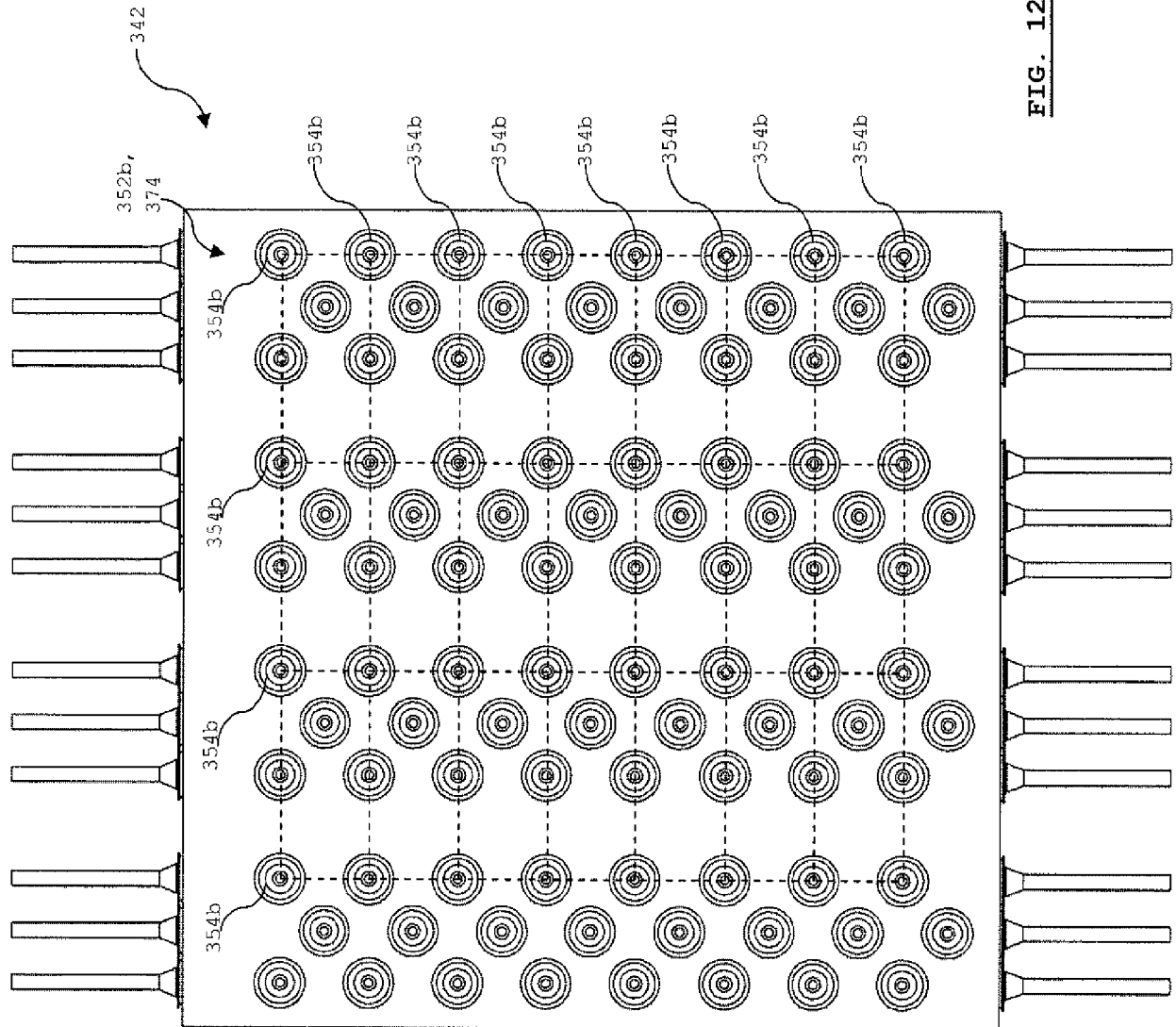


FIG. 12B

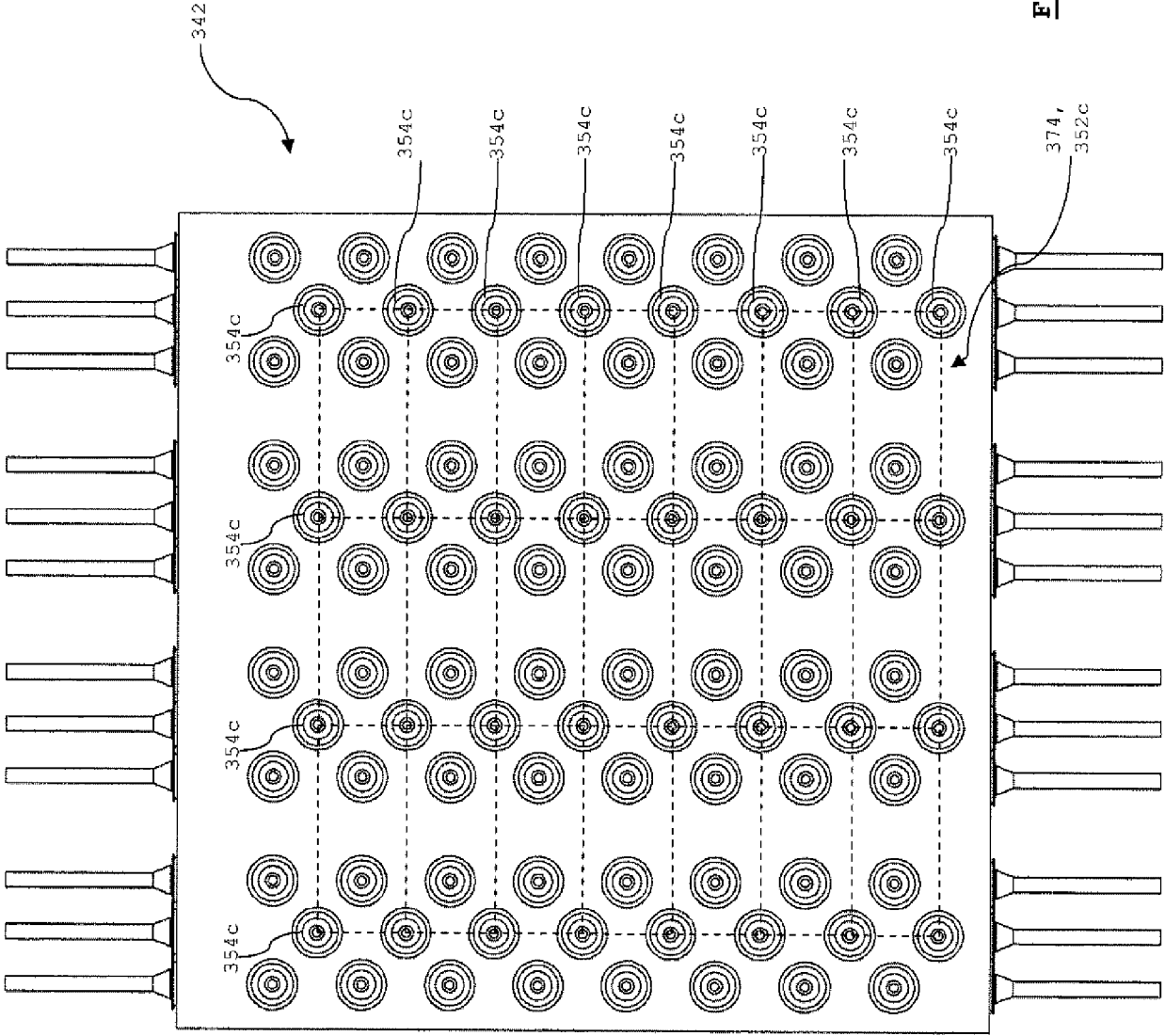


FIG. 12C

