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(54) Improvements in casting systems.

(57) A system to receive heated molds on a tray or car at a first point, transfer the tray or car containing the heated molds to a mold pouring and filling stations and transferring the same to a cooling station. The system includes a furnace or heating chamber for empty molds, a cooling chamber for cooling filled molds, and a transfer station for filling and transferring the molds. Additionally, an apparatus for pouring metal from a ladle to a mold includes gripping means for gripping a ladle and moving the ladle between pouring and non-pouring positions. Also disclosed is a tray that supports at least one mold having at least one bottom member, with surrounding side walls incorporating at least two segmented members of refractory material, and means for retaining these members relative to the bottom member.

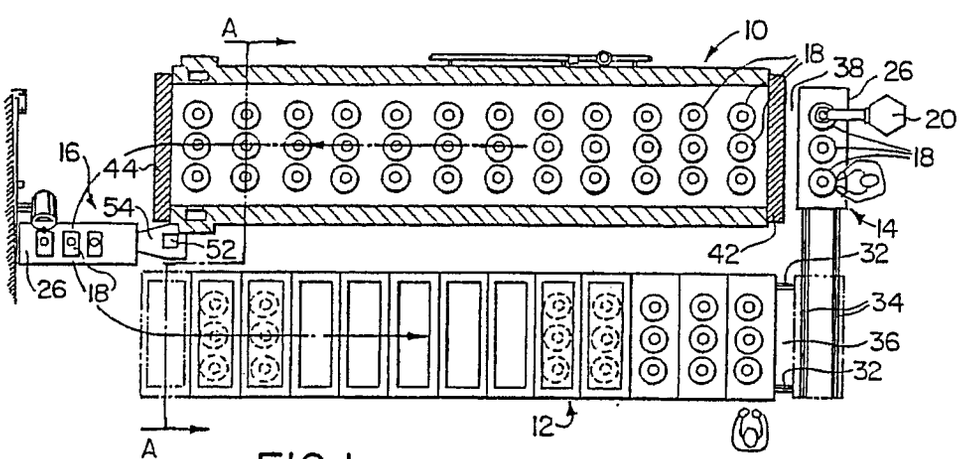

FIG. 1

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This invention relates to a system including an apparatus and a method for filling molds with molten metal, and also an apparatus for engaging a ladle adapted to contain molten metal and for moving the same between first and second positions.

In forming parts in molds as used in the casting industry, the mold, which may be solid or a shell, is heated to elevated temperatures to receive molten metal poured from a ladle. One technique involves putting the mold in a furnace, and then moving it to a mold pouring station. As this is a labour-intensive operation, it would be desirable to have an automated system to eliminate hazards associated with pouring molten metal into molds, and which is economical to carry out as well as one which can be operated in a reduced space.

Once a mold is filled with molten metal, it must then be cooled under controlled conditions before further processing. In simple systems, this means that molds are filled and then left to stand until the metal is solidified. This also means that, once the mold is filled at the pouring station, it has to be transported, e.g., manually, to the cooling station.

This invention provides a system or apparatus adapted to receive heated molds at a first point, transfer such heated molds to a mold pouring and filling station, and then subsequently transfer the molds to a cooling station in which the amount of manual labour is reduced to decrease safety hazards. According to this invention, in a casting system which includes a furnace or heating chamber for empty molds and a cooling station or chamber for cooling filled molds, there is provided the improvement of a transfer assembly comprising a rotatable support, rotatable from a first position at which the assembly is adapted to receive a mold from the furnace section, to a second position at a mold filling station at which the mold is filled, and further being rotatable from the second position to a third position at the cooling station, the rotatable support including means adapted to mount and retain at least one mold thereon, and means for rotating the rotatable support between the first, second and third positions.

