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CASTING APPARATUS WITH REGULATED COOLING STATION

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Fig.1

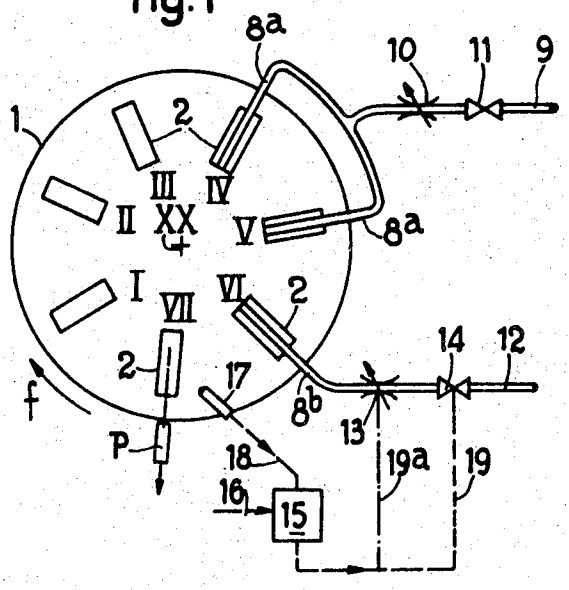
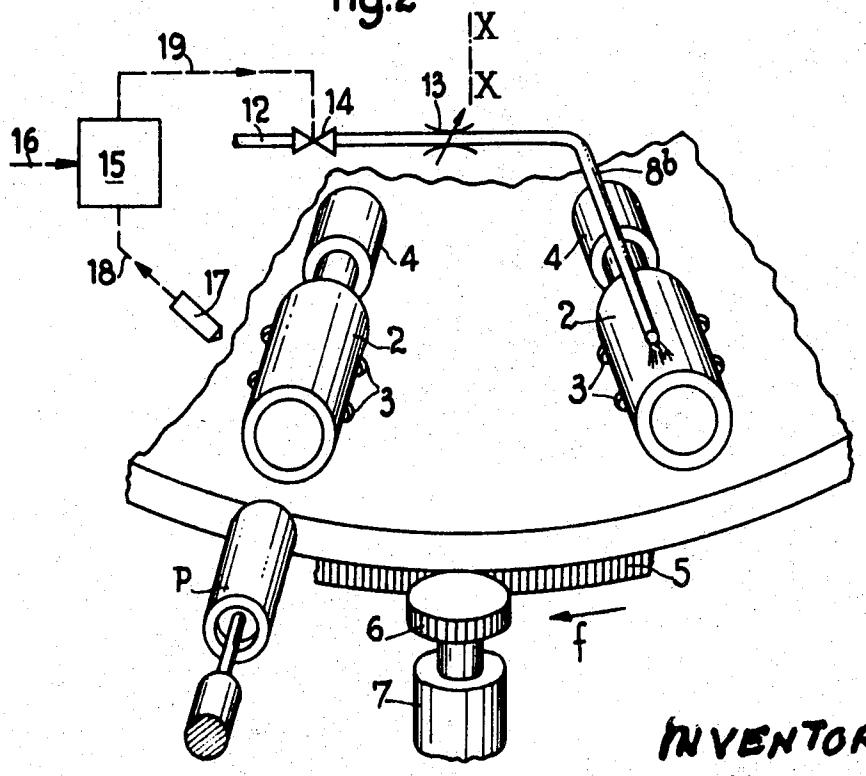


Fig.2



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CASTING APPARATUS WITH REGULATED COOLING STATION

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ABSTRACT OF THE DISCLOSURE

A foundry mould cooling apparatus for a mould turntable conveying the moulds between successive stations including a cleaning station, casting station, a first mould cooling station and a cast part extracting station. A complementary cooling station is provided following on the first cooling station and adapted to supply a complementary amount of cooling water which complements a minimum supply of water by the first cooling station. The amount of complementary water is governed by control means responsive to the temperature of a mould, for example the mould which has just left the cooling stations.

The present invention relates to the cooling of moulds employed in foundries so as to achieve a mould temperature which is practically constant throughout a production cycle including internal cleaning of the mould, a possible coating thereof, casting, cooling of the cast part and extraction of the cast part.

