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Roll cooling for flat product rolling

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SUMMARY

A cooling system for work rolls of a flat product rolling mill that reduces work roll crown is disclosed. The crown reduction is achieved by applying variable coolant flow along the roll body by grouping of spray nozzles 11 into independently controlled zones 9 and 14 across the width of the upper work roll 1 and lower work roll 2.
Each zone has a closed loop for coolant flow control and spraying time. Cooling water is provided through manifold 20 to supply pipes for each zone. For each supply pipe there is a flow monitor 21 and flow controller 22. Flow line 23 provides coolant to the outer most zones 24 and 25 and similarly coolant is provided to the pairs of zones on each side of the centre for upper and lower work rolls 1 and 2 respectively.

A process controller 26 uses information from a data input 27, a look up table within the process controller and the data from the flow monitor 21 to provide a setting for the flow controller 22.

The parameters upon which the controller 26 acts to control the amount of flow of coolant may be: product width, the degree of thickness reduction being achieved in a particular pass through the rolling mill, product temperature, material grade, rolling speed and roll diameter. Computer simulation of an optimum process is used to set up look up table or functions for each of parameters to be used by the process controller 26.

APPLICANT

IT-1 Pty. Ltd

17 May 1999

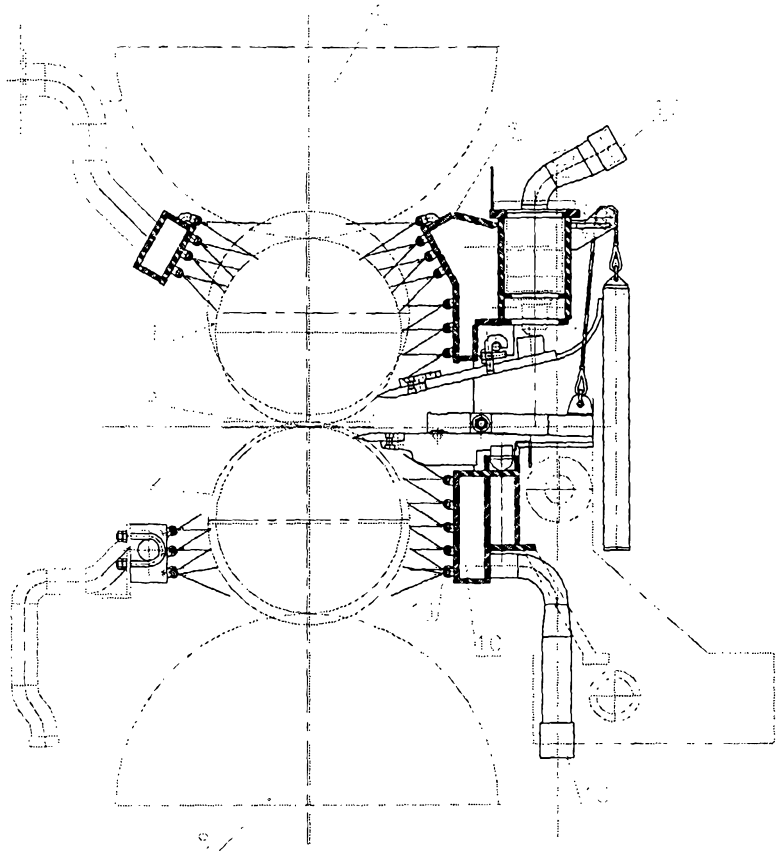

Figure 1

P/00/001
SECTION 29
REVISED 2/98

AUSTRALIA
Patents Act 1990

ORIGINAL
COMPLETE SPECIFICATION
STANDARD PATENT

ROLL COOLING FOR FLAT ROLLING

The following statement is a full description of this invention, including the best method of performing it known to me:

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A ROLL COOLING SYSTEM FOR FLAT ROLLING

The invention relates to cooling of work rolls in flat product rolling

Efficiently cooled rolls have much longer potential service life than poor cooled rolls. Poor cooled rolls are subjected to thermal damage and significant problems can occur with thermal crowning.

Thermal crown occurs because of discrepancies between heat input and output in a roll body. This is in particular significant when a range of a flat product widths and thickness is rolled while roll cooling is not suited for each width and thickness.

Generally the centre portions of the rolls are heated more than the ends of rolls so that more expansion occurs near the centre portions of the rolls thereby providing a larger roll in the centre portion and hence uneven thickness of a finished flat product.

The coolant flow rate is determined by analysing heat transfer, strain and stress inside the work roll by using numerical methods in order to minimise roll crown while maintaining acceptable work roll surface roughness. The optimum flow rates and duration of cooling are stored in look up tables. Flow rates and spraying duration for each product and each zone are selected as functions of actual rolling parameters.