In a preferred embodiment, the rotatable support includes a support for receiving a tray or a car which in turn, mounts one or more molds, and means for retaining the tray or car in operative relationship to the support to prevent undesirable movement of the tray or car during movement of the support between the first, second and third positions. The rotatable support preferably includes mounting means, a support rotatable about the mounting means, and means for controlling in time-related sequence the movement of the support means between the first, second and third positions.

There is also provided means for gripping and retaining a ladle used in a mold pouring operation, in which the gripping and retaining means retains a ladle and is adapted to move the ladle between mold pouring and non-pouring operations, and which gripping means provides enhanced safety, particularly for semi-automated or automated pouring at the mold pouring station, such as that outlined herein. The invention provides an improved gripping means suitable for a casting system. The gripping means grips a ladle and moves the ladle between ladle pouring and non-pouring positions. The gripping means has first frame means, first actuating means for engaging and releasably disengaging the first frame means, second frame means for releasably cooperating with the first frame means, and second actuating means for operatively engaging and disengaging the second frame means and for effecting relative engagement and disengagement of the first and second frame means.

In the overall apparatus and system, preferably a car or a tray is used to transport the molds between a furnace section and a cooling section; alternately, a conveying system can be used to move the trays or cars in sequence. Briefly, a tray may include heat-resistant walls, a base, and insulating material such as sand or the like and on which one or more molds are adapted to be placed for transport through the various sequences of heating, filling and cooling.

Another aspect of the invention relates to a tray or car utilized for moving a mold from the furnace to the pouring station, and subsequently to the cooling station. Such trays must withstand a high thermal shock load which in some cases, is basically equivalent to a quench treatment. In the prior art, many techniques and structures for holding molds would not be suitable due to this high thermal shock as conventional structures will not stand up to such a shock load so that they disintegrate or have a very limited life. This invention provides a segmented tray or car structure which overcomes such disadvantages.

Another aspect of this invention provides a tray adapted to support at least one mold, comprising at least one bottom member, side walls surrounding the bottom member and being comprised of at least two segmented members of refractory material, and means for retaining the segmented members about the bottom member.

Another system includes a car or tray with wheels, in which the car may be a monolithic or one-piece member of, e.g., refractory material, and in which the car or tray having such wheels may be run on guide means, e.g., tracks in the furnace, thereafter off-loaded to the transfer system of this invention, transferred to a mold filling station, and then placed back on such guide means at the

cooling station.

Reference is now made to the accompanying drawings, illustrating preferred embodiments and in which:

Figure 1 is a schematic plan view of a system of this invention showing certain features including a transfer arrangement between adjacent loading and unloading stations;

Figure 2 is a section along line A-A of Figure 1, showing the car units;

Figure 3A is a plan view, partially in outline, 2u showing the arm and gripper;

Figure 3B is a view similar to Figure 3A with a portion of the assembly removed, and illustrating a semi-engaged position of the gripping assembly;

Figure 3C is a side view of the gripping assembly;

Figure 3D is a diagrammatic view showing the pouring operation about a pivot point for the ladle;

Figure 3E is a partial enlarged sectional view taken from the right-hand side of Figure 3A, showing a portion of the manipulator arm;

Figure 4 is a top plan view of a tray assembly for transporting molds; and

Figure 5 is a section along line A-A of Figure 4.

Figure 1 illustrates a system of the invention including a furnace section 10, a cooling section 12, a loading station 14 and a transfer station 16 between furnace 10 and section 12.

In furnace 10, a plurality of shell molds 18 are loaded onto individual cars or trays at station 14; molds 18 are loaded by a robot 20 onto a platform or car assembly 26 (Figure 2) or the tray assembly of Figure 5 described hereinafter. In Figure 2, three molds 18 are loaded onto each car by robot 20, a typical car 26 comprising an elongated tray sliding along guide rails 30 in furnace 10 and on similar rails 32 in section 12. A pair of guide rails 34 is located at loading station 14 to receive a car 26 at a discharge end 36 of section 12 and to permit a car 26 to be transferred on rails 34 from section 14 adjacent entrance 38 of section 10.

