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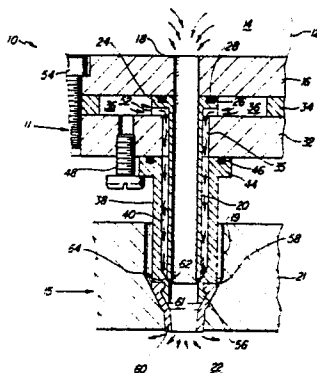
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D-8000 München 80(DE)(54) **Forming apparatus having catalyst introduction simultaneous with sand injection.**

(57) An apparatus and method for simultaneously injecting moulding material (14) and a curing additive into a form (22). The apparatus (10) includes a container (12) of moulding material (14) interconnected by a conduit (20) to a forming cavity (22). Moulding material (14) is discharged into cavity (22) through conduit (20). An integrally formed chamber (36) is provided for simultaneously supplying additive to the discharging moulding material (14). Moulding material (14) is forced into cavity (22) while simultaneously forcing the additive into the path of the discharging moulding material (14).

*Fig-1*

FORMING APPARATUS HAVING CATALYST INTRODUCTION SIMULTANEOUS WITH SAND INJECTION

The present invention relates to foundry equipment and more specifically to an apparatus and method for forming sand cores and sand molds.

5 **BACKGROUND ART**

Sand molds are commonly used as cores for casting processes in which a flowable material is cast around the sand core to form a part. When sand is employed to form the sand cores, it must be conditioned and controlled to give satisfactory and uniform results. Typically, the sand is conditioned with
 10 additives to meet four requirements: refractoriness, cohesiveness, permeability, and collapsibility. The various methods for conditioning sand generally fall within two broad categories: the "hot box" method and the "cold box" method. Each method requires the additives to be combined with the sand and then the mixture to be cured. The curing stage is what differentiates the two methods.

U.S. Patent No. 4,050,500 issued September 27, 1977, titled "Method of Making A Shell Mold"
 15 discloses one example of the hot box method in which a mixture of sand and a thermosetting binder are injected into a mold. After injection, the mold is heated to cure the composition. Examples of the hot box method are disclosed in U.S. Patent No. 3,461,948 issued August 19, 1969, titled "Blow Plate Assembly", and U.S. Patent No. 4,068,701 issued January 17, 1978, titled "Refractory Materials".

There are several disadvantages in the hot box method. Costly heating equipment is needed to heat the core box and keep it hot to polymerize the resin. If the core box cools, the lag time necessary to reheat the
 20 core box slows production time. Also, the temperature of the core box must be closely regulated to insure proper polymerization of the resin. Further, the core box is costly because it must be able to withstand the continuous heat.

The cold box method does not require the addition of heat. Typically, the cold box method requires a
 25 resin to be mixed with the sand and then polymerized by the action of a curing agent such as a catalyst. Examples of resin and catalyst mixtures are disclosed in the following U.S. Patents:

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35	<u>U.S. Patent No.</u>	<u>Issue Date</u>	<u>Title</u>
	4,540,724	9/10/85	Phenolic Resin- Polyisocyanate Binder Systems 40 Containing a Phosphorus Halide and Use Thereof
45	4,421,873	12/20/83	Oxidatively Coupled Cold-Set Binders

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5	4,366,266	12/28/82	Binder Compositions and Process for Making Molded Products Therewith
10	4,268,425	5/19/81	Phenolic Resin-Polyisocyanate Binder Systems Containing a Drawing Oil and Use Thereof
15	4,176,114	11/27/79	Process for Manufacturing Sand Cores and Molds
20	4,070,196	1/24/78	Binder Compositions
25	3,947,420	3/30/76	Method for Producing Foundry Molds and Cores as Well as Products Thereby Obtained
	3,590,902	7/6/71	Production of Foundry Cores and Molds

Typically, in the cold box method, a mixture of sand and resin is blown into the core box in one station of the casting operation. The core box is then transferred by a transfer mechanism to a station for adding the catalyst or alternately, the station is transferred to the core box. A catalyst is then introduced into the mold causing the resin to harden.

