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air at the hood (10, 11); wherein the system (1) comprises a management and control unit (9) operatively connected to the sensor assembly (14, 15) and to the burner device (12, 13) and adapted to: calculate a condensation temperature (T_{c1} , T_{c2}) of the air in the hood (10, 11) starting from the operating temperature (T_1 , T_2) and from the relative operating humidity (U_{r1} , U_{r2}) detected by the sensor assembly (14, 15); calculate the temperature deviation (ΔT_1 , ΔT_2) of the hood (10, 11) equal to the difference between the operating temperature (T_1 , T_2) and the condensation temperature (T_{c1} , T_{c2}) of the air in the hood (10, 11); adjust the burner device (12, 13) so as to maintain the temperature deviation (ΔT_1 , ΔT_2) of the hood (10, 11) comprised between two predefined limit values.

SHAKEOUT SYSTEM FOR FOUNDRY CASTINGS

Technical Field

The present invention relates to a shakeout system for foundry castings.

Background Art

- 5 Within the field of metallurgy, and in particular in the foundry sector for making foundry castings of cast iron, systems are known provided with a group of furnaces adapted to smelting, and therefore to the transition from solid to liquid state of the metal materials to obtain the required cast iron.

- The systems of known type are provided with primary furnaces, generally of the
10 type of cupolas, blast furnaces or rotating furnaces, into which the basic materials (iron and carbon) are introduced and, in addition to these, one or more additive materials (copper, phosphorus, ferrosilicon, ferromolybdenum, ferromanganese, ferrochrome) which, by mixing with the basic materials, permit obtaining the cast iron required in terms of physical-chemical
15 characteristics.

The systems also comprise a casting furnace in fluid-operated connection with the primary furnaces for the dispensing of a predefined quantity of liquid cast iron cast into a mold, generally made of sandy material, to obtain a foundry casting made of cast iron.

- 20 The molds made of sandy material are obtained by means of the compacting of particular sands and by making impressions on the compacted sandy material using tools suitable for obtaining the desired profile.

- Generally the molds comprise two half impressions, each corresponding to one half of the shape of the foundry casting to be made, associated with one another
25 to define the actual casting mold.

Once the casting phase of the liquid cast iron has been completed inside each mold, a cooling phase follows of the molds and relative foundry castings and a phase of cleaning off the sandy material making up the molds themselves from the castings.

- 30 Generally, the systems of known type are provided with suitable shakeout means to perform the phases of cooling and cleaning off the sandy material from the foundry castings.

The shakeout means, e.g., can comprise a shakeout drum member provided with an inlet opening, wherein the foundry castings and the molds made of sandy material are inserted for the cooling phase, and an outlet opening from which such foundry castings come out cleaned of the sandy material of the mold.

- 5 Each foundry casting and the relative mold in sandy material is mobile between the inlet opening and the outlet opening along a direction of forward movement. Such shakeout means are provided with suction systems for extracting the air contained inside the drum member, which are adapted to define a flow of air which substantially flows in counter current with respect to the direction of
10 forward movement so as to facilitate the cooling of the foundry castings and of the sandy material.

- Furthermore, the shakeout means are provided with water dispensing means arranged at the inlet and outlet openings and are adapted to deliver quantities of water proportionate to the temperatures involved inside the shakeout means and
15 to the flow rate of the material transiting inside it, so as to facilitate the reduction in the temperature of the foundry castings and of the sandy material.

The air contained inside the drum member therefore comprises the vapor generated by the evaporation of the residual relative humidity of the sand and of the water dispensed by the dispensing means.

- 20 In this respect, the systems are provided with suction means, connected in a fluid-operated manner with the shakeout means, equipped with extraction hoods arranged at the inlet and outlet openings and adapted to extract the air contained inside the shakeout means.

- The systems of known type are provided with suitable burner means operating
25 at the inlet and outlet openings and adapted to heat the flow of air exiting from the extraction hoods to reduce the level of relative humidity in the air flow itself.

- The exiting air flow, by means of the relative suction, flows through a filtering device such as to allow the filtering of the fine particles and the expulsion of the
30 filtered air.

The burner means have an autonomous and independent management system with respect to the actual thermodynamic state of the air in the inlet and outlet

areas of the drum member.

More in detail, the burner means are set at a preset temperature value which is generally modified with the change of season, and therefore according to the temperature and relative humidity of the outside air.

- 5 In the systems of known type, the main fan of the suction means works according to a pre-established and independent operating speed, with respect to the actual flow rate of the air circulating inside the ducts of the suction means themselves.

These foundry systems of known type do have a number of drawbacks.

- 10 The main drawback is tied to the fact that the phases of cooling and cleaning the foundry castings from the relative molds in sandy material are performed in a preset and independent way with respect to the hygrometric characteristics of the air contained inside the drum member and circulating in the extraction ducts of the suction means.
- 15 It follows therefore that the regulation of the operation of the burner means is performed manually by an operator who sets a preset operating temperature which is independent from the real hygrometric conditions of the air containing the vapors generated by the cooling of the foundry castings and of the sandy material.
- 20 In other words, the manual regulation of the shakeout systems of known type is such as to make the shakeout operations of the sandy material from the foundry castings difficult in the cases in which the burner means operate at temperatures which are too low and the sandy material has a high percentage of relative humidity.
- 25 On the contrary, in the cases in which the burner means operate at temperatures which are too high, the air extracted by the suction means could damage the filtering device and the suction means themselves, involving high expenditure in terms of energy consumption and damage to the shakeout system.

- One drawback of foundry casting shakeout systems of known type is tied to the
- 30 fact that they are without regulation of the relative operation in accordance with the hygrometric characteristics of the extracted air at the hoods, or in cases in which the temperature of the extracted air at the hood is below the relative

condensation temperature.

Another drawback of the foundry systems of known type is tied to the high consumption deriving from the operating modes of the burner means and of the suction means regardless of the hygrometric characteristics of the air contained
5 in the drum member.

