(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 612 276 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
15.04.1998 Bulletin 1998/16

(21) Application number: **93904665.2**

(22) Date of filing: **27.01.1993**

(51) Int. Cl.[6]: **B22D 17/22**, B22D 29/00, B22C 5/08

(86) International application number:
PCT/US93/00722

(87) International publication number:
WO 94/04297 (03.03.1994 Gazette 1994/06)

(54) **HEAT TREATMENT OF METAL CASTINGS AND IN-FURNACE SAND RECLAMATION**

WÄRMEBEHANDLUNG VON GIESSSTÜCKEN UND SANDRÜCKGEWINNUNG IM OFEN

TRAITEMENT THERMIQUE DE PIECES COULEES EN METAL ET RECUPERATION DU SABLE DANS LE FOUR

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IE IT LI LU NL PT SE

(30) Priority: **13.08.1992 US 930193**

(43) Date of publication of application:
31.08.1994 Bulletin 1994/35

(73) Proprietor:
CONSOLIDATED ENGINEERING COMPANY, INC.
Kennesaw, GA 30144-3651 (US)

(72) Inventor: **CRAFTON, Scott P.**
Kennesaw, GA 30144 (US)

(74) Representative:
Strasse, Joachim, Dipl.-Ing.
Strasse & Hofstetter,
Balanstrasse 57
81541 München (DE)

(56) References cited:
US-A- 4 478 572
US-A- 4 620 586
US-A- 4 700 766

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 0 612 276 B1

Description

BACKGROUND OF THE INVENTION

The present invention relates generally to the field of heat treating metal castings and the field of reclaiming sand from sand cores and sand molds used to make metal castings.

Generally, prior art methods and apparatus require that two or three distinctly separate steps be taken in order to heat treat a metal casting formed by a permanent mold or sand mold with a sand core, and reclaim sufficiently pure sand from the sand mold or sand core (see e.g. US 4,478,572, upon which the preambles of claims 1 and 10 are based; US 4,620,586; US 4,700,766). The present invention allows for heat treating and reclamation of sufficiently pure sand in a single step.

Methods and apparatus for manufacturing metal castings are well known. Molds and cores are used to displace molten material so that when the molten material is solidified, a casting is formed that reflects the features of the mold and core. Molds have the exterior features of the casting formed on the interior walls of the mold and cores have the interior features of the casting formed on the exterior surface of the core. The cores are typically made from sand whereas the molds are sometimes made from sand. Sand molds and cores are typically pre-molded from a mixture of sand and a combustible binder. For simplicity, sand molds and sand cores are referred to hereafter as simply sand cores.

In accordance with some of the prior art, once the casting is formed, three distinctly different steps are carried out in order to heat treat the metal casting and reclaim sufficiently pure sand from the sand core. The first step separates portions of sand core from the casting. The sand core is typically separated from the casting by one or a combination of means. For example, sand may be chiseled away from the casting or the casting may be physically shaken to break-up the sand core and remove the sand. Once the sand is removed from the casting, the second and third steps are carried out. In this typical, three-step prior art, the order in which the second and third steps are taken is not important, since the sand has already been separated from the casting. The second step consists of heat treating the casting. The casting is typically heat treated if it is desirable to strengthen or harden the casting. The third step consists of purifying the sand that was separated from the casting. The purification processes is typically carried out by one or a combination of means. These may include burning the binder that coats the sand, abrading the sand, and passing portions of the sand through screens. It is important that the reclaimed sand be sufficiently pure in order for it to be properly reused in the construction of new sand cores. It is also helpful if the reclaimed sand is rounded, at least to some degree, so as to assist in the casting of smooth surfaces and to assist in good bonding of the sand grains which causes strong cores. Therefore, portions of sand may be re-subjected to reclaiming processes until sufficiently pure sand is reclaimed.

The purity of the reclaimed sand can be measured in terms of the quantity of unburned binder. The less unburned binder, the more pure the sand. While seeking increased purity, some sand is reduced to "fines". Fines is the term used for sand particles smaller than a specified size. Fines are so small that they require excessive amounts of binder. These two measures (purity and fines) generally oppose each other in that the higher the measure of one, the lower the measure of the other. It is important to balance these measures; therefore, it is important that the sand reclaiming processes be capable of controlling these measures.

In accordance with the present inventor's previous invention disclosure of U.S. application Serial No. 07/705,626, only one step need be taken in order to heat treat metal castings formed by sand cores and reclaim sand from the sand cores. This is carried out by introducing the castings, with the sand cores attached thereto, into a furnace with an oxygenated atmosphere that is heated to at least the combustion temperature of the sand core binder material. This causes combustion of some of the binder of the sand core which, in combination with other means, causes the sand core to separate from the casting. The system disclosed in application Serial No. 07/705,626 promotes more binder combustion than is required to separate the sand core from the casting. The system disclosed in application Serial No. 07/705,626 ejects sand from the furnace in a sufficiently pure state for some applications; but, that system is not capable of combusting a sufficient amount of binder (or otherwise processing the sand core) so as to render sand that is sufficiently pure for certain other applications. Also, that system does not make provisions for varying the characteristics of the reclaimed sand; no selective control over sand roundness, amount of fines, or amount of unburned binder in the reclaimed sand is possible. Therefore, the sand reclaimed using the method and apparatus disclosed in application Serial No. 07/705,626 may require further processing in order to obtain sand that is sufficiently pure for certain applications or sand that has certain characteristics. Therefore, previous sand reclaiming systems are inherently inefficient in that they require at least a two step process, carried out in two separate venues by separate, specialized equipment, in order to heat treat a metal casting formed by a sand core and reclaim sufficiently pure sand from the sand core.

There is a need, therefore, for a more efficient method, and associated apparatus, that allows for more efficient heat treatment, sand core removal, and reclamation of sufficiently pure sand from the sand core.

SUMMARY OF THE INVENTION

Briefly described, the present invention provides an improved method and apparatus for heat treating metal castings that are manufactured using sand cores and for reclaiming sand from the sand cores. More specifically, the present invention provides an improved method and apparatus for collecting sand within a heat treating furnace, purifying the sand, and ejecting the sand from the furnace. The present invention can reclaim sand that is more pure than that typically extracted from heat treating furnaces. The method and apparatus of the present invention also allows for selective control over the amount of binder and fines in the sand ejected from the furnace.

The preferred embodiment of the present invention includes, associated with a furnace, apparatus for agitating sand which has been collected within the furnace. In the preferred embodiment, this agitation apparatus utilizes pressurized air to accomplish the agitating function through a process of "fluidization", and shall be referred to herein as a fluidizer. This fluidization process passes air, from a pressurized source, through sand collected in the furnace causing portions of the sand to be suspended and act like a turbulent fluid. The fluidizer, in conjunction with other components in the furnace, causes the binder portion of sand cores to sufficiently combust within the furnace so that sufficiently pure sand is reclaimed. In this embodiment, the sand cores, from which binder is combusted, are attached to the castings that are transported into the furnace. A preferred furnace embodiment, and some of the elements within the furnace are disclosed in application Serial No. 07/705,626. The fluidizer and some of the elements associated with it are disclosed for the first time in this application.

The fluidizer of the preferred embodiment of the present invention causes the fluidization of sand that has collected within the furnace hopper. The fluidizing causes portions of sand to abrade against one another, and in at least one embodiment, to also abrade against a metal target, in a manner that exposes the binder. The exposed binder then combusts. The process is repeated until a sufficient amount of binder has been combusted to satisfy the user as to the purity of the sand.

In the preferred embodiment of the present invention, the fluidizer adds oxygen to the furnace hopper so as to promote binder combustion. In one preferred embodiment of the present invention, the fluidizer is supplied with preheated air from a secondary heat source so as to further promote binder combustion. In an alternate, preferred embodiment, the air of the fluidizer is not pre-heated. In accordance with one aspect of the present invention, multiple fluidizers are employed, and, in such embodiment, appropriate fluidizer embodiments are chosen and selectively placed along a multiple zoned furnace.

The present invention further includes methods and apparatus for discharging reclaimed sand from the furnace. In the preferred embodiment of the present invention, this discharging is controlled so as to control the volume of sand contained in the furnace. This affects the amount of time that sand is subjected to the fluidizing, thus effecting a control over the characteristics of the reclaimed sand.

An alternate embodiment of the present invention includes a supplemental sand reclamation unit (the "SSRU"). The supplemental sand reclamation unit, which functions in conjunction with the furnace heat source and in conjunction with the fluidizer and other components in the furnace, provides supplemental reclamation of sand previously reclaimed from casting cores. For example, sand collected from prior art shakers and sand discharged from the troughs of the furnace of serial number 07/705,626 is reprocessed by the supplemental sand reclamation unit. The supplemental sand reclamation unit includes a bin that is outside of the furnace. A tube is connected to a bin outlet and passes into the furnace. The tube passes, within the furnace, in close proximity to furnace heaters and terminates toward the furnace hopper. Collected sand is deposited into the bin where it is heated to above the binder combustion temperature and exposed to an oxygen-rich atmosphere; this causes an initial binder combustion. The sand then enters the tube. While passing through the tube, the sand is heated by the furnace heaters and further binder combustion occurs. When the sand exits the tube it falls into the furnace where it is, preferably, further purified by the in-furnace sand reclamation unit of the present invention.

It is, therefore, an object of the present invention to provide an improved method and apparatus for heat treating castings, with sand core material attached thereto, and reclaiming sand from the sand core material.

Another object of the present invention is to provide an improved method and apparatus for removing sand core material from a casting and reclaiming sand from the sand core material.

Another object of the present invention is to provide a method and apparatus for reclaiming, within a furnace, sand from portions of sand core that are separated from castings within the furnace.

Another object of the present invention is to provide a method and apparatus for agitating, within a furnace, sand that is collected within the furnace.

Another object of the present invention is to provide a method and apparatus for fluidizing, within a furnace, sand that is collected within the furnace.

Another object of the present invention is to provide a method and apparatus for enhancing combustion, within a heat treating furnace, of binder that coats sand that is collected in the furnace.

Another object of the present invention is to provide a method and apparatus for heating, from a secondary

source, sand that is collected within a furnace.

Another object of the present invention is to provide a method and apparatus for providing oxygen to the area in which sand is collected within a furnace.

Another object of the present invention is to provide a method and apparatus for reclaiming sand outside of the furnace, and purifying the reclaimed sand within a furnace.

Yet another object of the present invention is to provide a method and apparatus for controlling the amount of time that sand core material is exposed to sand reclamation processing within a furnace so that the characteristics of the reclaimed sand can be controlled.

Other objects, features and advantages of the present invention will become apparent upon reading and understanding this specification, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cut-away view of a combination heat treating furnace and in-furnace sand reclamation unit, in accordance with the preferred embodiment of the present invention.

Fig. 2 is a cut-away view of selected elements of the sand reclamation unit of Fig. 1.

Fig. 3 is a cut-away top view of selected elements of the sand reclamation unit of Fig. 1, showing some of the elements that are cut-away in Fig. 1.

Fig. 4 is a cut-away top view of selected elements of the sand reclamation unit of Fig. 1, showing some of the elements that are cut-away in Fig. 1.

Fig. 5 is a cut-away side view of the discharge valve assembly of Fig. 1.

Fig. 6 is a cut-away top view of a portion of an in-furnace sand reclamation unit, in accordance with an alternate, preferred embodiment of the present invention.

Fig. 7 is a cut-away side view of a portion of the apparatus of Fig. 6.

Fig. 8 is a cross-sectional view of the fluidizer conduit of Fig. 6, taken along line 8-8 of Fig. 7.

Fig. 9 is a side view of an in-furnace sand reclamation unit, in accordance with an alternate, preferred embodiment of the present invention.

Fig. 10 is a detailed perspective view of the fluidizing ring of Fig. 9.

Fig. 11 is a cross-sectional view of the fluidizing ring of Fig 9, taken along line 11-11 of Fig. 10.

Fig. 12 is a cross-sectional view of the fluidizing ring of Fig 9, taken along line 12-12 of Fig. 11.

Fig. 13 is a cut-away view of a portion of an in-furnace sand reclamation unit, in accordance with an alternate embodiment of the present invention.

Fig. 14 is a cut-away view of a multi-zone embodiment of the heat treating furnace and in-furnace sand reclamation system, in accordance with the present invention.

Fig. 15 is an isolated side view of a supplemental sand reclamation unit which is part of an alternate embodiment of the present invention.

Fig. 16 is a cut-away, side view of the supplemental sand reclamation unit of Fig. 15 mounted on top of the combination heat treating furnace and in-furnace sand reclamation unit.

Fig. 17 is a cut-away view of the reclaimer hopper of Fig. 15.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

This section of the specification consists of two parts. The first part introduces components and describes their orientation and interconnections. The second part describes the operation of the components and provides some examples of acceptable components.

Referring now in greater detail to the drawings, in which like numerals represent like components throughout the several views, Fig. 1 shows a partially cut-away view of a combination heat treating furnace 19 and in-furnace sand reclamation unit 20, in accordance with the preferred embodiment of the present invention. The in-furnace sand reclamation unit 20 includes a hopper 30 which has a hopper wall 31 and defines a hopper inlet 33 and a hopper outlet 35. A portion of the hopper wall 31 and other elements are cut-away in Fig. 1 so that elements shown can be clearly seen. The in-furnace sand reclamation unit 20 further includes a fluidizer 40, guidance tube 80, abrasion disk 90 and a discharge valve assembly 100. The fluidizer 40 is shown passing through the hopper wall 31. The guidance tube 80 is shown oriented above the fluidizer within the hopper 30. The abrasion disk 90 is shown oriented above the guidance tube 80 within the hopper 30. The discharge valve assembly 100 is shown connected to the hopper outlet 35. In the preferred embodiment of the present invention, the hopper 30 of the in-furnace sand reclamation unit 20 doubles as the hopper 30 of the heat treating furnace 19. An appropriate heat treating furnace 19 is disclosed in application Serial No. 07/705,626. The specification of U.S. patent application Serial No. 07/705,626 is hereby incorporated herein by reference. The discharge valve assembly 100 provides a path to the outside of the furnace.

Fig. 2, which is a cut-away side view of selected elements of Fig. 1, shows the fluidizer 40 of the preferred embodiment of the present invention, in greater detail. Sand 25 is also shown, in representative form, collected at the hopper outlet 35. The fluidizer 40 is seen as including a fluidizer conduit 41; the fluidizer conduit 41 has a fluidizing end 42 that is within the hopper 30 and a source end 43 that is outside of the hopper 30. A portion of the fluidizer conduit 41 has been cut-away to expose a conduit interior 44 which is defined by the fluidizing conduit 41. The source end 43 of the fluid-

izer conduit 41 is sealed by an end plate 47. The end plate 47 is attached to the source end 43 in a manner that would be understood by those reasonably skilled in the industry; for example, by welding. A portion of the end plate 47 is cut away in Fig. 2, to fully expose a heater 60. The heater 60 is secured through the end plate 47 in a manner that facilitates removal for repair or replacement with a different type of heater. The heater 60 has an exhaust end 61 located within the conduit interior 44 and an intake end 62 outside of the fluidizer conduit 41. Pressurized air is supplied into the intake end 62 of the heater 60 through an air intake 65. In the preferred embodiment of the present invention, the heater 60 is a high pressure gas burner. In an alternate embodiment of the present invention, the heater 60 consists of an electric heating element. Other heater types are acceptable.