One of the disadvantages encountered in the cold box method is the necessity of transferring the core box. Depending upon the size and complexity of the machine and core box, the cost of the transfer mechanism could account for several thousand dollars. Further, the machine cycle time is increased by 3 to 10 seconds for the transfer motion and the core requires between 1 and 10 seconds for the addition of the catalyst, excluding purge time. Still further, there is the problem of premature curing of the catalyst/mixture composition in the cold box methods that do not employ an additive station.

One attempt was made to solve the problem of premature curing in one type of the cold box method. Typically, in this type of method, the catalyst and resin coated sand are mixed before they are introduced into the casting box. When this method is used, the curing process begins before the catalyzed-resin sand mixture is actually forced into the casting box. Less reactive resin-catalyst mixtures are not completely satisfactory because they require longer time to cure which slows production. U.S. Patent No. 3,994,332 issued November 30, 1976 and titled "Apparatus and Method for Manufacturing Cores and Molds With Means for Independently Releasing Catalyst and Resin Mixes", discloses a method and apparatus for forming core molds having two hoppers, wherein the first hopper dispenses a catalyst-polymerizable resin coated sand into a mixing tube while the second hopper dispenses a catalyst coated sand into the mixing tube. The two coated sand particles intermix prior to being injected into the mold resulting in minimal polymerization prior to injection.

The main disadvantage with the method disclosed in U.S. Patent No. 3,994,332 is the complexity of the machinery required to mix the two sands. The machine is clearly not adaptable to present casting machinery and would require total replacement of all machinery in the foundry.

SUMMARY OF THE INVENTION

The present invention overcomes the above disadvantages by providing a forming apparatus having catalyst introduction simultaneous with sand injection and a related forming method. The apparatus includes an injector for simultaneously introducing casting material and curing additive into a forming cavity.

The injector of the present invention is particularly useful in a forming apparatus having a container of casting material, such as for example resin coated sand, and a forming cavity positioned a spaced distance from the container. The injector is characterized by a conduit interconnecting the container and cavity so that resin coated sand can be discharged from an outlet in the container through the conduit into the cavity.

The injector is further characterized by a chamber which is interconnected to a supply of curing additive or catalyst for mixing with the sand. A passage is provided to direct the curing additive to the discharge end of the conduit. In this way, casting material and additive can be simultaneously discharged and intermixed before being deposited within the cavity. To facilitate intermixing, a mixing region is provided between the discharge end of the conduit and the cavity.

The chamber is preferably provided in an additive manifold. The manifold includes an opening therein which in axial alignment with the outlet in the container. A portion of the passage is defined by the outer wall of the conduit and the wall of the bore in the plate.

The method of forming a part in accordance with the present invention includes the steps of forcing casting material from the container into the forming cavity through the conduit, while simultaneously forcing additive from the chamber through the passage into the path of the discharging sand. In this manner, the casting material and additive are thoroughly intermixed before being deposited in the forming cavity.

The method is further characterized by the steps of pressurizing the container to discharge the forming material while simultaneously pressurizing the chamber to discharge additive. Once the cavity is filled, the flow of casting material and additive are stopped. Purging fluid is then forced through the passage forcing additive throughout the forming cavity.

A primary advantage of the present invention is the simultaneous injection of the casting material and curing additive. This thoroughly intermixes the curing additive with the casting material to insure proper curing of the formed part. In this way, stronger parts with the desired qualities can be obtained.

Another advantage of the present invention is the cost savings of avoiding expensive transfer machinery. As discussed above, conventional casting machinery requires a separate station for adding curing additive. The present invention includes an additive manifold as an integral part of the apparatus so that the additive may be simultaneously injected. Further, the manifold may be adapted for use on existing equipment, thereby reducing costs.

A further advantage of the invention is the savings of production time in not having to make the transfer. Still further, there is a savings of time which would usually be needed for injecting the curing additive at the separate station.

DETAILED DESCRIPTION OF THE INVENTION

FIGURE 1 is a cross-section of one embodiment of the forming apparatus of the present invention.

FIGURE 2 is a cross-section of a further embodiment of the present invention.

FIGURE 3 is a cross-section of a still further embodiment of the present invention.