Section 10 comprises an elongated housing 40 of suitable material heated by heating means (not shown) with an entrance door 42 and exit door 44, both movable in a vertical direction to permit loading/discharge of a car 26 carrying molds 18. Within housing 40, cars 26 travel on rails 30 mounted by frame members 46 within furnace 10.

Cooling section 12 comprises an elongated platform, including frame means 48 having spaced apart rails 32. Preferably, section 12 is mounted parallel to section 10 to save working space and for providing a compact processing operation.

Furnace 10 may contain a plurality of cars or transporting means 26 carrying molds 18 travelling through furnace 10 from the entrance, which is a "cold" end, to the discharge end where molds 18 have finished preheating and are ready to receive molten metal. The preheating timing will be such that the movement of the cars 26 through section 10 is sufficient to allow preheating.

Each of cars 26 may be advanced, as part of an array, through furnace 10 by pushing a new car 26 into furnace 10, effecting automatic discharge of a car at the discharge end to transfer station 16. Advancing a mold-loaded car 26 from the loading station may be effected, e.g., manually or with pneumatic advancing means through, e.g., a cylinder engaging car 26. Suitable means may be provided for raising and lowering doors 42 and 44 in time-related sequence to the advancement of a car 26 into the furnace 10.

Station 12 may be of an open atmosphere construction or may be enclosed in a suitable housing. Cooling station 12 may have a protective hood 50 (see Figure 2) on individual cars 26 covering molds 18.

This invention additionally provides a transfer station 16 between sections 10 and 12 to receive and transport a car assembly from the discharge end of furnace 10 to a mold filling operation and subsequently to place it onto rails 32 of station 12. The transfer assembly includes a mounting shaft 52 rotatably mounted on an internal shaft (not shown) operable by motor means (not shown) for rotation between a first tray receiving position at the exit of section 10, a second mold filling position shown in Figure 1 between sections 10 and 12, and a third tray discharge position at the entrance of section 12.

The transfer assembly includes a mounting arm 54 fixedly secured to shaft 52; arm 54 may have a supporting platform having a pair of spaced apart rails or a frame to receive and retain a car 26. Stabilization of car 26 on the supporting platform is achieved by, e.g., a hydraulic cylinder associated with the platform to engage car 26 effecting frictional engagement against the platform preventing movement of the car upon transfer from section 10 to section 12 during movement of the transfer assembly.

The transfer assembly initially moves between first and second stations, and at the latter, molten metal is poured into molds 18.

Referring to Figures 3A to 3C, a ladle assembly is illustrated, which grips a ladle which receives molten metal from a furnace, and transports it from the furnace to a heated mold at station 16. In Figure 3C, a ladle 60 of conventional construction is provided with jaw 62 in the form of a semiarcuate plate connected to frame member 64, enclosing movable frame member 66 (Figure 3C), movable between engaging and disengaging posi-

tions (Figures 3A and 3B).

Cooperating with member 64 is a notched frame member 68 of a configuration similar to member 64, the latter receiving member 68 when the latter is advanced into and out of engagement frame member 64 by an actuating assembly 70. Assembly 70 comprises a pair of piston assemblies having piston rods 72 and 74; rod 72 is operatively associated with member 64, while rod 74 is operatively associated with member 68. Actuation of piston rod 72 brings member 66 into and out of engagement with member 64, while actuation of piston rod 74 brings member 68 into and out of engagement with member 64. A very secure gripping arrangement for the ladle is thus achieved which reduces the possibility of accidental tipping and release of ladle 60 during its movement.

Rods 72 and 74 are mounted by means of a frame member 76 to a further piston assembly 78, which causes movement of frame 76 between positions 80 and 82 along a guide 84 (Figure 3A), thus achieving lateral movement of ladle 60.