Yet another drawback is tied to any difficulties that arise during the operations of separation and cleaning of the foundry castings from the molds in sandy material in cases in which the control of the burner means and of the suction means is inadequate to the hygrometric characteristics of the air contained
10 inside the shakeout means, with a consequent request of longer working times and further accessory operations for the completion of such operations.

Furthermore, in the cases in which the temperature of the air extracted from the suction means is too high or too low, damage could occur to the air filtering and suction system with consequent breakage of the foundry system and
15 interruptions of the production process.

Description of the Invention

The main aim of the present invention is to provide a shakeout system for foundry castings which permits optimizing the foundry casting cooling and cleaning away of sandy material operations in an automatic way and according
20 to the hygrometric characteristics of the air contained inside the drum member.

One object of the present invention is to provide a shakeout system for foundry castings which permits reducing the energy consumption tied to the operation of the shakeout means and of the suction means, with consequent adaptation with respect to the actual hygrometric conditions of the air contained in them.

25 Yet another object of the present invention is to provide a shakeout system for foundry castings which permits reducing any damage and breakdowns caused by incorrect and inadequate operating modes with respect to the actual hygrometric characteristics of the air circulating in them.

Another object of the present invention is to provide a shakeout system for
30 foundry castings which allows to overcome the mentioned drawbacks of the prior art within the ambit of a simple, rational, easy, effective to use and low cost solution.

The objects outlined above are achieved by the present shakeout system for foundry castings, having the characteristics of claim 1.

Brief Description of the Drawings

Other characteristics and advantages of the present invention will become more evident from the description of a preferred, but not exclusive, embodiment of a shakeout system for foundry castings, illustrated by way of an indicative, but non-limiting example in the accompanying drawings, wherein:

Figure 1 is a schematic representation of the system according to the invention; Figures 2 and 3 are flow diagrams that explain the operation of the system according to the invention.

Embodiments of the Invention

With particular reference to these illustrations, globally indicated with reference numeral 1 is a shakeout system for foundry castings comprising separation means for the separation of foundry castings 2 from relative molds made of sandy material 3.

More specifically, the system 1 is adapted to the shakeout of foundry castings 2 made of cast iron from the relative molds made of sandy material 3, wherein such sandy material 3 is suitably shaped to define the desired profile of the foundry casting 2 to be made, and inside which the liquid cast iron is cast.

The system 1 comprises a rotating drum member 4, having an inlet opening 5 for at least one of the foundry castings 2 to be shaken out and for the relevant molds made of sandy material 3, and an outlet opening 6 for the cooled and shaken out foundry casting 2 and for the sandy material 3.

Generally, the drum member 4 has a substantially cylindrical shape and is provided with at least one sifting septum adapted to separate the foundry castings 2 from the sandy material 3 of the relative molds.

In particular, the drum member 4 is of the rotating type and is arranged substantially inclined with respect to the ground so as to facilitate the forward movement, during the relative rotation, of the foundry castings 2 shaken out of the sandy material 3 along a direction of forward movement A.

More in detail, during the rotation of the drum member 4, the molds in sandy material 3 crumble and the separation takes place of the foundry castings 2 from

the sandy material 3.

The molds in sandy material 3 can be made using earths or other sandy material mixed with agglomerates such as to compact the sandy material 3.

Usefully, the drum member 4 comprises dispensing means 7 of a liquid fluid, generally water, arranged at at least one of the inlet opening 5 and the outlet opening 6 and adapted to cool the foundry castings 2 and the sandy material 3.

Advantageously, the dispensing means 7 are arranged at both the inlet opening 5 and the outlet opening 6.

In particular, the dispensing means 7 are adapted to the dispensing of the water at an initial section of the drum member 4 close to the inlet opening 5 to obtain a first lowering of the temperature of the foundry castings 2 and of the molds in sandy material 3 entering through the inlet opening itself.

In the same way, the dispensing means 7 are adapted to the dispensing of the water at a final section of the drum member 4 close to the outlet opening 6 to obtain a further lowering of the temperature of the foundry castings 2 and to manage the hygrometric characteristics of the sandy material 3 coming out of the outlet opening 6 and intended for reuse.

The dispensing means 7 are provided with command means that can be set by the operator to obtain the dispensing of a predefined quantity of water at the inlet opening 5 and the outlet opening 6.

The operator sets the command means according to the existing temperatures and quantity of foundry castings 2 and relative molds in sandy material 3 entering inside the inlet opening 5.

The system 1 comprises air suction means 8 having at least a hood 10, 11 arranged at at least one of the inlet opening 5 and the outlet opening 6.

The system 1 comprises at least a burner device 12, 13 which is connected in a fluid-operated manner to the hood 10, 11 and adapted to dispense a heating fluid adapted to heat air at the hood itself.

Moreover, the system 1 is provided with at least one sensor assembly 14, 15 associated with the hood 10, 11 and adapted to detect the operating temperature T_1 , T_2 and the relative operating humidity U_{r1} , U_{r2} of the air at the hood 10, 11.

According to the invention, the system 1 comprises a management and control

unit 9 operatively connected to the sensor assembly 14, 15 and to the burner device 12, 13 and adapted to:

- calculate a condensation temperature T_{c1} , T_{c2} of the air in the hood 10, 11 starting from the operating temperature T_1 , T_2 and from the relative operating humidity U_{r1} , U_{r2} detected by the sensor assembly 14, 15;
- calculate the temperature deviation ΔT_1 , ΔT_2 of the hood 10, 11 equal to the difference between the operating temperature T_1 , T_2 and the condensation temperature T_{c1} , T_{c2} of the air in the hood 10, 11;
- adjust the burner device 12, 13 so as to maintain the temperature deviation ΔT_1 , ΔT_2 of the hood 10, 11 comprised between two predefined limit values.

More in detail, within the scope of the present treatise, by the expression condensation temperature of the air in the hood is meant the temperature below which the transition occurs between the aeriform state and the liquid state of the water vapor contained in the air at the hood 10, 11 and is calculated by the management and control unit 9 according to the values of operating temperature T_1 , T_2 and the relative operating humidity U_{r1} , U_{r2} .

