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(54) **A casting roll and roll stand**

(57) The invention relates to a casting roll and casting stand therefore comprising an inner core (12) and an outer roll shell (11) and cooling channels (13) to permit liquid coolant to flow through the roll to cool the roll during casting, the shell being in intimate contact with the core and removably affixed thereto by an interference fit of at least 0.5 mm per metre of inner core diameter and the cooling channels are located within the roll shell. The cooling means may enter at one end of the roll and travel axially along the length of the roll and exits at the other end. The cooling channels (13) may be arranged in the roll core at least 20 mm from shell/core interface the grouped and connected to a coolant supply so that the direction of coolant flow can be reversed.

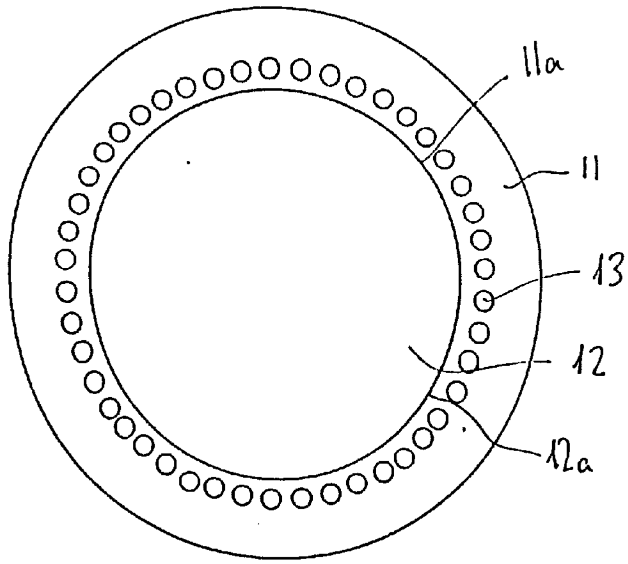

Fig 2

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Description

This invention relates to a casting roll and roll stand, in particular, to an improved design of the casting rolls.

Twin roll casting is an established technology for the production of metal strip. In the case of aluminium alloys, it is usual for the thickness of the cast strip to be in the range 6 - 10mm. In this casting process molten metal is fed by a refractory nozzle into the bite of a pair of internally cooled, counterrotating rolls. Because of the use of refractory feeder tip the strip does not cover the full width of the roll, this causes localisation of the heat which causes thermal distortions in the roll which make it difficult to control dimensions of the strip being cast and also leads to defects arising in the roll which means that a relatively short working time for the roll and frequent roll changes are required. The caster rolls typically comprise a core and a shell which is commonly shrunk onto the core with an interference fit. The cooling channels, which can be circumferential or axial are machined into the surface of the roll core and are connected to the water feed and return lines. The casting shells are typically 50 - 100mm thick and it is normal to periodically re-machine the surface to remove defects, for example defects known as heat checks. Heat check is characterised by the generation of a large number of fine cracks which result from contact with molten metal and the cyclic thermal and mechanical loading cycle the roll surface undergoes. The molten metal solidifies in contact with the casting rolls and then typically undergoes a hot reduction before exiting the caster as solid strip.

A major problem of the aforesaid process is the tendency of the cast strip to adhere to either or both of the casting rolls. It is known that the application of a parting agent, such as a suspension of colloidal graphite in water, to the casting rolls on the exit side of the machine is beneficial in reducing this sticking. The parting agent is usually applied to the casting rolls as an atomised spray.

Over the last ten years or so considerable efforts have been made to reduce the thickness of the cast strip and this has resulted in a fundamental change in the design of casting machines. It is well known that during roll casting the casting rolls deform under the action of the separating forces developed between the cast strip and the casting rolls. As the cast thickness is reduced the separating forces generated by the cast strip increase significantly. These increased separating forces can be accommodated by, either increasing the diameter of the casting rolls and roll necks or preferably by supporting the casting rolls with back up rolls. With this preferred solution the casting rolls are sized to suit the requirements of the process and the back up rolls are sized to accommodate the separating forces and torques generated during casting.