It is known practice to cool the foundry moulds by spraying devices. However, up to the present time, no satisfactory solution has been proposed for the problem of providing a suitable spraying to maintain the moulds at a roughly constant temperature notwithstanding the fact that in each production cycle there is supplied to the mould a considerable amount of heat in each casting operation, this heat being removed when extracting the cast part.

Now, it is essential to maintain the casting moulds at a constant temperature, at least in certain cases, for example when the moulds receive a coating of a wet mixture of powdered silica and water. Indeed, if the temperature of the moulds is too high, the water of the coating mixture vaporizes before reaching the mould surface and the solid particles of the mixture, which are insufficiently bound together, are distributed in an uneven manner on the mould surface and the coating does not perform its protecting function correctly. On the other hand, if the temperature is too low, the water does not completely vaporize and the coating is too damp when casting so that the water vaporizes in the course of the casting and gives off steam which passes through the molten metal. The cast part may then have flaws requiring its rejection.

Further, incidents could occur in the course of production (for example stoppage of the casting or acceleration of the production rate) which disturb the rhythm and regularity of the cooling of the moulds so that their temperature is substantially varied which could also result in rejection of the cast parts.

An object of the invention is to provide an apparatus for cooling foundry moulds which avoids these drawbacks.

The invention provides a foundry mould cooling apparatus for a mould turntable which conveys the moulds between successive stations for cleaning the moulds, possibly coating the inner face of the moulds, casting, cooling by spraying and extracting the cast part, said apparatus comprising at the spraying stations spraying means for spraying the moulds with water at a variable rate of flow controlled by electrically-operated valves and flow regulators, wherein there is provided, following on at least one permanent spraying station having a constant minimum rate of flow, a spraying station having a complementary rate of flow of water which is controlled through a control by a device measuring the temperature of the moulds.

According to a feature of the invention an electrically-operated valve in the supply conduit of the complementary spraying station is actuated by an electronic servo containing opening and closing instructions for two given temperatures and receiving temperature-indicating signals from a pyrometer which measures the temperature of the last mould which has passed through said complementary spraying station.

In this case, the spraying by the complementary spraying station is intermittent.

According to a modification of the invention, a flow regulator in the supply conduit of the complementary spraying station is actuated by an electronic control device controlled by the measurement of the temperature of the last mould which passed through said complementary spraying station.

In this case, the spraying effected by this station is continuous but at a variable rate of flow.

Owing to the invention the amount of spraying water supplied is increased if the moulds have a tendency to become overheated and reduced if the moulds have a tendency to cool. The temperature of the moulds is measured in a region where it is stabilized and is responsive to variations in the production rate, that is, following on the last spraying station. The temperature of the moulds indeed increases when the production rate increases and decreases when the production rate decreases. The amount of spraying water supplied is regulated beforehand, that is, before the mould reaches the station at which its stabilized temperature is measured.

Thus, the amount of spraying water supplied is constantly adjusted to the required value for maintaining the moulds at a practically constant temperature at the moment of application of the coating and at the moment of casting.

Further features and advantages of the invention will be apparent from the ensuing description with reference to the accompanying drawing.

In the drawing:

FIG. 1 is a diagrammatic plan view of an apparatus according to the invention, and

FIG. 2 is a perspective diagrammatic view of a detail of the apparatus showing the moulds sprayed by spraying devices having an intermittent water flow or output and the means for measuring the temperature of the moulds.

In the embodiment shown in drawing, the invention is applied to a turntable 1 carrying moulds or shells 2 used in foundries, for example moulds employed for centrifugal casting. Each mould 2 is mounted on rollers 3 and rotated about its longitudinal axis by a corresponding motor 4.

The turntable 1, which is for example circular and has an axis of rotation X—X, comprises a ring gear 5 whereby it is driven in rotation about the axis X—X in the direction of arrow *f* by a pinion 6 and a motor speed-reducer unit 7. The moulds 2, for example seven moulds, are arranged on the turntable 1 and pass in front of successive stations: namely station I for cleaning, that is, brushing the inner face of the mould; station II for coating the inner face of the mould by the projection or spraying of a liquid mixture, for example of silica and bentonite; station III for casting; stations IV, V, VI for

cooling by spraying; station VII for extracting the cast part.

Cold water spraying devices are arranged at the cooling stations IV, V, VI, the jets being arranged to spray the moulds **2** uniformly.

According to the invention, two series of spraying devices 8^a and 8^b are provided.

