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(54) **Apparatus and method for producing a core**

(57) A method is disclosed of producing a highly consolidated sand core. The method includes the steps of closing metal mold halves (13a, 13b) to define a core space (14), charging gas-curable molding sand into the mold space, evacuating the core space to a pressure of 2 - 100 Torr, introducing air into the evacuated core space at an air pressure that increases at a rate of 50 - 600 kg/cm² /sec to apply a pressure to the surface of the gas-curable molding sand to obtain a high charging density; and introducing a curing gas into the core space to harden the molding sand.

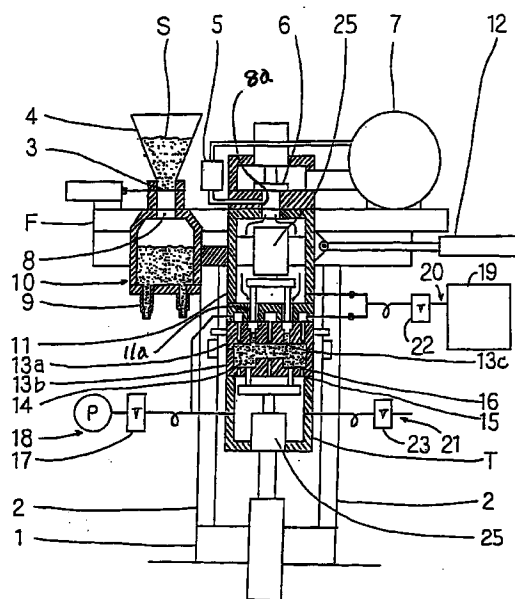


Fig. 1

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Description

Field of the Invention

This invention relates to an apparatus and method for producing a core with gas-curable molding sand.

Description of the Prior Art

A method and apparatus for producing a core is conventionally known wherein gas-curable molding sand is charged into a core space by the air-blowing method, and is then cured by curing gas introduced into the space. For example, Japanese Patent Publication No. 48 - 13804 discloses such an apparatus. It has a core box having a cope and a drag to mate each other to define a core space therebetween. The cope is fixedly mounted on a frame, and the drag is supported by a cylinder for vertical movement to and away from the fixed cope. An assembly of a gassing means, a blow head, and a core-pushing mechanism is disposed above the core box. The assembly is horizontally slidable on the frame through wheels such that it mates the upper portion of the cope to supply an air blow and curing gas into the core space.

However, since in the conventional apparatus molding sand is consolidated only by air-blowing, part of the molding sand in the core space cannot be well consolidated due to the differing capabilities among a plurality of blowing nozzles when a cope that has many nozzles is used.

Accordingly, it is necessary to predict how air flows during air-blowing, and many air-discharge ports such as vent plugs must be adequately disposed in the metal mold for air-blowing.

Further, to optimize the number and location of the vent plugs, some trial blowing must be repeated to evaluate the roughness of the surface and density of the molding sand of the core products, and the metal mold must be modified. Thus, to complete a metal mold takes a lot of time and costs.

The purpose of this invention is to provide an apparatus and method for producing a core having a high density wherein the number of vent plugs to be used and cost and time to produce a metal mold are reduced.

Summary of the Invention

To the above end, in one aspect the method of the present invention for producing a core includes the steps of charging gas-curable molding sand into the core space, reducing the pressure of the core space to 2 - 100 Torr, introducing from above an air flow into the core space at a rate that increases the pressure of the core space at 50 - 600 Kg/cm²/sec to apply pressure to the upper surface of the gas-curable molding sand to give it a high density, and introducing curing gas into the core space to harden the molding sand.

The apparatus of the present invention is one of the

type disclosed in Japanese Patent Publication No. 48 - 13804. However, in the apparatus of the present invention there is evacuating means to reduce the pressure of the core space. In one aspect the apparatus includes a blow head, pressure chamber, core halves to define a core space therebetween, evacuating means to reduce the pressure of the core space, a valve for air-blowing, a valve for introducing air, means for introducing curing gas, and means for discharging the curing gas.