A signal generating pressure gauge 70 is connected to the fluidizer conduit 41 by a gauge conduit 71. This connection is such that the signal generating pressure gauge 70 is in communication with the conduit interior 44 and can sense the pressure within the fluidizer conduit 41. A signal adjuster 74 is associated with the signal generating pressure gauge 70. The signal generating pressure gauge 70 is connected to an electric power supply by a gauge power cable 72. The signal generating pressure gauge 70 is connected by a signal cable 73 to the discharge valve assembly 100, which is not shown in Fig. 2.

The fluidizer end 42 of the fluidizer conduit 41 is turned upward in Fig. 2 toward a the guidance tube 80 and the abrasion disk 90. The guidance tube 80, part of which is cut away in Fig. 2, has a tube wall 81 and defines a tube passage 82. The abrasion disk 90, part of which is cut away in Fig. 2, has disk back 92 and a concave disk face 91.

Fig. 3 is a top view of the apparatus of Fig. 2 in greater detail and with the abrasion disk 90 removed. As shown in Fig. 3, the guidance tube 80 is connected to tube support rods 85a,b which are connected to the hopper wall 31. These connections are made in a manner as would be understood by those reasonably skilled in the industry; for example, by welding or bolting. The guidance tube 80 is positioned such that the guidance tube 80 is oriented above the fluidizer end 42 of the fluidizer conduit 41 and the tube passage 82 is in-line with the conduit interior 44 at the fluidizer end 42.

Fig. 4 is a top view of the apparatus of Fig. 2 in greater detail. In Fig. 4 the disk face 91 of the abrasion disk 90 is oriented toward the fluidizer end 42 and is therefore not seen. As seen in Figs. 2 and 4, the abrasion disk 90 is connected to disk support cables 95 which are attached to the hopper wall 31. The cables 95 have a disk end 96, a hook end 97, and a turnbuckle 98 disposed between the disk end 96 and the hook end 97. The disk ends 96 of the cables 95 are attached to the abrasion disk 90 in a manner that would be understood by those reasonably skilled in the industry; for example, by welding or bolting. The hook end 97 of each cable 95 is attached to the inner hopper wall 31 by an eyehook 99; the hook ends 97 are hooked to eyehooks 99. The eyehooks 99 are connected to the hopper wall 31 in a manner that would be understood by those reasonably skilled in the industry; for example, by welding or bolting. There are a plurality of eyehooks 99, each of which is oriented so that the height of the abrasion disk 90 above the fluidizer end 42 is capable of being adjusted, as will be explained below. The fluidizer end 42, conduit interior 44, and guidance tube 80 are not seen in Fig. 4 because they are concealed by the abrasion disk 90.

Fig. 5 is a cut-away side view of the discharge valve assembly shown in Fig. 1. The discharge valve assembly 100 includes a double dump valve 110 and a pneumatic valve operator 130. The double dump valve 110 has a valve inlet 111 and a valve outlet 112. The valve inlet 111 is connected to the hopper outlet 35 (see Fig. 1) in a manner that would be understood by those reasonably skilled in the industry; for example, by welding or bolting. The valve outlet 112 is located outside of the heat treating furnace 19 such that the double dump valve 110 provides a path from within the hopper 30 to the outside of the furnace 19. A portion of the double dump valve 110 is cut away in Fig. 5 to expose a first disk 116, a second disk 117, a first seat 118, and a second seat 119. The pneumatic valve operator 130 is connected to the double dump valve 110, in a manner that is understood by those reasonably skilled in the art, such that the pneumatic valve operator 130 controls the operation of the double dump valve 110. The pneumatic valve operator 130 is connected to a pneumatic supply line 131 and the signal cable 73. In an alternate embodiment of the present invention, the pneumatic valve operator 130 is replaced with an electric, motorized valve operator; hydraulic valve operator; or some other type of valve operator.

Fig. 6 and Fig. 7 show an alternate, preferred embodiment of the present invention. Fig. 6 is a cut-away top view of portions of the present invention in accordance with the alternate embodiment. This alternate embodiment does not include the guidance tube 80 or abrasion disk 90. This alternate embodiment does include a fluidizer 40' which is somewhat similar to the fluidizer 40 of the preferred embodiment. However, the fluidizer 40' has a fluidizer conduit 41' that splits into three fluidizer conduits 41'a,b,c, each of which pass through the hopper wall 31. The fluidizer conduits 41'a,b,c originate from a conduit header 55. The conduit header 55 originates from the source end 43 of the fluidizer conduit 41'. Also, the fluidizer ends 43'a,b,c are sealed in a manner that would be understood by those reasonably skilled in the industry; for example, with a plug 50. Also, as is indicated by Fig. 7, which is a side view of the fluidizer 40' showing a portion of the hopper 30, each fluidizer conduit 41'a,b,c defines a plurality of fluidizing holes 51 that are oriented toward the hopper outlet 35. (In Fig. 7, two of the fluidizer conduits 41'b,c

are concealed by one of the fluidizer conduits 41'a.) Fig. 8 is a cross-sectional view taken along line 8 - 8 in Fig. 7; only one fluidizer conduit 41'a is shown for simplicity; the other conduits 41'b,c being similarly constructed. As seen in Fig. 8, the fluidizing holes are in communication with the conduit interior 44'. Also, in the embodiment shown in Figs. 7 and 8, the fluidizing holes 51 are spaced linearly and radially along the portion of the fluidizer conduit 41'a that faces the hopper outlet 35. Preferably, the angle between the center-lines 52 defined by two fluidizing holes 51 that are radially positioned with respect to one another is ninety degrees. In alternate embodiments of the present invention, the fluidizing holes 51 are spaced in a different manner.

Another alternate embodiment of the present invention, which is not shown, is similar to the previously disclosed alternate embodiment of Figs. 6-8, except that the fluidizer conduit 40 splits into six fluidizer conduits. Three of the six fluidizer conduits penetrate one furnace hopper 30 and the other three of the six fluidizer conduits penetrate a different furnace hopper 30. Actually, there are a variety of alternate embodiments of the present invention that are variations upon those just disclosed. Although not shown in Figs. 6 and 7, the signal generating pressure gauge 70, with all of its associated elements, is included in these alternate embodiments of the present invention.

Fig. 9 shows an alternate, preferred embodiment of the present invention which does not include the guidance tube 80 or the abrasion disk 90. In this alternate embodiment, a fluidizing ring 140 is disposed between the hopper outlet 35 and the valve inlet 111. The fluidizing ring 140 is connected to the hopper outlet 35 and the valve inlet 111 in a manner that would be understood by those reasonably skilled in the industry; for example, by welding or bolting. Also shown in Fig. 9 is a fluidizer conduit 41". The fluidizer conduit 41" defines a conduit interior 44" (not shown). The fluidizer conduit 41" has a fluidizing end 42", which is connected to the fluidizing ring 140, and a source end 43", into which pressurized air is supplied.

Fig. 10 is a detailed perspective view of the fluidizing ring 140 of Fig 9. The fluidizing ring 140 includes a hollow ring frame 141 which defines a ring interior 142 (see Fig. 11). The fluidizing ring 140 bounds an open area 145 that is in communication with the ring interior 142 by way of a plurality of fluidizing holes 146 that are defined by the ring frame 141. Only two of the fluidizing holes are labeled in Fig. 10 for simplicity. The ring frame 141 further defines a conduit connection hole 147. The ring frame 141 is connected at the conduit connector hole 147 to the fluidizing end 42" of the fluidizer conduit 41" such that the conduit interior 44" is in communication with the ring interior 142. This connection is made in a manner that would be understood by those reasonably skilled in the industry; for example, by welding.

Fig. 11 is a cross-sectional view taken along line 11 - 11 in Fig. 10. Fig. 11 shows the ring interior 142. Fig. 12 is a cross sectional view taken along line 12 - 12 in Fig. 11. Fig 12 shows one of the plurality of fluidizing holes 146 defined by the ring frame 141. The fluidizing holes 146 are angled steeply enough so that portions of sand core which pass through the open area 145 defined by the ring frame 141 cannot easily migrate up, through the fluidizing holes 146, into the ring interior 142.

In an alternate embodiment of the present invention, no signal generating pressure gauge 70 is included. As shown in Fig. 13, which is a cut-away view, this alternate embodiment of the present invention includes signal generating sensors 170a,b,c that are mounted within the hopper 30, to the hopper wall 31. The sensors 170a,b,c are mounted such that they detect a predetermined level of sand core in the hopper 30. Each signal generating sensor 170a,b,c is connected by signal cable 73' to the discharge valve assembly 100 (not shown in Fig. 13). A selector 171 is associated with the signal generating sensors 170a,b,c. In the preferred embodiment of this alternate embodiment, the signal generating sensors 170a,b,c are electric probes.

Fig. 14 shows a multi-zone embodiment of the present invention, which includes a multi-zone furnace 211 employing several embodiments of the in-furnace sand reclamation unit 20. An example of furnace 211 is disclosed in application Serial No. 07/705,626. As disclosed, in Fig. 14 hereof, the furnace 211 includes: a work chamber 215; zones 216A-H; furnace heaters 218; a pre-heat chamber 224; a furnace input door 225; a furnace upper end 226; a furnace discharge door 227; a furnace lower end 228; a roller hearth 234; rollers 236; baskets 240, for transporting castings; axial fans 244; a furnace top 245; screens 252; baffles 253; a sand conveyor 259; and a central collection bin 260. For a clear understanding of the furnace 211, please refer to application Serial No. 07/705,626, which has been incorporated into this specification. The furnace 211 further includes hoppers 30 and discharge valve assemblies 100. Zones 216A,B are equipped with the fluidizer 40 (see Figs. 1, 2, 3, and 4) guidance tube 80, and abrasion disk 60. The pre-heat chamber and Zone 216E are equipped with the fluidizer 40' (see Figs. 6, 7, and 8), and Zones 216F,G,H are equipped with the fluidizer 40" (see Figs. 9, 10, 11, and 12). Sand 25 is shown, in representative form, collected at the hopper outlet 35.

Fig. 15 shows a supplemental sand reclamation unit 180 which is part of an alternate embodiment of the present invention. The supplemental sand reclaiming unit 180 includes a reclaimer hopper 181 which has a reclaimer inlet 182, a reclaimer outlet 183, and a reclaimer wall 184. The supplemental sand reclamation unit 180 further includes a discharger 190 that has a discharger inlet 191 and a discharger outlet 192. In the preferred, alternate embodiment, the discharger 190 is a screw auger. The discharger inlet 191 is connected to the hopper outlet 183 in a manner that would be under-

stood by those reasonably skilled in the industry; for example, by welding or bolting. The supplemental sand reclamation unit 180 further includes a delivery tube 195 that defines a tube interior 199. The delivery tube 195 also has a tube inlet 196, a tube outlet 197, and an oxygen supply line 198 that is in communication with the tube interior 199. The tube inlet 196 is connected to the discharger outlet 192 in a manner that would be understood by those reasonably skilled in the industry; for example, by welding or bolting.

Fig. 16 is a cut-away view of the supplemental sand reclamation unit 180 of Fig. 15 mounted on top of the combination heat treating furnace 19 and in-furnace sand reclamation unit 20 in accordance with an alternate embodiment of the present invention. The reclaimer hopper 181 and discharger 190 are located outside of the heat treating furnace 19. The delivery tube 195 penetrates the heat treating furnace 19 and is in close proximity to u-tube furnace heaters 218'. The tube outlet 197 is oriented toward the hopper inlet 33.

Fig. 17 is a cut-away view of the reclaimer hopper 181 of Fig. 15. A portion of the reclaimer wall 184 is cut-away to show a reclaimer interior 185 that is defined by the reclaimer wall 184. Included within the reclaimer interior 185 are heaters 186, oxygen suppliers 187 and a level indicator 188. The reclaimer hopper 181 also includes a recycle exhaust duct 189 that exhausts into the heat treating furnace 19 and a baghouse exhaust duct 198.

OPERATION

Referring back to Figs. 1 and 14, as the casting, with sand core attached thereto, is acted upon in accordance with the method and apparatus disclosed in application Serial No. 07/705,626, portions of sand and sand core fall through the hopper inlet 33 and sand collects within the hopper 30 toward the hopper outlet. Before a defined level of sand accumulates in the hopper 30, the first disk 116 and second disk 117 within the double dump valve 110 are maintained in contact with the first seat 118 and second seat 119, respectively. Therefore, as portions of sand and sand core continue to fall through the hopper inlet 33, the level of sand core within the hopper 30 increases.

Figs. 1, 2, 3, and 4 disclose the first, preferred embodiment of the present invention. The equipment and process that are at the heart of the first, preferred embodiment are referred to as "high temperature fluidization with a target". In this embodiment, pressurized air is supplied through the air intake 65. Oxygenated and heated exhaust from the heater 60 discharges from the fluidizer end 42 of the fluidizer conduit 41. As the level of sand rises above the level of the fluidizer end 42, fluidization begins; the oxygenated and heated exhaust fluidizes portions of sand core that are above the fluidizer end 42. That is, the exhaust passes up through the sand, causing the sand to be suspended and act like a turbulent fluid. The fluidization further propels portions of sand through the guidance tube passage 82 where the trajectory of the entrained portions of sand is oriented toward the disk face 91 of the abrasion disk 90. Portions of sand contact the abrasion disk 90 and fall back toward the fluidizer end 42 where they are further fluidized. The portions of sand that are fluidized abrade against each other and the disk face 91. The abrasion caused by this process knocks away ash that is adhered to the sand. This exposes unburned binder and thus promotes binder combustion. In addition to promoting binder combustion by exposing unburned binder, the fluidizer 40 promotes combustion by providing a hot and oxygenated environment. Thus, the exposed binder combusts to promote purification of the sand reclaimed from the sand core. Since the "high temperature fluidization with a target" incorporates a variety of techniques to reclaim sand (which include, at least, fluidization, fluidization in combination with an abrasion disk, heating to promote combustion, and oxygenating to promote combustion) it has a relatively high capacity as compared the processes referred to below.

