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(54) Ingot mould with tubular crystallizer.

(57) The invention concerns an ingot mould (10) with a tubular crystallizer for continuous horizontal casting, said ingot mould including in coordinated cooperation:

- a replaceable tubular crystallizer (20) having a modest thickness and located in the inner part of the ingot mould (10),
- a tubular cooling sleeve (30) which is located in the outer part of the ingot mould (10) and forms a cooling interspace (33) around the tubular crystallizer (20), whereby each end of said tubular sleeve (30) is provided with an annular chamber (36) communicating with said interspace (33), and
- circular crown means (40) which are located in the end of the ingot mould (10) near the channel feeding the liquid metal and which are able to connect the end of the tubular crystallizer (20) to the end of the tubular cooling sleeve (30),

whereby said circular crown means (40) are provided with a plurality of cooling ducts (42) which connect the interspace (33) to the annular chamber (36) envisaged in said end.

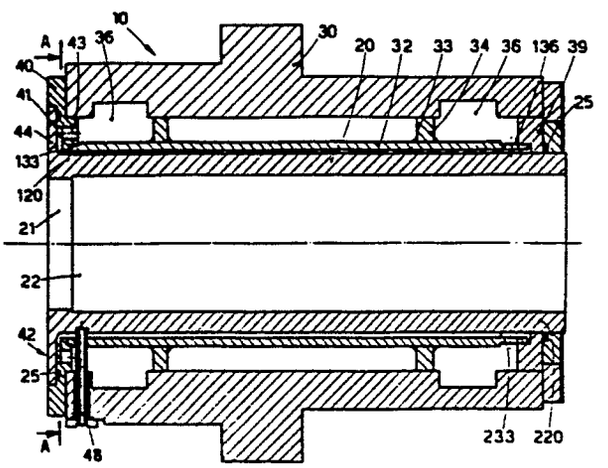

fig.1

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Description of the invention entitled:

"INGOT MOULD WITH TUBULAR CRYSTALLIZER"

in the name of DANIELI & C. OFFICINE MECCANICHE SpA at Buttrio

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This invention concerns an ingot mould with a tubular crystallizer. To be more exact, the invention concerns an ingot mould for continuous casting provided inside with a tubular crystallizer of a modest thickness, whereby an interspace within which a cooling liquid circulates is envisaged outside the tubular crystallizer.

Known ingot moulds consist generally of one single tubular body having a great thickness for withstanding and dispersing considerable amounts of heat, whereby said tubular body acts as a crystallizer and is made of a special and very expensive copper alloy able to withstand high temperatures and to disperse the heat quickly, in the meanwhile undergoing limited wear and facilitating good performance of the crystallization process and withdrawal of the ingot.

Said known ingot moulds are cooled on their outside and, when the inner walls of the crystallizer become worn and deteriorate, steps are taken to replace the whole ingot mould.

As said ingot moulds consist of one single very thick tubular body made of an expensive material, the necessary

replacements of the ingot mould represent a great burden for the user.

So as to overcome the aforesaid problems, ingot moulds have been embodied which are equipped inwardly with a thinner crystallizer outside which an interspace is envisaged, and a cooling liquid runs within said interspace; however, in said ingot moulds problems of insufficient or badly distributed cooling arise during working, particularly so in relation to the surfaces in the portion facing the feed of the crystallizer.

The purpose of this invention is to embody an ingot mould wherein only the inner part with a modest thickness is made of a valuable material, and wherein an interspace between the inner part acting as a crystallizer and the remaining part of the ingot mould is comprised together with suitable ducts; in said interspace a cooling liquid runs and is able to ensure dispersion of heat and the efficient working of the crystallizer and to improve the conditions for cooling the crystallizer, above all in the portion nearest to the feed of the crystallizer itself.

The ingot mould of the invention provides the advantage of improving the cooling of the crystallizer, above all in the end part and end surface near to the feed of liquid metal.

The ingot mould of the invention also entails the advantage of minimising the employment of valuable material and is of a more economical overall construction.

Another advantage of the ingot mould of the invention lies in the fact that it obviates the complications arising from a badly distributed cooling of the crystallizer.