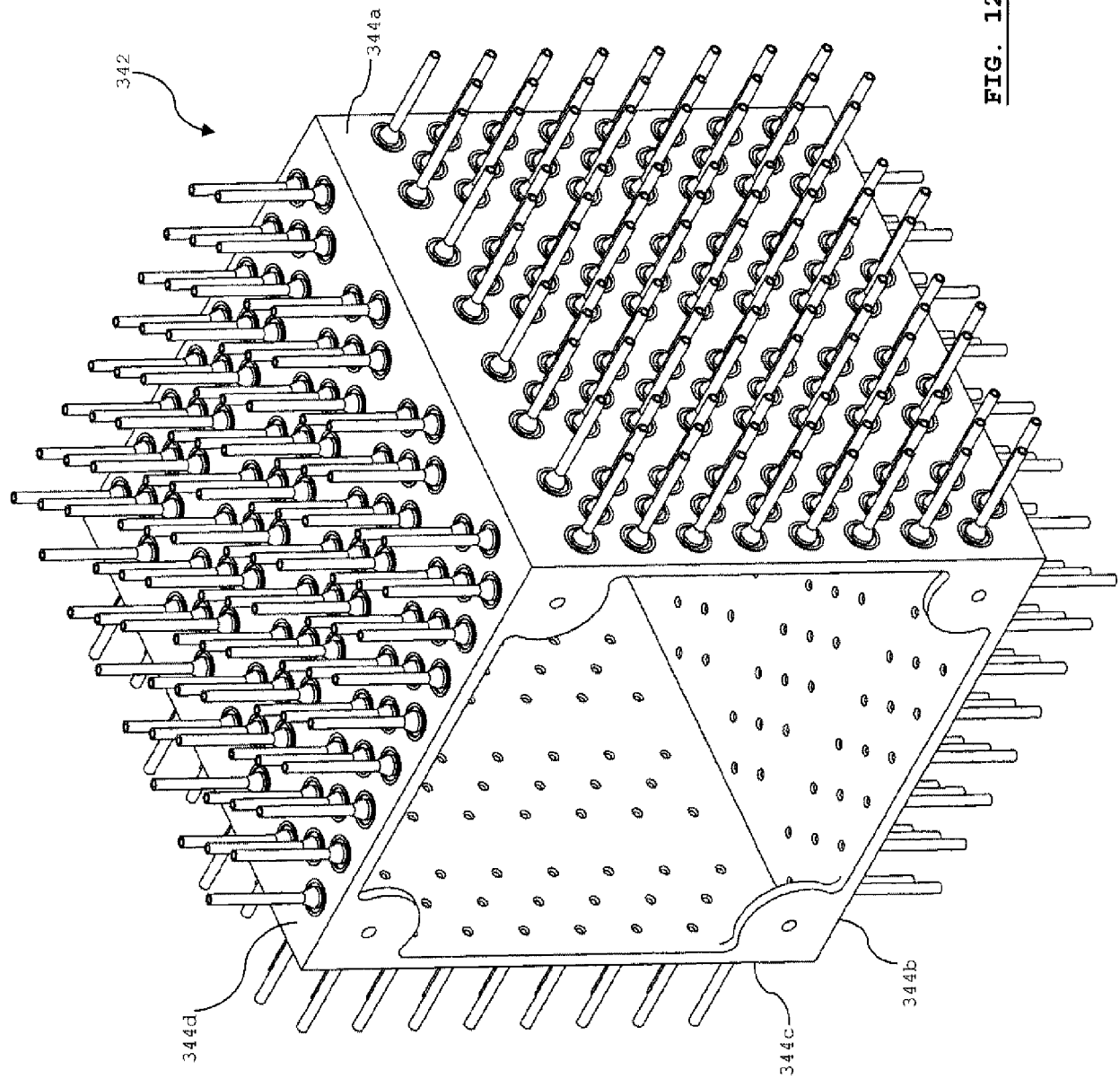


FIG. 12D

17/28

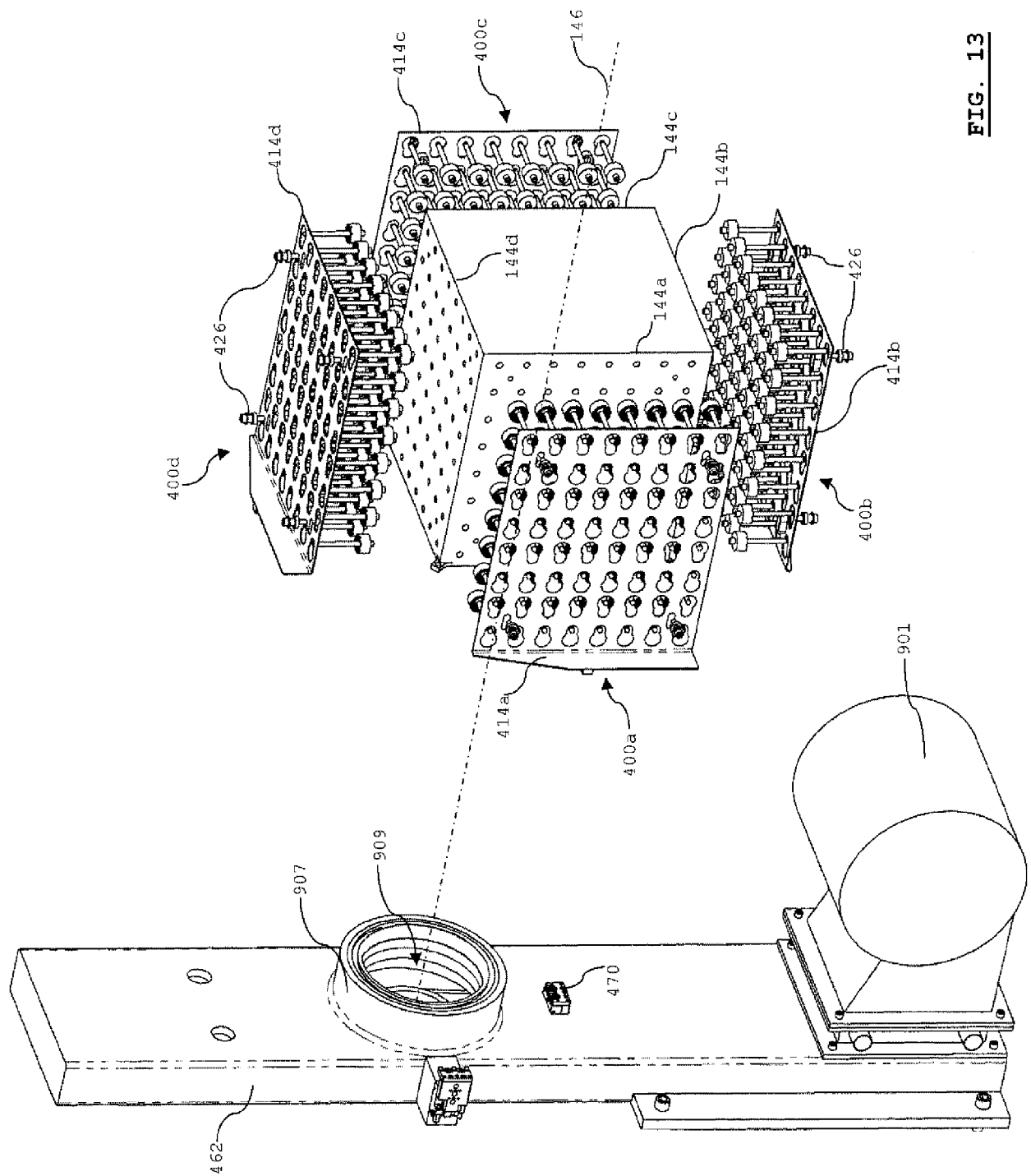


FIG. 13