Some alternate embodiments of the present invention, one of which is shown in Figs. 6, 7, and 8, are referred to as "hot fluidization". "Hot fluidization" does not propel portions of sand core toward a target. However, "hot fluidization" is otherwise similar to "hot fluidization with a target". Pressurized air is supplied through the air intake 65. Oxygenated and heated exhaust from the heater 60 discharges from the fluidizer holes 51. As the level of sand approaches the level of the fluidizing holes 51, fluidization begins. Fluidization is promoted and enhanced by the placement and orientation of the fluidizing holes 51. The portions of sand that are fluidized abrade against each other. The abrasion caused by this process knocks away ash that is adhered to the sand. This exposes unburned binder and thus promotes binder combustion. In addition to promoting binder combustion by exposing unburned binder, the fluidizer 40' promotes combustion by providing a hot and oxygenated environment. Thus, the exposed binder combusts to promote purification of the sand reclaimed from the sand core. Since "hot fluidization" does not utilize a target, it does not typically cause as much abrasion as "hot fluidization with a target". Thus, "hot fluidization" typically exposes less binder than and therefore causes less combustion than "hot fluidization with a target". Therefore, "hot fluidization" typically has less capacity than "hot fluidization with a target". Thus, "hot fluidization with a target" is used where relatively large portions of sand and sand core fall through the hopper inlet 33 and "hot fluidization" is used where relatively moderate portions of sand and sand core fall through the hopper inlet 33.

Other alternate embodiments of the present invention, one of which is shown in Figs. 9, 10, 11, and 12, are referred to as "cool fluidization". "Cool fluidization" is somewhat similar to "hot fluidization" except that it does

not incorporate heating. Pressurized air is supplied to the source end 43" of the fluidizer conduit 41". The pressurized air passes into the ring interior 142 by way of the fluidizer end 42" of the fluidizer conduit 41" and the conduit connection hole 147. The pressurized air then escapes from the fluidizing ring 140 through the fluidizing holes 146. As the level of sand rises above the fluidizing holes 146, fluidization begins. The portions of sand that are fluidized abrade against each other. The abrasion caused by this process knocks away ash that is adhered to the sand. This exposes unburned binder and thus promotes binder combustion. In addition to promoting binder combustion by exposing unburned binder, the fluidizer 40" promotes combustion by providing added oxygen to the environment (the heat necessary for combustion is provided by the heat treating furnace 19). Thus, the exposed binder combusts to promote purification of the sand reclaimed from the sand core. Since "cool fluidization" does not add heat to promote combustion, it does not typically cause as much combustion as "hot fluidization". Therefore, "cool fluidization" typically has less capacity than "hot fluidization". Thus, "cool fluidization" is used where relatively small portions of relatively clean sand fall through the hopper inlet 33. "Cool fluidization", in addition to reclaiming sand, cools portions of sand before they pass through the double dump valve 110. This protects the double dump valve 110 from heat related stress and strain and allows for the use of a less expensive double dump valve 110.

As specified above, the different embodiments of the present invention have different capacities. As specified in application Serial No. 07/705,626, different zones 216 (see Fig. 14) within a continuous-process furnace 211 have different capacities for loosening sand core from castings. Therefore, it is necessary to reclaim more sand in some zones 216 and less from others. In accordance with one multi-zone embodiment of the present invention, as shown in Fig. 14, higher capacity embodiments of the in-furnace sand reclamation unit 20 (for example Figs. 1 - 4) are employed in high capacity zones 216A,B; moderate capacity embodiments of the in-furnace sand reclamation unit 20 (for example Figs. 6 - 8) are employed in the pre-heat chamber 224 and moderate capacity zones 216E; and lower capacity embodiments of the in-furnace sand reclamation unit 20 (for example Figs. 9 - 12) are employed in lower capacity zones 216F,G,H of the furnace 211. Likewise, it is preferred to employ higher capacity embodiments of the present invention in higher capacity batch-type furnaces and lower capacity embodiments of the present invention in lower capacity batch-type furnaces.

In several embodiments of the present invention, the signal generating pressure gauge 70 and the equipment associated with it, serves to provide positive control over the level, and therefore the volume, of sand that accumulates within the hopper 30 (refer to Figs. 2 and 9). As portions of sand continue to fall through the hopper inlet 33, the level of sand within the hopper 30 increases. As the level increases there is more resistance to the flow of air from the fluidizer end of the conduit 42 and the back-pressure in the fluidizer conduit 41 increases. The signal adjuster 74 associated with the signal generating pressure gauge 70 is set such that when a certain back-pressure is detected within the conduit interior 44 by the signal generating pressure gauge 70, a "high level" signal is generated. The pneumatic valve operator 140 receives the "high level" signal by way of the signal cable 73. While the pneumatic valve operator 140 receives the signal it operates the double dump valve 120. The double dump valve 120 is operated such that the first disk 126 and second disk 127 alternately move away from and then return to the first seat 118 and second seat 119, respectively. This operation is such that while the first disk 116 is not in contact with the first seat 118, the second disk 117 is in contact with the second seat 119, and visa-versa. Thus, while the double dump valve 110 is operating and sand is flowing from within the hopper 30 to outside of the heat treating furnace 19 by way of the double dump valve 110, back-pressure is maintained at the hopper outlet 35 such that fluidization is not disrupted. It is important that back-pressure is maintained at the hopper outlet 35 because the pressurized air that is being supplied through the fluidizer conduit 41 will take the path of least resistance. If both the first disk 116 and the second disk 117 where off of their seats, and there was a level of sand within the hopper, the path of least resistance would be through the doubled dump valve 110 to the atmosphere outside of the furnace. Therefore, the pressurized air would flow through the double dump valve 110 rather than forcing its way up through the sand accumulated in the hopper. In an alternate embodiment of the present invention, the double dump valve 110 is replaced with a star valve or screw auger, or another type of device that performs a discharging and a sealing function.

In alternate embodiments of the present invention, signal generating sensors 170, mounted to the hopper wall 31 (see Fig. 13), serve to provide positive control over the level, and therefore the volume, of sand that accumulates within the hopper 30. In one embodiment the signal generating sensors 170 consist of electric capacitance probes. An electric capacitance probe is mounted to the hopper wall at each position that corresponds to a level at which it is desired to operate the double dump valve 110. The particular level at which the double dump valve will operate is established by operating the selector 171 which establishes which electric probe is controlling. As the level of sand increases and comes into contact with the controlling electric probe, a "high level" signal is generated. The pneumatic valve operator 140 receives the "high level" signal by way of the signal cable 73'. When the pneumatic valve operator 140 receives the signal it operates the double dump valve 110 as is disclosed above.

The characteristics of reclaimed sand are controlled by controlling the dwell time of portions of sand within the hopper 30. The longer the dwell time, the longer the amount of time that the portions of sand are fluidized. When portions of binder coated sand are fluidized for a relatively longer period of time, less binder is contained in the reclaimed sand but more fines are contained in the reclaimed sand. When portions of binder coated sand are fluidized for a relatively shorter period of time, more binder is contained in the reclaimed sand but less fines are contained in the reclaimed sand. The dwell time is controlled by controlling the volume of sand that is allowed to accumulate in the hopper 30. The greater the volume of sand allowed to accumulate in the hopper 30, the greater the dwell time (assuming a constant input of sand). The volume of sand that is allowed to accumulate in the hopper 30 is selected by adjusting the signal adjuster 74 in the one disclosed preferred embodiment of the present invention or by adjusting the selector 171 in the second disclosed embodiment of the present invention. In the embodiment which includes the signal generating pressure gauge 70, a larger volume of sand accumulates in the hopper 30 when the signal adjuster 74 is adjusted so that the signal generating pressure gauge 70 emits a "high level" signal at a higher pressure. A smaller volume of sand accumulates in the hopper 30 when the signal adjuster 74 is adjusted so that the signal generating pressure gauge 70 emits a "high level" signal at a lower pressure. In the embodiment which includes signal generating sensors 170 a larger or smaller volume of sand is allowed to accumulate in the hopper 30 by adjusting the selector 171 to select the signal generating sensor 170 that is mounted at the level that corresponds to the desired volume.

Referring back to Figs. 2 and 4, the characteristics of the reclaimed sand are also controlled, in the preferred embodiment of the present invention, by adjusting the height of the abrasion disk 90 above the fluidizer end 42 of the fluidizer conduit 41. The height is adjusted by loosening the turnbuckles 98, unhooking the hook ends 97 from the eyehooks 99, hooking the hook ends 97 to the appropriate eyehooks 99, and tightening the turnbuckles 98. These components can be accessed by entering the hopper 30 through the furnace 19 or through trap doors in the hopper wall 31. Generally, when the height of the abrasion disk 90 is decreased more abrasion occurs because propelled portions of sand impact the abrasion disk 90 with more force; therefore, less binder is contained in the reclaimed sand and more fines are contained in the reclaimed sand. Generally, when the height is increased less abrasion occurs because propelled portions of sand impact the abrasion disk 90 with less force; therefore, more binder is contained in the reclaimed sand and less fines are contained in the reclaimed sand.

Referring back to Figs. 15-17, the supplemental sand reclamation unit 180 is used, in conjunction with the fluidizer 40 and other components in the heat treating furnace 19, to further purify sand that has already been reclaimed by some other process, and to reclaim sand from portions of sand core initially reclaimed by another process. The portions of sand core and coated sand that are introduced into the supplemental sand reclamation unit 180 are not adhered to castings. For example only, if a core was accidently molded into the wrong shape such that it could not be used for casting, it could be crushed and the portions thereof could be introduced into the supplemental sand reclamation unit 180. Portions of sand core and coated sand are introduced into the supplemental sand reclamation unit 180 through the reclaimer inlet 182. The heaters 186 and oxygen suppliers 187 maintain an atmosphere within the reclaimer interior 185 that causes some of the binder associated with the introduced sand and portions sand core to combust such that sand is reclaimed within the reclaimer hopper 181. The reclaimed sand is transferred from the reclaimer hopper 181 to the delivery tube 195 by the discharger 190. The sand within the delivery tube 195 is drawn by gravity from the tube inlet 196 toward the tube outlet 197. The sand in the delivery tube 195 is heated due to the fact that the delivery tube 195 is in close proximity to u-tube furnace heaters 218'. The sand in the delivery tube 195 is also exposed to oxygen that is supplied through the oxygen supply line 198. Therefore, at least some exposed binder that passes through the delivery tube 195 is combusted. As sand passes from the tube outlet 197 it falls into the hopper 30 where it is further purified by fluidization, as is discussed above.

The embodiments of the present invention can be constructed from a variety of materials and include a variety of components. The following is offered for example only. The hopper 30, guidance tube 80, and abrasion disk could be made out of various abrasion resistant alloys. More specifically, the hopper 30 and guidance tube 80 could be made out of 4130, 4140 or 1020 steel, and the abrasion disk 90 could be made out of a cast high manganese alloy. The fluidizing ring 140 could be constructed of A36 structural steel square tubing. The high pressure burner, which serves as the heater 60 in one embodiment of the present invention, could be an Eclipse brand. The signal generating pressure gauge 70 could be a Dwyer brand photoelectric gauge. The electric capacitance probes, that serve as the signal generating sensors 170 in one embodiment of the present invention, and the level indicator 188 could be an Endress Hauser brand, LSC 1110 Series capacitance probe. A low voltage is applied to these probes, and when the probe comes into contact with some material (for example sand) current flows into the material and the probe senses the current flow. The double dump valve 110 could be a Ni-Hard and nickel chrome alloy high temperature double dump valve made by Plattco Corporation. The Fluidizer conduit 41 can be constructed from stainless steel. The heater 186 could be a National brand silicon carbide heating ele-

ment.

Whereas this invention has been described in detail with particular reference to preferred embodiments and alternate embodiments thereof, it will be understood that variations and modifications can be effected within the scope of the invention, as defined in the appended claims.

Claims

1. A method for heat treating a casting with sand core, comprising sand bound by a combustible binder, attached thereto and for reclaiming sand from the sand core, characterised by the following steps:

   introducing the casting into a furnace (19);
   heating the furnace (19) such that portions of sand core are loosened from the casting; and
   agitating the loosened portions of sand core within the furnace (19).

2. The method according to claim 1, further comprising the steps of:

   exposing loosened portions of sand core to an oxygenated atmosphere; and
   abrading combustion by-products off of loosened portions of sand core, whereby binder of loosened portions of sand core is exposed to the oxygenated atmosphere and is combusted.

3. The method according to claim 1 or 2, further comprising the step of:

   causing loosened portions of sand core to abrade against each other.

4. The method according to at least one of the preceding claims, further comprising the step of:

   fluidizing loosened portions of sand core.

5. The method according to claim 4, comprising the step of:

   causing loosened portions of sand core to be suspended and act like a turbulent fluid.

6. The method according to at least one of the preceding claims, further comprising the steps of:

   discharging reclaimed sand from the furnace (19); and selectively controlling the dwell time by controlling the volume of sand that is allowed to accumulate in the hopper (30).

7. The method according to at least one of the preceding claims, further comprising the steps of:

   discharging reclaimed sand from the furnace (19); and
   selectively controlling the characteristics of the reclaimed sand by adjusting the height of an abrasion disc (90) above a fluidizer end (42) of a fluidizer conduit (41).

8. The method according to at least one of the preceding claims, further comprising the steps of:

   controlling the discharging by determining the quantity of portions of sand core collected in the furnace (19);
   initiating said step of discharging when a predetermined quantity of portions of sand core is collected in the furnace (19).

9. The method according to at least one of the preceding claims, further comprising the steps of:

   introducing unattached portions of sand core into the furnace (19), wherein the unattached portions of sand core are not attached to the casting; and
   reclaiming sand of loosened portions of sand core and sand of unattached portions of sand core within said furnace (19), wherein said step of reclaiming includes at least, agitating the portions of sand core.

10. An apparatus for heat treating a casting with sand core, comprising sand bound with a combustible binder, attached thereto and for reclaiming sand from the sand core, characterised in:

    a furnace (19) for receiving a casting therein;
    furnace heating means for heating said furnace (19) and loosened portions of sand core; and
    means (40) for agitating portions of sand core within said furnace (19).

11. The apparatus according to claim 10, further characterised in a supplemental sand reclamation assembly (20), including at least,

    a reclaimer hopper (30), defining a hollow hopper interior, wherein said hopper (30) includes at least,
    a hopper inlet (33), through which portions of sand core are deposited into the hopper interior; and
    a hopper outlet (35) from which partially reclaimed portions of said core pass out of said hopper interior, means (40, 80, 90) for partially reclaiming portions of sand core within the hopper interior, and
    discharge means (100, 110), connected to said hopper outlet (35), for ejecting partially

reclaimed portions of sand core.

12. The apparatus according to claim 10 or 11, characterised in

that said means for reclaiming (40, 80, 90) within said furnace (19) includes at least a fluidizer (40).

13. The apparatus according to claim 12, characterised in

that the fluidizer (40) includes a source of pressurized air, and a fluidizer conduit (41) which defines a hollow conduit interior (44), wherein said fluidizer conduit (41) extends from a first end (43) that is in communication with said source of gas and terminates at a second end (42) in a manner that causes loosened portions of sand core to be

fluidized within said furnace (19).