The series of spraying devices 8^a is disposed at the stations IV and V, these being the permanent spraying devices supplied with water by a conduit **9** whose rate of flow or output is regulated by a flow regulator **10** at a minimum value sufficient to ensure a correct mould cooling when the production rate and the metal casting temperature are minimum. This value is determined by trials. There is provided in the conduit **9** an electrically-operated valve **11** of known type (shown symbolically) for opening and closing the conduit. The valve **11** remains open in normal operation of the apparatus.

The second series of spraying devices 8^b comprises at least one spraying device 8^b placed at the complementary spraying station VI. The device 8^b is supplied with water by a conduit **12** having an intermittent flow or variable output which is complementary to the flow of the aforementioned minimum flow. This complementary spraying supplies the remaining water so as to cool the moulds in an improved manner when the production rate increases. Water supply control means are provided in the conduit **12** which comprises a flow regulator **13** for regulating the rate of flow and an electrically-operated valve **14** of known type connected in series with the regulator **13** in the conduit **12** for rendering the flow intermittent. The valve **14** is opened and closed by the effect of the temperature of the moulds **2** at the part extracting station VII through a servo control **15**.

The servo control **15** is for example electronic but it may be pneumatic. It is of a known commercially-available type and has therefore been shown merely symbolically. It contains opening instructions for an excessively high mould temperature t^1 and closing instructions for an excessively low mould temperature t^2. The temperatures t^1 and t^2 are determined by trials. The instructions are shown symbolically by an arrow **16**.

The control device **15** receives signals representing the temperature of a pyrometer **17** through a transmission line **18**. The pyrometer **17** measures the mould at a station where its temperature is stabilized and responsive to variations in the production rate, that is to say, the pyrometer is located at station VII following on the spraying stations IV, V, VI.

Finally, the servo control **15** transmits the opening and closing signals to the valve **14** through a transmission line **19**.

The apparatus operates in the following manner:

In normal operation, when the turntable is rotating, one mould is being cleaned at station I, another is being coated at station II, a third receives molten metal, for example iron, at station III, three other moulds are being cooled at stations IV, V and VI under spraying devices 8^a and 8^b, and a last mould is at the station VII where the cast part is extracted from the mould.

In respect of cooling stations IV and V, the valve **11** is open. The first series of spraying devices 8^a permanently sprays the moulds **2** with water at a flow rate Q^1 regulated by the flow regulator **10**. The flow rate Q^1 is the minimum necessary flow.

The spray device or devices **8** of the complementary spraying station VI either sprays the mould **2** at a complementary flow rate Q^2 or does not spray the mould, depending on whether the valve **14** is open or closed. The valve **14** is open if the temperature of the mould **2** measured by the pyrometer **17** at station VII is sufficiently high, for example higher than t^1. It is closed if the temperature is too low, for example below t^2. The flow Q^1 is constant and the flow Q^2 is therefore intermittent. The

two flows are added to each other and give a total flow rate Q.

Thus, the correction of the spraying flow rate is effected at station VI in respect of mould **2** whose temperature is not read off directly, since it is not stabilized, but is, as it were, previously estimated by measuring the temperature of the preceding mould **2** at station VII so as to ascertain the influence of the spraying on the cooling. When the mould **2** sprayed at station VI in turn reaches the extracting station VII, its temperature is in turn measured and may possibly result in the valve **14** effecting a further correction so as to provide a corrected cooling of the following mould.

Owing to the fact that the pyrometer **17** measures each mould **2** at station VII which follows the spraying stations IV, V, VI, the temperature of the mould is measured in a region where it is stabilized but nevertheless responsive to variations in the production rate, this temperature tending to increase when the production rate increases and decreases when the production rate decreases. For this reason it is in this region that the temperature variations can best be detected in that the correction by cooling can be checked.

Owing to the invention, the temperature of the moulds is practically stabilized at the coating station II and casting station III and it is possible to considerably improve the casting conditions and thus avoid the aforementioned rejection of the cast parts.

As a modification of the invention, it could be arranged that the pyrometer measure not the mould **2** directly but, for reasons of convenience, the cast part extracted from the mould at station VII in a region where it is separated from the mould and open to the free air, whereby to ascertain the temperature of the mould indirectly.