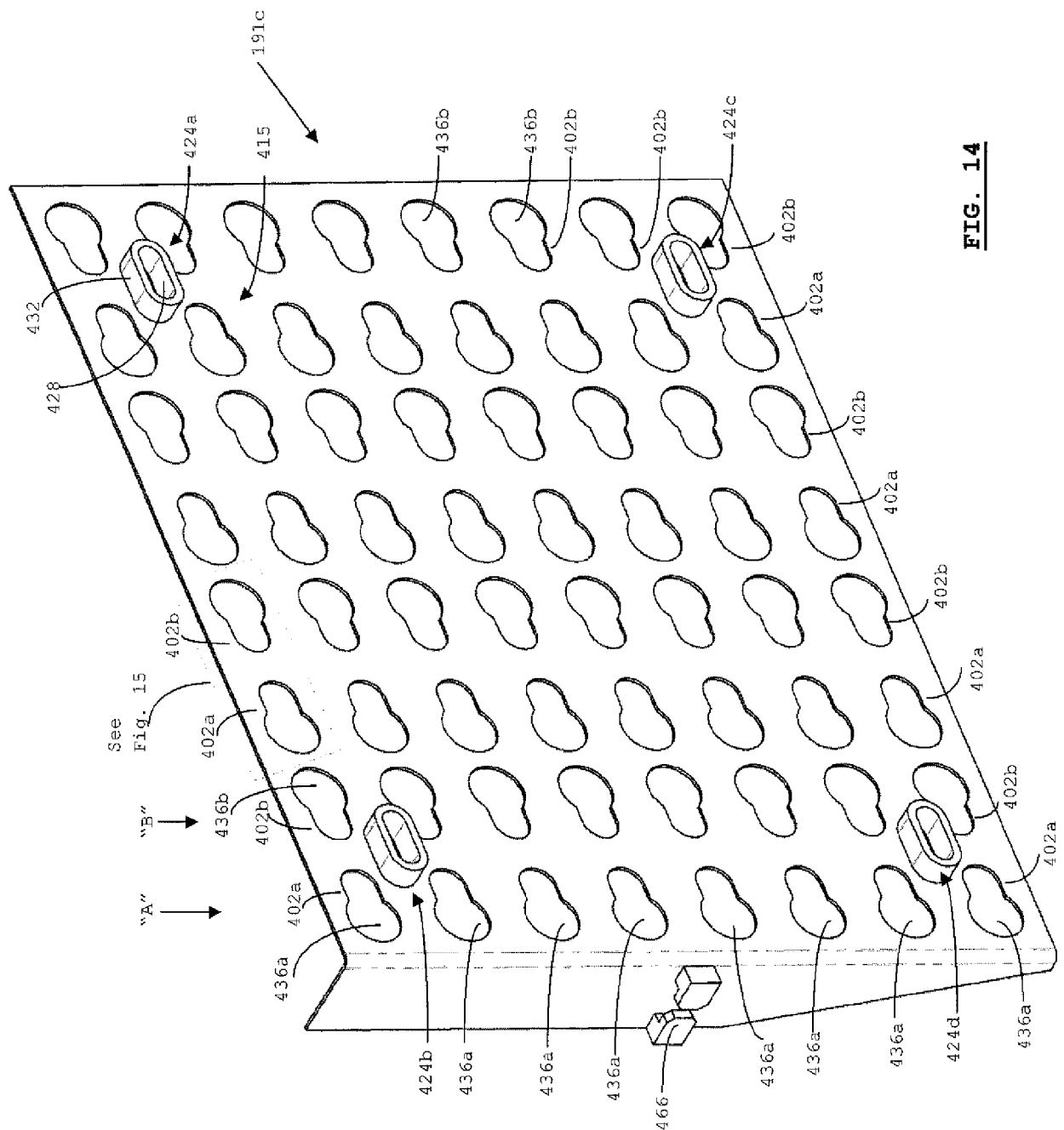


FIG. 14

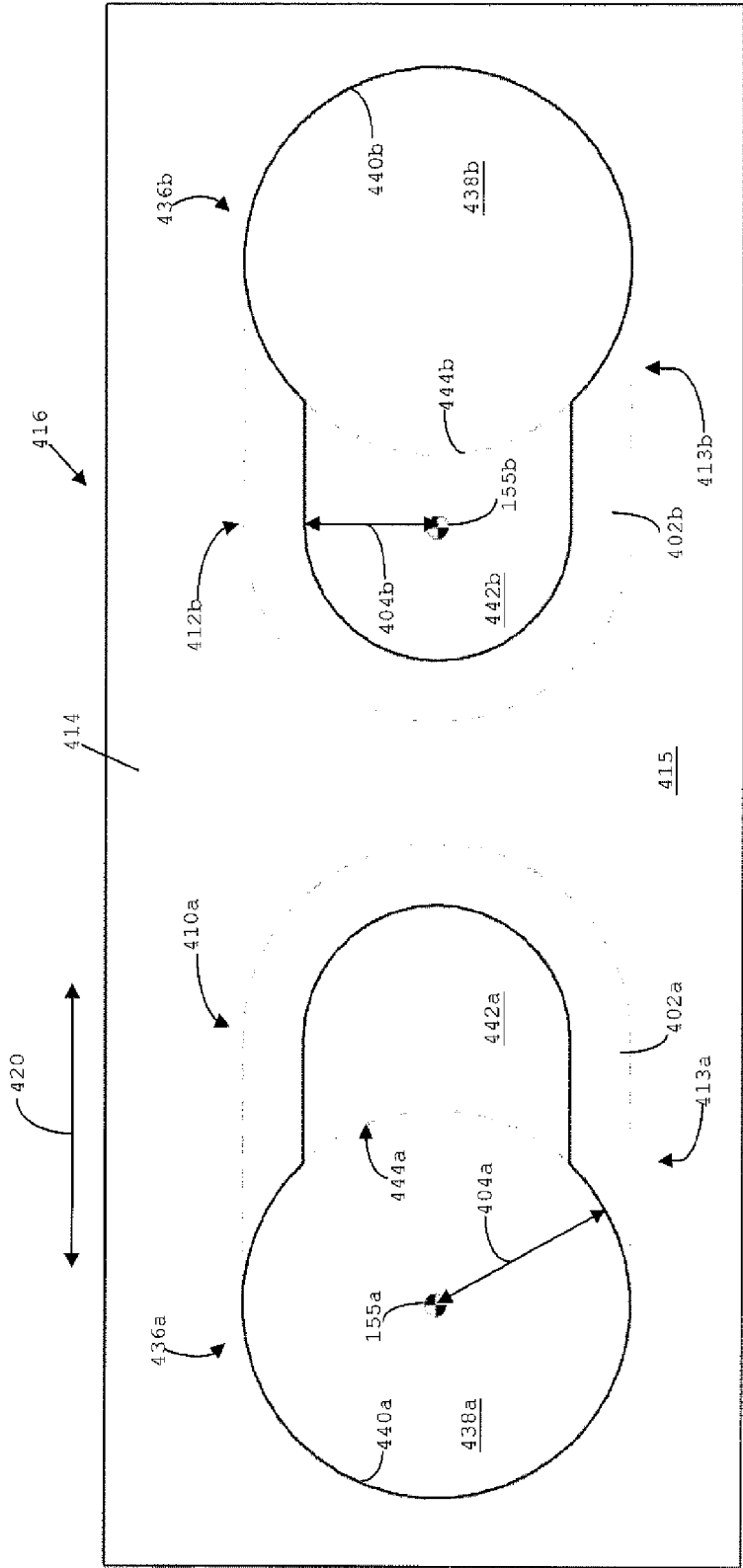


FIG. 15

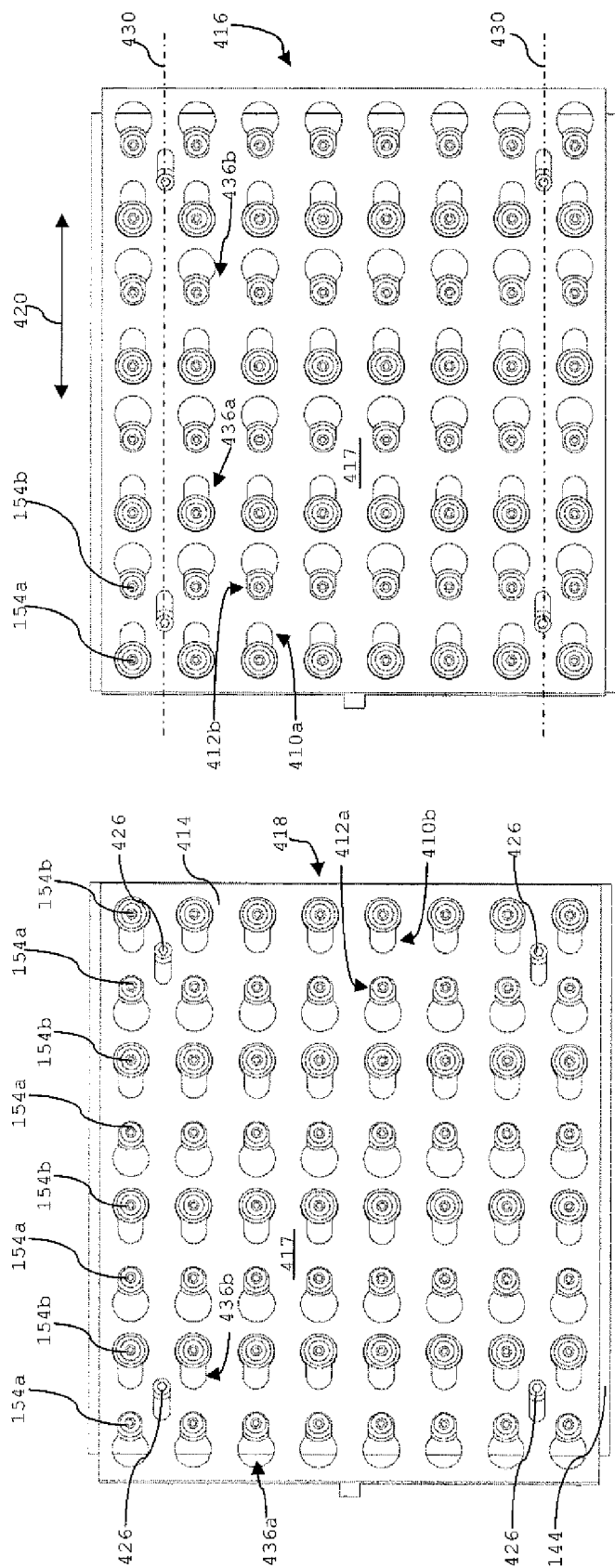