Yet another advantage of the ingot mould of the invention is that it permits an easier and quicker regulation of the cooling intensity by varying the flow and/or characteristics of the cooling liquid.

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Lastly, it is an advantage of the ingot mould of the invention that, when the inner walls of the crystallizer become worn and deteriorate beyond a given limit, said mould requires only an economical replaceable crystallizer tube, for the remainder of the ingot mould can be used with a new crystallizer the same as the one employed beforehand.

The invention is therefore embodied in an ingot mould with a tubular crystallizer for continuous horizontal casting, said ingot mould being characterized by including in coordinate cooperation:

- a replaceable tubular crystallizer having a modest thickness and located in the inner part of the ingot mould,
- a cooling tubular sleeve located in the outer part of the ingot mould and forming a cooling interspace around the tubular crystallizer, whereby said tubular sleeve is equipped at each end with an annular chamber communicating with said interspace, and
- circular crown means located at the end of the ingot mould near the feed channel for the liquid metal, whereby said circular crown means can connect together the end of the tubular crystallizer and the end of the tubular cooling sleeve and are provided with a plurality of cooling ducts connecting the interspace to the annular chamber envisaged in said end.

To be more exact, the ingot mould of the invention comprises a replaceable tubular crystallizer having a modest thickness and made of valuable material, whereby said crystallizer is located in the inner part of the ingot mould and is equipped at its end facing the feed of metal with a flange which is suitable for improving the connection to the feed channel envisaged upstream from the ingot mould and for improving the conditions for cooling the end of the crystallizer facing said feed channel, and whereby one or more thermo-

couples are comprised and can monitor the temperature at that end of the crystallizer; the ingot mould also comprises a tubular cooling sleeve made of ordinary steel or cast iron, whereby said sleeve is located in the outer part of the ingot mould, is provided on its inside with a tubular jacket having an inner diameter greater than the outer diameter of the crystallizer tube, is able to form, together with the outer surface of the crystallizer tube, an interspace for the circulation of the cooling liquid and is also equipped with two annular chambers made between said jacket and the tubular cooling sleeve; one of said annular chambers is envisaged as being in the end of the ingot mould facing the direction of withdrawal of the ingot and communicates radially with the interspace formed by the jacket of the tubular cooling sleeve and by the crystallizer tube and is provided with at least one inlet for cooling liquid, whereas the other annular chamber envisaged at the end of the ingot mould facing the feed is provided with at least one outlet for cooling fluid and communicates with the end of the interspace formed between the jacket of the tubular cooling sleeve and the crystallizer tube and located behind the flange, through a circular crown provided with a plurality of ducts suitably conformed for improving the cooling of the crystallizer in the zone whereinto the liquid metal is fed; said circular crown also acts to connect the crystallizer to the tubular sleeve of the ingot mould.

We shall give hereinafter a description of a preferential embodiment of the ingot mould of the invention as a non-restrictive example with the help of the table, wherein: -

Fig.I shows a lengthwise section of the ingot mould according to the invention;

Fig.2 shows a crosswise section of the ingot mould of the invention along the line A-A.

With reference to the figures we have as follows: IO is

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the ingot mould according to the invention; 20 is the replaceable tubular crystallizer, which has a modest thickness and is made of a valuable material and located in the inner part of the ingot mould IO; said crystallizer 20 is equipped on its outside, at its end I20 facing the feed of liquid metal, with a flange 24 able to improve the conditions for cooling said end I20 and to improve the connection of the ingot mould IO to a feeding device envisaged as being upstream from said ingot mould; said crystallizer 20 is equipped on its inside with an initial portion 2I having a smaller diameter than that of the remainder 22 of the inner conduit of the crystallizer 20, said initial portion 2I being able to improve the quality of the surface of the ingot thus obtained; 30 is a tubular cooling sleeve made of ordinary steel or cast iron and is located in the outer part of the ingot mould IO and is equipped on its inside with a tubular jacket 32 secured to said tubular cooling sleeve 30 by means of anchorage rings 34, whereby said tubular jacket 32 has an inner diameter greater than the outer diameter of the crystallizer 20 and, together with the outer surface of said crystallizer 20, is able to form an interpsace 33 for the circulation of cooling liquid on the outside of the crystallizer 20.