In Figure 3C, ladle 60, normally horizontal, can be tilted (Figure 3D) to a pouring position at station 16 where ladle 6u rotates about pivot point 88. The assembly of Figure 3A may be mounted on a manipulator arm of a robot assembly. A backing plate 83 is connected to a frame member 85 through plate 87, with a portion of the arm indicated by 89. A conventional robot capable of rotating arm 89 may be employed to rotate the arm about a horizontal axis permitting metal to be poured from spout 61 into molds 18. The robot assembly may be mounted on a track system permitting axial movement whereby movement of the robot system brings ladle 60 into pouring alignment with additional molds on car 26.

The arm and gripping assembly additionally includes lateral movement between points 80 and 82 along guide 84. In Figure 3A, lateral movement along guide 84 positions the gripping assembly for pouring on one side (where the ladle spout is located), but inasmuch as ladles normally contain molten material in excess of that required to fill a mold or a plurality of molds, when the mold filling operation is finished, the excess material must be returned to the furnace for reheating. Due to structural limitations associated with such procedures, excess material is poured from ladle 60 not at spout 61, but normally at an opposed side indicated by 61a, back into the furnace. To permit the manipulator arm to be moved into operative position with the furnace, travel is provided along guide 84 for assembly 76 and thus, ladle 60. This is necessary since the arc described by ladle 60 in emptying its contents into the furnace is broader than the fixed pivot point from which the metal pours in the mold filling operation, due to the mounting of ladle 60 in the gripping assembly since the pouring operation requires point 88 to provide precise pouring of molten metal from ladle 60 into the narrow mouths of molds 18. Pouring metal through spout 61 causes minor rotation of ladle 60 about an arc, whereas the arc described in emptying excess metal into the furnace due to point 88 is much larger, and hence the degree of lateral travel must be provided by the arrangement in Figure 3A.

Transporting means 26 may comprise a single or monolithic refractory frame 90, having a layer of sand 92 upon which molds 18 rest. Frame 90 is mounted on platform 94, which mounts wheels 96 of each car assembly and permits movement of car 26 along rails 30, 32, etc. Alternatively, the arrangement of Figures 4 and 5 may be employed and car 26 may be constructed of refractory bricks 98 forming a rectangular enclosure retaining insulating bricks 100 with a layer of sand 92 for mounting molds 18. Bricks 98 thus form a perimeter and bricks 100 may be mounted on a suitable base or frame member 104 including side walls 106 for retaining the bricks in the desired configuration.

The tray or car member 26 of Figures 4 and 5 may include wheels, as illustrated in Figure 2. Alternatively, the tray arrangement may be mounted on a suitable conveyor to replace the rail system used in the furnace and cooling sections. Likewise, a conveyor may replace the rails at the unloading and loading stations to transport the trays between the terminal discharge of section 12 and the entrance of section 10.

Claims

1. In a system adapted to receive heated molds at a first point, transfer such molds to a pouring station and then to a cooling area, said system including a furnace or heating chamber for empty molds, and a station or chamber for cooling filled molds, said system having a transfer assembly comprising a support rotatable from a first position at which said assembly is adapted to receive a mold from said furnace section, to a second position at a mold filling station, and further rotatable to a third position at said cooling station, said rotatable support including means adapted to mount and retain at least one mold thereon, and means for rotating said support between said first, second and third positions.

2. A system according to Claim 1, wherein said rotatable support is adapted to receive a tray or car for transport between said first and third positions, and means for retaining said tray or car in relative position to said support during movement between said first and third positions.

3. A system according to Claim 1, wherein said system includes a rotatable support having mounting means for said support, said support being rotatable about said mounting means, and means for effecting movement of said support between said first, second and third positions.

4. In an apparatus for pouring metal from a ladle to a mold, the improvement wherein there is included a gripping component for gripping a ladle and moving it between pouring and non-pouring positions, said gripping component comprising a gripping means for engaging a ladle, first frame means associated with said gripping means, first actuating means for engaging and disengaging said first frame means, second frame means for releasably cooperating with said first frame means, and second actuating means for engaging and disengaging said second frame means, and for engaging and disengaging said first and second frame means.