FIG. 16a

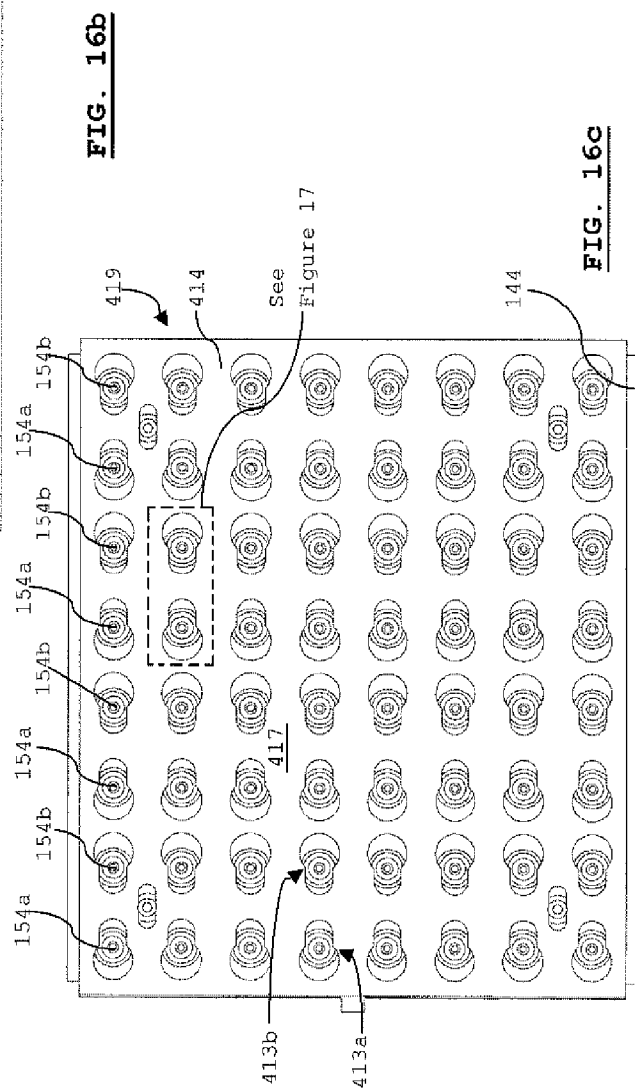


FIG. 16b

FIG. 16c

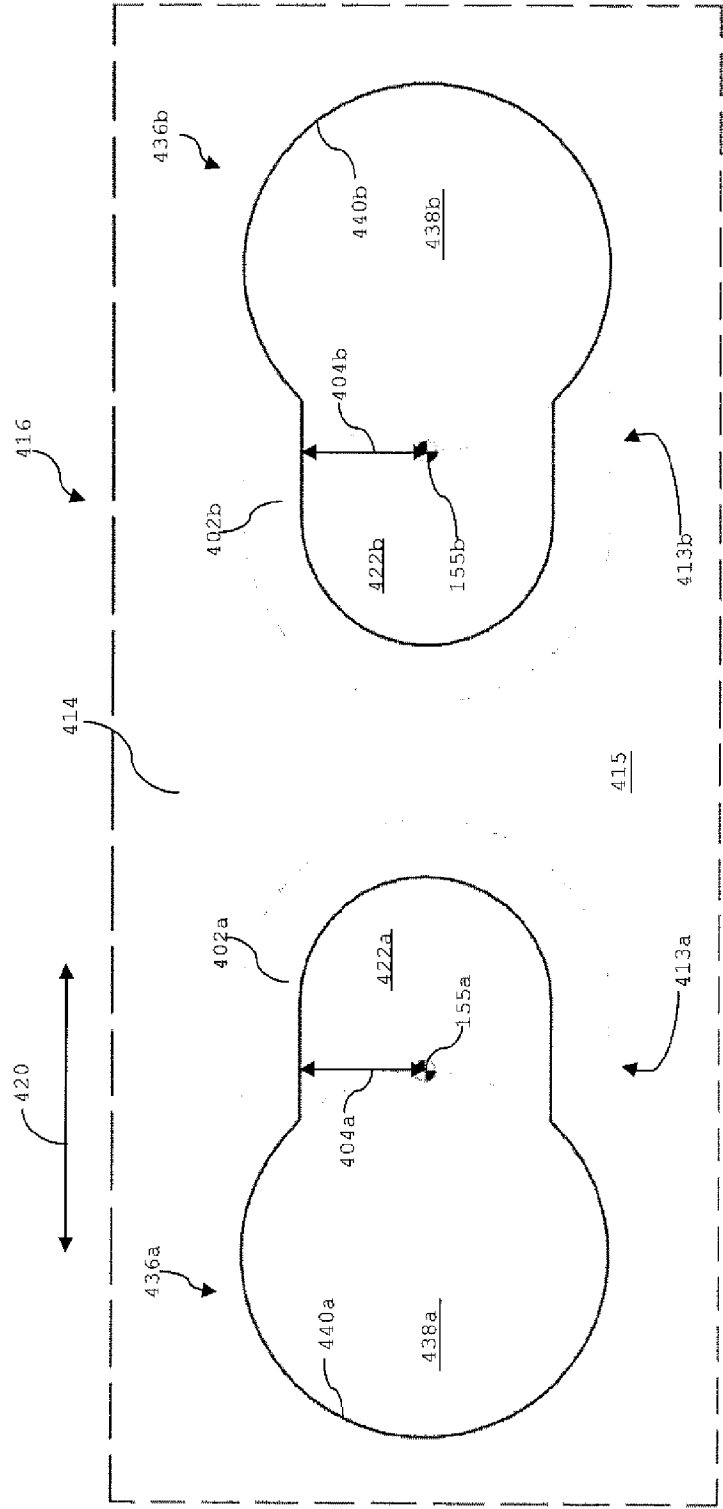