With reference to FIGURE 1, the forming apparatus of the present invention is shown generally at 10 having an injector head 11 and forming base 15. Head 11 includes a container or magazine 12 which contains a quantity of casting material 14, such as for example, resin coated sand. The base of magazine 12 is formed by a blow plate 16 having a bore or passage 18 therethrough for the discharge of casting material 14. Conduit 20 is sealingly mounted to the bottom surface of blow plate 16 and interconnects magazine 12 with forming base 15.

Forming base 15 includes a forming cavity 22 within a form 21. Form 21 may be either a mold box or core box. Form 21 has a countersunk bore 19 for receipt of conduit 20 and an additive tube 38 which is concentric with conduit 20. The head 11 is preferably reciprocated with respect to base 15 to insert conduit 20 and tube 38 into bore 19. Alternatively, however, base 15 may be reciprocated with respect to head 11.

The conduit 20 is substantially tubular in shape with a mounting flange 24 at one end thereof for mounting to blow plate 16. Flange 24 has a groove 26 formed therein for receipt of an O-ring 28 to insure sealing engagement between the flange 24 and the blow plate 16.

Mounted directly below plate 16 a plate defining an additive manifold 32. A chamber 36 is defined by the facing surfaces of manifold 32 and plate 16. Chamber 36 is connected to a supply of curing additive which when mixed with the casting material 14 will cure the combination of casting material 14 and additive to form the cast part. Spacers 34 are used to define the area of chamber 36. Of course, means other than
 5 spacers 34 may be used to provide the necessary spacing. An opening 35 is provided in manifold 32 and is axially aligned with bore 18 for receipt of conduit 20. Opening 35 has a larger diameter than conduit 20 to permit additive to flow out of chamber 36 into additive tube 38 which is positioned about conduit 20.

Conduit 20 and tube 38 are preferably concentric. The interior diameter of tube 38 is greater than the outer diameter of conduit 20 to form a passage 40 therebetween. In this manner, additive in chamber 36
 10 can be forced through opening 35 and passage 40 to the discharge end of conduit 20. A mounting flange 44 is provided for mounting tube 38 to manifold 32. An O-ring 46 is provided between flange 44 and manifold 32 to insure proper sealing. A fastener 48 may be used to removably mount tube 38 on manifold 32.

To permit additive to flow from chamber 36 into opening 35, space must be provided between flange 24
 15 and the facing surface of manifold 32. In the preferred embodiment, notches 52 are formed in flange 24 to permit the free flow of additive. In this manner, fasteners 54 may be used to mount manifold 32 to plate 16 while simultaneously retaining conduit 20 between the two plates. Other methods may be used to secure flange 24; for example, conduit 20 may be bolted to plate 16.

Mounted on the opposite end of tube 38 is a resilient nozzle 60. Tube 38 is notched to form tabs for
 20 receipt of complimentary tabs 58 on nozzle 60 to fasten it to tube 38. A mixing region 61 is defined by the interior of nozzle 60. In the preferred embodiment, the discharge ends of conduit 20 and tube 38 are sloped inwardly at 62 and 64 respectively to direct the discharging additive into the path of the discharging material 14 within region 61. Region 61 permits turbulent mixing of the additive and material 14 immediately before entry into cavity 22. In this manner, the additive and material 14 are thoroughly and uniformly intermixed
 25 prior to deposit. Further, nozzle 60 facilitates alignment of tube 38 in bore 19 and seals conduit 20 and tube 38 within bore 19.

FIGURE 2 depicts another embodiment of the forming apparatus of the present invention is shown generally at 70 having an injector head 71 and forming base 73. Injector head 71 includes a magazine 72
 30 containing casting material 74, a discharge bore 76 provided in a blow plate 78 and a conduit 80. In this embodiment, the surface of plate 78, opposite magazine 72, is counter-sunk at 82 for receipt of flange 84 to insure proper sealing. Flange 84 is retained by fasteners 86. Of course, other methods of sealing conduit 80 to plate 78 are within the intended scope of this invention.

Attached at the opposite end of conduit 80 is a resilient nozzle 88. Nozzle 88 is mounted to conduit 80 by complimentary interfitting tabs 90 and 92.