14. The apparatus according to claim 13, characterised in

a fluidizing ring (140) connected to said second end (42) of said fluidizer conduit (41), wherein said fluidizing ring (140) includes a ring frame (141) at least partially bounding a central open area (145) and defining, a hollow ring interior (142) in communication with the conduit interior (44) of said fluidizer conduit (41), and a plurality of fluidizing holes (146) communicating between the central open area (145) and the ring interior (142) for fluidizing the portions of sand core that fall into said hopper inlet (33) and tend to accumulate toward said hopper outlet (35).

15. The apparatus according to at least one of claims 10 to 14, characterised in that

said means (40, 80, 90) for reclaiming further includes an abrasion disc (90) within said furnace (19), wherein said fluidizer (40) and said abrasion disc (90) are constructed and oriented such that loosened portions of sand core are propelled by said fluidizer (40) toward said abrasion disc (90) such that loosened portions of sand core contact said abrasion disc (90) in a manner that contributes to the reclaiming of sand.

16. The apparatus according to claim 15, characterised in that

said means for reclaiming further includes a guidance tube (80) defining a guidance passage (82) therethrough and oriented between said second end (42) of said fluidizer conduit (41) and said abrasion disc (90) such that loosened portions of sand core are propelled by said fluidizer (40) into the guidance passage (82) where loosened portions of sand core are directed towards said abrasion disc (90).

17. The apparatus according to at least one of claims 10 to 16, characterised in

dwell means for selectively controlling said discharge means (100, 110), including measurement means (74, 171) for determining the amount of portions of sand core collected within the hopper interior, and
signal means (70, 170) for generating a signal when said measurement means (74, 171) determines that a predetermined amount of portions of sand core is within the hopper interior, wherein said discharge means (100, 110) is responsive to said signal of said signal means (70, 170) to effect discharge of portions of sand core, wherein portions of sand core pass from the hopper interior and are discharged from said furnace (19).

18. The apparatus according to at least one of claims 10 to 17, characterised in

a screw auger disposed between said discharge means (100, 110) and said hopper outlet (35).

Patentansprüche

1. Verfahren zur Wärmebehandlung eines Gußstücks mit einem daran anhaftenden Sandkern, der mit einem ausbrennbaren Bindemittel gebundenen Sand umfaßt, sowie zur Rückgewinnung von Sand aus dem Sandkern, gekennzeichnet durch folgende Verfahrensschritte:

Einführen des Gußstücks in einen Ofen (19);
Erhitzen des Ofens (19), so daß Teile des Sandkerns vom Gußstück losgelöst werden; und
Durchschütteln der losgelösten Sandkernteile innerhalb des Ofens (19).

2. Verfahren nach Anspruch 1, des weiteren umfassend folgende Schritte:

Aussetzen von losgelösten Teilen des Sandkerns einer sauerstoffangereicherten Atmosphäre; und
Abtragen von Verbrennungs-Nebenprodukten

von den losgelösten Sandkernteilen, wodurch das in den losgelösten Sandkernteilen enthaltene Bindemittel der sauerstoffangereicherten Atmosphäre ausgesetzt und verbrannt wird.

3. Verfahren nach Anspruch 1 oder 2, des weiteren umfassend folgenden Verfahrensschritt:

Bewirken, daß losgelöste Sandkernteile einander durch Reibung abtragen.

4. Verfahren nach wenigstens einem der voranstehenden Ansprüche, weiterhin umfassend den Verfahrensschritt des Fluidisierens bzw. Wirbelns losgelöster Sandkernteile.

5. Verfahren nach Anspruch 4, umfassend den Verfahrensschritt des Bewirkens, daß losgelöste Sandkernteile schwebend gehalten werden und wie ein turbulentes Strömungsmedium wirken.

6. Verfahren nach wenigstens einem der voranstehenden Ansprüche, des weiteren umfassend folgende Verfahrensschritte:

Ausleiten von zurückgewonnenem Sand aus dem Ofen (19); und
selektives Steuern der Verweilzeit durch Regeln des Sandvolumens, das sich im Trichter (30) akkumulieren darf.

7. Verfahren nach wenigstens einem der voranstehenden Ansprüche, des weiteren folgende Schritte umfassend:

Ausleiten von zurückgewonnenem Sand aus dem Ofen (19); und
selektives Steuern der Charakteristiken des rückgewonnenen Sandes durch Einstellen der Höhe einer Abrasionsscheibe (90) über einem Fluidisiererende (42) eines Fluidisiererrohrs (41).

8. Verfahren nach wenigstens einem der voranstehenden Ansprüche, des weiteren folgende Schritte umfassend:

Steuern des Ausleitens durch Bestimmen der Menge der im Ofen (19) angesammelten Sandkernteile;
Initiieren dieses Ausleiteschrittes, wenn sich eine vorbestimmte Menge von Sandkernteile im Ofen (19) angesammelt hat.

9. Verfahren nach wenigstens einem der voranstehenden Ansprüche, des weiteren folgende Schritte umfassend:

Einleiten von nicht anhaftenden Sandkernteilen in den Ofen (19), wobei die nicht anhaftenden Sandkernteile nicht am Gußstück anhaften; und
Rückgewinnen von Sand aus losgelösten Sandkernteilen und Sand aus nicht anhaftenden Sandkernteilen innerhalb des Ofens (19), wobei der Schritt des Rückgewinnens wenigstens das Durchschütteln der Sandkernteile einschließt.

10. Vorrichtung zur Wärmebehandlung eines Gußstücks mit einem daran anhaftenden Sandkern, der mit einem ausbrennbaren Bindemittel gebundenen Sand umfaßt, sowie zur Rückgewinnung von Sand aus dem Sandkern, gekennzeichnet durch:

einen Ofen (19) zur Aufnahme eines Gußstücks darin;
eine Ofenheizvorrichtung zum Aufheizen des Ofens (19) sowie losgelöster Sandkernteile; und
eine Vorrichtung (40) zum Durchschütteln von Sandkernteilen innerhalb des Ofens (19).

11. Vorrichtung nach Anspruch 10, des weiteren gekennzeichnet durch einen zusätzlichen Sandrückgewinnungsaufbau (20), welcher mindestens folgendes einschließt:

einen Rückgewinnungstrichter (30) mit einem hohlen Trichterinneren, wobei der Trichter (30) mindestens aus folgendem besteht:

einem Trichtereinlaß (33), durch den Sandkernteile im Trichterinneren abgelagert werden; und
einem Trichterauslaß (35), aus dem teilweise rückgewonnene Sandkernteile aus dem Trichterinneren austreten, einer Vorrichtung (40, 80, 90) zum teilweisen Rückgewinnen von Sandkernteilen im Inneren des Trichters; und
einer mit dem Trichterauslaß (35) verbundenen Ausleitvorrichtung (100, 110), zum Ausleiten der teilweise zurückgewonnenen Sandkernteile.

12. Vorrichtung nach Anspruch 10 oder 11, dadurch gekennzeichnet, daß die Vorrichtung zum Rückgewinnen (40, 80, 90) innerhalb des Ofens (19) mindestens einen Fluidisierer (40) umfaßt.

13. Vorrichtung nach Anspruch 12, dadurch gekennzeichnet, daß der Fluidisierer (40) eine Druckluftquelle einschließt, und ein Fluidisiererrohr (41), das ein hohles Rohrinneres (44) definiert, wobei das Fluidisiererrohr (41) auf eine Art und Weise von

einem ersten Ende (43), das mit der Gasquelle verbunden ist, zu einem zweiten Ende (42) verläuft, daß losgelöste Sandkernteile im Inneren des Ofens (19) fluidisiert werden.

14. Vorrichtung nach Anspruch 13, gekennzeichnet durch einen mit dem zweiten Ende (42) des Fluidisiererrohrs (41) verbundenen Fluidisiererring (140), wobei dieser Fluidisiererring (140) einen Ringrahmen (141) aufweist, der zumindest teilweise an einen zentralen offenen Bereich (145) angrenzt und ein hohles Ringinneres (142) definiert, das mit dem Rohrinneren (44) des Fluidisiererrohrs (41) in Verbindung steht, und eine Vielzahl von Fluidisiereröffnungen (146), die zwischen dem zentralen offenen Bereich (145) und dem Ringinneren (142) in Verbindung stehen, um die Sandkernteile zu fluidisieren, die in den Trichtereinlaß (33) fallen und dazu tendieren, sich zum Trichterauslaß (35) hin anzusammeln.

15. Vorrichtung nach mindestens einem der Ansprüche 10 bis 14, dadurch gekennzeichnet, daß

die Vorrichtung (40, 80, 90) zum Rückgewinnen des weiteren eine Abrasionsscheibe (90) im Inneren des Ofens (19) enthält, wobei der Fluidisierer (40) und die Abrasionsscheibe (90) derart aufgebaut und ausgerichtet sind, daß losgelöste Sandkernteile vom Fluidisierer (40) derart zur Abrasionsscheibe (90) hin getrieben werden, daß losgelöste Sandkernteile die Abrasionsscheibe (90) auf eine Weise kontaktieren, die zur Sandrückgewinnung beiträgt.

16. Vorrichtung nach Anspruch 15, dadurch gekennzeichnet, daß

die Vorrichtung zur Rückgewinnung ein Führungsrohr (80) umfaßt, das einen Führungsdurchlaß (82) durch dieses hindurch definiert und derart zwischen dem zweiten Ende (42) des Fluidisiererrohrs (41) und der Abrasionsscheibe (90) ausgerichtet ist, daß losgelöste Sandkernteile vom Fluidisierer (40) in den Führungsdurchlaß (82) getrieben werden, wo losgelöste Sandkernteile zur Abrasionsscheibe (90) hin geleitet werden.

17. Vorrichtung nach mindestens einem der Ansprüche 10 bis 16, gekennzeichnet durch

Verweilvorrichtungen zum selektiven Steuern der Ausleitvorrichtung (100, 110), einschließlich einer Meßvorrichtung (74, 171) zum Bestimmen der Menge der Sandkernteile, die sich im Trichterinneren angesammelt hat, und eine Signalvorrichtung (70, 170) zum Erzeugen eines Signals, wenn die Meßvorrichtung (74, 171) bestimmt, daß sich eine vorbestimmte Menge von Sandkernteilen im Trichterinneren befindet, wobei die Auslaßvorrichtung (100, 110) auf das Signal von der Signalvorrichtung (70, 170) anspricht, um das Ausleiten von Sandkernteilen zu bewirken, wobei Sandkernteile aus dem Trichterinneren heraus verlaufen und aus dem Ofen (19) ausgeleitet werden.

18. Vorrichtung nach mindestens einem der Ansprüche 10 bis 17, dadurch gekennzeichnet, daß

zwischen der Ausleitvorrichtung (100, 110) und dem Trichterauslaß (35) ein Schneckenbohrer angeordnet ist.

Revendications

1. Procédé de traitement thermique d'une pièce moulée à noyau de sable, constitué de sable lié par un liant combustible et attaché à la pièce moulée, et de récupération du sable à partir du noyau de sable, caractérisé en ce qu'il comprend les étapes consistant à introduire la pièce moulée dans un four (19), à chauffer le four (19) de telle façon que des portions du noyau de sable soient détachées de la pièce moulée, et à agiter les portions de noyau de sable détachées à l'intérieur du four (19).

2. Procédé suivant la revendication 1 caractérisé en ce qu'il comprend en outre les étapes consistant à exposer les portions de noyau de sable détachées à une atmosphère oxygénée et à éroder les sous-produits de combustion des portions de noyau de sable détachées de telle façon que le liant des portions de noyau de sable détachées soit exposé à l'atmosphère oxygénée et brûlé.

3. Procédé suivant l'une quelconque des revendications 1 ou 2 caractérisé en ce qu'il comprend en outre l'étape consistant à amener les portions de noyau de sable détachées à s'éroder les unes contres les autres.

4. Procédé suivant l'une au moins des revendications précédentes caractérisé en ce qu'il comprend en outre l'étape consistant à fluidiser des portions de noyau de sable détachées.

5. Procédé suivant la revendication 4 caractérisé en ce qu'il comprend l'étape consistant à amener les portions de noyau de sable détachées à être mises en suspension et à se comporter comme un fluide turbulent.

6. Procédé suivant l'une au moins des revendications précédentes caractérisé en ce qu'il comprend en

outre les étapes consistant à décharger le sable récupéré à partir du four (19) et à commander sélectivement le temps de séjour en commandant le volume de sable qui est autorisé à s'accumuler dans la trémie (30).

7. Procédé suivant l'une au moins des revendications précédentes caractérisé en ce qu'il comprend en outre les étapes consistant à décharger le sable récupéré à partir du four (19) et à commander sélectivement les caractéristiques du sable récupéré en réglant la hauteur d'un disque d'abrasion (90) au-dessus d'une extrémité de fluidisation (42) d'un conduit de fluidisation (41).

8. Procédé suivant l'une au moins des revendications précédentes caractérisé en ce qu'il comprend en outre les étapes consistant à commander le déchargement en déterminant la quantité de portions de noyau de sable détachées collectée dans le four (19) et à faire démarrer cette étape de déchargement lorsqu'une quantité prédéterminée de portions de noyau de sable détachées est collectée dans le four (19).

9. Procédé suivant l'une au moins des revendications précédentes caractérisé en ce qu'il comprend en outre les étapes consistant à traduire des portions de noyau de sable non attachées dans le four (19), ces portions de noyau de sable non attachées n'étant pas attachées à la pièce moulée, et à récupérer le sable des portions de noyau de sable détachées et le sable des portions de noyau de sable non attachées dans le four (19), cette étape de récupération comportant au moins une agitation des portions de noyau de sable.

10. Appareil pour traiter thermiquement une pièce moulée à noyau de sable, comprenant du sable lié au moyen d'un liant combustible et attaché à la pièce moulée, et pour récupérer le sable à partir du noyau de sable, caractérisé en ce qu'il comprend un four (19) pour recevoir une pièce moulée à l'intérieur du four, un moyen de chauffage du four pour chauffer le four (19) et des portions de noyau de sable détachées, et un moyen (40) pour agiter des portions de noyau de sable à l'intérieur du four (19).

11. Appareil suivant la revendication 10 caractérisé en ce qu'il comprend un ensemble de récupération supplémentaire du sable (20) comportant au moins une trémie de récupération (30), définissant un intérieur creux de la trémie, la trémie (30) comportant au moins un orifice d'entrée (33) de la trémie, à travers lequel des portions de noyau de sable sont déposées à l'intérieur de la trémie, et un orifice de sortie (35) de la trémie à partir duquel des portions partiellement récupérées du noyau de sable sortent de l'intérieur de la trémie, des moyens (40,80,90) pour récupérer partiellement des portions de noyau de sable à l'intérieur de la trémie, et des moyens de décharge (100,110) connectés à l'orifice de sortie (35) de la trémie, afin d'éjecter des portions de noyau de sable récupérées partiellement.