The other aspects of the apparatus and the method of the invention will be understood from the below embodiments and attached claims.

According to the present invention, an air flow is suddenly introduced into the evacuated core space. This introduced air flow applies an impulse pressure to the upper surface of the molding sand, and therefore it is consolidated to a higher density than an upper surface that is consolidated only by air-blowing.

Brief Description of the Drawings

Fig. 1 is a cross-sectional view of a first embodiment of the apparatus of the present invention.

Fig. 2, which is like Fig. 1, is a cross-sectional view of the first embodiment.

Fig. 3 is a cross-sectional view of a second embodiment of the apparatus of the present invention.

Description of the Preferred Embodiments

Now the embodiments of the apparatus of the present invention will be explained by reference to the drawings. The first embodiment is shown in Figs. 1 and 2, and the second in Fig. 3.

In Fig. 1 a plurality of columns 2 are mounted on the base 1, and a frame F is mounted on the top of the columns 2. On the frame F are mounted a sand hopper 4 having a sand feeding gate 3, and an air-introducing means having a valve 5 for air-blowing, a valve 6 for introducing air, and an air tank 7.

A blow head 10 is mounted on the frame below the sand hopper 4. The blow head 10 has a port 8 for receiving gas-curable molding sand S from the hopper 4 and introducing compressed air 10 into the blow head. The blow head 10 is moved horizontally along the frame F so that it communicates with the air-blowing valve 5.

A pressure chamber 11 is horizontally spaced apart from and connected to the blow head 10 so that the assembled pressure chamber and the blow head are moved horizontally along the frame by a cylinder 12 connected to the pressure chamber 11. The pressure chamber 11 communicates with the air-introducing valve 6 at the top and sealingly meets the top of a metal cope 13a or metal mold half at the bottom. The metal cope 13a is mounted on the columns 2 such that it can move up from its position shown in Fig. 2.

A lifter table T is disposed between the lower parts of the columns 2. The lifter table T supports a metal drag or metal mold half 13b on the top of the table T.

The cope and drag or mold halves define a core space 14 between them. A plurality of apertures 13c for air-blowing are formed in the cope 13a. These apertures 13c communicate with blow nozzles 9 formed in the bottom of the blow head 10.

A plurality of vent plugs 16 fit in vent holes 15 formed in the cope 13a and drag 13b. The vent holes 15 communicate with a vacuum pump P or evacuating means 18, which evacuates the core space 14. One end of the evacuating means 18 communicates with the upper and lower parts of the core space 14 through the bottom of the pressure chamber 11, the wall of the lifter table 4, and vent holes 15, while the other end communicates with the vacuum pump P through an evacuating valve 17. The pump P reduces the pressure of the core space 14 to a pressure of 2 - 100 Torr.

Further, the vent holes 15 of the pressure chamber 11 and cope 13a communicate with means 19 for introducing curing gas from a gas generator 19 into the core space 14 through a valve 22. The vent holes 15 of the drag 13b communicate with a curing-gas-discharging means 21 through the lifter table T and a valve 23.

In the operation of the apparatus of Fig. 1, the gas-curable molding sand S, which has been previously mixed at a location (not shown), is placed into the hopper 4. The amount of the molding sand in the hopper, which is more than one shot for the core space, is then fed into the blow head 10 when the sand feeding gate 3 is opened.

The assembly of the blow head 10 and pressure chamber 11 are moved laterally by the cylinder 12 until the blow head 10 is located just above the mold halves and lifter table T (Fig. 2). The port 8 is connected to a port 8a of the valve 6.

The lifter table T is then moved up with the drag 13b until the drag 13b mates and pushes up the cope 13a so that the blow nozzles 9 engage and communicate with the apertures 13c of the cope 13a. The lifter table T is locked at that position. (This state is shown in Fig. 3 of the second embodiment of the present invention.)