Finally, the water supply control means could consist solely of the flow regulator **13** instead of the valve **14** which is controlled by the control device **15**. In this case, a line **19***a*, shown in dot dash line in FIG. 1, connects the control device **15** to the regulator **13**, the part of the line **19** beyond line **19***a* being eliminated. When the temperature of the mould **2** at station VII is too high, the regulator **13** is actuated in such manner as to increase the supply of water. In other words, the flow passage section is increased. In the opposite case, it is actuated in such manner as to decrease the flow, that is, the flow passage section is decreased.

Having now described my invention what I claim and desire to secure by Letters Patent is:

1. A foundry mould cooling apparatus in combination with a mould turntable which is rotatable and carries a plurality of moulds and is combined with means for rotating the turntable so that each of said moulds is conveyed in a path in turn to each one of a plurality of successive stations which are circumferentially spaced part from each other equal distances, said stations including a station for cleaning the inside of the mould prior to casting, a station for casting a part in the mould, and a station for extracting the cast part from the mould, said cooling apparatus comprising a plurality of cooling stations which are part of said successive stations and are interposed between said casting station and said extracting station, a cooling station of said cooling stations which is adjacent said extracting station being a complementary cooling station having a complementary water spraying device for spraying the outside of the mould, and the remainder of said cooling stations having water spraying means for spraying the outside of the mould with a given amount of water, said cooling apparatus further comprising adjustable water supply control means for regulating the amount of water issuing from said complementary spraying device, a temperature measuring device located in said path on a position beyond said cooling stations relative to the direction in which the moulds are conveyed and adapted and arranged to measure a temperature related to the temperature of the mould, a control device responsive to said

temperature measuring device and associated with said water supply control means to regulate the amount of water issuing from said complementary spraying device in accordance with a predetermined desired temperature of the mould in one of said stations other than said cooling stations.

2. An apparatus as claimed in claim 1, wherein said temperature measuring device is located in said path adjacent said complementary cooling station.

3. An apparatus as claimed in claim 1, wherein said water supply control means comprise selectively opening and closing valve means and said control device comprises an electronic servo-device adapted to selectively open and close said valve means at two predetermined reference temperatures, and said temperature measuring device comprises a pyrometer which is positioned and arranged to measure a temperature related to the temperature of a mold which has left the complementary cooling station with respect to the direction in which the moulds are conveyed.

4. An apparatus as claimed in claim 3, wherein said valve means are electrically controlled means and a transmission line connects said valve means to said servo-device and said pyrometer is adapted to produce electrical temperature indicating signals and is connected through a transmission line to said servo device.

5. An apparatus as claimed in claim 4, wherein said pyrometer is positioned and arranged to measure the temperature of the mould at said extracting station.

6. An apparatus as claimed in claim 4, wherein said pyrometer is positioned and arranged to measure the temperature of said cast part extracted from the mould at said extracting station in a region where said cast part is separated from the mould and exposed to free air.

7. An apparatus as claimed in claim 1, wherein said water supply control means comprise a water flow regulator for regulating the rate of flow of water from said complementary water spraying device.

8. An apparatus as claimed in claim 7, wherein said temperature measuring device is adjacent said complementary cooling station.

9. A foundry mould cooling apparatus in combination with a mould turntable which is rotatable and carries a plurality of moulds and is combined with means for rotating the turntable so that each of said moulds is conveyed in a path in turn to each one of a plurality of successive stations which are circumferentially spaced apart from each other equal distances, said stations including a station for cleaning the inside of the mould prior to casting, a station for coating the inside surface of the mould, a station for casting a part in the mould, and a station for extracting the cast part from the mould, said cooling apparatus comprising a plurality of cooling stations which are part of said successive stations and are interposed between said casting station and said extracting station, a cooling station of said cooling stations which is adjacent said extracting station being a complementary cooling station having a complementary water spraying devices for spraying the outside of the mould, and the other cooling stations of said cooling stations having water spraying means for spraying the outside of the mould with a given amount of water, said cooling apparatus further comprising adjustable water supply control means for regulating the amount of water issuing from said complementary spraying device, a temperature measuring device located in said path on a position beyond said cooling stations relative to the direction in which the moulds are conveyed and adapted and arranged to measure a temperature related to the temperature of the mould, a control device responsive to said temperature measuring device and associated with said water supply control means to regulate the amount of water issuing from said complementary spraying device in accordance with a predetermined desired temperature of the mould in one of said stations other than said cooling stations.

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ROBERT D. BALDWIN, Primary Examiner

U.S. Cl. X.R.

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