12. Appareil suivant l'une quelconque des revendications 10 ou 11 caractérisé en ce que les moyens de récupération (40,80,90) à l'intérieur du four (19) comportent au moins un dispositif de fluidisation (40).

13. Appareil suivant la revendication 12 caractérisé en ce que le dispositif de fluidisation (40) comporte une source d'air sous pression et un conduit de fluidisation (41) qui définit un intérieur creux (44) du conduit, le conduit de fluidisation (41) s'étendant à partir d'une première extrémité (43) qui est en communication avec la source de gaz et se terminant à une seconde extrémité (42) d'une façon qui amène les portions de noyau de sable détachées à être fluidisées à l'intérieur du four (19).

14. Appareil suivant la revendication 13 caractérisé en ce qu'il comporte un anneau de fluidisation (140) connecté à la seconde extrémité (42) du conduit de fluidisation (41), cet anneau de fluidisation (140) comportant un cadre annulaire (141) délimitant au moins partiellement une aire ouverte centrale (145) et définissant un intérieur creux (142) de l'anneau en communication avec l'intérieur (44) du conduit de fluidisation (41), et une pluralité de trous de fluidisation (146) établissant une communication entre l'aire ouverte centrale (145) et l'intérieur (142) de l'anneau, afin de fluidiser les portions de noyau de sable qui tombent dans l'orifice d'entrée (33) de la trémie et tendent à s'accumuler vers l'orifice de sortie (35) de la trémie.

15. Appareil suivant l'une au moins des revendications 10 à 14 caractérisé en ce que les moyens (40,80,90) de récupération comportent en outre un disque d'abrasion (90) à l'intérieur du four (19), le dispositif de fluidisation (40) et le disque d'abrasion (90) étant construits et orientés de telle façon que des portions de noyau de sable détachées soient propulsées par le dispositif de fluidisation (40) en direction du disque d'abrasion (90) si bien que les portions de noyau de sable détachées viennent en contact avec le disque d'abrasion (90) d'une façon qui contribue à la récupération du sable.

16. Appareil suivant la revendication 15 caractérisé en ce que les moyens de récupération comportent en outre un tube de guidage (80) définissant à travers lui un passage de guidage (82) et orienté entre la seconde extrémité (42) du conduit de fluidisation

(41) et le disque d'abrasion (90) de telle façon que des portions de noyau de sable détachées soient propulsées par le dispositif de fluidisation (40) vers et dans le passage de guidage (82) où les portions de noyau de sable détachées sont dirigées vers le disque d'abrasion (90).

17. Appareil suivant l'une au moins des revendications 10 à 16 caractérisé en ce qu'il comporte un moyen de contrôle du temps de séjour afin de commander sélectivement les moyens de décharge (100,110), ce moyen comportant des moyens de mesure (74,171) pour déterminer la quantité de portions de noyau de sable collectées à l'intérieur de la trémie, et des moyens générateurs de signaux (70,170) pour produire un signal lorsque les moyens de mesure (74,171) déterminent qu'une quantité prédéterminée de portions de noyau de sable se trouve à l'intérieur de la trémie, les moyens de décharge (100,110) répondant au signal émis par les moyens générateurs de signaux (70,170) en effectuant un déchargement des portions de noyau de sable, ces portions de noyau de sable s'écoulant à partir de l'intérieur de la trémie et étant déchargées à partir du four (19).

18. Appareil suivant l'une au moins des revendications 10 à 17 caractérisé en ce qu'il comprend un transporteur à vis d'Archimède disposé entre les moyens de décharge (100,110) et l'orifice de sortie (35) de la trémie.

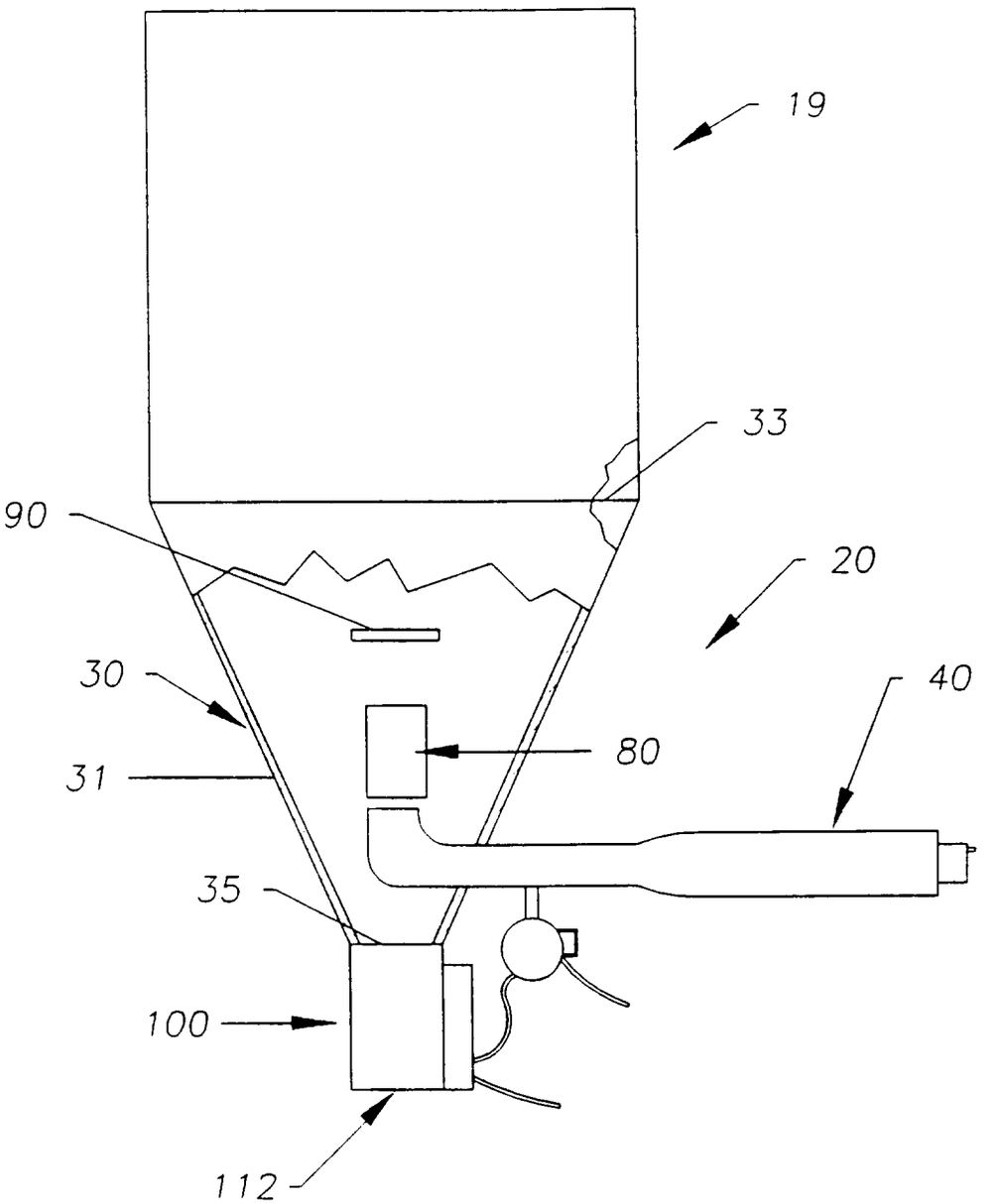


Fig. 1

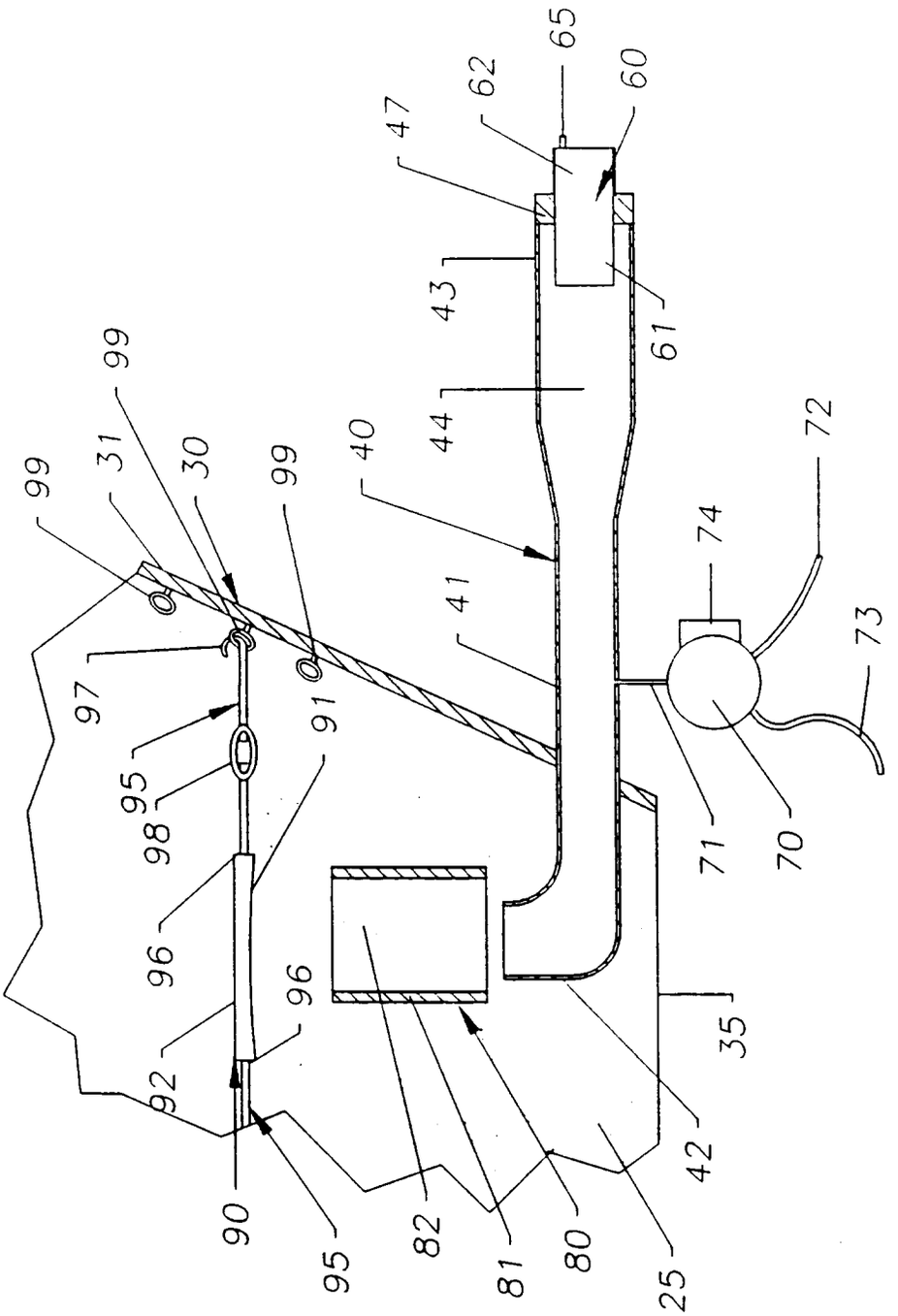

65
62
60
47
43
61
99
31
30
99
40
44
72
99
74
41
73
97
91
95
98
71
70
96
96
92
35
42
90
95
82
81
80
25