The air-blowing then starts. When the blow valve 5 is opened, compressed air from the air tank 7 is introduced into the blow head 10. The air blown into the blow head 10 and the molding sand in it flow together through the nozzles 9 into the core space 14, so that the molding sand accumulates in the core space 14 and the air is discharged through the vent plugs 16. The location of these vent plugs can be determined by just considering their proper venting. Arranging them for a good consolidation of the molding sand need not be considered.

The lifter table T is then lowered until the cope 13a returns to its original lower position shown in Fig. 2, where the cope 13a is separated from the blow head 10. The assembly 10, 11 is moved to its original position shown in Fig. 1. The lifter table T is then moved up until air supply holes 11a of the pressure chamber 11 engage and communicate with the apertures 13c of the cope 13a. The core space 14 is evacuated by opening the valve 23 so that the pressure of the core space

becomes 2 - 100 Torr. As was explained above, the location of the vent plugs 16 can be determined by just considering their proper venting, and a good consolidation need not be considered.

The valve 6 is then opened, so that an air flow is suddenly introduced into the core space 14. The flow applies an impulse pressure to the surface of the molding sand in the core space, so that the molding sand S is well consolidated. Thus it has a charging density higher than that when it is subjected only to the air blow.

Curing gas from the curing-gas-introducing means 20 is then introduced into the core space 14. The gas passes through the molding sand S, so that it is hardened. Purging is then carried out, if necessary. The lifter table T is lowered, while upper and lower pushers 25, 25 are operated to push and take out the core product.

Preferably, for gas curing, binders such as a water glass, phenol resin, polyurethane resin, furan resin, etc. are used for gas-curable molding sand. For such gas-curable molding sand, curing gases such as carbon dioxide, TEA gas, sulfur dioxide, methyl formate, etc. may be used.

Preferably the air is introduced into the pressure chamber such that the pressure in the chamber is increased at a rate of 50 - 600 kg/cm²/sec. More preferably the rate is 200 - 400 kg/cm²/sec. The air to be introduced may be ambient air of the atmosphere or compressed air. When compressed air is used, its pressure is preferably 10 kg/cm² at maximum. The pressure may be optimized depending on the size and shape of the air-introducing valve.

The above embodiment shown in Figs. 1 and 2 is exemplary only. Clearly to one skilled in the art some modification may be made to the embodiment. For example, although in the device of Figs. 1 and 2 the evacuating means 18 communicates with the core space at its upper and lower parts, it may be modified to communicate with the space at both sides of it. Further, instead of using a cope and a drag, vertical mold halves may be used. The mold halves may be opened and closed by one or more cylinders that extend horizontally. The blow head 10 and pressure chamber 11, which in the embodiment are connected, may, alternatively, be separated and moved separately.

Further, in the above embodiment the molding sand S is charged into the core space by air-blowing. This charge can be done using the gravity of the sand or using a vacuum. When a vacuum is used in the core space 14, the molding sand is charged into it due to the pressure difference between the blow head 10 and the vacuum. Accordingly, for this case the blow head 10 acts as a pressure chamber like the pressure chamber 11. Thus the pressure chamber 11 can be eliminated. Further, either the air-blowing valve 5 or air-introducing valve 6 may be also eliminated.

Fig. 3 shows a second embodiment of the apparatus of the invention. In it the same reference numbers are designated for the same elements as in Figs. 1 and 2.

In Fig. 3 the apparatus includes a frame F secured to columns 2 mounted on a base 1, the same as in Figs. 1 and 2. A sand hopper 4, which has a sand-feeding gate 3, and an air-introducing mean, which has an air-introducing valve 6 and air tank 7, are mounted on the frame F.