As has already been mentioned, there is a tendency for the cast strip to stick to either or both of the casting rolls. This is a particular problem with 4 high casters as there is the possibility that material that is stuck to the casting rolls can pass through the casting roll/back up roll bite and be rolled. If this occurs considerable forces are generated and these forces can cause damage to both the casting and back up rolls. This damage has a number of effects. The most visible effect is the formation of localised depressions in both the casting roll and the back up roll in the immediate vicinity of the stuck material. This damage is easily repaired by grinding the rolls.

A more serious problem occurs at the interface between the casting roll shell and the casting roll core. If material at this interface is damaged it is possible that the intimate contact between the shell and the core will be diminished locally with the result that the shell is not adequately supported. Moreover if the intimate contact is reduced the transfer of heat between the shell and the core and between the shell and the cooling water will be adversely affected. The combined effect of these various factors is the occurrence of localised sheet defects. This problem is not always immediately apparent but becomes more noticeable as the thickness of the cast shell is reduced and is characterised by localised gauge variations in the cast sheet in the vicinity of regions of the shell where material has previously stuck.

US 5469909 describes a typical casting roll used in the roll casting of steel with a core and a relatively thin shell with cooling channels in the shell, and intimate contact at the interface of the core and the shell, however this intimate contact can only be achieved by diffusion bonding of the shell to the core by means of this specialised process which is time consuming and very expensive and does not permit the shell to be easily removed to be replaced in close proximity to the casting line. Such a means of bonding the shell to the roll would not be able to withstand the loads during aluminium casting. Due to the different method of operation employed when casting aluminium alloys, much greater loads are applied and the shell would separate from the roll and fail after a very short time.

The present invention is aimed principally at overcoming the problems caused by the rolling action of the back up rolls on any material that passes through the casting roll/back up roll bite, but is applicable to all roll casters.

It is also an objective of the invention to provide a casting roll with a relatively thick shell for casting aluminium with a strong bond between the roll and the core, but also permitting easy and inexpensive removal and fitting of the shell to the core.

According to the invention there is provided a casting roll and casting roll stand comprising an inner core and an outer roll shell and cooling channels to permit liquid coolant to flow through the roll to cool the roll during casting, the shell being in intimate contact with the core and removably affixed thereto by an interference fit, characterised in that interference fit is at least 0.5 mm per metre of inner core diameter and the cooling channels are located within the roll shell. The cooling channels may alternatively or additional be located in the roll core.

In a further aspect of the invention the cooling channels are arranged axially along the length of the roll. The cooling channels may be grouped together and connected to a coolant supply sop that the direction of coolant flow can be reversed.

Various embodiments of the invention will now be described in more detail with reference to the appended figures in which:

Figure 1 is a longitudinal cross section of a known casting roll for casting aluminium;
Figure 2 is a transverse cross section through a casting roll according to a first embodiment of the invention;
Figure 3 is a longitudinal cross section through a segment of the circumference of a casting role according to a further aspect of the invention;
Figure 4 is a transverse cross section through a casting roll according to a further embodiment of the invention;
Figure 5 is a transverse cross section through a cooling channel of a casting roll according to a further aspect of the invention;
Figure 6 is a longitudinal cross section through the end of a casting roll of the embodiment shown in figure 2,
Figure 7 is a longitudinal cross section through the end of a casting roll of the embodiment in figure 4, and
Figure 8 is an enlarged longitudinal cross section through the end of a casting role of the embodiment in fig. 4.

As has been described previously continuous casting rolls for aluminium are made up of a shell 1 and a core 2 and the cooling channels 3 are machined into the surface of the core. This is shown schematically in Figure 1. In this example the cooling channels are circumferentially arranged in the surface of the core. The shell 1 is typically arranged to be relatively thick compared to a steel casting roll in order to with stand the mechanical loads during aluminium casting. The cooling channels 3 are in the form of square cross sectional channels which are easy to machine into the core 2 before the shell 1 is fitted onto the core to form the roll.

In a first embodiment of the invention a plurality of cooling holes 13 are provided which are circular in cross section and which are located in the shell 11 as shown in figures 2 and 7. The cooling holes 13 are provided longitudinally in the shell 11 spaced equidistantly around the circumference of the shell and at a constant distance from the internal surface 11a of the shell. The shell 11 is secured to the core 12 by means of an interference fit. Preferably the interference fit is of the order of 1 mm per metre of roll diameter in order to provide a sufficiently secure fitting of the core 12 and the shell 11 to withstand the high torque and loads experienced in particular in aluminium casting. If the shell 11 is not sufficiently securely attached to the core, the cyclical thermal and mechanical loading can result in movement of the shell with respect to the core. This relative movement is sometimes referred to as "walking". The only means of effectively preventing this effect or reducing it to an acceptable degree is by an interference fit of the order of lmm per meter of roll diameter. Any less than this and the walking effect is not reduced enough to prevent permanent damage to the roll to occur.