FIG. 17

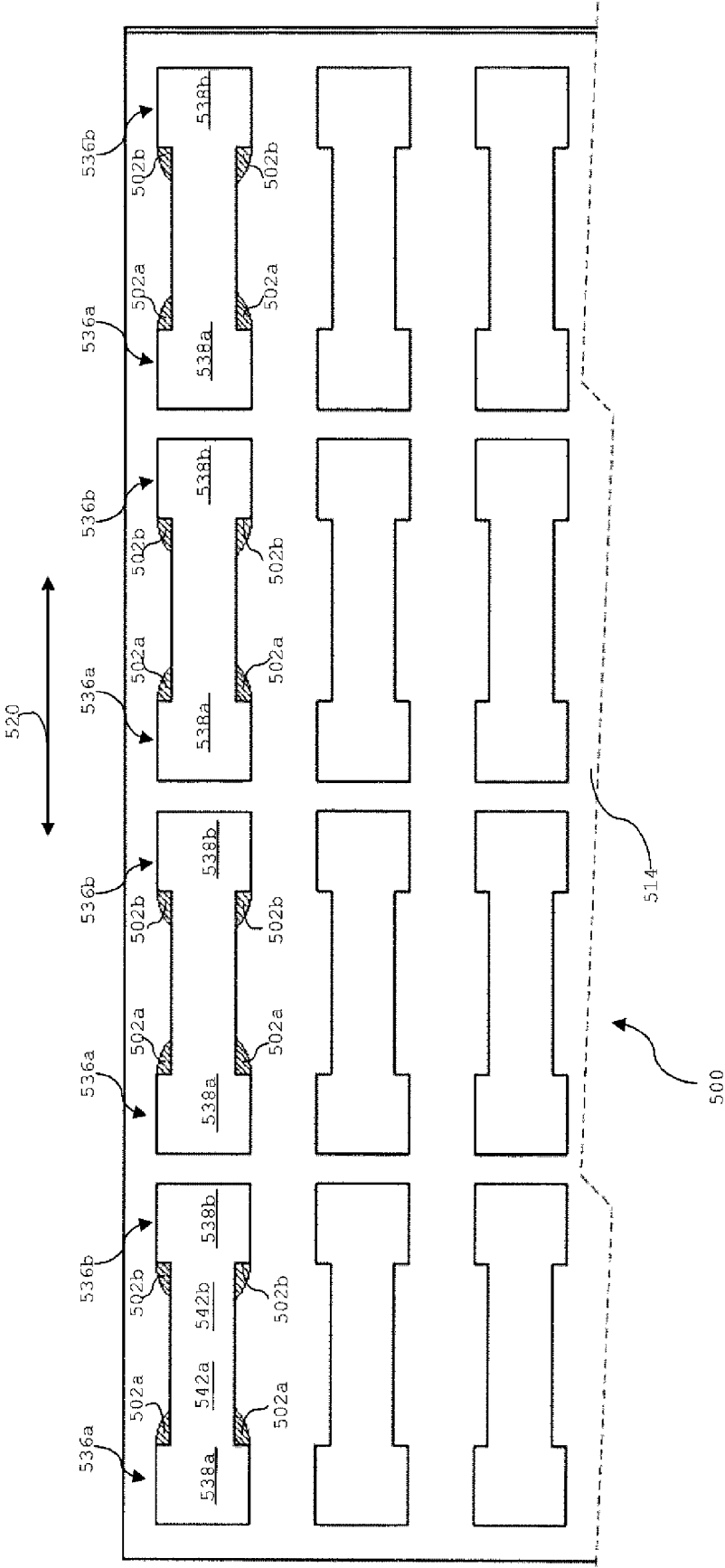


FIG. 18

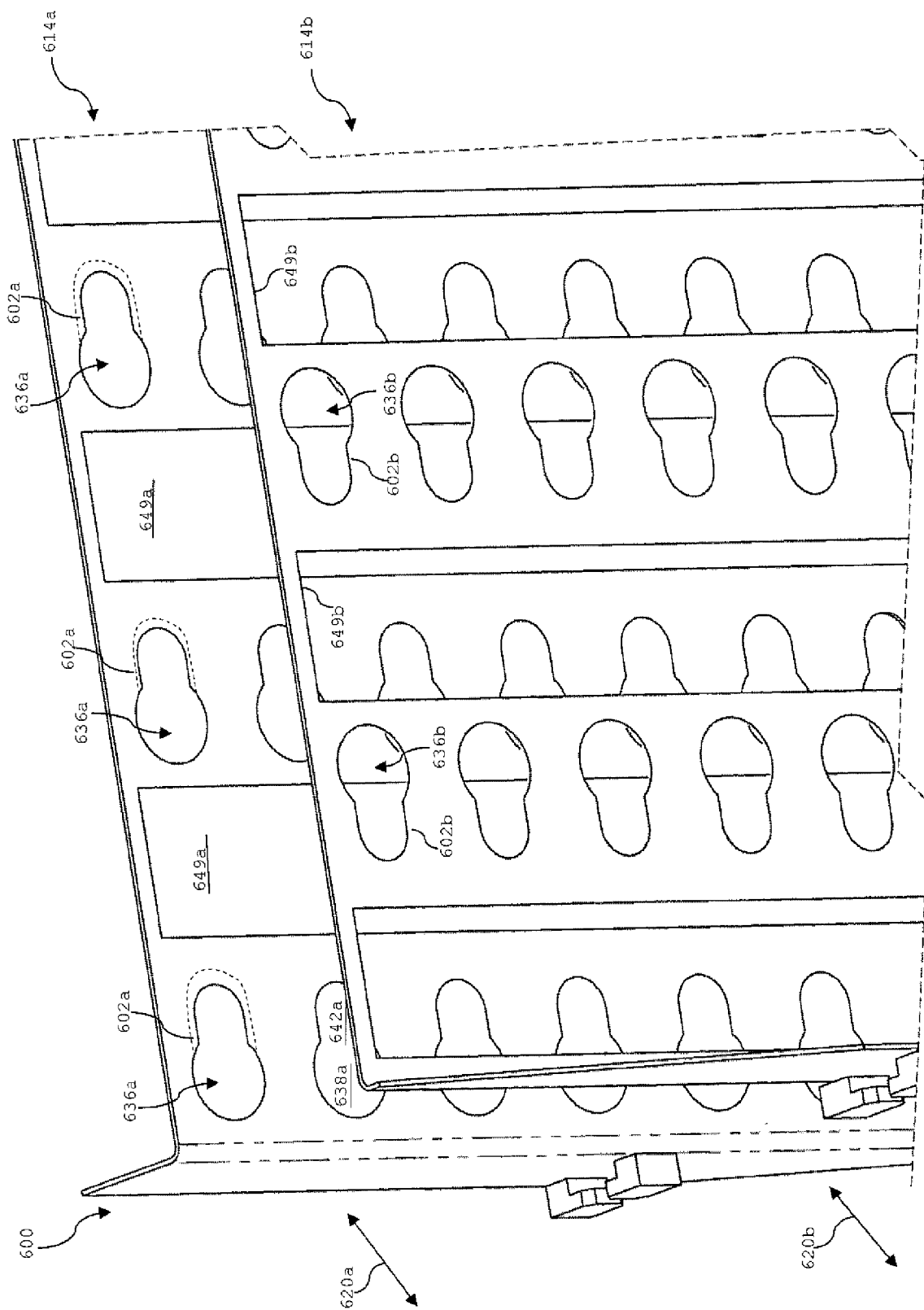