Fig. 2

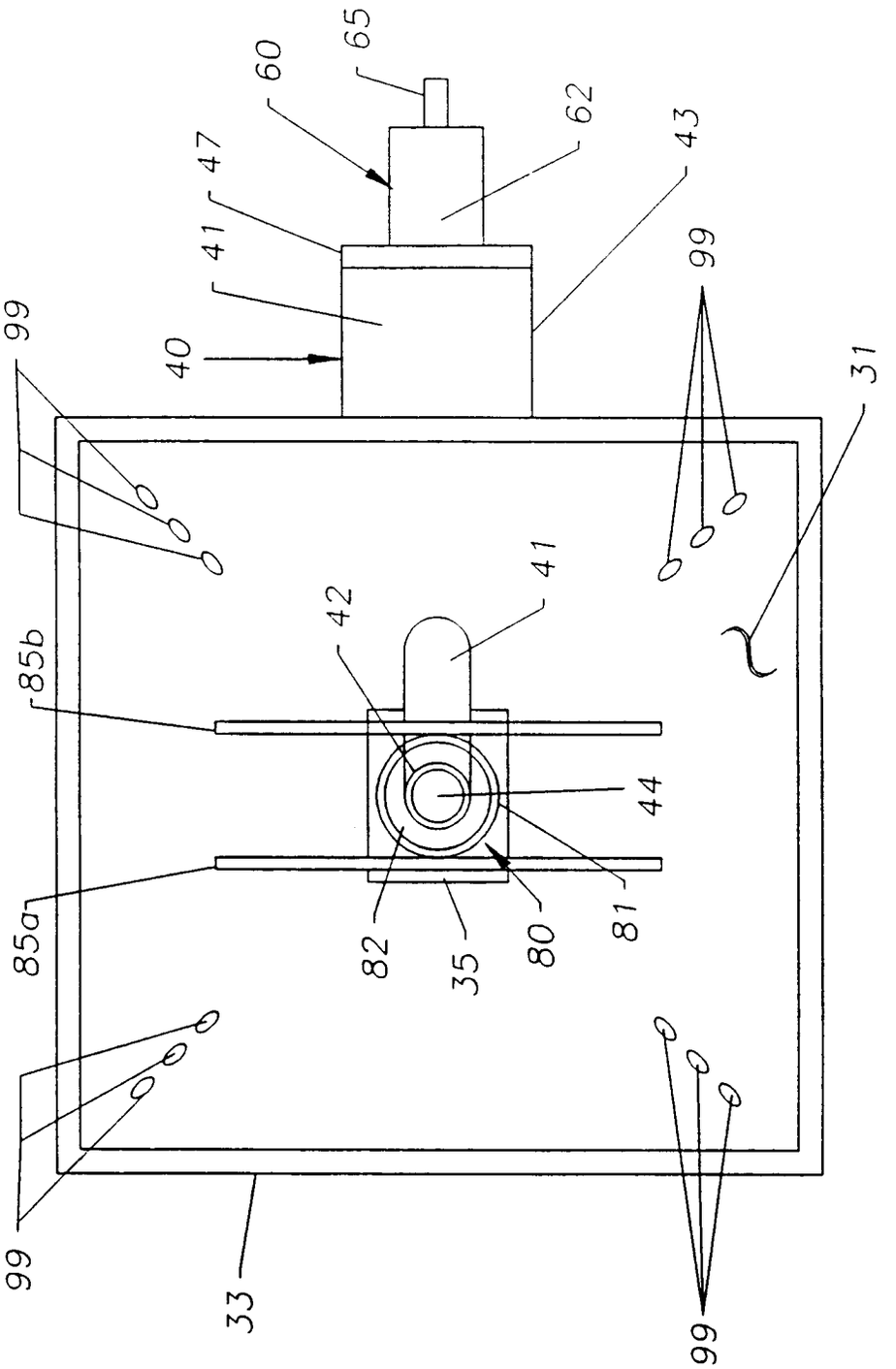


Fig. 3

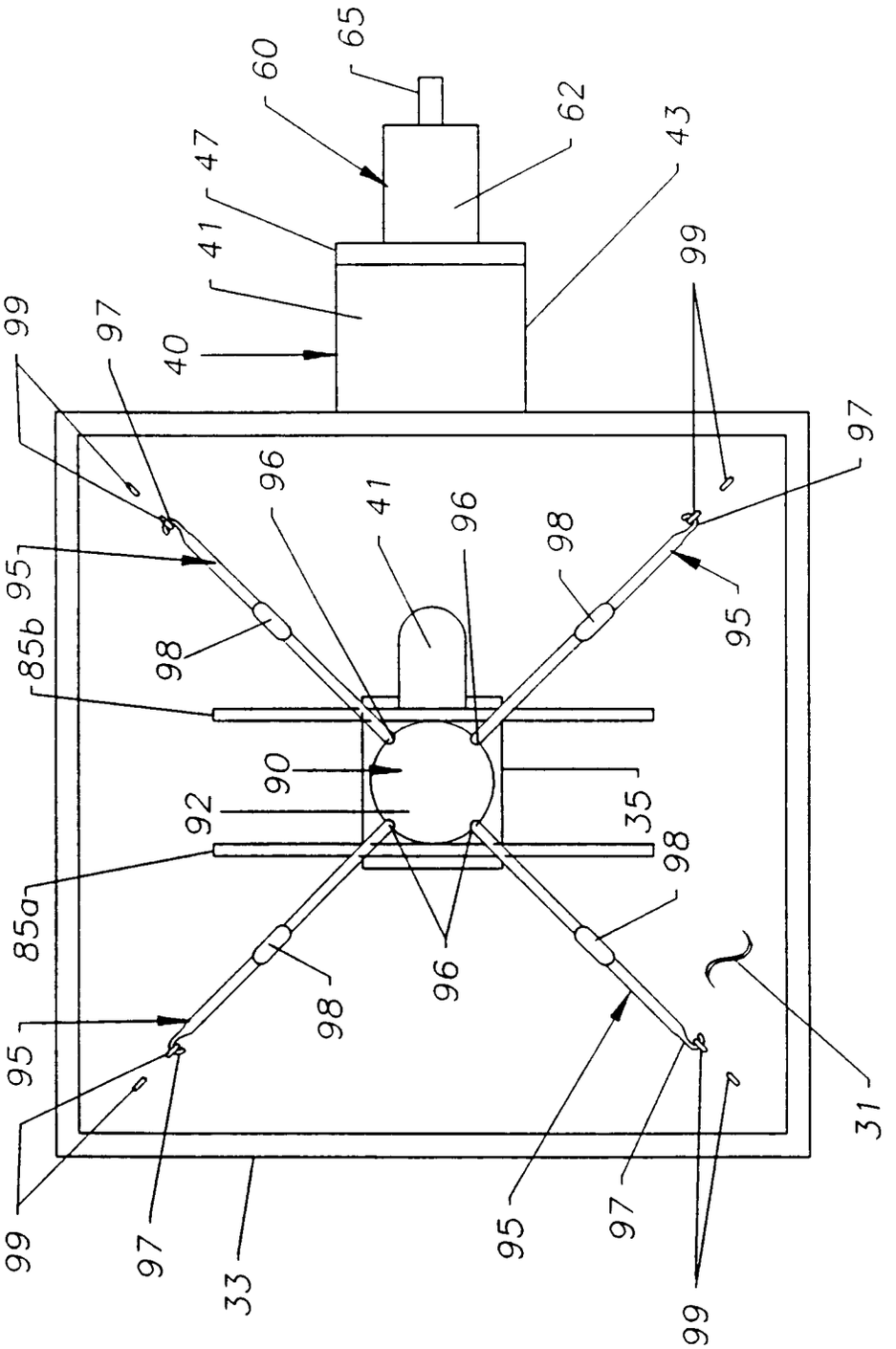

65
60
62
47
43
41
99
40
97
96
41
96
98
95
85b
98
95
90
92
35
98
85a
96
98
95
31
99
97
33
95
97
99