It will be appreciated that although in this embodiment the cooling channels are conveniently located away from the interface between the shell and the core they could also be located at the interface. In this event the cooling channels could conveniently have a rectangular cross section or some other preferred shape.

By way of example the casting roll of this first embodiment has the following dimensions:

Roll diameter OD	600 mm
Core diameter OD	440 mm
Shell thickness	80 mm
Cooling holes	20 mm dia. holes on a p.c.d of 480mm
Cooling hole spacing	20 mm
Interference	0.44 mm

With the above example the thickness of shell between the holes and the outside diameter of the shell would be 50mm and as with conventional aluminium caster rolls would have a useable thickness of approximately 25mm.

The axial cooling holes 13 are conveniently machined the complete length of the shell 11 and are connected to a cooling water feed and return lines 16 by means of a plenum chamber 14 at each end of the roll as shown in figure 8. On this basis the cooling water would enter the roll at one end and exit at the other.

In an alternative arrangement the cooling holes 13 could be arranged in groups such that the direction of flow of the cooling water was reversed. This is shown schematically in Figure 3.

A further embodiment of the invention for the construction of the casting roll is shown in figures 4 and 6 in which the cooling channels 23 are located in the core 22 of the roll and in this case it is preferred to locate the cooling holes 23 which are conveniently in the form of a series of axial holes some distance below the surface 22a of the core 22.

The dimensions of the casting roll according to the embodiments of the invention roll should fall within the following ranges:

Roll diameter OD	550 to 1200 mm
Core diameter OD	310 to 1100 mm
Shell thickness	50 to 120 mm
Cooling holes to 60 mm from the interface.	10 to 30 mm dia. holes on a p.c.d. of 20
Cooling hole spacing	10 to 30 mm
Interference	0.5 to 1.5 mm per metre of roll diameter.

The above range for the location of the cooling holes 20 to 60 mm from the interface of the core and shell is for cooling holes arranged in the core. for cooling holes arranges in the shell the range is 0 to 60 mm.

It is well established that the higher velocity of the cooling water through the cooling channels the greater the rate of heat removal. The velocity of the water in the cooling channels can conveniently be increased by reducing the effective cross section of the cooling channels. This can be achieved by, for example inserting suitably sized rods 31 into each of the cooling holes 13, 23 as shown in Figure 5. The precise location of the rods and if necessary diameter of the rods can be selected to optimise heat transfer into the cooling water.

Claims

1. A casting roll comprising an inner core and an outer roll shell and cooling channels to permit liquid coolant to flow through the roll to cool the roll during casting, the shell being in intimate contact with the core and removably affixed thereto by an interference fit, characterised in that interference fit is at least 0.5 mm per metre of inner core diameter and the cooling channels are located within the roll shell.

2. A casting roll comprising an inner core and an outer roll shell and cooling channels to permit cooling means to flow through the roll to cool the roll during casting the shell being in intimate contact with the core and removably affixed thereto by an interference fit, characterised in that interference fit is at least 0.5 mm per metre of inner core diameter and that the cooling means enters one end of the roll, travels axially along the length of the roll and exits at the other end.

3. A casting roll according to claim 1 or claim 2, characterised in that the cooling channels are grouped and connected to a coolant supply so that the direction of coolant flow can be reversed.

4. A casting roll according to claim 1, characterised in that the shell incorporates a plurality of cooling channels arranged along the axis of the shell at least 20 mm from the caster core/caster shell interface

5. A casting roll comprising an inner core and an outer roll shell and cooling channels to permit cooling means to flow through the roll to cool the roll during casting the shell being in intimate contact with the core and removably affixed thereto by an interference fit, characterised in that interference fit is at least 0.5 mm per metre of inner core diameter and that a plurality of cooling channels are arranged along the axis of the shell and positioned in the core at least 20 mm from the inner diameter of the shell.