Forming base 73 includes an additive manifold defined by plate 96 and a form in the nature of a
 35 forming box 100. Nozzle 88 is received within a counter-sunk opening 94 formed in the surface of additive manifold 96 which is mounted to casting box 100 by fasteners 98. Manifold 96 has a partially hollow interior which forms additive chamber 102. Axially aligned with opening 94 is a bore 103 in forming box 100. As described in the previous embodiment, injector head 71 and forming box 73 are relatively reciprocal to permit the insertion of conduit 80.
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To separate chamber 102 from the discharging casting material 74, a liner or inner sleeve 104 is inserted into bore 106 of conduit 80. Tabs 108 are provided on liner 104 to insure proper positioning. The outer wall of liner 104 is spaced from the inner wall of bore 103 to form a passage 105 between chamber 102 and cavity 110. In this manner, additive can be forced from chamber 102 along passage 105 into cavity
 45 110. Liner 104 also permits adjustable positioning of conduit 80 with respect to bore 103 by telescoping liner 104 with respect to conduit 80.

In this embodiment, a separate mixing region is not defined. The additive and casting material 74 intermix within cavity 110 immediately before being deposited. However, a mixing region can be easily added by shortening the length of liner 104 to define a mixing region within bore 103 immediately adjacent
 50 cavity 110. Further, the shortened end of liner 104 may be sloped inwardly for improved intermixing of additive and material 74.

With reference to FIGURE 3, another embodiment of the present invention is shown generally at 112 having an injector head 113 and base 115. As before, head 113 and base 115 are relatively reciprocal. Head 113 includes a magazine 114 having a blow plate 116 connected thereto by fasteners 118. A bore
 55 120 is formed in plate 116 for discharge of casting material 122.

A bushing 124 is tightly fitted within bore 120. Bushing 124 has a tubular body portion 126 which tightly engages the wall of bore 120 and a flange 128 which sealingly engages plate 116.

Base 113 includes an additive manifold defined by a plate 130 which is fixedly mounted to a forming box 132 by fasteners 134. Manifold 130 has a partially hollow interior forming an additive chamber 136 between forming box 132 and manifold 130. An opening 138 extends through manifold 130 into chamber 136 and is in axial alignment with a bore 140 in forming box 132. Bore 140 has a larger diameter than opening 138 and both opening 138 and bore 140 are axially aligned with bore 120 in plate 116.

A second bushing 142 is tightly received within opening 138 and extends into bore 140. Bushing 142 has a tubular body portion 141 and a flange 143. In this embodiment, the end of body portion 141 is flush with the top interior surface of forming box 132. Due to the larger diameter of bore 140, a passage 144 is defined by the exterior wall of body portion 141 and the wall of bore 140. Passage 144 extends from chamber 136 to forming cavity 146.

As in the previous embodiment, this embodiment does not have a separate mixing region. As before, a mixing region can be added by shortening the bushing 142 to form a mixing region within bore 140.

The method of forming a part will be described with reference to FIGURE 1, however, it is to be understood that the method is intended for use in all embodiments of this invention and any equivalent embodiments thereof. The method of forming includes the steps of first pressurizing container or magazine 12 to force the casting material 14 through conduit 20. Simultaneously with pressuring container 12, chamber 36 is pressurized to force additive through passage 40 to be discharged at the discharge end of conduit 20. By controlling the pressures applied to magazine 12 and chamber 36 the quantity and mixing of additive and material 14 can be controlled. Once cavity 22 has filled, the pressure to both magazine 12 and chamber 36 is stopped. At this time, a purge fluid, such as air is forced into passage 40 which forces the additive throughout the casting cavity to insure proper distribution.

It is to be understood that the term "curing additive" as used herein is intended to mean any liquid, particulate, or other material which is flowable. The curing additive may, for example, comprise sand having a curing agent added thereto.

The method preferably employs a so-called "ashland" cold box. In this method, foundry sand is mixed with a resin which can be polymerized by the action as a catalyst. As an example, the catalyst may be triethylamine or dimethylethylamine. The catalyst is added to a gas such as carbon dioxide to facilitate injection.

OPERATION

Referring now to FIGURE 1, the operation of apparatus 10 is as follows. A forming box 21 is positioned under plate 16 such that bores 18 and 19 are in alignment. Typically this will be done with a conveyor system so that successive forming boxes can be filled. Once in position conduit 20 and tube 38 are inserted into bore 19 for the simultaneous discharge of additive and casting material 14.