The present invention is directed to the finding that optimum cooling can not be achieved using a single zone manifold fitted with flat spray nozzles or thickening flat nozzles and the present invention proposes a system based on individually controlled groups of nozzles.

In one form therefore although this may not necessary be the only or broadest form the invention is said to reside in a cooling system

for work roll of a flat product rolling mill, the system including a plurality of nozzles arranged in a plurality of zone nozzle may be designed to have a particular selected flow rate with normally greater flow rates near the centre of the rolls where more heating means to provide a flow of coolant to each zone, flow control and monitoring means to monitor and control the flow of coolant, and a controller to control the supply of coolant dependent on rolling mill parameters.

It will be seen in generally by this invention that the amount of coolant flow in each zone can be varied depending upon the width and thickness of the product being feed into the rolling mill so that heat build up in the central portion of a roll is reduced and hence thermal crowing is reduced as much is possible in the mill to provide a more even product thickness.

The coolant may be water only or water and air/water mist combined. Alternatively coolant may be some from of specialised coolant for particular applications (ie. Cold rolling). Air/water mist spray may be part of a system to reduce water flow and increase cooling efficiency per unit of coolant used.

Flow monitoring is provided so that a selected actual flow of coolant to the nozzles of a particular zone is achieved independent of the actual supply pressure. The flow control can then operate according to the amount of coolant required according to look up tables and to the actual flow rate supplied to the flow control and monitoring means.

In one preferred embodiment of the invention there may be ten zones across the width of the roll. Other number of zones may be used where different widths of rolls are used or where different widths of products are usually produced. Each zone may have five to seven banks of nozzles with between one to six nozzles in each bank. Each nozzle may be directed at a selected angle to provide the desired coverage of the roll.

Each nozzle may provide a fan or flat spray which is set to an angle so that adjacent sprays provide good coverage without interception to achieve even cooling.

Number of zones for top roll and bottom roll is identical. A total flow rate for a top and corresponding bottom zone is controlled with one control loop. Total coolant quantity for top and bottom roll is divided by selection of adequate nozzles for top and bottom zones.

There is provided a specific cooling box design or zone design to ensure adequate supply of coolant to the rolls.

This then generally describes the invention but assist with understanding reference will now be made to the accompanying drawings which show a preferred embodiment of the invention.

In the drawings:

Figure 1 shows a schematic side view of a rolling mill incorporating one embodiment of the invention;

Figure 2 shows a typical layout of nozzles in upper and lower spray boxes (for clarity the rolls have been omitted); and

Figure 3 shows a schematic view of the coolant flow and controller according to the invention.

Now looking more closely at the drawings it will be seen that the mill has two work rolls, upper roll 1 and lower roll 2 between which a work piece 3 travels. Upper work roll 1 is supported with upper backing roll 4 and lower work roll 2 is supported by a lower back up roll 8.

As it passes through the gap between the upper work roll 1 and the lower work roll 2 the thickness of the work piece 3 is reduced. Work piece temperature may be ranging from ambient temperature (cold rolling) to over 1250 degrees C (hot rolling at roughing stand). By passing through the mill rolls a large amount of heat is transferred to the contacting area of the work rolls 1 and 2. In cold rolling heat is developed by friction and deformation of the work piece 3.

According to this invention cooling is provided by plurality of coolant spray nozzles arranged in zones in upper and lower multi-compartment header tanks 9 and 14 across the width of the upper work roll1 and lower work roll 2.

Each zone for the cooling of the upper work roll 1 comprises a tank 6 for instance which has a plurality of nozzles 7 which are directed towards upper work roll 1.

The lower work roll 2 has a tank 10 for each zone with banks of nozzles 11 which are directed to supply coolant to each zone to the lower work roll 2. A coolant supply pipe 12 is provided to supply coolant to each zone for the upper work roll and a coolant pipe 13 is provided to supply coolant to the zone of the lower work roll.

It will be realised that where the coolant is liquid only a single supply pipe is necessary for each zone but where the coolant is an air/water mist then both air and water may be provided to the respective zones.

The number and spacing of nozzles in each bank in each zone can be varied depending upon the amount of cooling required. Each nozzle also may be of a selected flow rate depending upon the amount of cooling required at a particular area.

As can be seen in Figure 3 which shows a schematic view of the liquid flow and controller according to the invention cooling water is provided through manifold 20 and provided to supply pipes for each zone. For each supply pipe there is a flow monitor 21 and flow controller 22. Flow line 23 provides coolant to the outer most zones 24 and 25 and similarly coolant is provided to the pairs of zones on each side of the centre for upper and lower work rolls 1 and 2 respectively.