6. A casting roll according to any preceding claim, characterised in that the velocity of the cooling water is adjustable to provide the optimum heat transfer

7. A casting roll according to any preceding claim, characterised in that a coolant chamber or plenum chamber is provided at least one end of the roll for feeding and removing cooling water from said casting roll.

8. A casting roll stand comprising a pair of casting rolls, each casting roll comprising an inner core and an outer roll shell and cooling channels to permit cooling means to flow through the roll to cool the roll during casting the shell being in intimate contact with the core and removably affixed thereto by an interference fit, characterised in that interference fit is at least 0.5 mm per metre of inner core diameter and that the cooling means enters one end of the roll, travels axially along the length of the roll and exits at the other end.

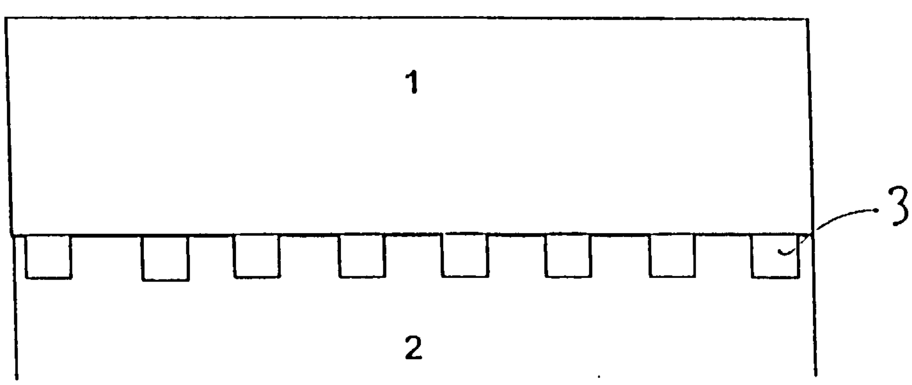

Fig. 1

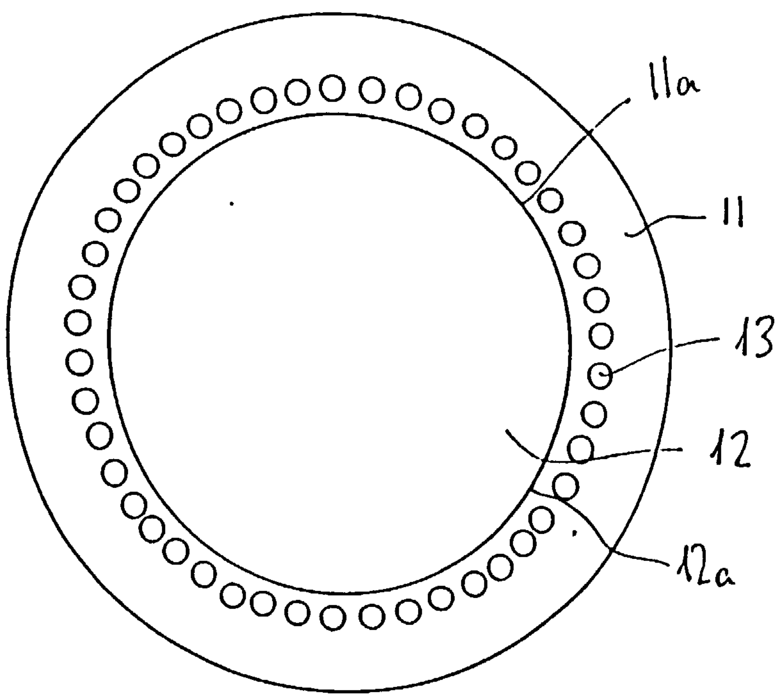

fig 2

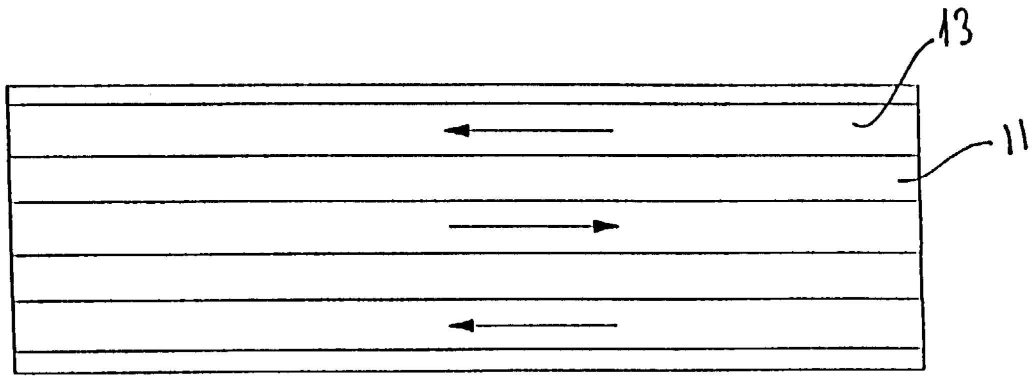

Fig. 3

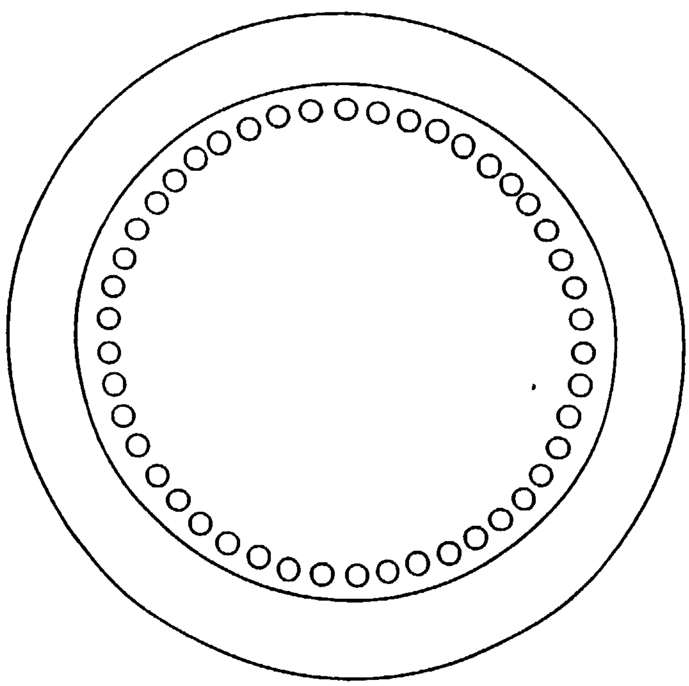

Fig. 4

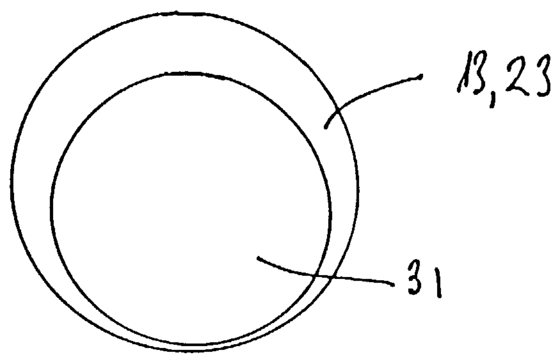

fig. 5