The resin coated sand is forced through conduit 20 and the catalyst gas is forced through passage 40 into mixing region 61 where the two intermix. This immediately begins the curing process. Since the catalyst and sand are almost immediately blown out of region 61 into casting cavity 22, the initiation of the curing process in region 61 is not a problem. The advantage of the mixing immediately before discharge into the cavity is the rapid and complete mixing of catalyst and resin coated sand before deposit in cavity 22. The catalyst is more evenly distributed when compared to the distribution obtained in conventional "gassing" stations.

When cavity 22 is filled, the flow from container 12 and chamber 36 is stopped. Purge fluid is then passed through passage 40 to force the catalyst throughout the sand. The conduit 20 and the tube 38 are then removed from bore 19 to allow another forming box 21 to be aligned. It should be noted here that a conventional forming apparatus may be retrofitted with the injector of the present invention.

The operation of the apparatus shown in FIGURES 2 and 3 is identical to that of FIGURE 1 except for the use the additive manifold (96,130) to the forming box (100,132) rather than to the blow plate (16).

Claims

1. Apparatus for forming a part from chemically curable, particulate material such as treated sand, and including a source (12) of said particulate material, a source (36) of catalyst gas for curing said particulate material, a form (21) having a forming cavity (22) therein for forming the part and an inlet (19) through which the particulate material can be introduced from the source of particulate material (12) into the forming cavity

(22), characterized by:

an injector (11) connected with said source (12, 36) for simultaneously introducing said particulate material and said catalyst gas into said forming cavity (22).

2. The apparatus of Claim 1, wherein said injector (11) includes:

- 5 a conduit (20) connected to said source (12) of particulate material and insertable into said inlet (19) for directing particulate material from said source (12) into said cavity (22), and
a passage (40) at least partially defined by an outer wall of said conduit (20) and connecting said source (36) of catalyst gas with one end of said conduit (20) so as to direct catalyst gas from said source (36) thereof to said one end of said conduit (20) where said particulate material is introduced from said injector
10 (11) into said cavity (22).

3. The apparatus of Claim 2, wherein said injector (11) further includes a tube (38) concentrically surrounding said conduit (20), said passage (40) being defined between the outer wall of said conduit (20) and the inner wall of said tube (38).

4. The apparatus of any one of claims 1 to 3, wherein said injector (11) includes a nozzle (60) on one
15 end thereof which is insertable into said form (21), said nozzle (60) including a mixing region (61) therein in which said catalyst gas and said particulate material are mixed before being injected into said cavity (22).

5. The apparatus of any one of claims 2 to 4, further characterized by a gas manifold (32) connected with source (36) of a catalyst gas and said injector (11) for directing said catalyst gas to said passage (40).

6. The apparatus of any one of the foregoing claims, wherein said injector (11) includes a conduit (80,
20 104) extending into said inlet (103), and a passage is defined between at least a portion of the outer wall of said conduit (80, 104) and the inner wall of said form (21) which defines said inlet (103), said passage being connected with said source of catalyst gas (36).

7. A process for forming a part in which chemically curable particulate material is introduced into a forming cavity (22) having the shape of the part and the particulate material is cured by subjecting the
25 particulate material to a catalyst gas, characterized in that:
the particulate material and the catalyst gas are simultaneously introduced into said forming cavity (22).

8. The process of Claim 7, wherein the particulate material and the catalyst gas are mixed in a mixing chamber (61) of a nozzle (60) prior to being simultaneously introduced into said forming cavity.

9. The process of Claim 8, wherein the nozzle is reciprocated from a standby position spaced from said
30 cavity (22) to an operating position in which said nozzle (60) extends through an inlet (19) in a form (22) defining said cavity (22).

10. The process of any one of claims 7 to 9, wherein the particulate material and catalyst gas are respectively guided through concentric passageways (20, 40) into said cavity (22).