FIG. 19

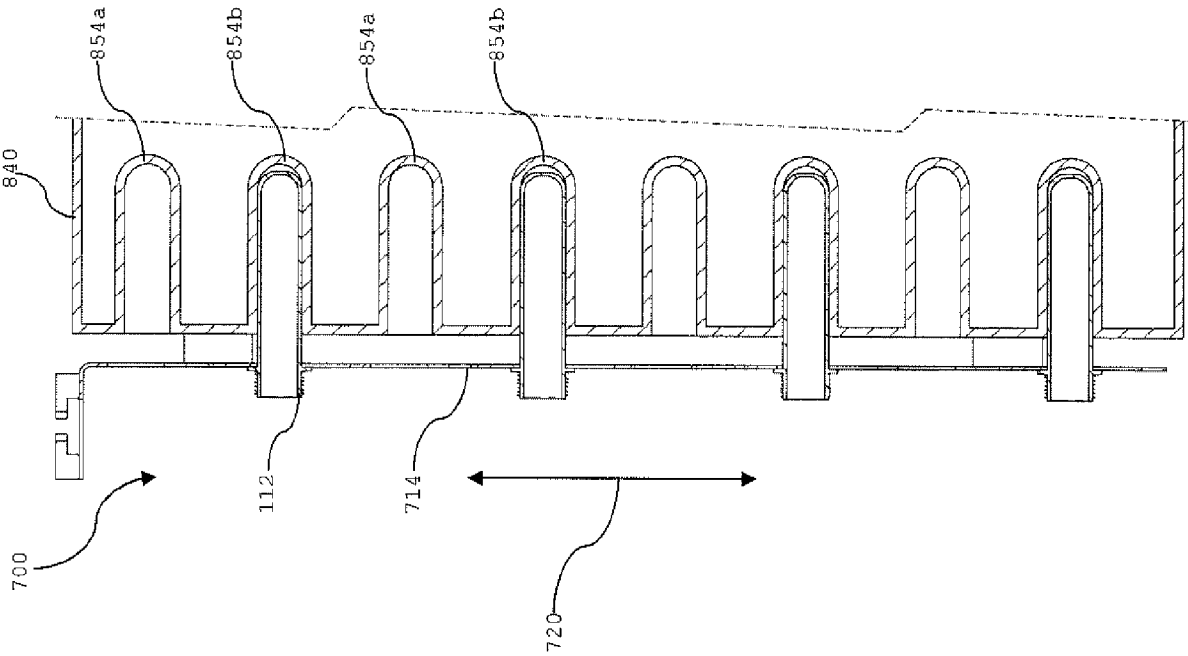


FIG. 20

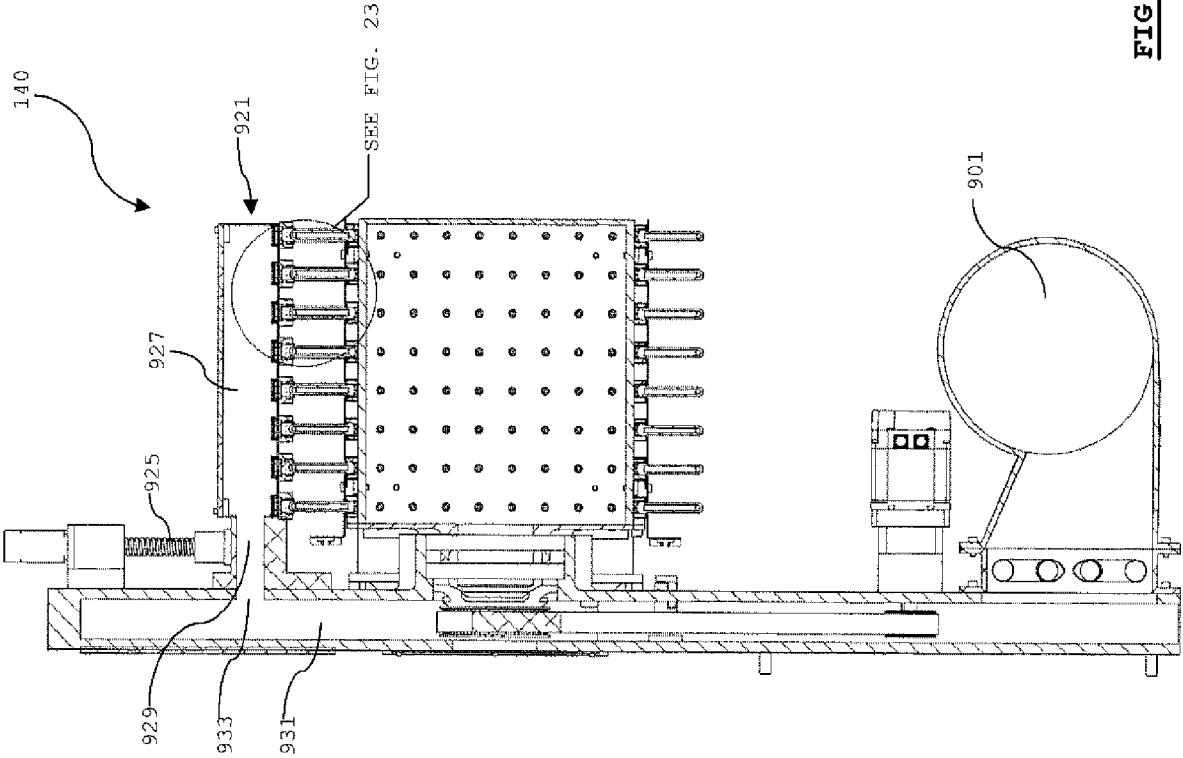


FIG. 22