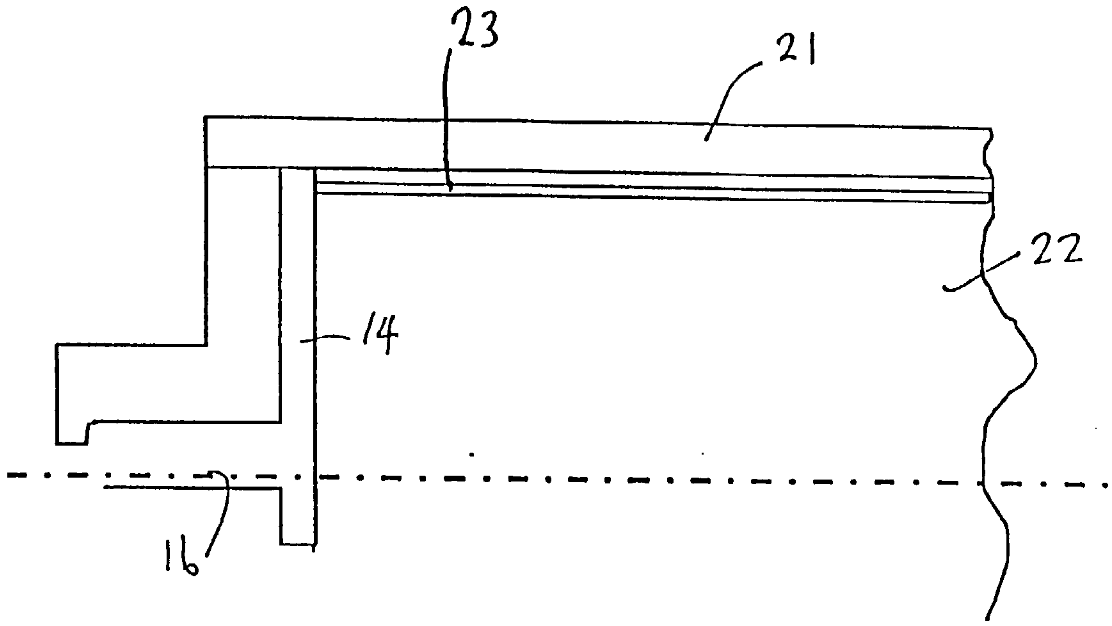

Fig. 6

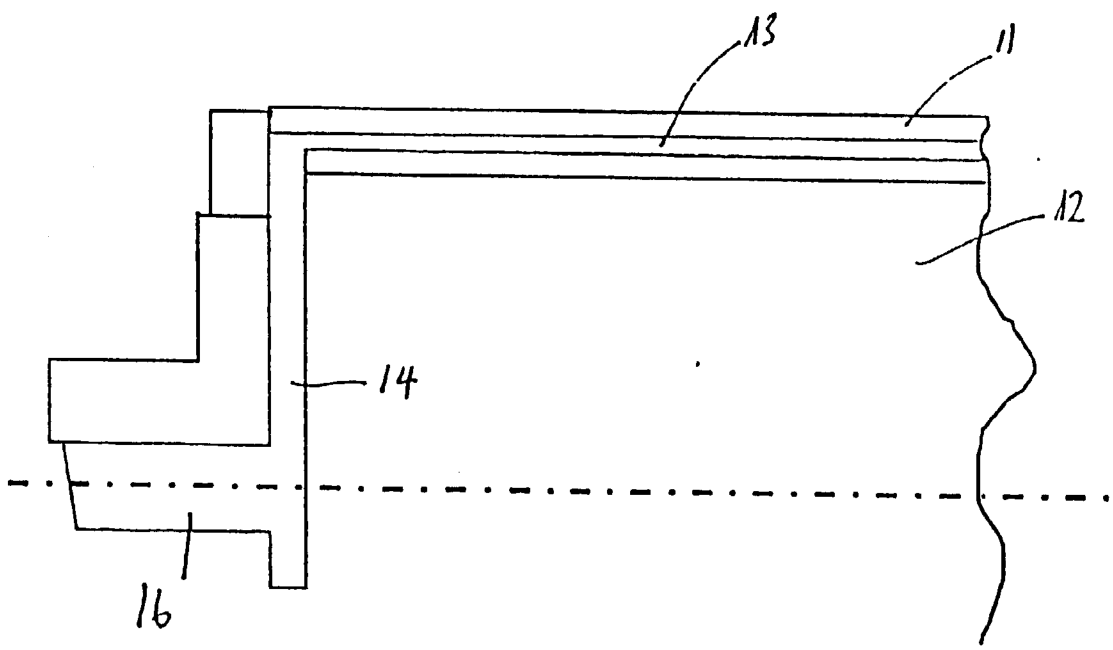

Fig. 7

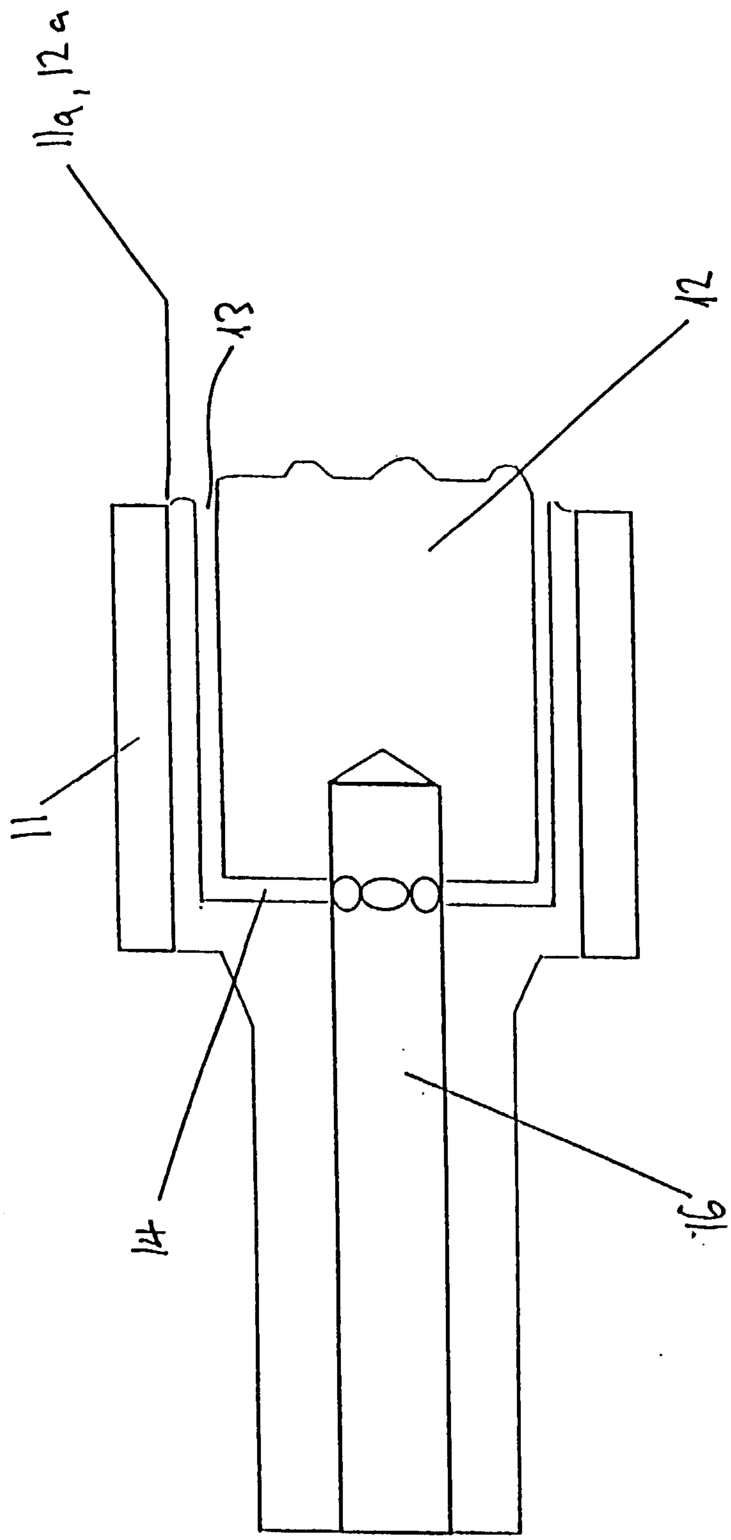

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 98 30 3018

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)
X	DE 38 39 110 A (HITACHI LTD ;NISSHIN STEEL CO LTD (TOKIO, JP)) 1 June 1989 * column 4, line 13 - line 60 * * figure 1 *	1,2,7,8	B22D11/06 B22D11/128
Y	US 2 850 776 A (HUNTER, JOSEPH L., RIVERSIDE, US) 9 September 1958 * column 1, line 15 - line 21 * * column 1, line 57 - column 2, line 18 * * figures 1-3 *	1,2,7,8	
Y	PATENT ABSTRACTS OF JAPAN vol. 006, no. 113 (M-138), 24 June 1982 & JP 57 041811 A (KOBE STEEL LTD), 9 March 1982, * abstract *	1,2,7,8	
A	WO 93 19874 A (DALFORS ANGSTROM N AB ;HOLMGREN BERTIL (SE)) 14 October 1993 * page 5, line 20 - page 6, line 19 * * figure 1 *	1-3,5,8	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	US 3 834 205 A (MAAG G ET AL, CRESTVIEW HILLS, US) 10 September 1974 * column 2, line 48 - line 56 * * figure 1 *	6	B22D B21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24 July 1998	Peis, S

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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