Preferably, the management and control unit 9 is equipped with a suitable software program adapted to activate the operating cycle of the management and control unit itself, at periodical and pre-established control intervals T_{ck} .

Preferably, such control intervals T_{ck} are between 60 sec and 150 sec.

In the preferred embodiment shown in the illustrations, the suction means 8 comprise two hoods 10, 11 of which a first hood 10, arranged at the inlet opening 5, and a second hood 11, arranged at the outlet opening 6.

Usefully, the first hood 10 and the second hood 11 are adapted to extract the air at the inlet opening 5 and outlet opening 6 respectively, in such a way as to generate a counter flow of air with respect to the direction of forward movement A to facilitate the cooling of the foundry castings 2 and of the sandy material 3 even further with respect to what is obtainable by means of the dispensing means 7.

The system 1 comprises two burner devices 12, 13 of which a first burner device 12, arranged at the first hood 10 and adapted to heat the air at the first

hood 10, and a second burner device 13, arranged at the second hood 11 and adapted to heat the air at the second hood 11.

Each of the burner devices 12, 13 is adjustable by the operator so that the heating fluid dispensed by them has a heating temperature T_{b1} , T_{b2} predefined
5 and preset by the operator him/herself depending on the applications.

In this case, each burner device 12, 13 is adapted to dispense the heating fluid having a minimum heating temperature T_{b1} , T_{b2} substantially equal to 80°C , below which the burner devices 12, 13 switch off.

More in detail, the first burner device 12 and the second burner device 13
10 operates to dispense the heating fluid at a first heating temperature T_{b1} and at a second heating temperature T_{b2} respectively, substantially between 80°C and 185°C .

Preferably, both the burner devices 12, 13 are adjusted so as to each dispense the heating fluid at the heating temperature T_{b1} , T_{b2} substantially equal to 80°C .

15 Usefully, the system 1 comprises two sensor assemblies 14, 15 of which:

- a first sensor assembly 14 associated with the first hood 10 and adapted to detect a first operating temperature T_1 and a first relative operating humidity U_{r1} of the air at the first hood 10; and
- a second sensor assembly 15, associated with the second hood 11 and
20 adapted to detect a second operating temperature T_2 and a second relative operating humidity U_{r2} of the air at the second hood 11.

More in detail, each sensor assembly 14, 15 is of the type of a probe adapted to detect the temperature and the relative humidity of the air circulating in the proximity of the probe itself.

25 In the case of the first hood 10, the first sensor assembly 14 detects the first operating temperature T_1 and the first relative operating humidity U_{r1} relating to the hygrometric characteristics of the air at the first hood 10 and therefore dependent on the temperature of the foundry castings 2 and of the relative molds in sandy material 3 entering through the inlet opening 5.

30 The management and control unit 9 is operatively connected to the first sensor assembly 14 and to the first burner device 12 and is adapted to:

- calculate a first condensation temperature T_{c1} of the air in the first hood 10

starting from the first operating temperature T_1 and from the first relative operating humidity U_{r1} ;

- calculate a first temperature deviation ΔT_1 of the first hood 10 equal to the difference between the first operating temperature T_1 and the first condensation temperature T_{c1} of the air in the first hood 10;
- adjust the first burner device 12 so as to maintain the first temperature deviation ΔT_1 of the first hood 10 comprised between two predefined limit values.

Figure 2 shows a flow chart which indicates the operating mode preferred by the management and control unit 9 adapted to pilot the first sensor assembly 14 and the first burner device 12.

More in detail, the first burner device 12 is adapted to maintain the first temperature deviation ΔT_1 of the first hood 10 between a first lower limit value, below which the air extracted by the first hood 10 has a temperature substantially below the first condensation temperature T_{c1} , and a first higher limit value, above which the air has a substantially high temperature.

It follows that the air extracted from the first hood 10 has a first operating temperature T_1 higher than the first condensation temperature T_{c1} , thus avoiding the transition from the aeriform state to the liquid state of the water contained in the air in the first hood 10.

More in detail, if the first temperature deviation ΔT_1 of the first hood 10 is between a lower limit value equal to 8°C and a higher limit value equal to 11°C , then the management and control unit 9 is adapted to maintain the first burner device 12 at a first adjusted heating temperature T_{b1r} coinciding with the first heating temperature T_{b1} :

$$T_{b1r} = T_{b1}$$

If the first temperature deviation ΔT_1 of the first hood 10 is below the first lower limit value, then the management and control unit 9 adjusts the first burner device 12 so that the first heating temperature T_{b1} increases to a predefined value.

For example, if the first temperature deviation ΔT_1 of the first hood 10 is below the lower limit value equal to 5°C , then the management and control unit 9

adjusts the first burner device 12 so that the first adjusted heating temperature T_{b1r} is equal to 160°C.

If the first temperature deviation ΔT_1 of the first hood 10 is between a lower limit value equal to 5°C and a higher limit value equal to 8°C, then the management and control unit 9 is adapted to adjust the first burner device 12 at a first adjusted heating temperature T_{b1r} equal to:

$$T_{b1r} = T_{b1} + 20^\circ\text{C}$$

If the first temperature deviation ΔT_1 of the first hood 10 is above a higher limit value, then the management and control unit 9 adjusts the first burner device 12 so that the first heating temperature T_{b1} is reduced by a predefined value.

For example, if the first temperature deviation ΔT_1 of the first hood 10 is above 11°C but below 13°C, then the management and control unit 9 adjusts the first burner device 12 so that the first adjusted heating temperature T_{b1r} is equal to:

$$T_{b1r} = T_{b1} - 10^\circ\text{C}$$

If the first temperature deviation ΔT_1 of the first hood 10 is above 13°C, then the management and control unit 9 adjusts the first burner device 12 so that the first adjusted heating temperature T_{b1r} is equal to:

$$T_{b1r} = T_{b1} - 20^\circ\text{C}$$

The management and control unit 9 is configured so that with the passing of the execution time T_{ex} of the system 1, at the end of each control interval T_{ck} , such operating mode is repeated.