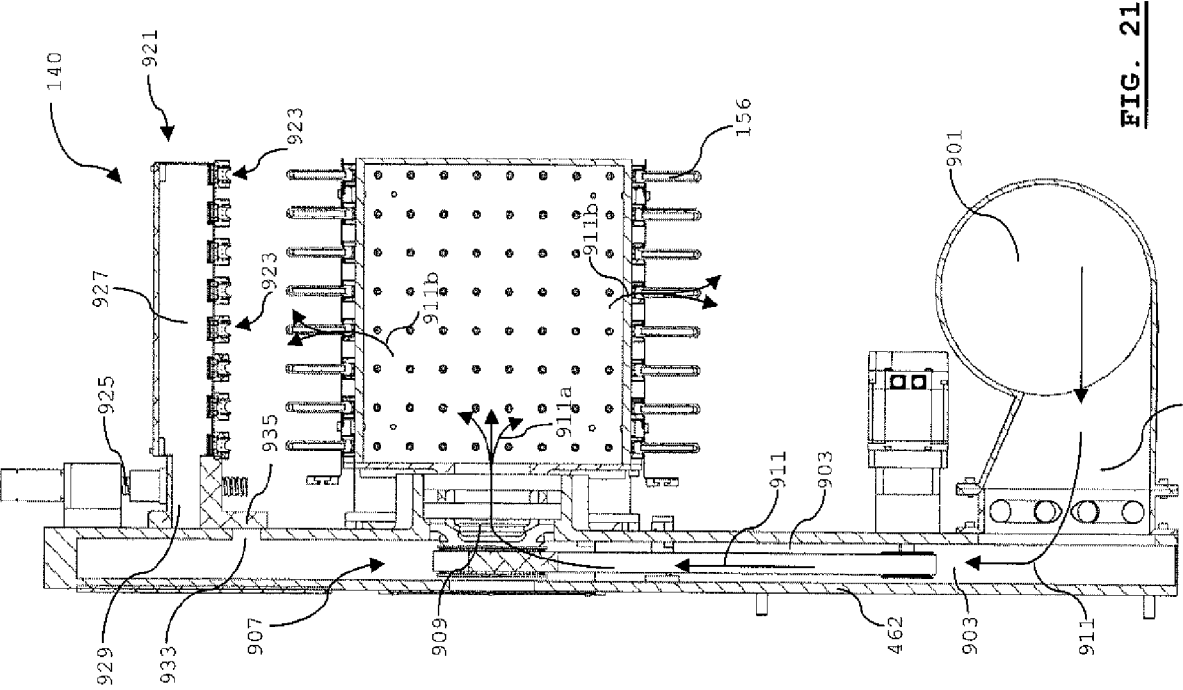
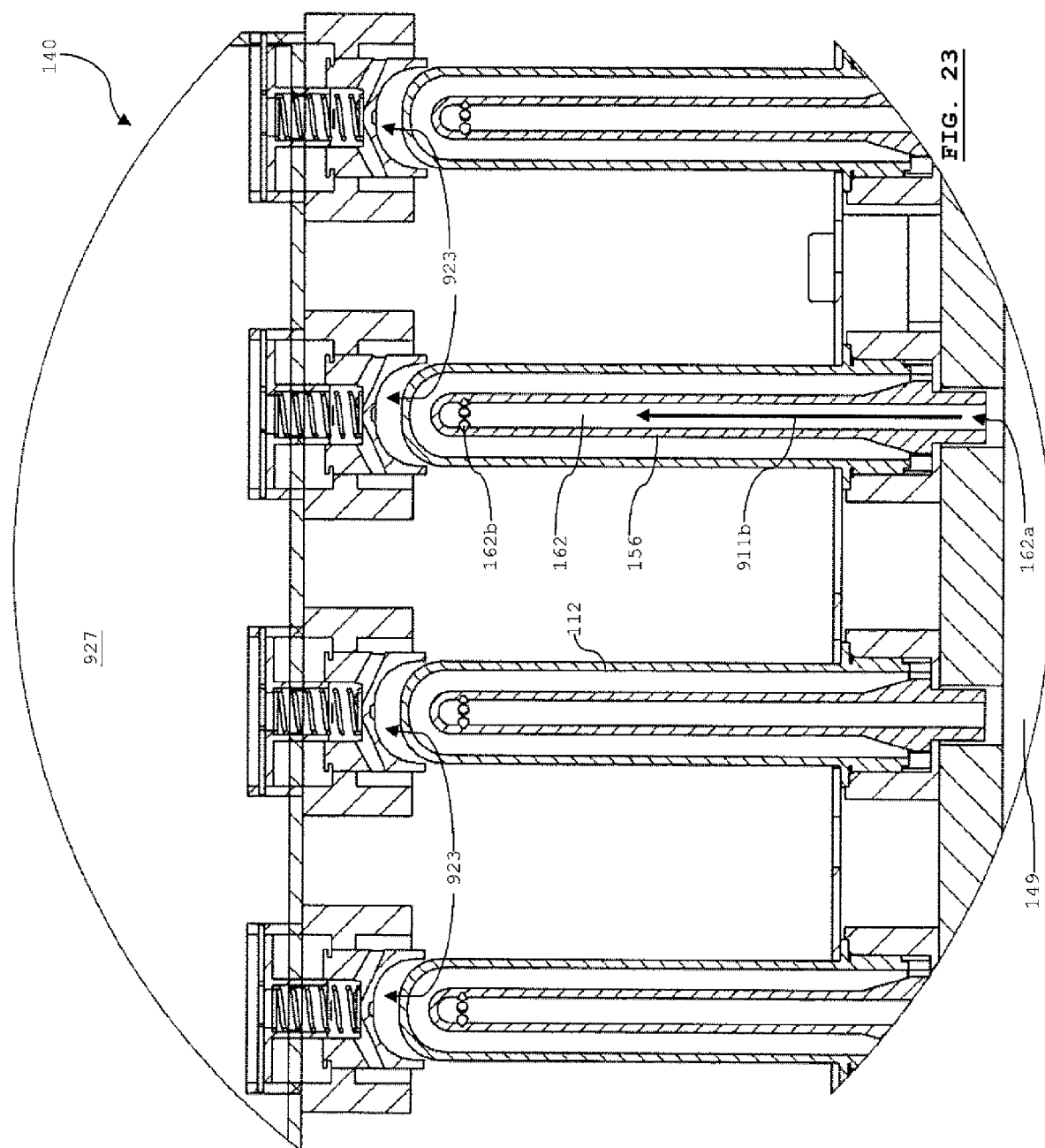
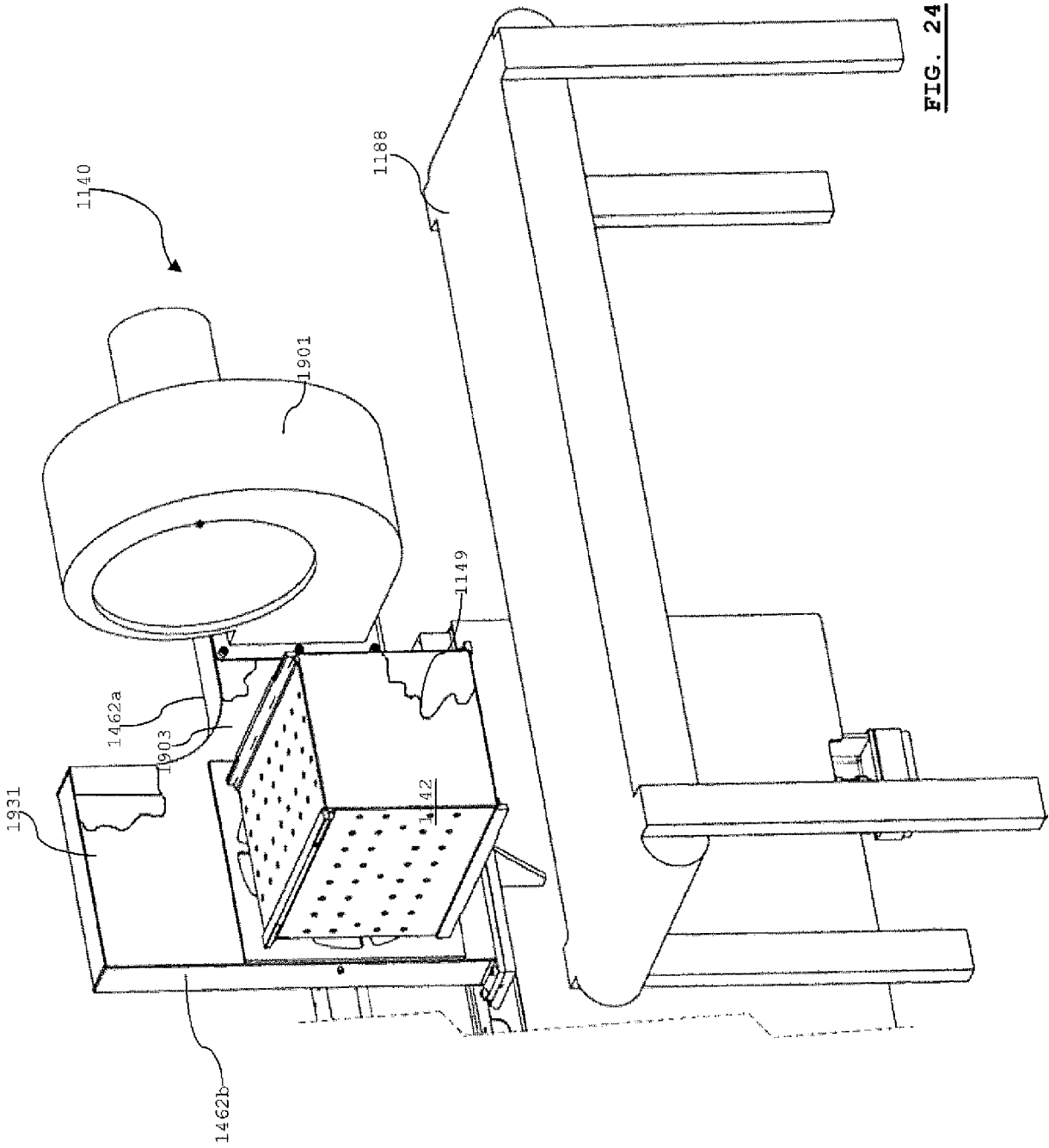