Fig. 4

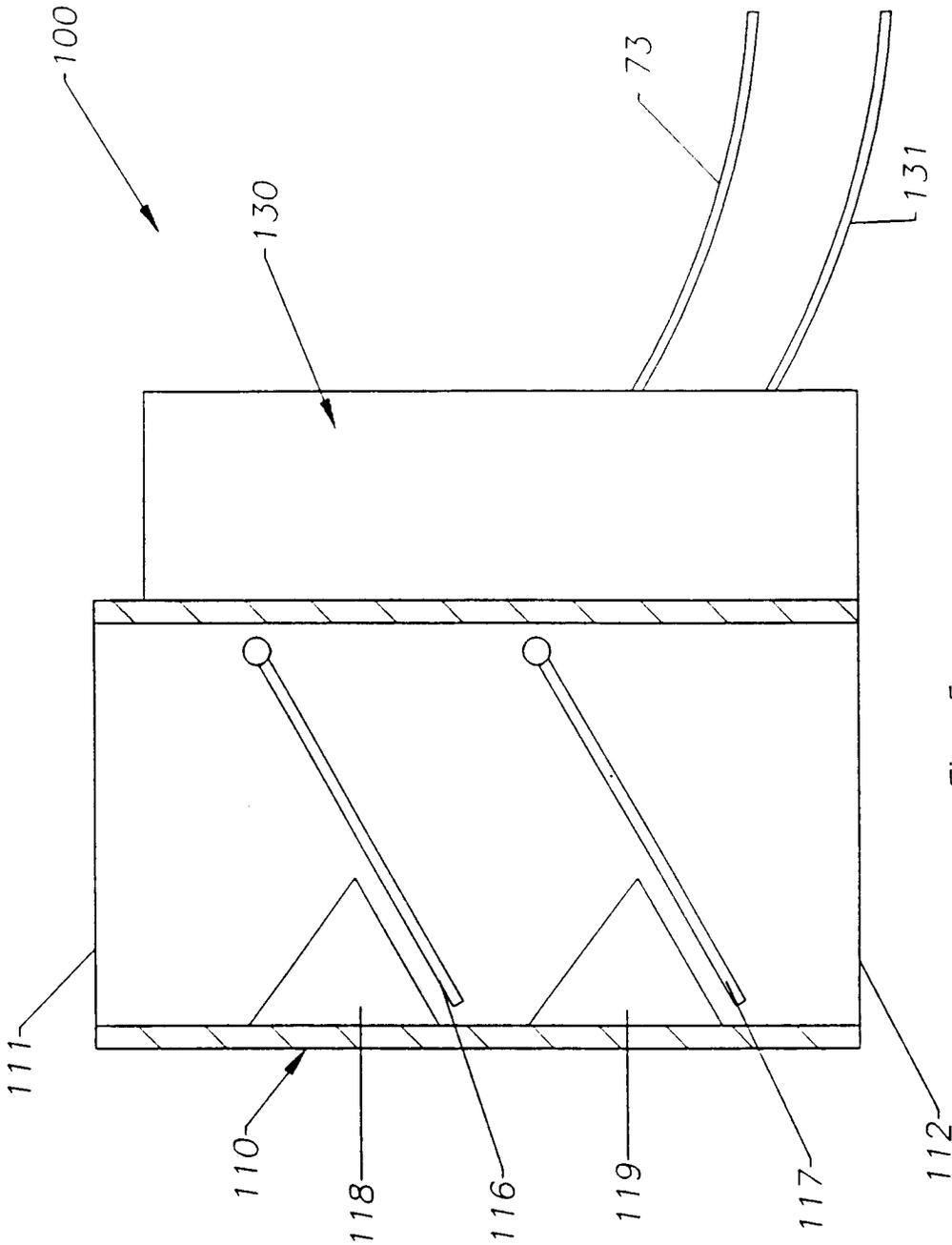


Fig. 5

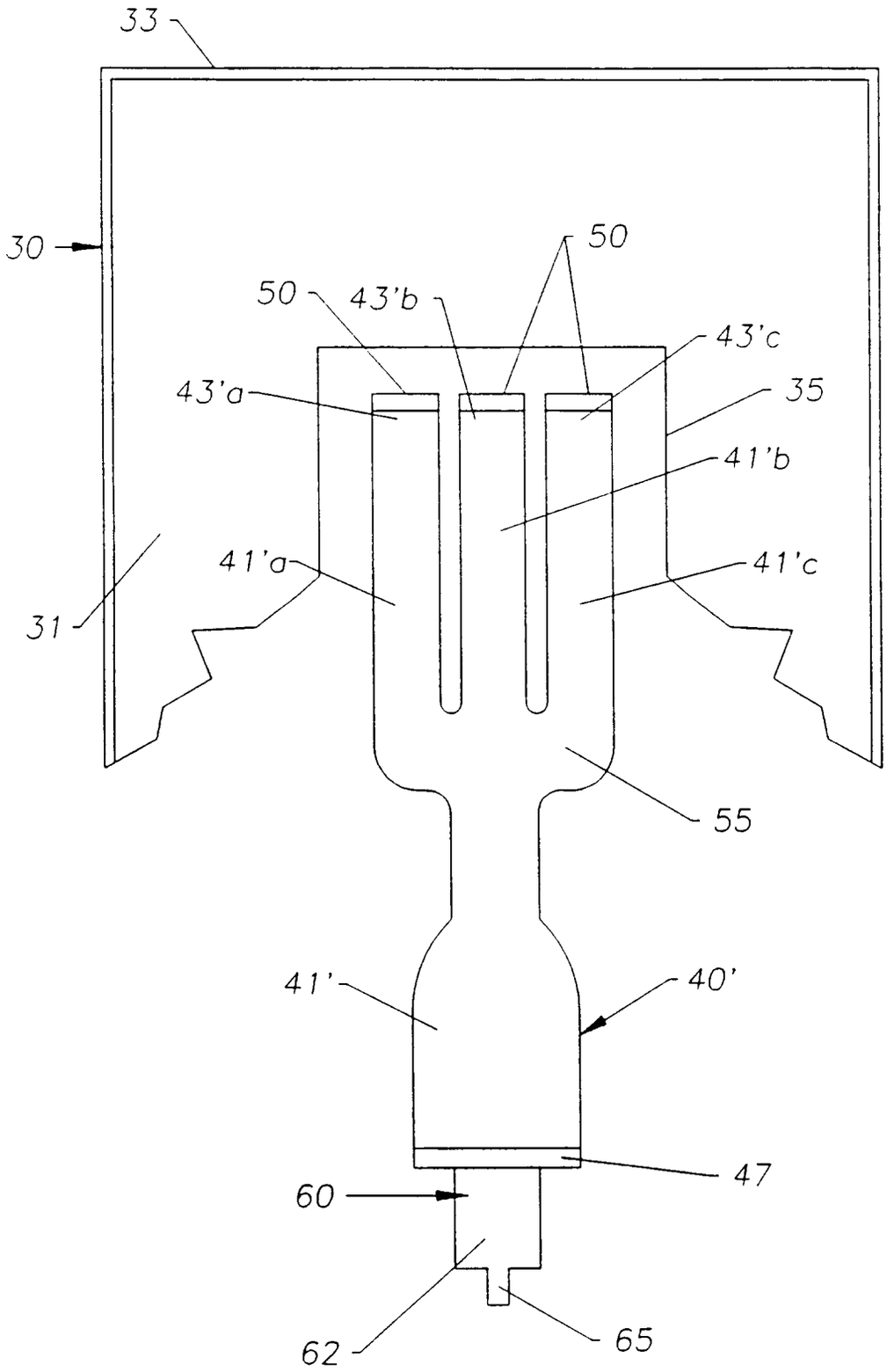


Fig. 6

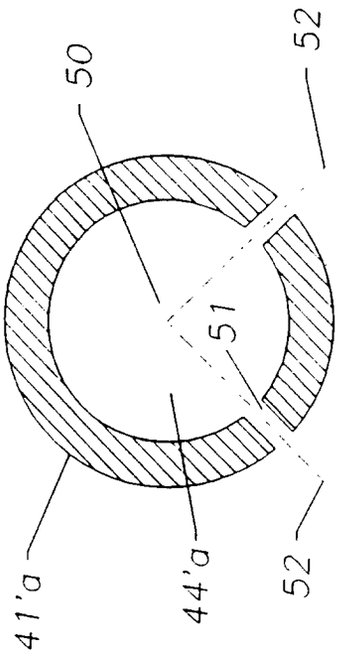


Fig. 8

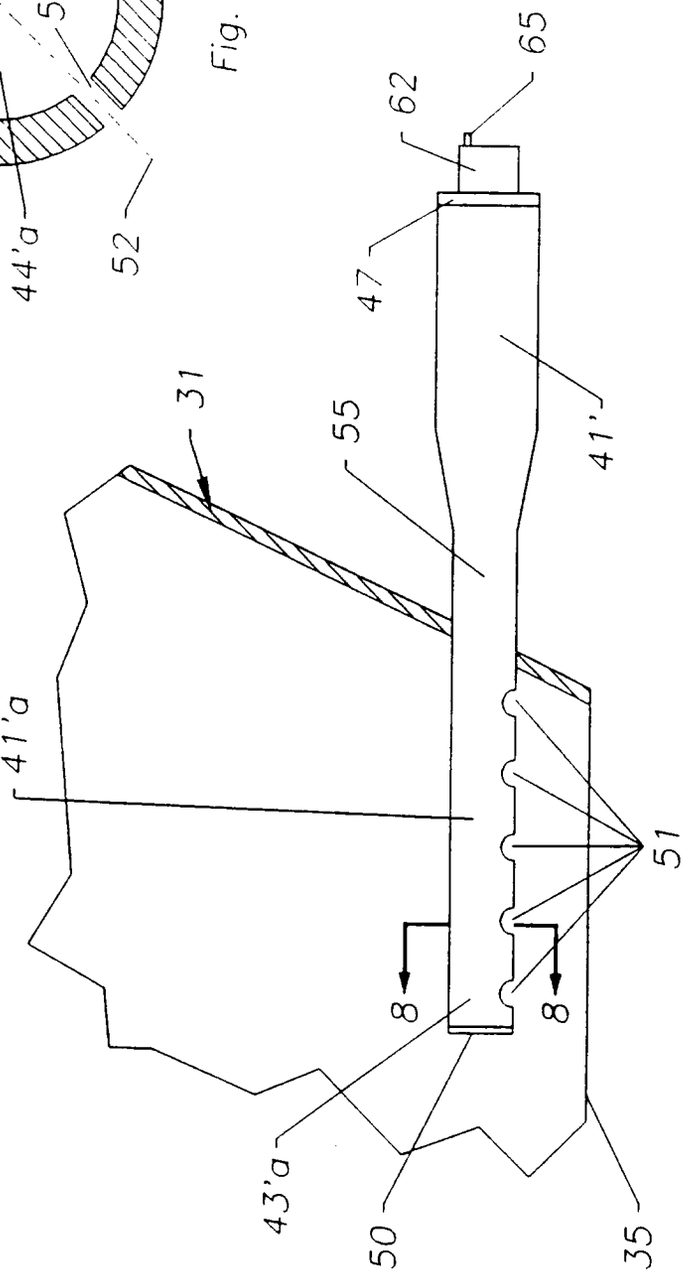


Fig. 7

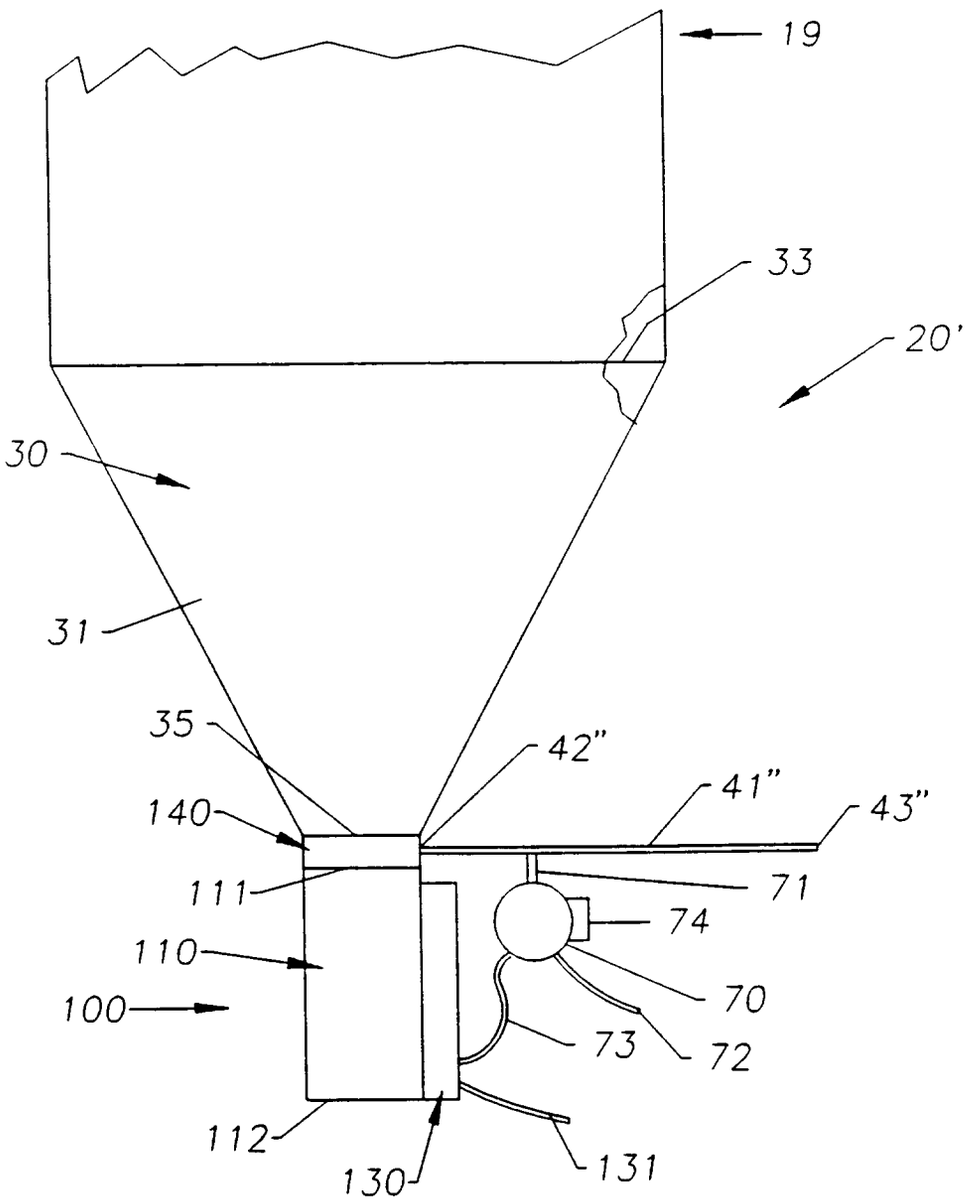


Fig. 9

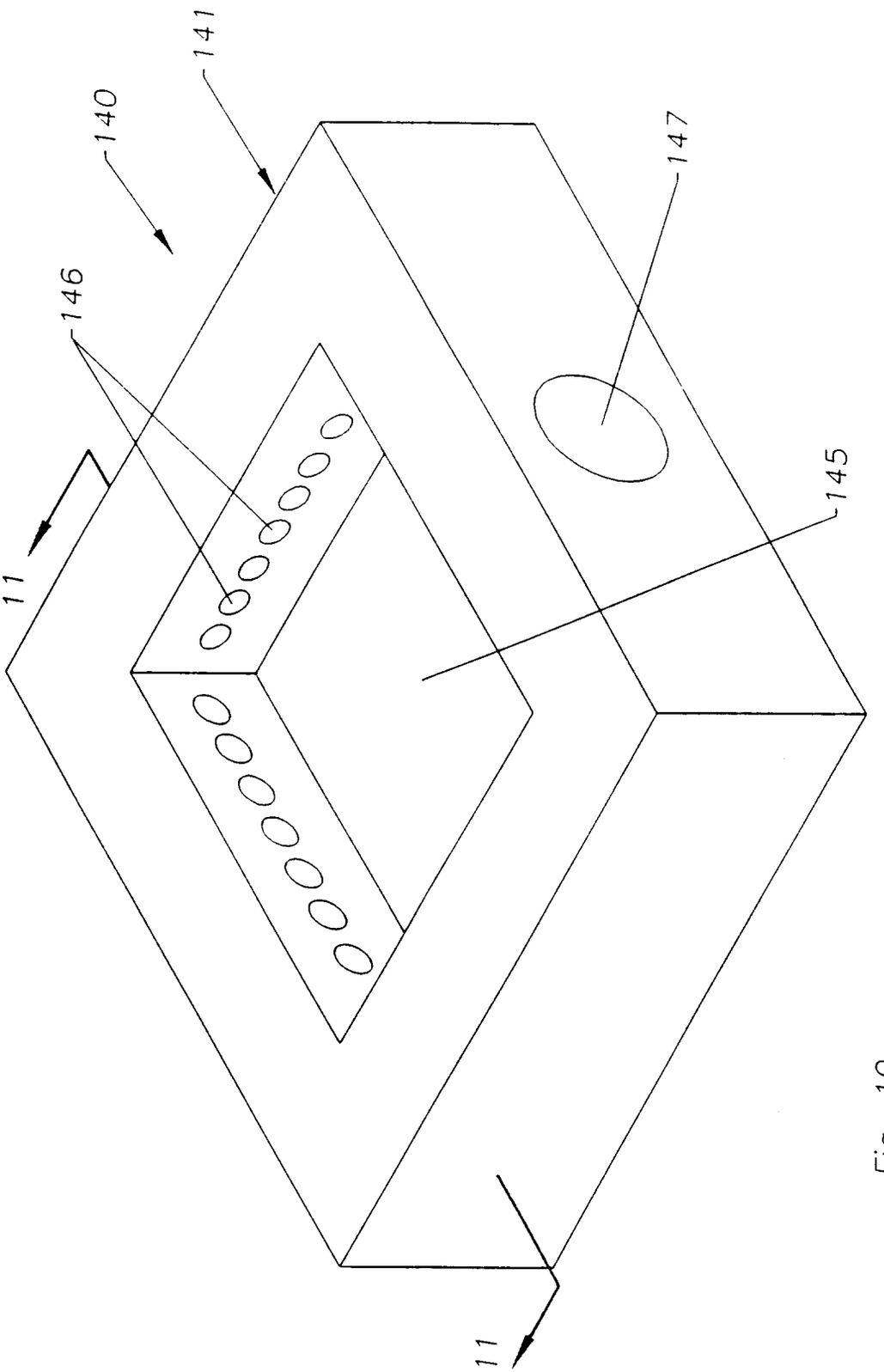


Fig. 10

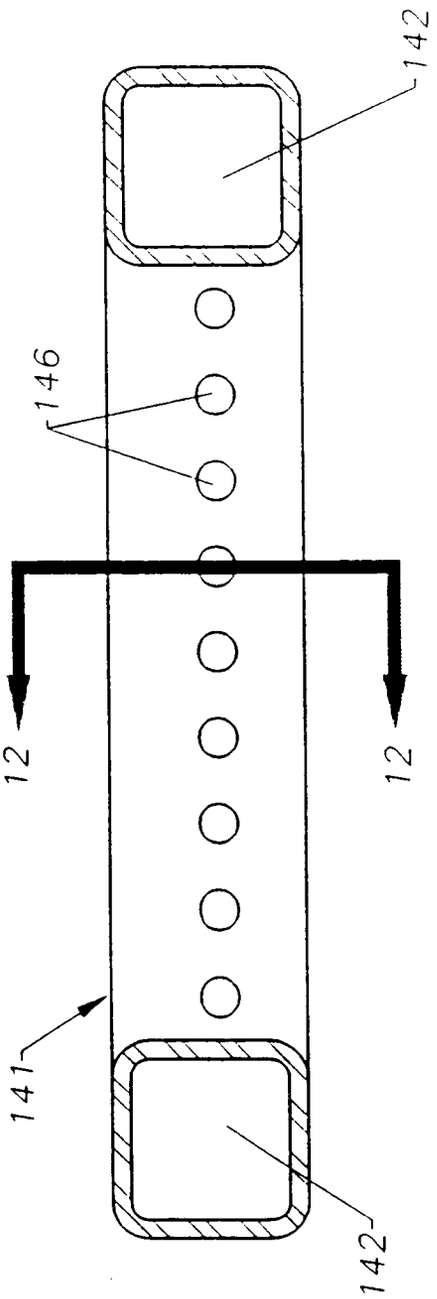


Fig. 11

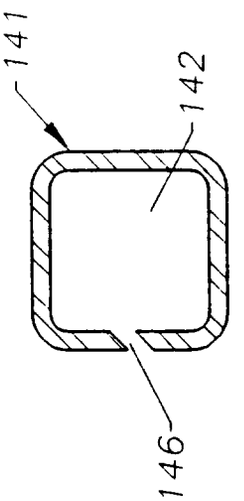


Fig. 12

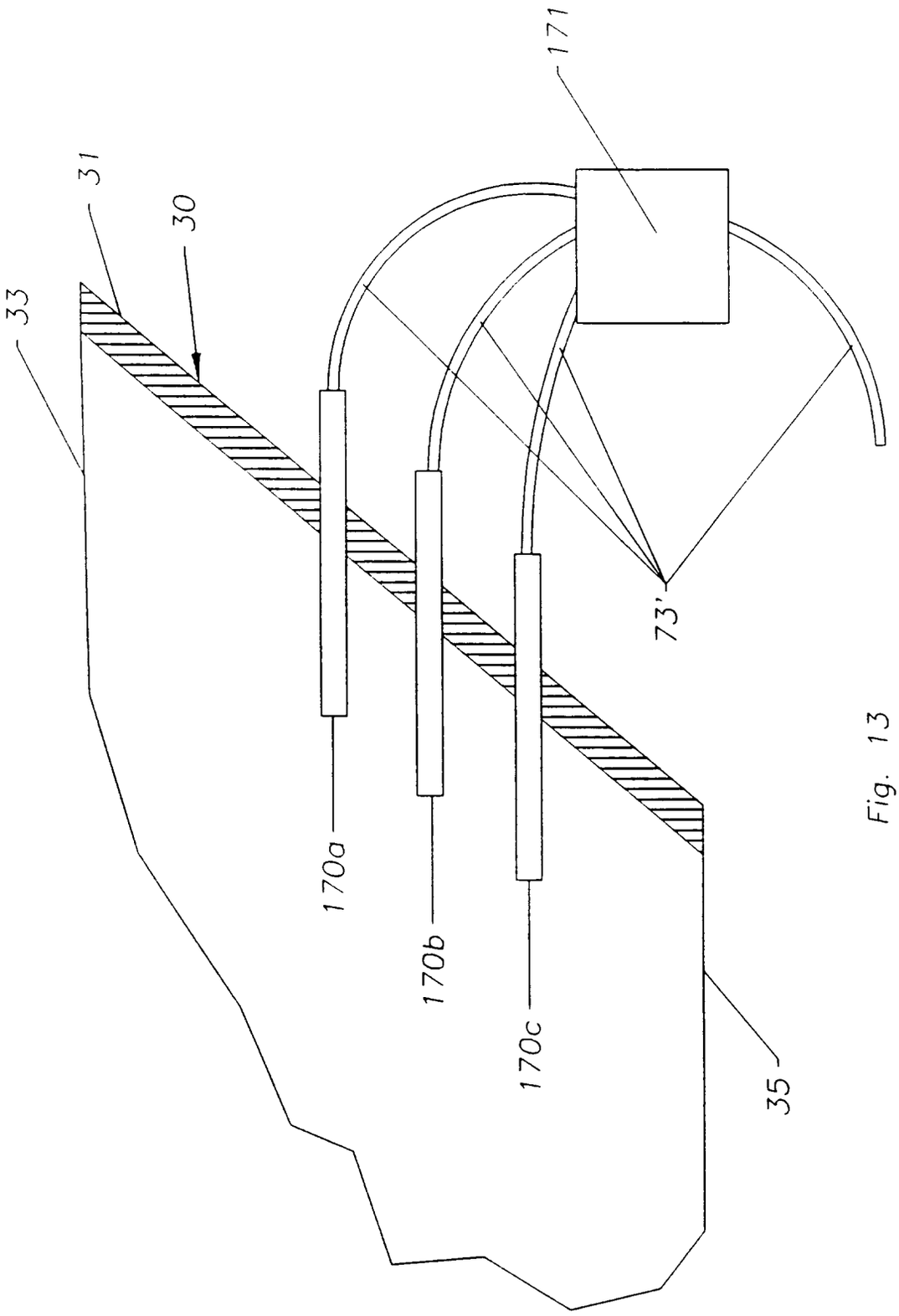