A hollow cylindrical connecting body H is disposed under the hopper 4. The connecting body H has a port 8 to receive molding sand from the hopper and a port 8b through which air is introduced into the connecting body H. Under the connecting body H a pressure chamber 31 having nozzles 9 is disposed. The pressure chamber 31 and the connecting body H are integrally fixed to each other and they move integrally. The port 8b is opened and closed by a valve 6. A gas chamber 32 is connected to the pressure chamber 31 so that the assembled gas chamber and pressure chamber are horizontally moved along the frame F by a cylinder 12. The gas chamber 32 communicates with a gas generator 19. A pusher 25 having pushing pins is disposed within the gas chamber. The gas chamber 32 sealingly meets a metal mold half or cope 13a when moved onto it.

Midway in the connecting body H a sand-containing box B is disposed. Since this box B has a turner R, it can drop the molding sand contained in it into the pressure chamber 31 when turned over by the turner R.

A sand-measuring means having a belt conveyor measures the molding sand of one shot by controlling the operation of the belt conveyor and the period that the sand-feeding gate 3 is opened.

Other components of the apparatus, such as a lifter table T, curing-gas-introducing means 20, etc. are substantially the same as those in Figs. 1 and 2.

In operation, when the gate 3 is opened, an amount (corresponding to one shot) of gas-curable molding sand S from the hopper 4 is dropped into the connecting body H. Part of the molding sand is caught by the sand-containing box B, and the remaining part accumulates on the bottom of the pressure chamber 32, while the lifter table T, which carries a metal drag or mold half 13b, starts to move up until the nozzles 9 fit in holes 13c of the cope 13a.

The gate 3 is then closed, and a core space 14 is evacuated by evacuating means 18 to a pressure of 2 - 100 Torr. By this evacuation, part of the molding sand in the pressure chamber 31 is charged into the core space, and this charged molding sand is to some degree consolidated (initial degree or initial density).

The air-introducing valve 6 is then opened to apply compressed air to the pressure chamber 31. The pressure of the compressed air is preferably 10 kg/cm² at maximum, and the rate of the air pressure that increases in the core space is preferably 50 - 600 kg/cm²/sec. The air flow and molding sand in the pressure chamber flow into the core space 14. The air flow goes out through the vent plugs 16, and the molding sand is consolidated in the core space 14. It is consolidated to a higher density than the initial density due to just the vacuum.

These evacuations and air flows are repeated to further consolidate the molding sand. Immediately before the final air flow, the sand-containing box B is turned over to drop the sand in it onto the bottom of the pressure chamber 31.

After the final air-blowing, the gas chamber 32 is then connected to the mold halves in a way similar to the embodiment of Figs. 1 and 2. Similarly, the molding sand is cured and taken out from the mold halves by upper and lower pushers.

Claims

1. A method of producing a core, comprising the steps of:

closing metal mold halves to define a core space therebetween;
charging gas-curable molding sand into the mold space;
evacuating the core space to a pressure of 2 - 100 Torr;
introducing an air flow into the evacuated core space at an air-pressure rate that increases at 50 - 600 kg/cm²/sec to apply a pressure to the surface of the gas-curable molding sand to obtain a high charging density; and
introducing a curing gas into the core space to harden the molding sand.

2. The method of claim 1, wherein the gas-curable molding sand is charged into the mold space by air-blowing.
3. The method of claim 1, wherein the gas-curable molding sand is charged into the mold space by using a vacuum.
4. The method of claim 1, wherein the air introduced into the evacuated core space is at atmospheric pressure.
5. The method of claim 1, wherein the air introduced into the evacuated core space is compressed air.
6. The method of claim 1, further comprising a step of again evacuating the core space between the steps of introducing an air flow into the core space and introducing a curing gas into the core space.
7. An apparatus for producing a core by introducing gas-curable molding sand into a core space defined by a closed metal cope and drag, comprising:

a blow head (10) for receiving gas-curable molding sand, the blow head having an air-introducing port (8) at an upper part thereof and blow nozzles (9) at a lower part thereof;
a movable pressure chamber (11) to sealingly