FIG. 21





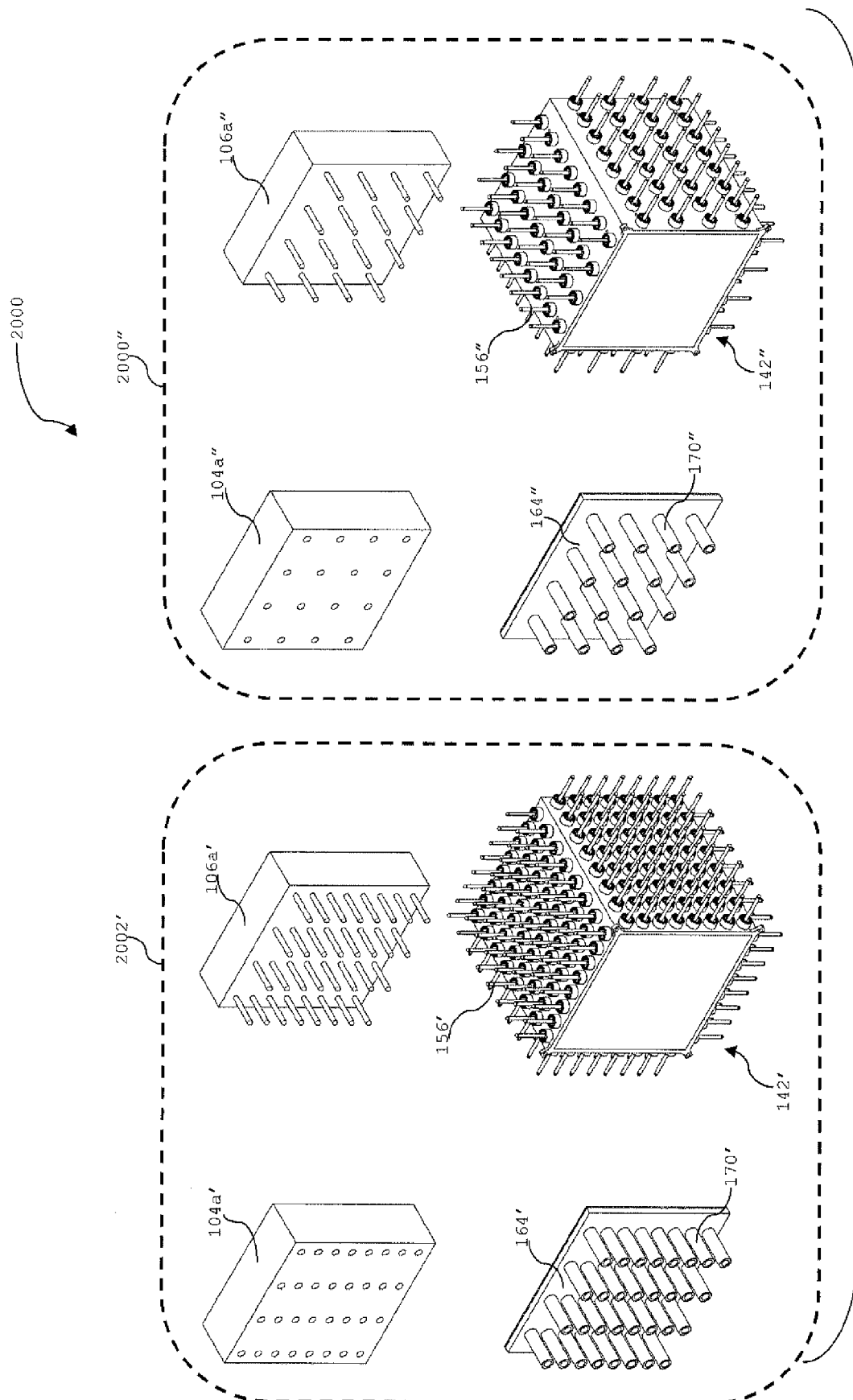


FIG. 25

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2011/050587

A. CLASSIFICATION OF SUBJECT MATTER IPC: B29C 45/76 (2006.01) , B29C 45/17 (2006.01) , B29C 45/40 (2006.01) , B29C 45/73 (2006.01) According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC: B29C 45/* (2006.01) Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used) EPOQUE (EPODOC and X-FULL), CPD with key words, such as: preform*, tak*_out, tak*_off, EOAT, end of arm tooling, robot, remov*, pick*, post_mold*, cool*, rotat*, turn*, turret, cooling receiver/shell/pin*, machine, multi-cavity, multiple cavit*, assembly, cavity layout, family mold, different size*/shape*/part*, first/second mold*, two_set* mold*, two mold set*, first/second inject* and first mold* article* part* product*		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CA 2589424 A1 (NETER, W. et al.) 15 June 2006 (15-06-2006) *figs. 2A - 4C; page 9, line 35 to page 11, line 2*	1-44 and 45-50
Y	US 6299431 B1 (NETER, W.) 9 October 2001 (09-10-2009) *cited by applicant* *figs. 1-4B*	1-44 and 45-50
Y	US 4836767 (SCHAD, R. D. et al.) 6 June 1989 (06-06-1989) *cited by applicant* *fig. 1*	1-32, 35-41 and 45-50
Y	JP 3219932 A (FUKAO, H.) 27 September 1991 (27-09-1991) *abstract, figs. 1-5*	45-50
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "B" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
Date of the actual completion of the international search 17 January 2012 (17-01-2012)	Date of mailing of the international search report 24 January 2012 (24-01-2012)	
Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	Authorized officer Pengfei Zhang (819) 953-0654	

INTERNATIONAL SEARCH REPORTInternational application No.
PCT/CA2011/050587

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CA 2482781 C (NETER, W. et al.) 27 November 2003 (27-11-2003)	1-44 and 45-50
A	US 5773038 A (HETTINGA, S.) 30 June 1998 (30-06-1998) *figs. 4-11*	45-50
A	KR 20100021764 (AN, S. I) 26 February 2010 (26-02-2010) *abstract; fig. 1*	45-50

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2011/050587

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of the first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons :

1. ☐ Claim Nos. :
because they relate to subject matter not required to be searched by this Authority, namely :
2. ☐ Claim Nos. :
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically :
3. ☐ Claim Nos. :
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows :

The application does not comply with subsection 36(1) of the *Patent Act*. The claims are directed to a plurality of alleged inventions as follows:

- Group A -** Claims 1-44 are directed to a method and an apparatus for cooling molded preforms, wherein a plurality of subsequent molding sets of the molded preforms with the same size and the same shape are subsequently loaded on one side of the shell to be cooled down.
- Group B -** Claims 45-50 are directed to an apparatus for cooling molded preforms, wherein a plurality of subsequent molding sets of the molded preforms with different sizes and shapes are subsequently loaded on one side of the shell to be cooled down.
- Group C -** Claims 51-76 are directed to an apparatus for cooling molded preforms, wherein a gripper assembly can be adjusted to use for the different sized and shaped molded preforms.

According to subsection 36(2) of the Patent Act, after limiting the claims of the present application to one invention only, the applicant may make any other invention disclosed the subject of a divisional application. The applicant is advised that once an election has been made, further prosecution of the present application will be limited to the invention so elected.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claim Nos. : 1-44 and 45-50
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim Nos. :

- Remark on Protest**
- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
 - ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
 - ☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2011/050587

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
CA 2589424 A1	15 June 2006 (15-06-2006)	AU2005313787A1 CN101072667A EP1824654A1 JP2008522863A KR20070092980A RU2007125483A US2006121153A1 WO2006060893A1	15 June 2006 (15-06-2006) 14 November 2007 (14-11-2007) 29 August 2007 (29-08-2007) 03 July 2008 (03-07-2008) 14 September 2007 (14-09-2007) 20 January 2009 (20-01-2009) 08 June 2006 (08-06-2006) 15 June 2006 (15-06-2006)
US 6299431 B1	09 October 2001 (09-10-2001)	US6299431B1 US2003205841A1 US6663813B2	09 October 2001 (09-10-2001) 06 November 2003 (06-11-2003) 16 December 2003 (16-12-2003)
US 4836767 A	06 June 1989 (06-06-1989)	None	
US 5773038 A	30 June 1998 (30-06-1998)	None	
KR 20100021764	26 February 2010 (26-02-2010)	None	
JP 3219932 A	27 September 1991 (27-09-1991)	None	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2011/050587

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
CA 2482781 A1	27 November 2003 (27-11-2003)	AT403534T	15 August 2008 (15-08-2008)
		AU2003212166A1	02 December 2003 (02-12-2003)
		AU2003212166B2	06 July 2006 (06-07-2006)
		AU2003218841A1	02 December 2003 (02-12-2003)
		AU2003218841B2	22 June 2006 (22-06-2006)
		BR0309967A	01 March 2005 (01-03-2005)
		BR0310059A	15 February 2005 (15-02-2005)
		CA2482781C	18 March 2008 (18-03-2008)
		CA2482786A1	27 November 2003 (27-11-2003)
		CA2482786C	18 December 2007 (18-12-2007)
		CN1652919A	10 August 2005 (10-08-2005)
		CN100406231C	30 July 2008 (30-07-2008)
		CN1652920A	10 August 2005 (10-08-2005)
		CN100404235C	23 July 2008 (23-07-2008)
		DE60322701D1	18 September 2008 (18-09-2008)
		EP1515828A1	23 March 2005 (23-03-2005)
		EP1515829A1	23 March 2005 (23-03-2005)
		EP1515829B1	06 August 2008 (06-08-2008)
		IL164653D0	18 December 2005 (18-12-2005)
		IL164653A	08 July 2008 (08-07-2008)
		IL164653D0	18 December 2005 (18-12-2005)
		JP2006501080A	12 January 2006 (12-01-2006)
		JP4516422B2	04 August 2010 (04-08-2010)
		JP2005533677A	10 November 2005 (10-11-2005)
		JP4549846B2	22 September 2010 (22-09-2010)
		MXPA04011211A	14 February 2005 (14-02-2005)
		MXPA04011217A	14 February 2005 (14-02-2005)
		RU2004137003A	10 June 2005 (10-06-2005)
		RU2293019C2	10 February 2007 (10-02-2007)
		RU2004137002A	10 June 2005 (10-06-2005)
		RU2294832C2	10 March 2007 (10-03-2007)
		TW590874B	11 June 2004 (11-06-2004)
		TWI235107B	01 July 2005 (01-07-2005)
		US2003214077A1	20 November 2003 (20-11-2003)
		US6817855B2	16 November 2004 (16-11-2004)
		US2005042324A1	24 February 2005 (24-02-2005)
		US6951452B2	04 October 2005 (04-10-2005)
		US2003214079A1	20 November 2003 (20-11-2003)
		US6986653B2	17 January 2006 (17-01-2006)
		US2005142244A1	30 June 2005 (30-06-2005)
		US7052270B2	30 May 2006 (30-05-2006)
		US2005133970A1	23 June 2005 (23-06-2005)
		US7056465B2	06 June 2006 (06-06-2006)
		US2005040560A1	24 February 2005 (24-02-2005)
		US7384587B2	10 June 2008 (10-06-2008)
		WO03097326A1	27 November 2003 (27-11-2003)
		WO03097327A1	27 November 2003 (27-11-2003)