The management and control unit 9 is also operatively connected to the second sensor assembly 15 and to the second burner device 13 and is adapted to:

- calculate a second condensation temperature T_{c2} of the air in the second hood 11 starting from the second operating temperature T_2 and from the second relative operating humidity U_{r2} ;
- calculate a second temperature deviation ΔT_2 of the second hood 11 equal to the difference between the second operating temperature T_2 and the second condensation temperature T_{c2} of the air in the second hood 11;
- adjust the second burner device 13 so as to maintain the second temperature deviation ΔT_2 of the second hood 11 comprised between two predefined limit values.

It follows that the air extracted from the second hood 11 has a second operating temperature T_2 higher than the second condensation temperature T_{c2} , thus avoiding the transition from the aeriform state to the liquid state of the water contained in the air in the second hood 11.

- 5 In particular, the sandy material 3 coming out of the outlet opening 6 must have temperature and relative humidity values substantially constant and predefined, such as to ensure an adequate degree of compactness.

More in detail, if the second temperature deviation ΔT_2 of the second hood 11 is between the lower limit value equal to 8°C and the higher limit value equal to
 10 11°C , then the management and control unit 9 is adapted to maintain the second burner device 13 at a second adjusted heating temperature T_{b2r} substantially coinciding with the second heating temperature T_{b2} :

$$T_{b2r} = T_{b2}$$

If the second temperature deviation ΔT_2 of the second hood 11 is below the
 15 lower limit value, then the management and control unit 9 adjusts the second burner device 13 so that the second heating temperature T_{b2} increases by a predefined value.

For example, if the second temperature deviation ΔT_2 of the second hood 11 is below the lower limit value equal to 5°C , then the management and control unit
 20 9 adjusts the second burner device 13 so that the second adjusted heating temperature T_{b2r} is equal to 160°C .

If the second temperature deviation ΔT_2 of the second hood 11 is between the lower limit value equal to 5°C and the higher limit value equal to 8°C , then the management and control unit 9 adjusts the second burner device 13 so that the
 25 second adjusted heating temperature T_{b2r} is equal to:

$$T_{b2r} = T_{b2} + 20^\circ\text{C}$$

If the second temperature deviation ΔT_2 of the second hood 11 is above the higher limit value, then the management and control unit 9 adjusts the second burner device 13 so that the second heating temperature T_{b2} is reduced by a
 30 predefined value.

For example, if the second temperature deviation ΔT_2 of the second hood 11 is above 11°C , but below 13°C , then the management and control unit 9 adjusts

the second burner device 13 so that the second adjusted heating temperature T_{b2r} is equal to:

$$T_{b2r} = T_{b2} - 10^{\circ}\text{C}$$

If the second temperature deviation ΔT_2 of the second hood 11 is above 13°C ,
5 then the management and control unit 9 adjusts the second burner device 13 so that the second adjusted heating temperature T_{b2r} is equal to:

$$T_{b2r} = T_{b2} - 20^{\circ}\text{C}$$

It can therefore be deduced that the operating mode of the management and control unit 9 adapted to pilot the second sensor assembly 15 and the second
10 burner device 13 is substantially the same as the preferred operating mode shown in figure 2 for the piloting of the first sensor assembly 14 and of the first burner device 12, and is repeated periodically with the passing of the execution time T_{ex} according to the predefined control intervals T_{ck} .

Alternative embodiments cannot however be ruled out wherein the management
15 and control unit 9 is adapted to command only the first sensor assembly 14 and the first burner device 12 or the second sensor assembly 15 and the second burner device 13, thereby intervening on just one of the two hoods 10, 11.

Alternative embodiments cannot furthermore be ruled out wherein the burner devices 12, 13 have manual operating means adapted to the manual switch-off
20 by the operator of at least one of the burner devices 12, 13 in cases in which the temperature deviations ΔT_1 , ΔT_2 have substantially high values compared to the higher limit value.

In the particular embodiment shown in the Figures, the suction means 8 comprise:

- 25 - a suction machine 16 for setting the air in motion;
- a suction channel 17 for the fluid-operated connection of the suction machine 16 to each hood 10, 11; and
- motor means 18 operatively connected to the suction machine 16 and adapted to adjust the flow rate of the air flow sucked by the suction machine
30 16.

The suction machine 16 comprises at least one fan element and the motor means 18, e.g., of the electric type, are adapted to start the rotation of the fan element

itself.

More in detail, the motor means 18 have an inverter adapted to adjust the rotation speed of the fan element, as well as of the flow rate of the air flow moved along the channel 17.

- 5 The channel 17 is substantially a tubular element with a predefined diameter, the dimensions of which relate to the flow rate of the air flow circulating in it. The system 1 comprises detection means 19 of a pressure value of the air flow sucked at the channel 17.

- In the preferred embodiment shown in the illustrations, the detection means 19
10 are arranged along the channel 17 in a pre-established position for detecting the pressure value in such pre-established position.

- The management and control unit 9 is operatively connected to the detection means 19 for the comparison of the pressure value of the air flow at the pre-established position of the channel 17 with a substantially predefined reference
15 pressure value.

Such reference pressure value is suitably calculated according to the dimensions of the channel 17 and to the particular position along the channel 17 in which the detection means 19 are arranged.

- On the basis of such calculations, the reference pressure value relating to the
20 particular position in which the detection means 19 are arranged is equal to 145 mmH₂O.

Usefully, the management and control unit 9 is adapted to adjust the inverter so that the pressure value of the air flowing along the channel 17 is substantially coincident with the reference pressure value.

- 25 In other words, by means of the pressure value detected by the detection means 19, the management and control unit 9 makes a comparison between the air pressure value at the channel 17, detected at each operating cycle having period T_{ck} , and the reference pressure value.

- More in detail, the reference pressure value is predefined so as to maintain a
30 speed of air substantially above 20 m/s along the entire channel 17.

In this respect, the fact that the air speed value along the entire channel 17 is above 20 m/s prevents any deposit of fumes and dusts in the air along the

channel 17.

In other words, such predefined pressure value results in the extracted air flow being fully conveyed along the channel 17 thus preventing any deposit of fumes and dust along the channel itself.