The tubular sleeve 30 is provided at its ends with two annular chambers 36 made between the tubular jacket 32 and the outer body of the tubular sleeve 30.

The annular chamber 36 made in the end of the ingot mould IO facing in the direction of withdrawal of the ingot communicates radially with the interspace 33 formed by said jacket 32 and by the crystallizer 20 through holes I36 provided in the jacket 32 so as to correspond with the end 233 of the interspace 33 and comprises at least one inlet (not shown in the figures) for the cooling liquid.

Said annular chamber 36 and the interspace duct 33 are

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delimited, on their side facing in the direction of withdrawal of the ingot, by a circular crown 39 acting to connect the end 220 of the crystallizer 20 to the tubular sleeve 30.

The annular chamber 36 made in the end of the ingot mould I0 facing the feed of liquid metal comprises at least one outlet (not shown in the figures) for the cooling liquid and communicates with one end I33 of the interspace 33 through a circular crown 40, which is provided with ducts 42 and also acts to connect the end I20 of the crystallizer 20 to the tubular sleeve 30.

The ducts 42 in the circular crown 40 consist of lengthwise holes 43 opening into the chamber 36 and communicating behind the flange 24 with hollows 44 obtained by machining radial grooves on the surface of the circular crown 40 cooperating with the back of the flange 24; said grooves communicate with the end I33 of the interspace 33 formed by the jacket 32 and by the crystallizer 20 and are able to bestow on the cooling liquid a speedy passage between wide cooling surfaces.

Between the flange 24 and circular crown 40 and also between the end 220 of the crystallizer 20 and the crown 39 a sealing ring 25 made of a thermoplastic material or like material is envisaged which is able to ensure a perfect seal for the connection between said elements.

At least one seating 48 able to lodge a thermocouple suitable for monitoring the temperature of the end I20 of the crystallizer 20 is comprised in the end of the ingot mould I0 facing the feed of liquid metal.

When the ingot mould is working, the path of the cooling liquid is as follows: after having been introduced through at least one intake into the annular chamber 36, the cooling liquid is distributed through the holes I36 into the end 233 of the interspace 33 and then pursues its action to cool the crystallizer 20 along the whole interpsace 33; thereafter it.

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passes quickly through the ducts 42 and removes a considerable amount of heat from the end I20 of the crystallizer 20, afterwards running into the annular chamber 36, in which there is at least one discharge outlet for said cooling liquid.

We have described here a preferential embodiment of the invention but variants are possible for a person skilled in this field.

The shapes, sizes and proportions can be changed and the parts can be connected together with screws, welding or by any other desired connecting means; the cooling liquid can be made to circulate in the opposite direction to that shown; different developments and conformations can be visualised for the ducts 42 or interspace 33 within which the cooling liquid runs without departing thereby from the scope of the solution of this invention.

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C L A I M S

I. Ingot mould (I0) with tubular crystallizer for continuous horizontal casting, characterized by including in coordinated cooperation:

- a replaceable tubular crystallizer (20) having a modest thickness and located in the inner part of the ingot mould (I0),
- a tubular cooling sleeve (30) which is located on the outside of the ingot mould (I0) and forms a cooling interspace (33) around the tubular crystallizer (20), whereby said tubular sleeve (30) is provided at each end with an annular chamber (36) communicating with said interspace (33), and
- circular crown means (40) which are located in the end of the ingot mould (I0) facing the channel feeding the liquid metal and are able to connect the end of the tubular crystallizer (20) to the end of the tubular cooling sleeve (30), whereby said circular crown means (40) are provided with a plurality of cooling ducts (42) which connect the interspace (33) to the annular chamber (36) visualised in said end.

2. Ingot mould (I0) with tubular crystallizer as in Claim I, characterized by the fact that the tubular crystallizer (20) is equipped at its end (I20) facing the feed of liquid metal with a flange (24) which cooperates with the feed channel and which is able to improve the conditions for cooling said end of the tubular crystallizer (20).

3. Ingot mould (I0) with tubular crystallizer as in Claims I and 2, characterized by the fact that the annular chamber (36) made in the end of the ingot mould (I0) facing in the direction of withdrawal of the ingot is able to receive the cooling liquid entering, and that the annular chamber (36) made in the end of the ingot mould (I0) facing the feed of liquid metal is able to discharge the cooling liquid from.