Fig. 13

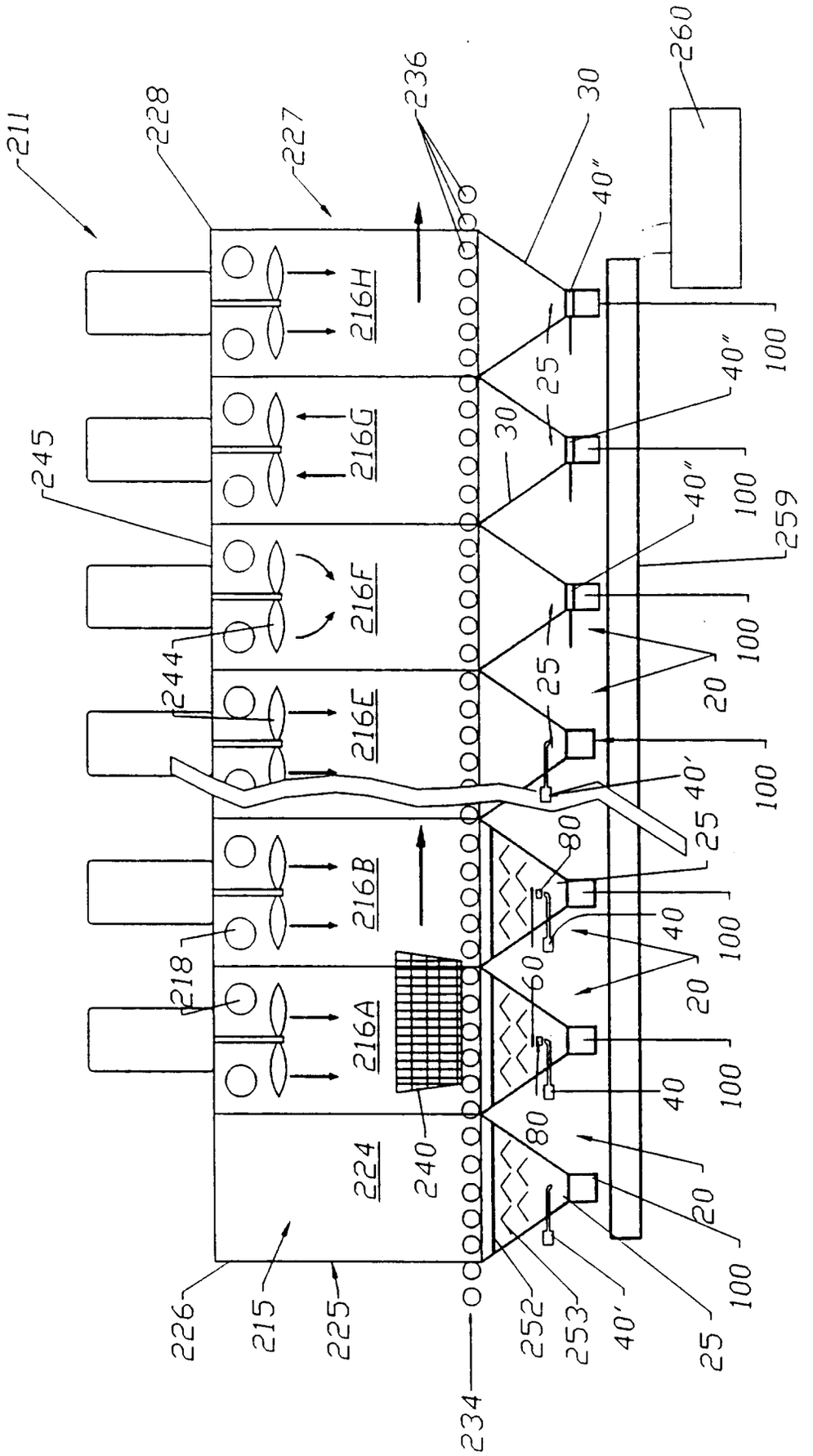

211
228
227
236
30
260
40"
216H
216G
216F
216E
216B
216A
245
244
218
224
240
226
215
225
234
252
253
40'
25
100
259
20
40
60
80

Fig. 14

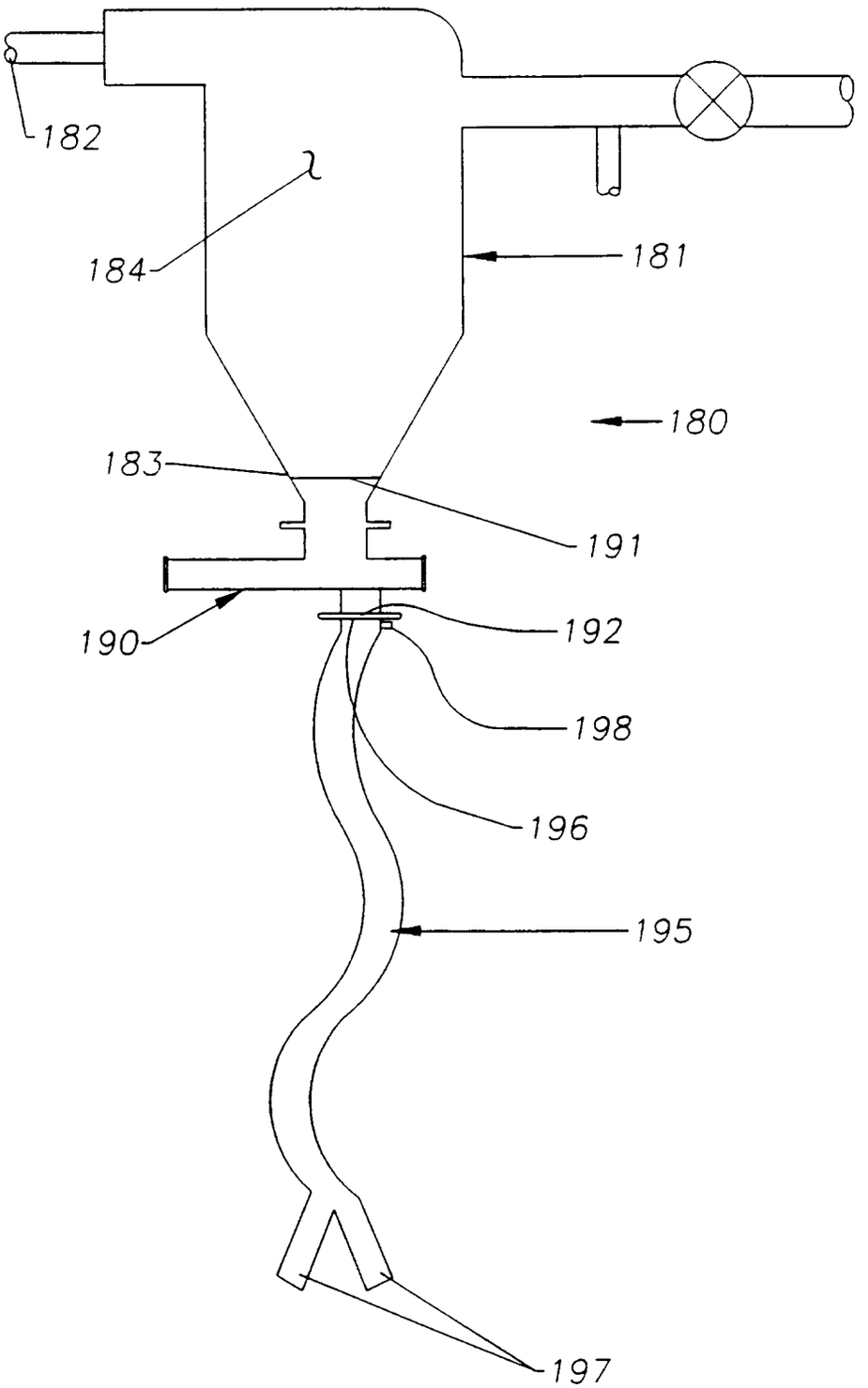


Fig. 15

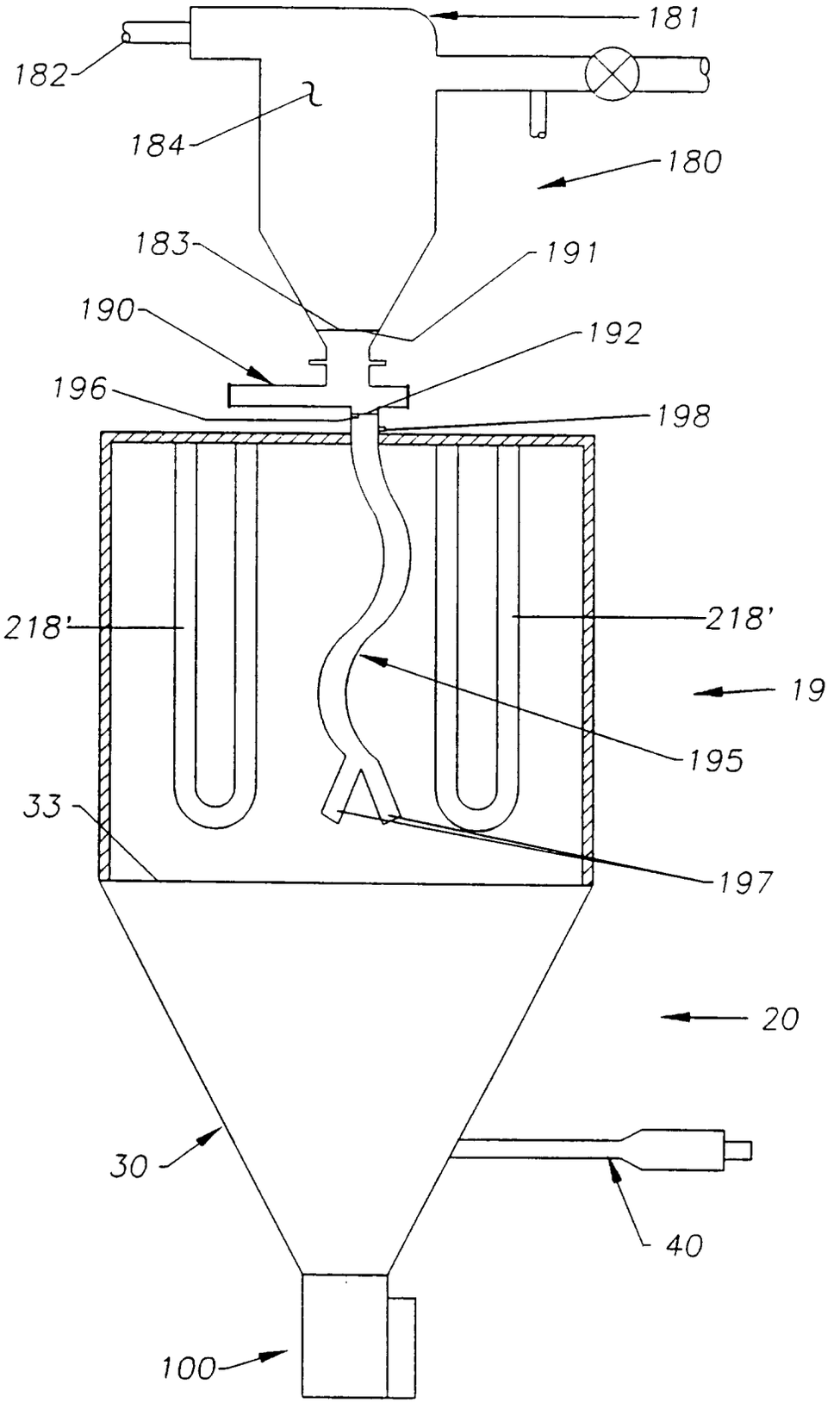

181
182
184
180
183
191
190
192
196
198
218'
218'
19
195
33
197
20
30
40
100

Fig. 16

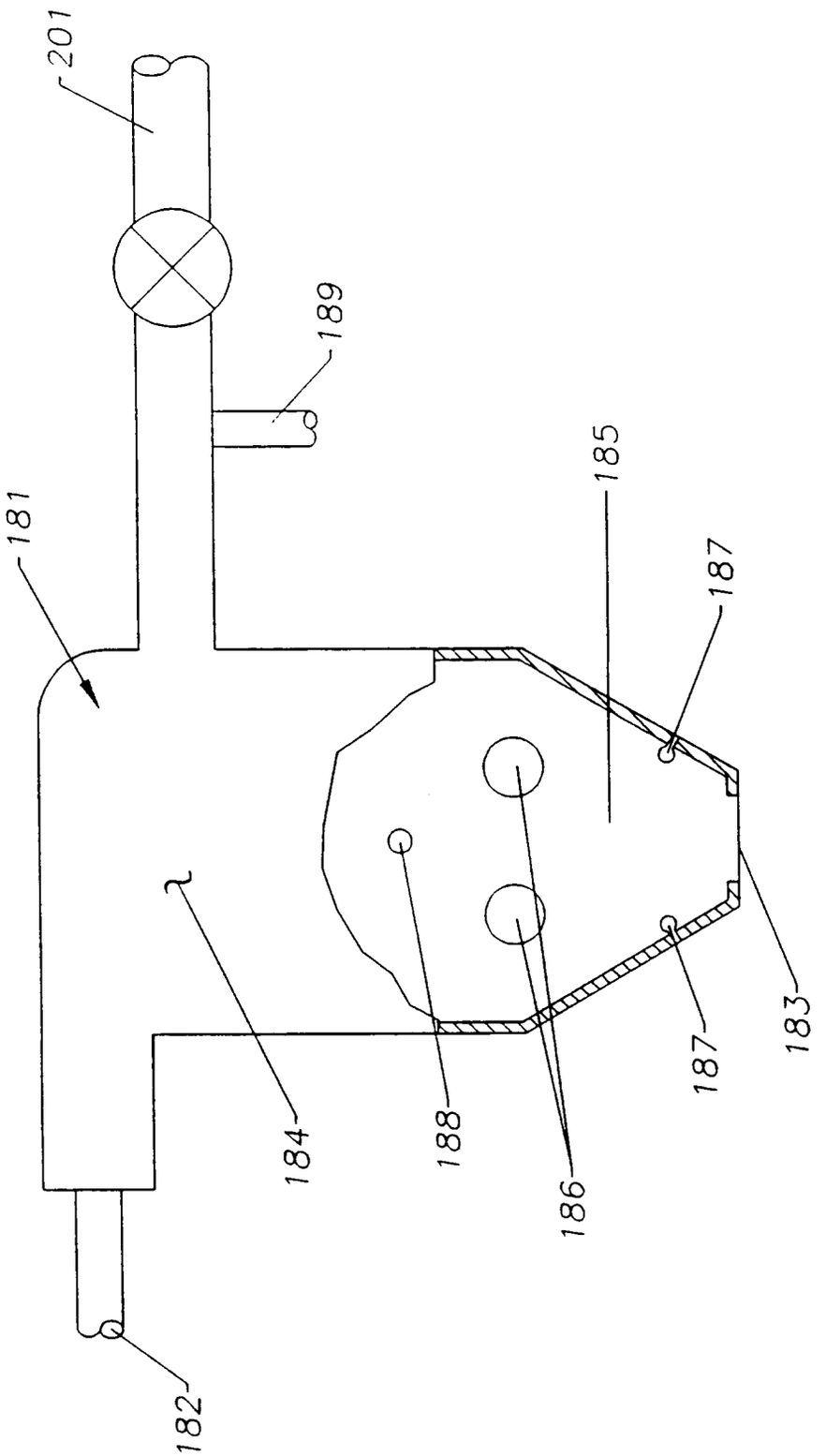


Fig. 17