- 5 Usefully, the system 1 comprises sensor means 20 arranged along the channel 17 and adapted to detect a value of final temperature T_f and of final relative humidity U_{rf} of the air flowing along the channel 17.

The management and control unit 9 is operatively connected to the sensor means 20 and is adapted to:

- 10 - calculate a final condensation temperature T_{cf} of the air in the channel 17 starting from the final temperature T_f and from the final relative humidity U_{rf} ;
- calculate a final temperature deviation ΔT_f of the channel 17 equal to the difference between the final temperature T_f and the final condensation
- 15 temperature T_{cf} of the air in the channel 17;
- command each burner device 12, 13 at the maximum power in the event of the final temperature deviation ΔT_f of the channel 17 dropping below a predetermined threshold value T_s .

Figure 3 shows a flow chart of a preferred operating mode wherein the

20 management and control unit 9 pilots the burner devices 12, 13 according to the data detected by the sensor means 20; such operating mode is repeated according to the control intervals T_{ck} with the passing of the execution time T_{ex} of the system 1.

Preferably, the threshold value T_s is substantially equal to 3°C and in the case of

25 the final temperature deviation ΔT_f of the channel 17 being below such threshold value T_s , the first burner device 12 is adapted to dispense a first maximum heating temperature $T_{b1\max}$ substantially equal to 200°C , while the second burner device 13 is adapted to dispense a second maximum heating temperature $T_{b2\max}$ substantially equal to 180°C .

30 Usefully, the management and control unit 9 commands the burner devices 12, 13 so that they dispense heating fluids at adjusted heating temperatures T_{b1r} , T_{b2r} such as to avoid the condensation of the air flowing along the channel 17.

More in detail, within the scope of the present treatise by the expression final condensation temperature T_{cf} of the air in the channel 17 is meant the temperature below which the transition occurs between the aeriform state and the liquid state of the water vapor contained in the air flowing along the channel 5 17 and is calculated by the management and control unit 9 according to the values of final temperature T_f and of final relative humidity U_{rf} .

Usefully, the system 1 comprises a filtering device 21 of the air sucked by the suction machine 16, interposed between the hoods 10, 11 and the suction machine itself, adapted to filter and abate polluting fumes and dust present in 10 the air flowing along the channel 17.

Preferably, the filtering device 21 is a sleeve filter made of specific fabric for removing dust from the air extracted by the suction machine 16.

Advantageously, the suction means 8 comprise at least an opening valve 22 arranged along the channel 17 and adapted to convey an auxiliary air flow 15 substantially at ambient temperature or at a lower temperature than the air temperature circulating along the channel 17.

In particular, such auxiliary air flow comes, e.g., from the space surrounding the channel 17 or from areas within the foundry installation.

The management and control unit 9 is operatively connected to the opening 20 valve 22 and is adapted to command the opening of the opening valve itself in the event of the final temperature deviation ΔT_f of the channel 17 rising above a preset safety value.

In the event of the temperature of the air along the channel 17 being above such preset safety value, the filtering device 21 may be subject to possible damage 25 caused by the overheating of the sleeves making up the filtering device itself.

Preferably, the system 1 comprises a pressure transducer 23 arranged along the channel 17 and interposed between the filtering device 21 and the suction machine 16.

The pressure transducer 23 is adapted to detect the pressure drop value of the 30 filtering device 21.

More in detail, the drop in pressure indicates the pressure variation between the flow of air entering the filtering device 21 and the flow of air exiting from the

filtering device 21 due to the passive forces exercised by the filtering device itself which oppose resistance to the transit of the air flow inside it.

Such drop in pressure represents a sign of the degree of efficiency of the filtering device 21.

- 5 In the event of the pressure drop value being below a certain minimum threshold, then the filtering device 21 will have reduced efficiency or inefficiency of the filtering of the fumes and dusts present in the air circulating along the channel 17, with consequent need to replace the filtering device 21.

Usefully, the suction means 8 comprise an exhaust chimney 24 arranged
10 downstream of the suction machine 16 and adapted to expel the air flow circulating along the channel 17.

The exhaust chimney 24 is provided with a group of detection devices 25 for detecting the temperature, flow rate and dustiness of the air flowing along the exhaust chimney 24 as a result of the relevant suction and filtering.

- 15 More in detail, the group of detection devices 25 comprises:

- a temperature sensor adapted to detect the temperature of the air flowing along the exhaust chimney 24;
- a pressure sensor adapted to detect the pressure of the air flowing along the exhaust chimney 24;
- 20 - means of detection of the dustiness of the air flowing along the exhaust chimney 24.

Preferably, such pressure sensor is a Pitot tube adapted to detect the speed of the air flow starting with the pressure of the air flow itself.

The means of detection of the dustiness can be, e.g., of the type of optical
25 sensors or triboelectric effect sensors.

Such group of detection devices 25 permits monitoring the parameters of the air flowing in the exhaust chimney 24 and checking whether these are contained within predefined levels such as to ensure compliance with the standards relating to the emission of polluting substances into the air.

- 30 In this respect, the appointed operator can detect any faults or malfunctions of the burner devices 12, 13, of the suction means 8 and of the filtering device 21 and perform relevant maintenance and/or resetting jobs on them.

This way, the system 1 is adapted to continuously monitor the necessary and crucial parameters for their correct operation.

It has in practice been ascertained how the described invention achieves the intended objects and in particular the fact is underlined that the system made
5 this way permits optimizing the cooling and cleaning operations of the castings from the sandy material in an automatic way, reducing the energy consumption tied to the operation of the shakeout means and of the suction means.

In particular, the system made this way permits obtaining a reduction in the consumption of electricity of up to 15000 KW/year and of fuel, e.g., natural gas,
10 of up to 10000 Sm³/year.

More in detail, the system made this way sets up automatically depending on the changes in the hygrometric characteristics of the air extracted through the hoods.