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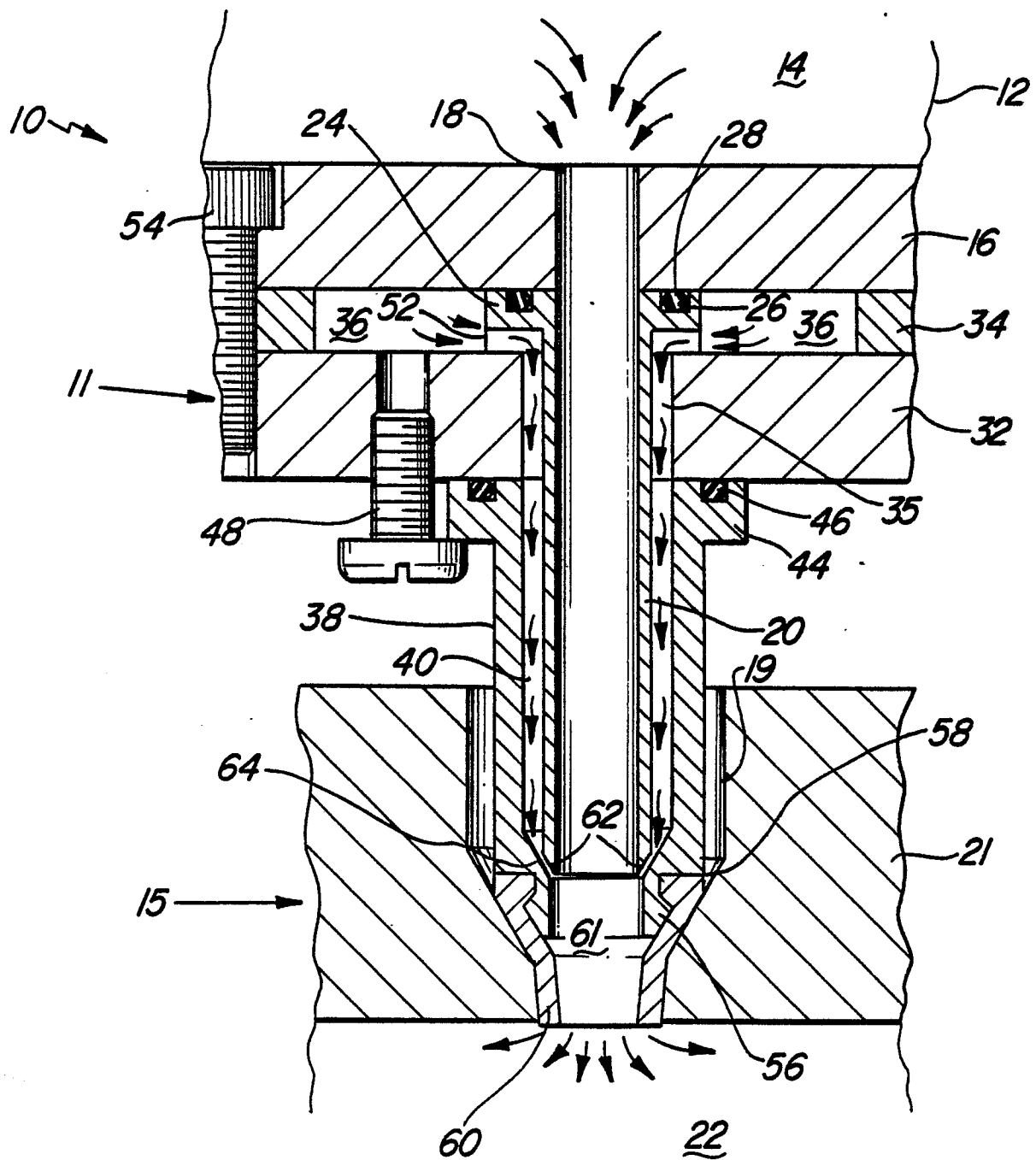