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the ingot mould (IO).

4. Ingot mould (IO) with tubular crystallizer as in Claim I and in one or the other of the Claims thereafter, characterized by the fact that each of the ducts (42) envisaged in the circular crown means (40) consists of a substantially radial hollow (44) located at the outlet (I33) of the interspace (33) and communicating with a substantially lengthwise hole (43) which opens into the annular chamber (36) made in the end of the ingot mould (IO) facing the feed of liquid metal.

5. Ingot mould (IO) with tubular crystallizer as in Claim I and in one or another of the Claims thereafter, characterized by the fact that the hollows (44) envisaged at the outlet (I33) of the interspace (33) consist of radial grooves made in the surface of the circular crown (40) cooperating with the back of the flange (24) of the crystallizer tube (20).

6. Ingot mould (IO) with tubular crystallizer as in Claim I and in one or another of the Claims thereafter, characterized by the fact that the holes (43) which form a part of the ducts (42) envisaged in the circular crown (40) are sloped in relation to the lengthwise axis of the crystallizer (20) and are suitably rounded terminally so as to increase the cooling of the end (I20) of the crystallizer (20).

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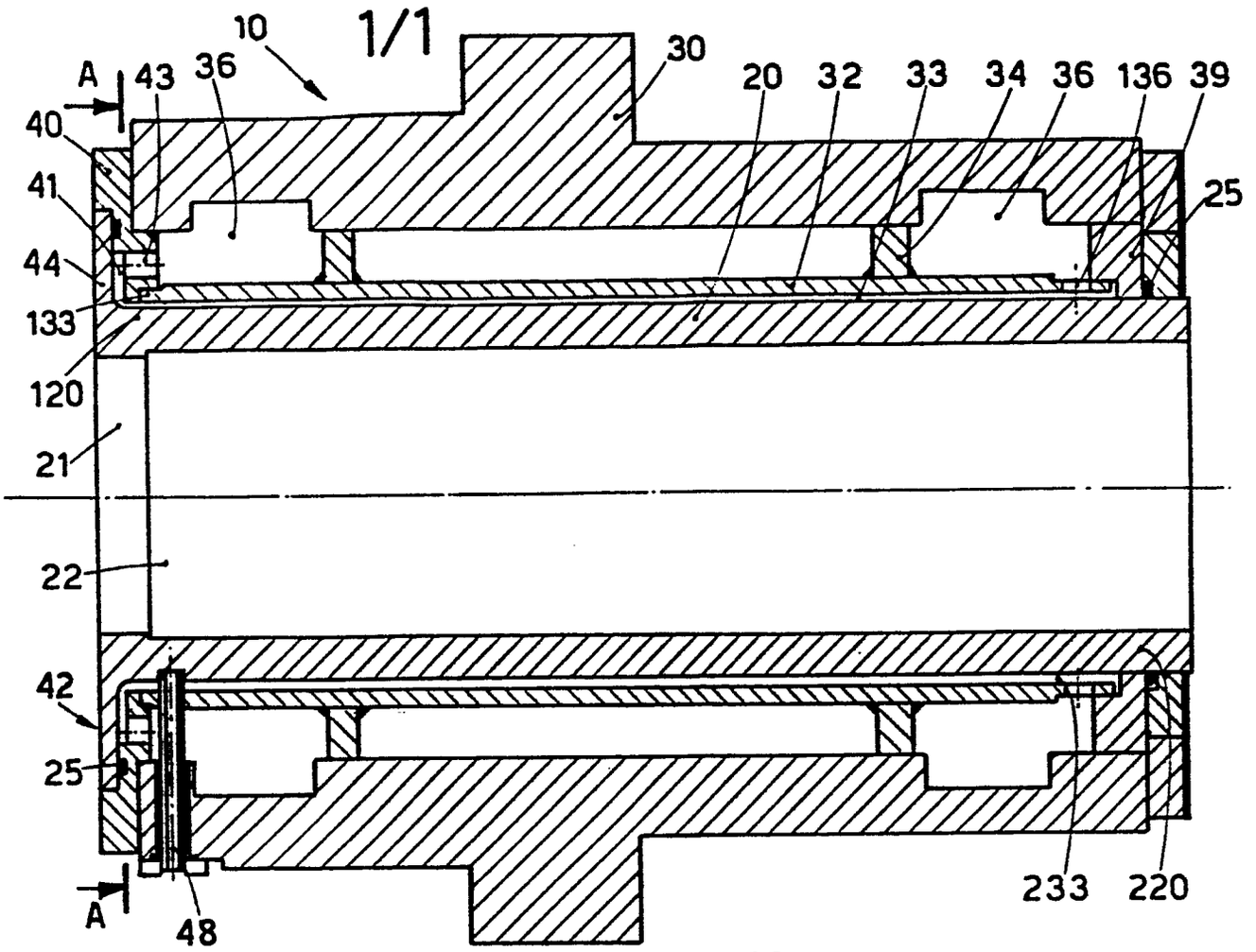