5. Apparatus as defined in Claim 4, wherein said first and second actuating means are mounted on a frame member movable along an axis displaced from the axis of said first and second actuating means, whereby said gripping means may be moved between first and second positions relative to the displacement of said first and second actuating means.

6. Apparatus as defined in Claim 5, wherein said frame member is slidably mounted on a guide member adapted to permit said frame member to be laterally displaced relative to an axial movement of said first and second actuating means.

7. Apparatus as defined in Claim 4, wherein said first and second actuating means are rotatable between first and second positions about an axis horizontal to the axis of movement of said actuating means.

8. A tray suitable for mounting on said rotatable support of claim 1 and being adapted to support at least one mold comprising at least one bottom member, side walls surrounding said bottom member and being comprised of at least two segmented members of refractory material, and means for retaining said segmented members about said bottom member.

9. A tray as defined in Claim 9 wherein said tray member comprises adjacent side wall members, each side wall member being comprised of at least one wall member segmented from adjacent wall members.

10. A tray as defined in Claim 9, wherein said segmented members form a continuous wall about said bottom member and wherein said bottom member includes refractory material thereon between said segmented wall members.

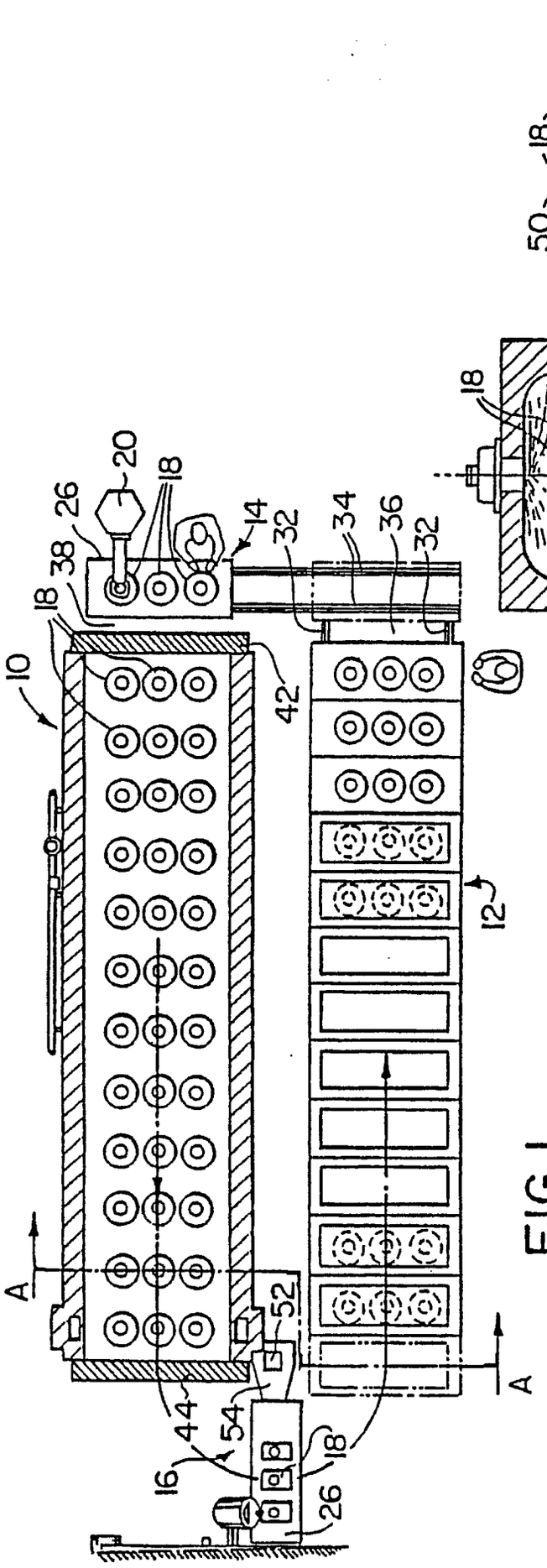
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FIG. 1