- engage an upper part of the cope (13a) which has holes in the upper part;
 evacuating means (18) for evacuating the core space (14);
 a blow valve (5) for introducing air into the blow head;
 an air-introducing valve (6) for introducing air into the pressure chamber (11);
 curing-gas-introducing means (20) for introducing curing gas into the core space;
 a curing-gas-discharging means (21) for discharging the curing gas from the core space; and
 a lifter table (T) to vertically move the cope and drag.
8. An apparatus for producing a core by introducing gas-curable molding sand into a core space defined by a closed metal cope and drag which are closed by metal-mold-closing means that includes a lifter table disposed between columns, comprising:
- a blow head (10) provided with an air-introducing port (8) at an upper part thereof and blow nozzles (9) at a lower part thereof for receiving and feeding the gas-curable molding sand into the core space, the blow head being movable below a frame (F) mounted on upper parts of the columns and positioned below a sand hopper (4);
 a blow valve (5) mounted on the frame (F) for introducing air into the blow head through the air-introducing port (8);
 means (18) for evacuating the core space;
 means (20) for introducing curing gas into the core space; and
 means (21) for discharging the curing gas from the core space.
9. The apparatus of claim 8, wherein the apparatus further comprises a pressure chamber 11 connected to the blow head (10) and sealingly engaged with the upper part of the metal cope (13a) and an air-introducing valve (6) mounted on the frame for introducing air into the pressure chamber (11).
10. A method of producing a core, comprising the steps of:
- closing metal mold halves by means for closing and opening the mold halves so as to define a core space within the mold halves;
 dropping a measured amount of gas-curable molding sand into a pressure chamber that communicates with an upper part of the core space;
 evacuating the core space to a pressure of 2 - 100 Torr;
 introducing air into the evacuated core space
- one or more times at an air pressure that increases at a rate of 50 - 600 kg /cm² /sec to apply a pressure to the surface of the gas-curable molding sand to obtain a high charging density; and
 introducing a curing gas into the core space to harden the molding sand.
11. The method of claim 10, wherein the introduced air is at atmospheric pressure.
12. The method of claim 10, wherein the introduced air is compressed air.
13. The method of claim 10, wherein the air is introduced through the pressure chamber.
14. The method of claim 14, further comprising a step of again evacuating the core space before the step of introducing a curing gas into the core space to harden the molding sand.
15. An apparatus for producing a core by charging gas-curable molding sand into a core space defined in closed metal mold halves (13a, 13b) which are closed by means for closing and opening the mold halves, comprising:
- measuring means for measuring an amount of one shot of the molding sand S;
 a pressure chamber (31) disposed below the measuring means, the pressure chamber having an air-introducing port (6) and a sand-receiving port (8) at an upper part thereof and having sand-introducing nozzles (9) at a lower part thereof so as to receive and feed the gas-curable molding sand (S);
 a gas chamber (32) movable to sealingly engage the upper part of one of the metal mold halves (13a) which has holes in the upper part;
 evacuating means (18) for evacuating the core space;
 an air-introducing valve (6) for introducing air into the core space;
 means (20) for introducing a curing gas into the core space;
 means (21) for discharging the curing gas from the core space; and
 a lifter table (T) for vertically moving the mold halves.