fig.1

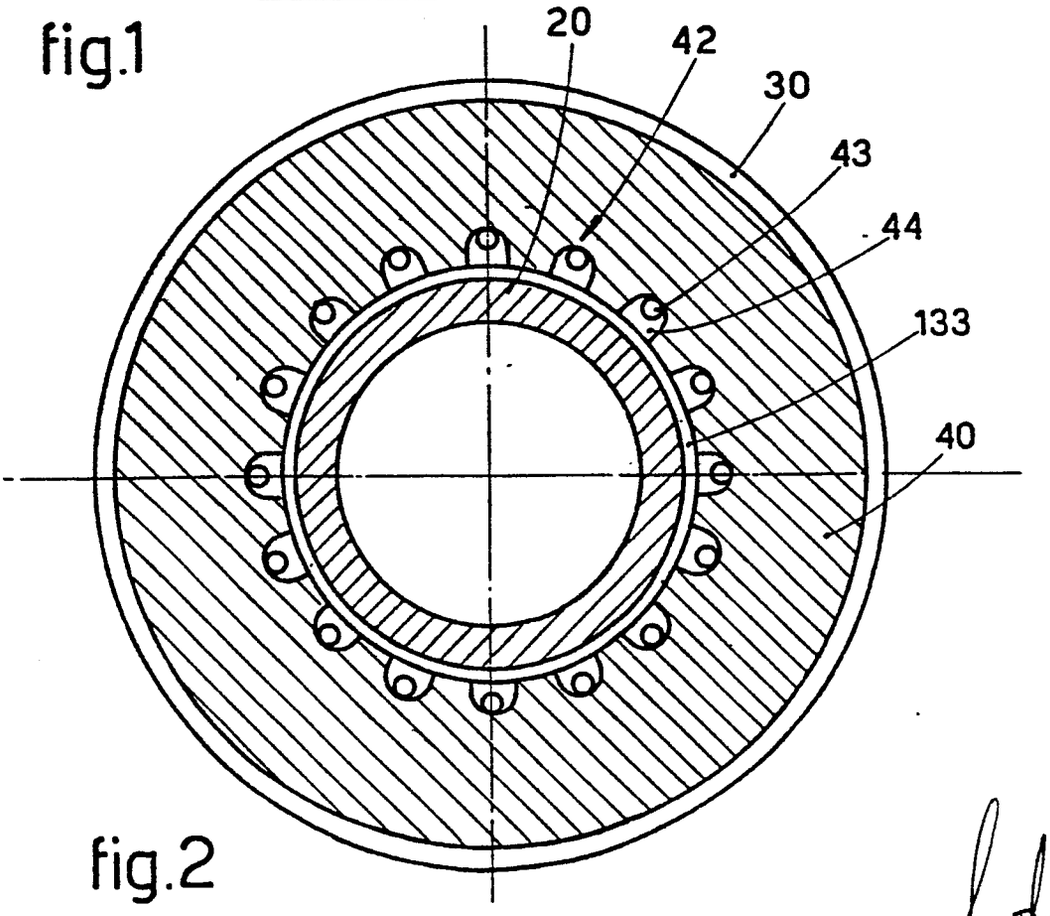

fig.2

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