Fig-1

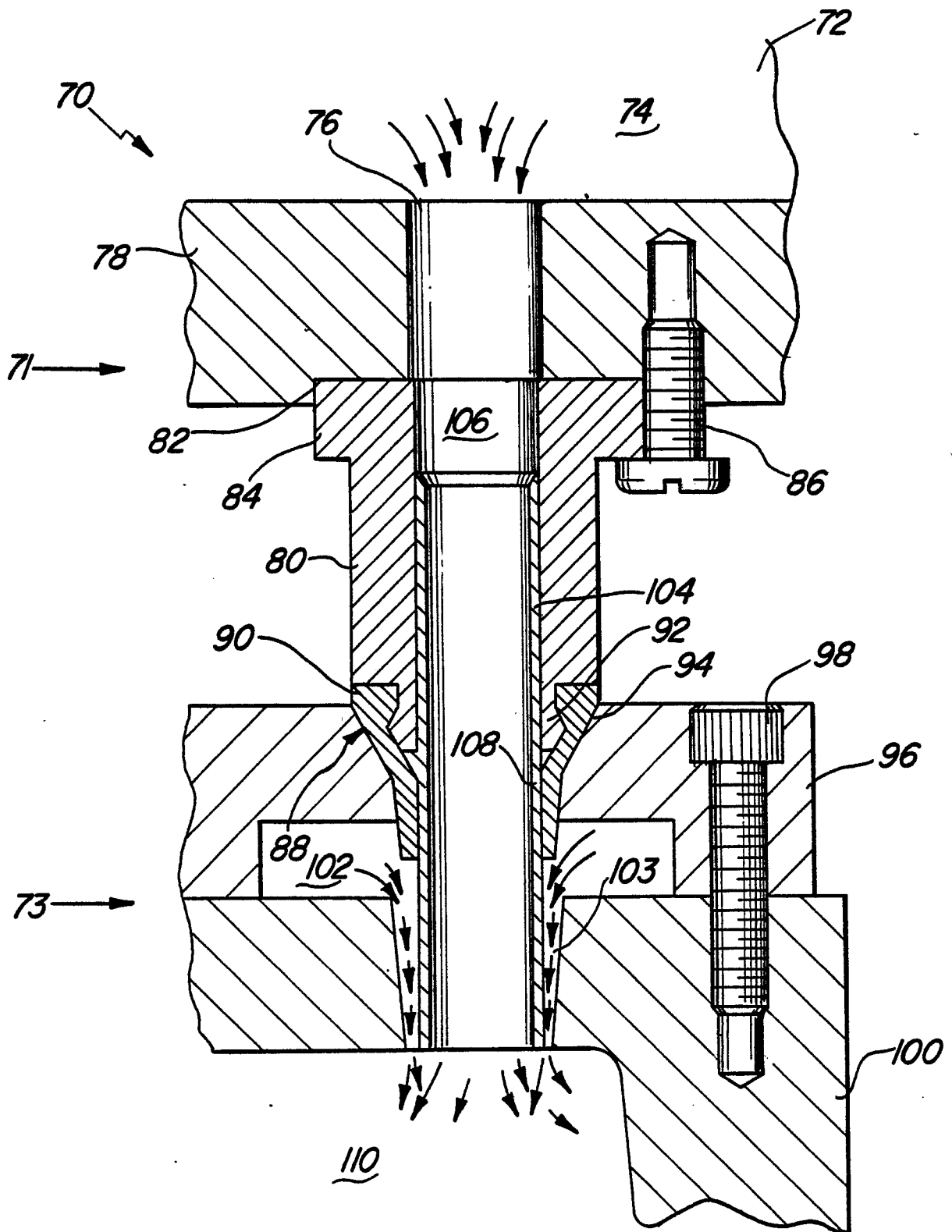


Fig-2

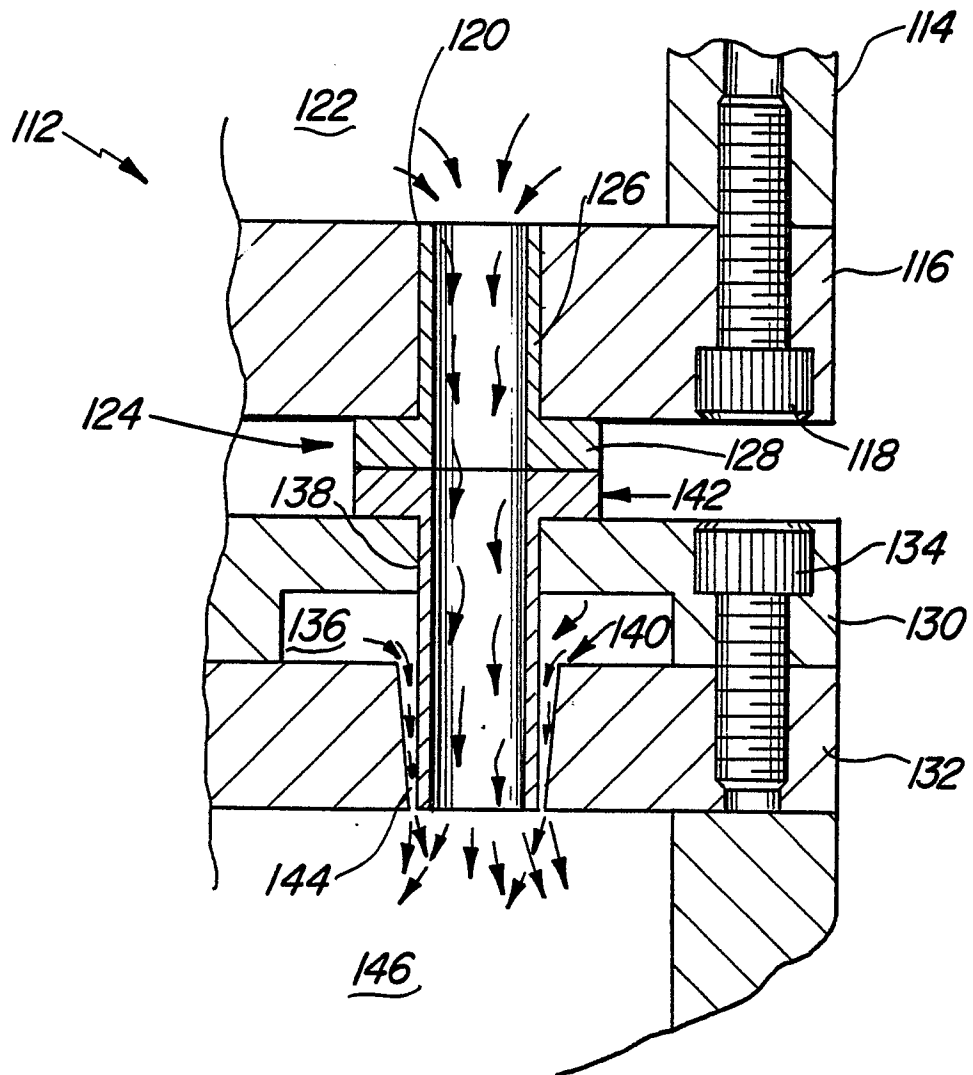


Fig-3



DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	GB-A- 780 039 (FOUNDRY SERVICES) * Page 1, lines 20-59; page 2, line 89 - page 3, line 46; figures 1-5 *	1,4,7,8	B 22 C 15/24 B 22 C 9/12
Y		2,3,5,6,9,10	
Y	FR-A-1 496 753 (AUTOMATIVE PATTERN CO.) * Figures 1-5; abstract *	2,3,5,6,9,10	
X	PATENT ABSTRACTS OF JAPAN, vol. 6, no. 228 (M-171)[1106], 13th November 1982; & JP-A-57 130 737 (NANIWA SEISAKUSHO K.K.) 13-08-1982 * Abstract *	1,2,3,5,7,10	
A	DE-A-3 023 949 (K. WOLF)		TECHNICAL FIELDS SEARCHED (Int. Cl.4) B 22 C
A	FR-A-2 504 035 (MITSUBISHI JUKOGYO K.K.) -/-		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 26-10-1987	Examiner MAILLIARD A.M.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	



DOCUMENTS CONSIDERED TO BE RELEVANT				Page 2
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)	
A	SOVIET INVENTIONS ILLUSTRATED, section P/Q, week K19, 22nd June 1983, Derwent Publications Ltd, London, GB; & SU-A-939 160 (A.F. VLASOV) 30-06-1982 -----			
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)	
The present search report has been drawn up for all claims				
Place of search THE HAGUE		Date of completion of the search 26-10-1987	Examiner MAILLIARD A.M.	
CATEGORY OF CITED DOCUMENTS				
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document				
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document				