A process controller 26 uses information from a data input 27, a look up table within the process controller and the data from the flow monitor 21 to provide a setting for the flow controller 22.

It will be realised that where a narrow strip is being rolled than coolant may only be supplied to the

central zones 28 and 29 and no coolant or considerably reduced flow of coolant may be supplied to the outer zones 24 and 25. This may reduce water usage when narrower work pieces are rolled.

Throughout this specification unless the context requires otherwise the words comprise and include in variations such as comprising and including will be understood to imply the inclusion of a state of integer or a group of integers but not the exclusion of any other integer or group of integers.

Throughout this specification various indications have been given as to the scope of the invention but the invention not limited to any one of these but may reside in two or more of these combined together. The examples are given illustration only and not for limitation.

Claims defining the invention are as follows:

1. **A cooling system for work rolls of a flat product rolling mill including a plurality of spray nozzles arranged in a plurality of independent zones with a closed loop coolant flow control to each zone. Number of zones utilised and coolant flow rate for a particular product may be product width, the degree of thickness reduction being achieved in a particular pass through the rolling mill, product temperature, material grade, rolling speed, roll diameter and total available coolant flow rate.**

2. **The roll cooling system of claim 1 where coolant can be air/liquid mist .**

3. **The roll cooling system of claim 1 where coolant flow rate is determined by analysing heat transfer strain and stress inside the work roll by using numerical methods in order to minimise roll crown while maintaining acceptable work roll surface roughness. Numerical methods are used to predict roll crown and cooling requirements, flow rate and duration of cooling, then the results are stored in look up tables or functional equations. Flow rates and spraying duration for each zone are selected as functions of actual rolling parameters.**

4. **The roll cooling system of claim 1 where number of zones for top roll and bottom roll is identical.**

5. **The roll cooling system of claim 1 where a total flow rate for a top and corresponding bottom zone is controlled with one control loop. Total coolant quantity for top and bottom roll is divided by selection of adequate nozzles for top and bottom zones.**

6. **The roll cooling system substantially as herein described with reference to the accompanying drawings.**