CLAIMS

1) Shakeout system (1) for foundry castings, comprising separation means for the separation of at least a foundry casting (2) from at least a mold made of sandy material (3) which have:

- 5 - at least a rotating drum member (4), having at least an inlet opening (5) for said foundry casting (2) to be shaken out and for said mold made of sandy material (3) and at least an outlet opening (6) for said cooled and shaken out foundry casting (2) and for said sandy material (3);
- air suction means (8) having at least a hood (10, 11) arranged at at least one
10 of said inlet opening (5) and said outlet opening (6);
- at least a burner device (12, 13) which is connected in a fluid-operated manner to said hood (10, 11) and adapted to dispense a heating fluid adapted to heat air at said hood (10, 11);
- at least a sensor assembly (14, 15) associated with said hood (10, 11) and
15 adapted to detect the operating temperature (T_1 , T_2) and relative operating humidity (U_{r1} , U_{r2}) of the air at said hood (10, 11);

characterized by the fact that said system (1) comprises at least a management and control unit (9) operatively connected to said sensor assembly (14, 15) and to said burner device (12, 13) and adapted to:

- 20 - calculate a condensation temperature (T_{c1} , T_{c2}) of the air in the hood (10, 11) starting from said operating temperature (T_1 , T_2) and from said relative operating humidity (U_{r1} , U_{r2}) detected by said sensor assembly (14, 15);
- calculate the temperature deviation (ΔT_1 , ΔT_2) of the hood (10, 11) equal to the difference between said operating temperature (T_1 , T_2) and said
25 condensation temperature (T_{c1} , T_{c2}) of the air in the hood (10, 11);
- adjust said burner device (12, 13) so as to maintain said temperature deviation (ΔT_1 , ΔT_2) of the hood (10, 11) comprised between two predefined limit values.

2) System (1) according to claim 1, characterized by the fact that said suction
30 means (8) comprise:

- at least a suction machine (16) for setting the air in motion;
- at least a suction channel (17) for the fluid-operated connection of said

suction machine (16) to said hood (10, 11);

- motor means (18) operatively connected to said suction machine (16) and adapted to adjust the flow rate of the air flow sucked by said suction machine (16).

5 3) System (1) according to one or more of the preceding claims, characterized by the fact that it comprises at least a filtering device (21) of the air sucked by said hood (10, 11) interposed between said hood (10, 11) and said suction machine (16).

4) System (1) according to one or more of the preceding claims, characterized
10 by the fact that it comprises detection means (19) adapted to detect a pressure value of the air flow sucked at said channel (17), wherein:

- said management and control unit (9) is operatively connected to said detection means (19) for the comparison of the pressure value of the air flow at said channel (17) with a substantially predefined reference pressure
15 value;
- said management and control unit (9) is adapted to adjust said motor means (18) so that the pressure value of the air flow flowing along said channel (17) is substantially coincident with the reference pressure value; and
- said reference pressure value is predefined so as to maintain a speed of air
20 along said channel (17) substantially above 20 m/s.

5) System (1) according to one or more of the preceding claims, characterized by the fact that it comprises sensor means (20) arranged along said channel (17) and adapted to detect a final temperature value (T_f) and a final relative humidity value (U_{rf}) of the air flowing along said channel (17), said management and
25 control unit (9) being operatively connected to said sensor means (20) and adapted to:

- calculate a final condensation temperature (T_{cf}) of the air in the channel (17) starting from said final temperature (T_f) and from said final relative humidity (U_{rf});
- 30 - calculate a final temperature deviation (ΔT_f) of the channel (17) equal to the difference between said final temperature (T_f) and said final condensation temperature (T_{cf}) of the air in the channel (17);

- command said burner device (12, 13) at the maximum power in the event of said final temperature deviation (ΔT_f) of the channel (17) dropping below a predetermined threshold value (T_s).
- 6) System (1) according to one or more of the preceding claims, characterized by the fact that said suction means (8) comprise at least an opening valve (22) arranged along said channel (17), said management and control unit (9) being operatively connected to said opening valve (22) and adapted to command the opening of said opening valve (22) in the event of said final temperature value (T_f) rising above a preset safety value.
- 7) System (1) according to one or more of the preceding claims, characterized by the fact that it comprises at least a pressure transducer (23) arranged along said channel (17) and interposed between said filtering device (21) and said suction machine (16), said pressure transducer (23) being adapted to detect the load loss value of said filtering device (21).
- 8) System (1) according to one or more of the preceding claims, characterized by the fact that said rotating drum member (4) comprises dispensing means (7) of at least a liquid fluid arranged at at least one of said inlet opening (5) and said outlet opening (6) and adapted to cool said foundry casting (2) and said sandy material (3).
- 9) System (1) according to one or more of the preceding claims, characterized by the fact that said suction means (8) comprise at least an exhaust chimney (24) arranged downstream of said suction machine (16) and adapted to expel the air flow circulating along said channel (17), said exhaust chimney (24) having at least a group of detection devices (25) for detecting the temperature, flow rate and dustiness of the air flow flowing along said exhaust chimney (24).
- 10) System (1) according to one or more of the preceding claims, characterized in that:
- said suction means (8) comprise two of said hoods (10, 11) of which a first hood (10) arranged at said inlet opening (5) and a second hood (11) arranged at said outlet opening (6);
 - said system (1) comprises two of said burner devices (12, 13) of which a first burner device (12), arranged at said first hood (10) and adapted to heat