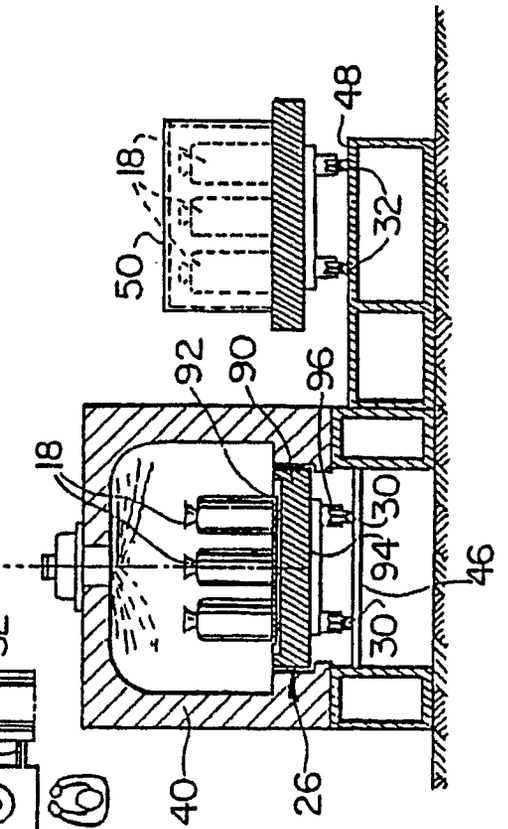
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FIG. 2