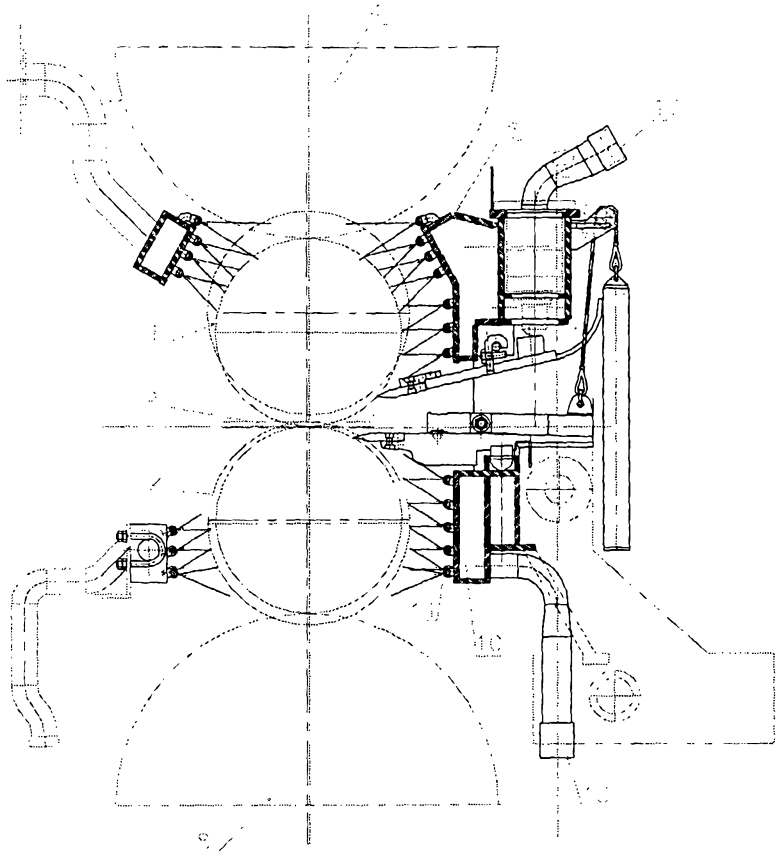

Figure 1

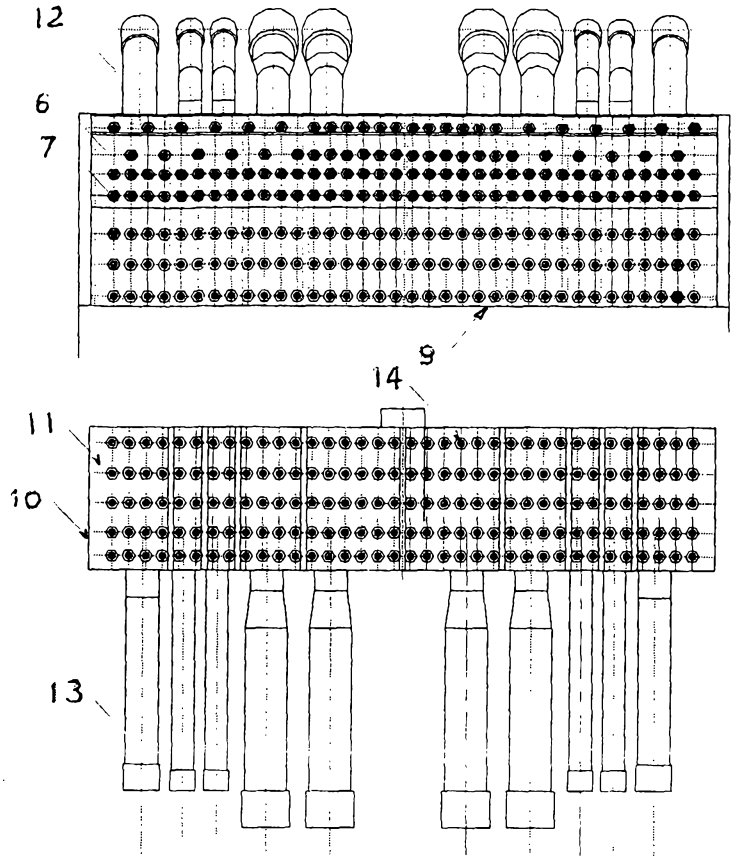

Figure 2

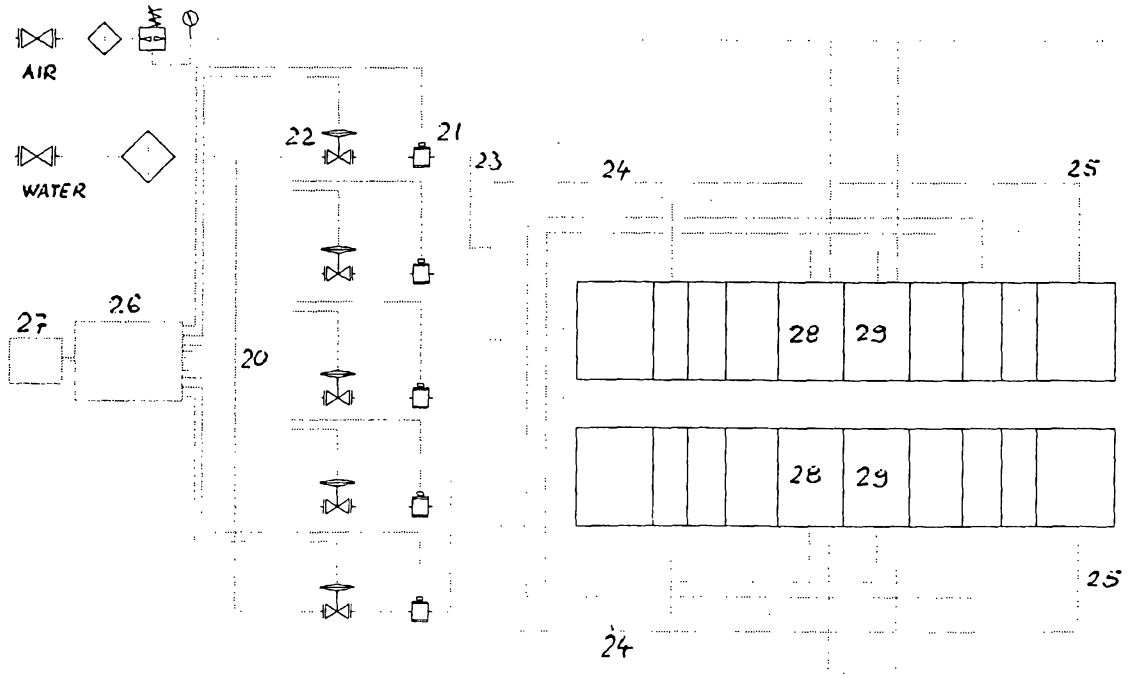

Figure 3