- the air at said first hood (10), and a second burner device (13), arranged at said second hood (11) and adapted to heat the air at said second hood (11);
- said system (1) comprises two of said sensor assemblies (14, 15) of which a first sensor assembly (14), associated with said first hood (10) and adapted to detect a first operating temperature (T_1) and a first relative operating humidity (U_{r1}) of the air at said first hood (10), and a second sensor assembly (15), associated with said second hood (11) and adapted to detect a second operating temperature (T_2) and a second relative operating humidity (U_{r2}) of the air at said second hood (11);
 - 10 - said management and control unit (9) is operatively connected to said first sensor assembly (14) and to said first burner device (12) and is adapted to:
 - calculate a first condensation temperature (T_{c1}) of the air in the first hood (10) starting from said first operating temperature (T_1) and from said first relative operating humidity (U_{r1});
 - 15 - calculate a first temperature deviation (ΔT_1) of the first hood (10) equal to the difference between said first operating temperature (T_1) and said first condensation temperature (T_{c1}) of the air in the first hood (10);
 - adjust said first burner device (12) so as to maintain said first temperature deviation (ΔT_1) of the first hood (10) comprised between
 - 20 two of said predefined limit values;
 - said management and control unit (9) is operatively connected to said second sensor assembly (15) and to said second burner device (13) and is adapted to:
 - calculate a second condensation temperature (T_{c2}) of the air in the
 - 25 second hood (11) starting from said second operating temperature (T_2) and from said second relative operating humidity (U_{r2});
 - calculate a second temperature deviation (ΔT_2) of the second hood (11) equal to the difference between said second operating temperature (T_2) and said second condensation temperature (T_{c2}) of the air in the second
 - 30 hood (11);
 - adjust said second burner device (13) so as to maintain said second temperature deviation (ΔT_2) of the second hood (11) comprised between

two of said predefined limit values.