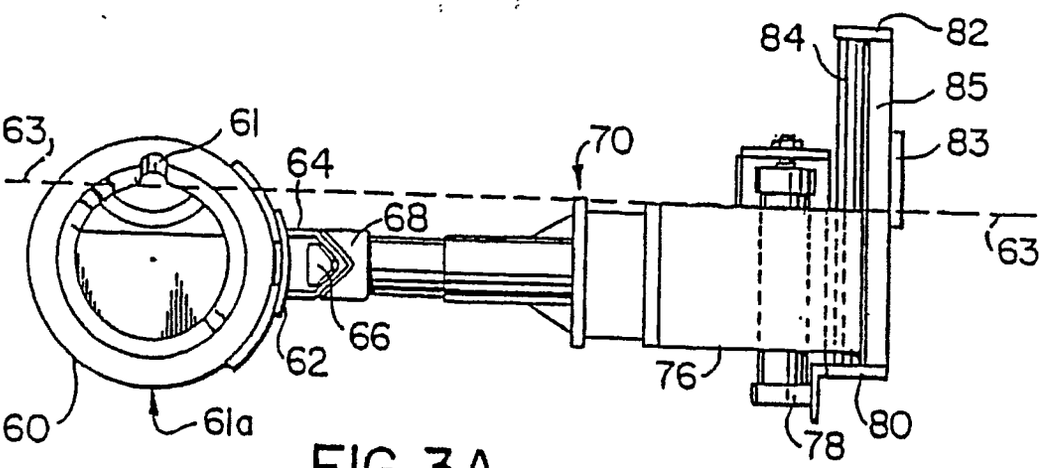

FIG. 3A

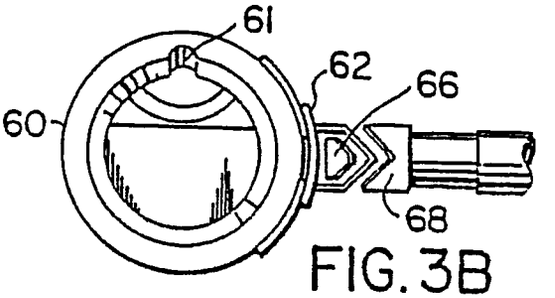

FIG. 3B

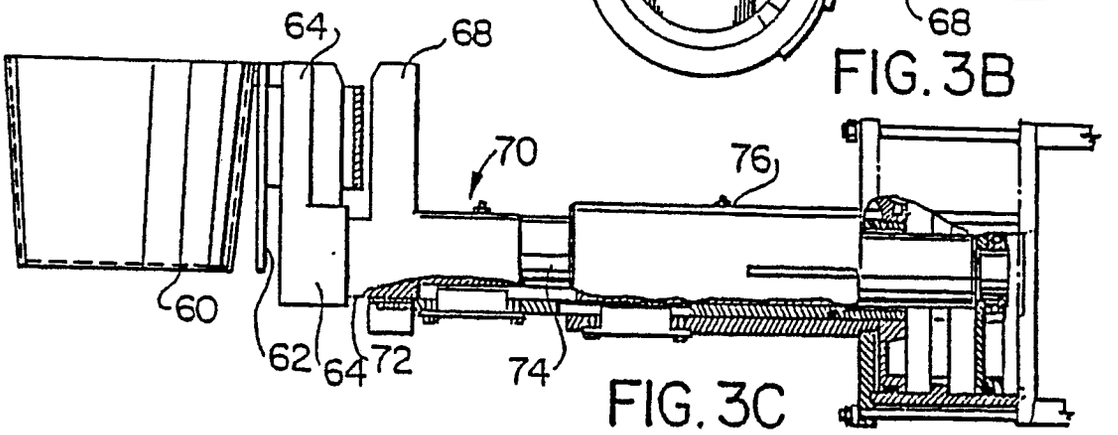

FIG. 3C

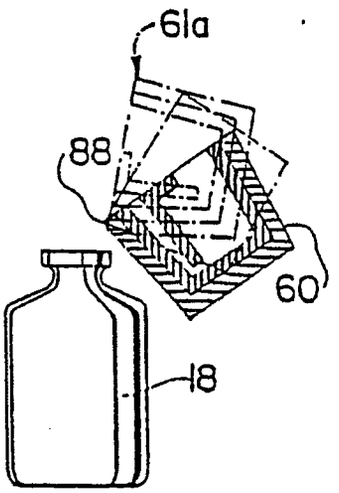