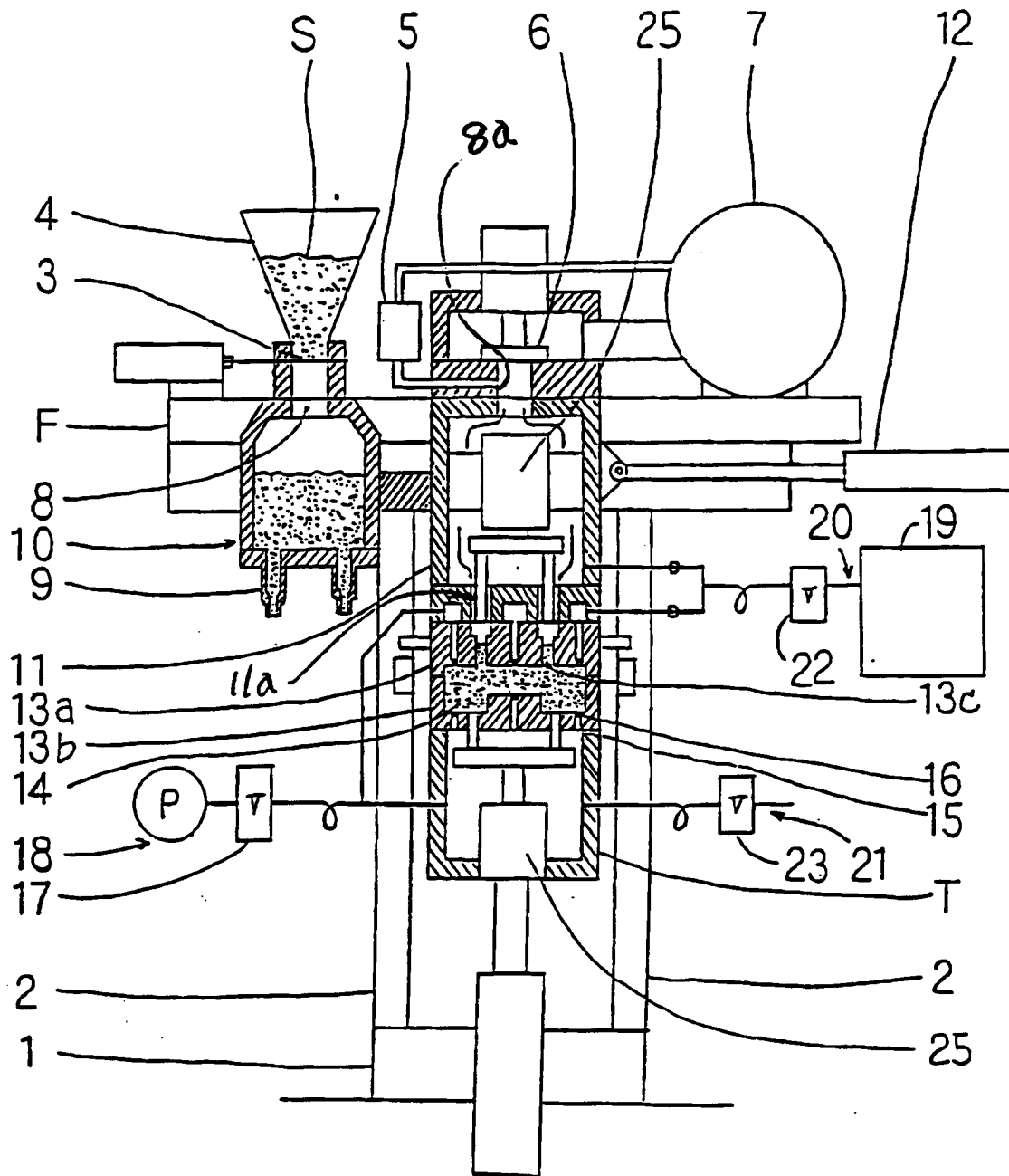


Fig. 1

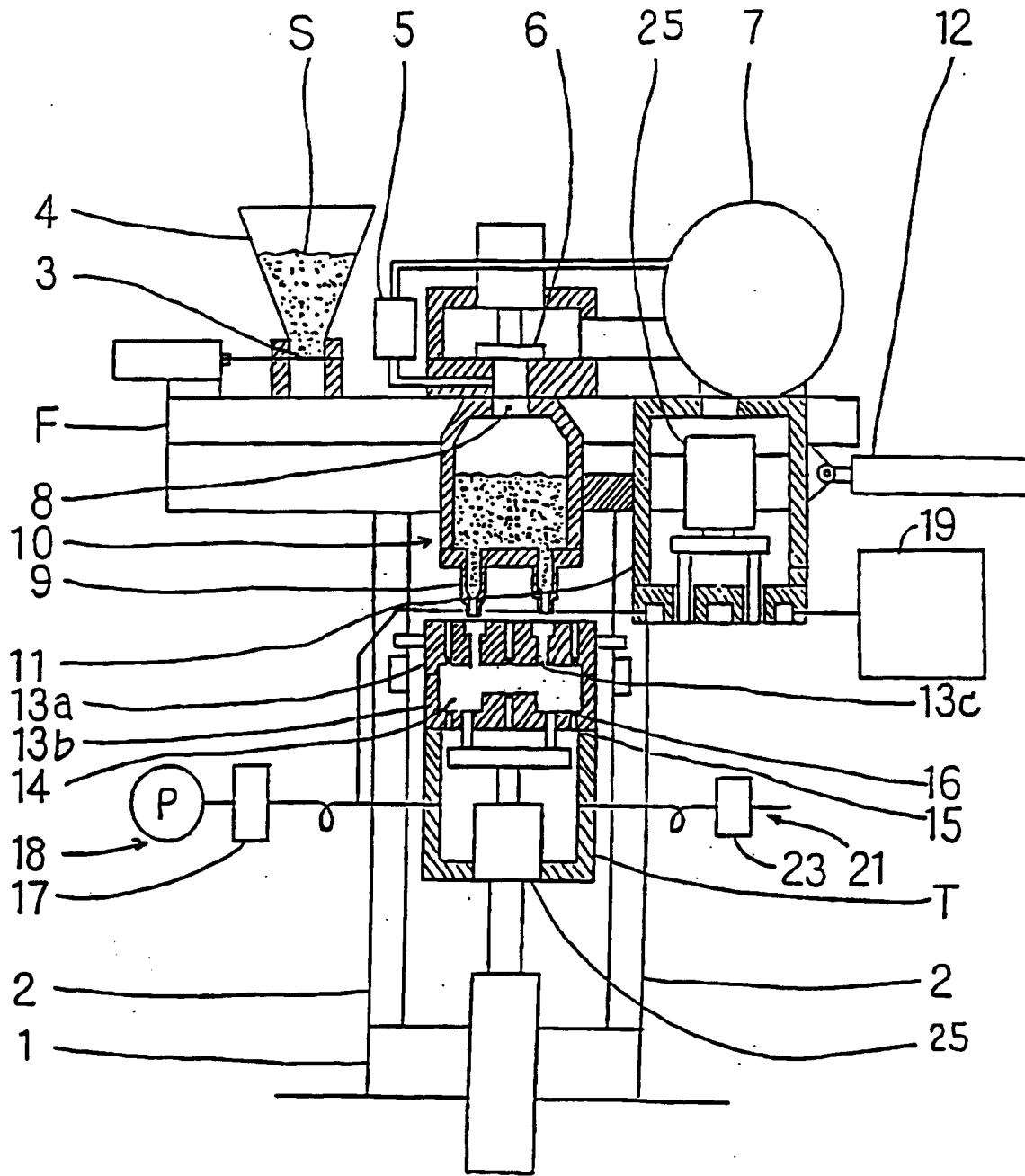


Fig. 2

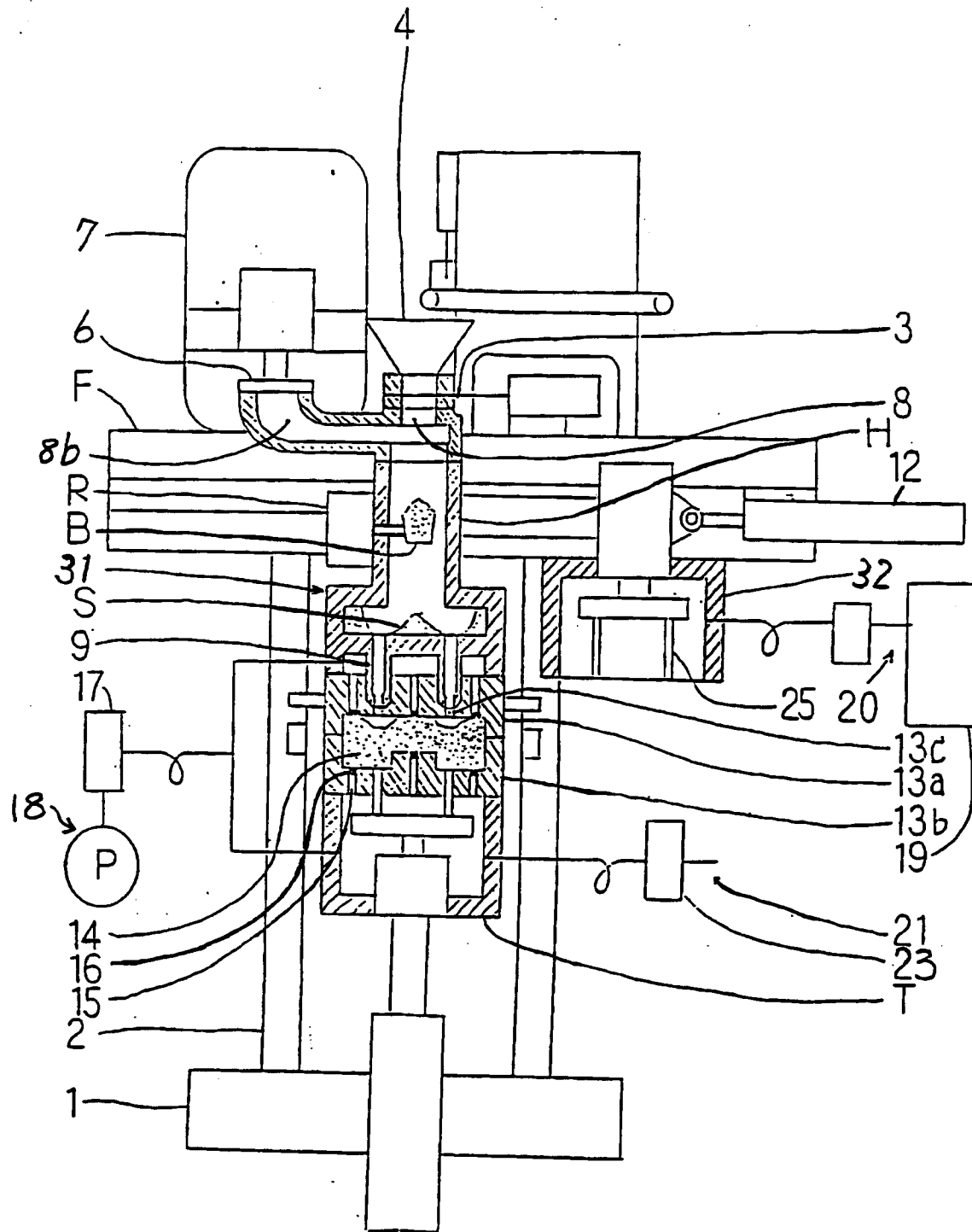


Fig. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 96 11 8272

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.6)
Y	EP 0 123 756 A (NANIWA PRODUCTS CO LTD) 7 November 1984 * page 6, line 3 - page 7, line 3; figure 1 *	1-15	B22C15/24
Y	CH 612 605 C (GEORG FISCHER AG) 15 August 1979 * the whole document *	1-15	
A	DE 93 15 614 U (ADOLF HOTTINGER MACHINENBAU GMBH) 10 February 1994 * the whole document *	10-15	
A	EP 0 443 287 A (NANIWA PRODUCTS CO LTD) 28 August 1991 * claims; figures *	1-15	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B22C
Place of search		Date of completion of the search	Examiner
THE HAGUE		24 February 1997	WOUDENBERG, S
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