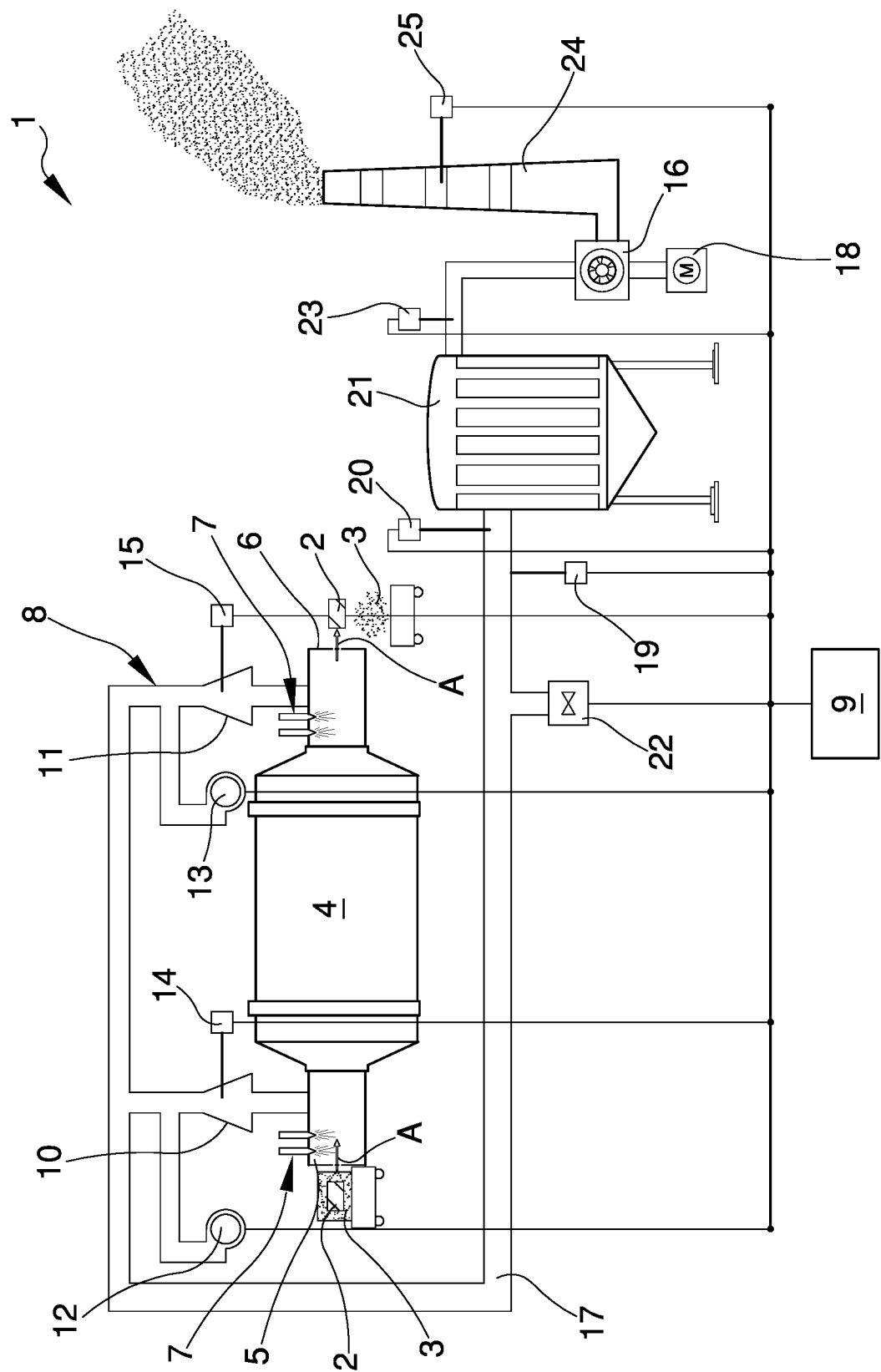


Fig.1

Fig.2

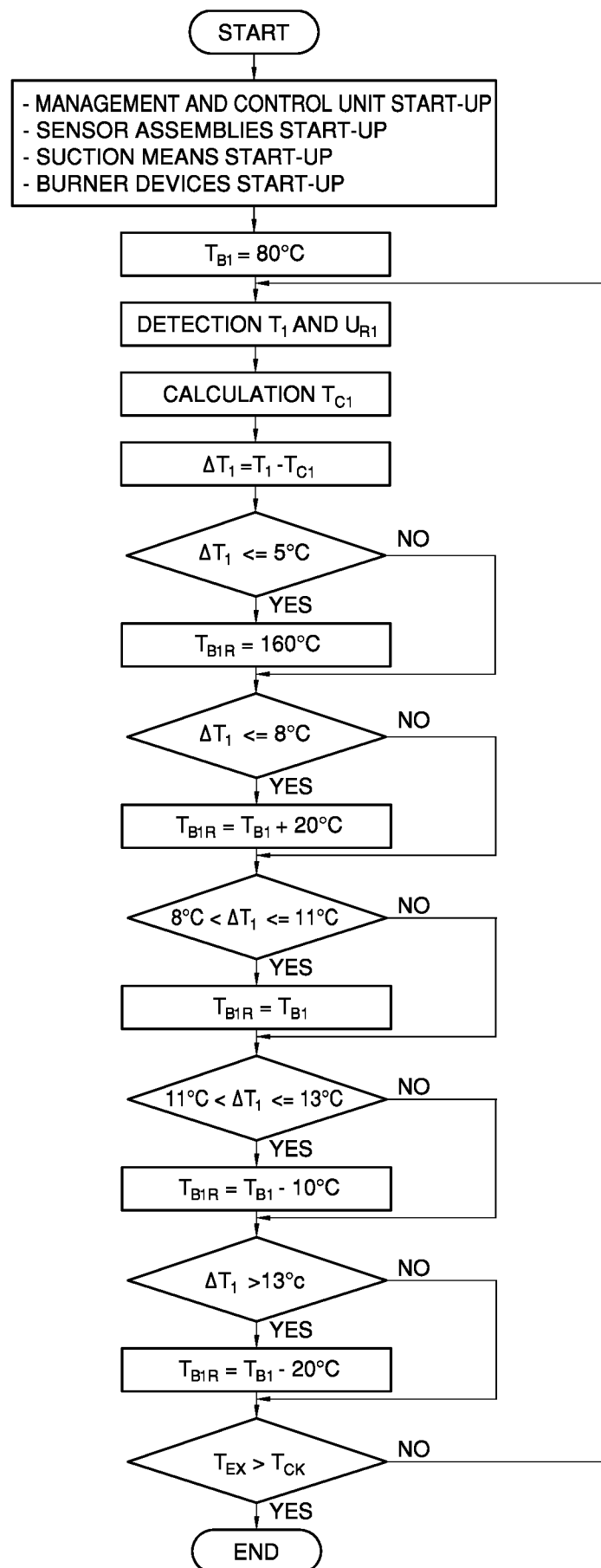
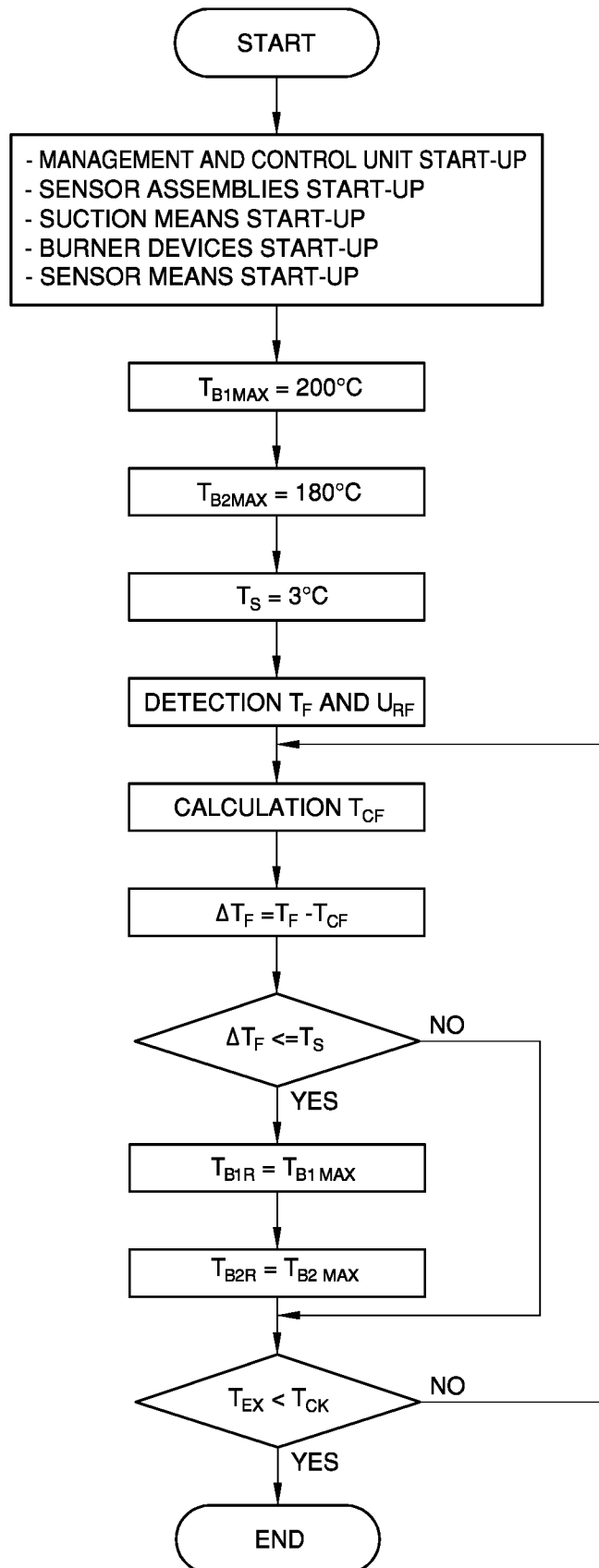


Fig.3



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/053176

A. CLASSIFICATION OF SUBJECT MATTER

INV. B22C5/08 B22D29/00 B22D30/00 B22D31/00 F26B11/04
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B22C B22D F26B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	----- EP 0 066 931 A1 (MULTINORM BV [NL]) 15 December 1982 (1982-12-15) the whole document	1-10
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Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search

22 August 2017

Date of mailing of the international search report

01/09/2017

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INTERNATIONAL SEARCH REPORT

International application No
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A	SMITH R J: "SELECTING A THERMAL RECLAIMER FOR GREEN SAND. \PART 1: TYPES OF EQUIPMENT", MODERN CASTING, AMERICAN FOUNDRY SOCIETY, SCHAUMBURG, IL, US, vol. 81, no. 8, 1 August 1991 (1991-08-01) , pages 32-34, XP000237676, ISSN: 0026-7562 the whole document -----	1-10
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International application No

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