FIG. 3D

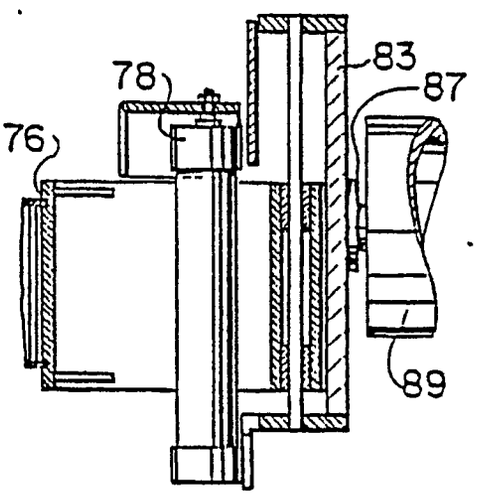

FIG. 3E

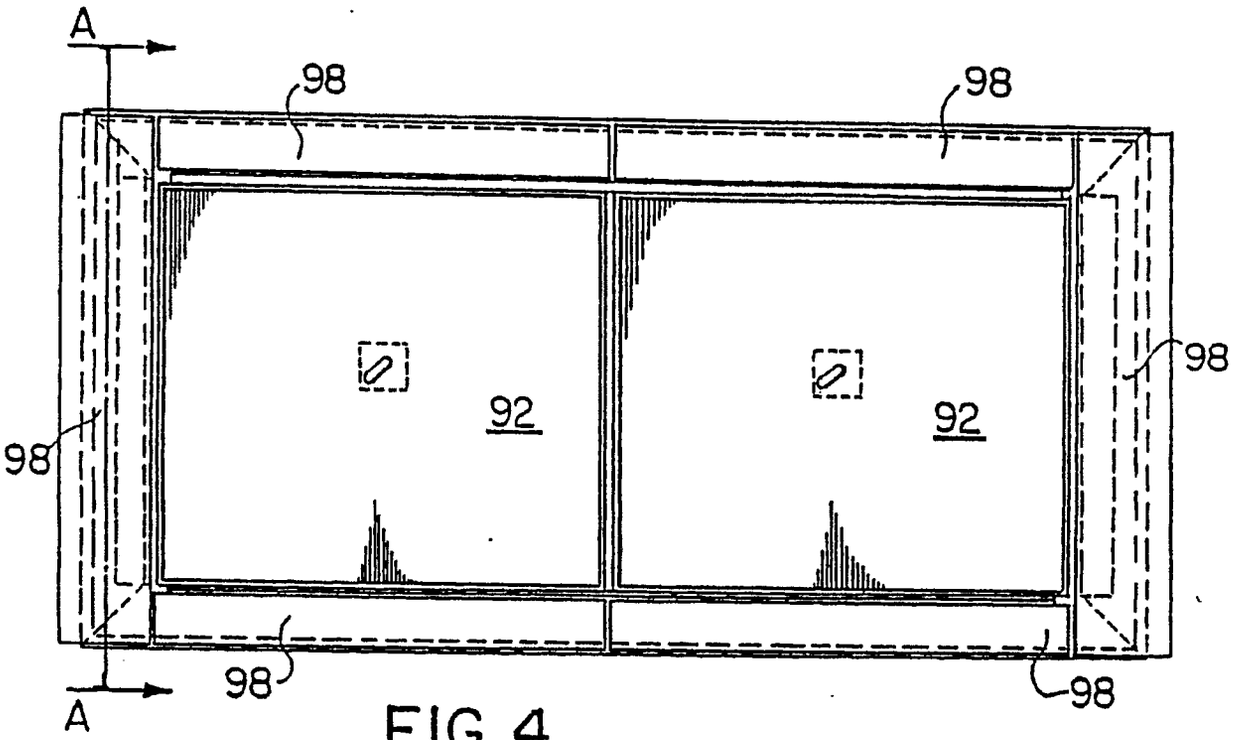

FIG. 4

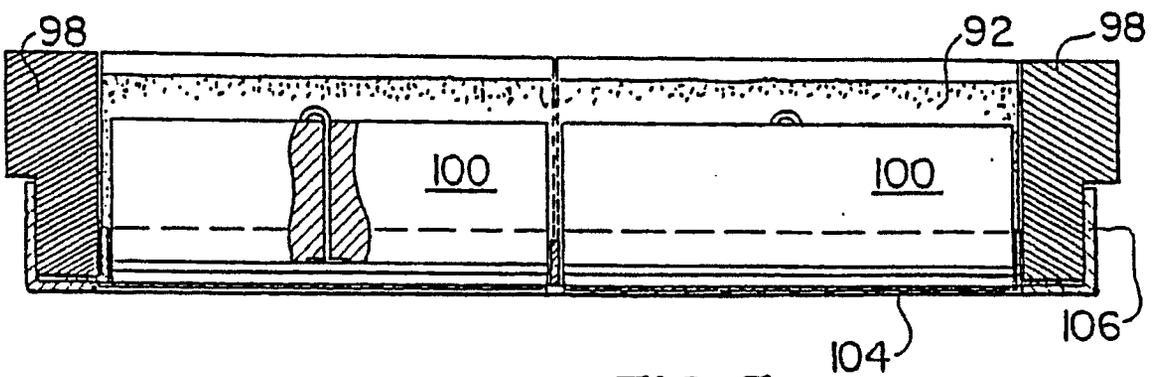

FIG. 5