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54 Rolling mill.

57 A rolling mill for rolling metal strip is described which has the rolled strip temperature compensated. The mill illustrated includes stands 12, 13 and 14, and strip 15 which is coiled on to coiler 16. A shape sensor 17 indicates the shape of the strip by detecting widthwise variations in tension in the strip. A temperature sensor 18. Upstream of the shape

sensor 17 detects widthwise temperature variations in the strip which affects operation of the shapemeter upstream of the temperature sensor 18 are coolant applicators 20, 23 for differentially cooling the strip across its width to reduce those temperature variations prior to arrival of the strip at the shape sensor.

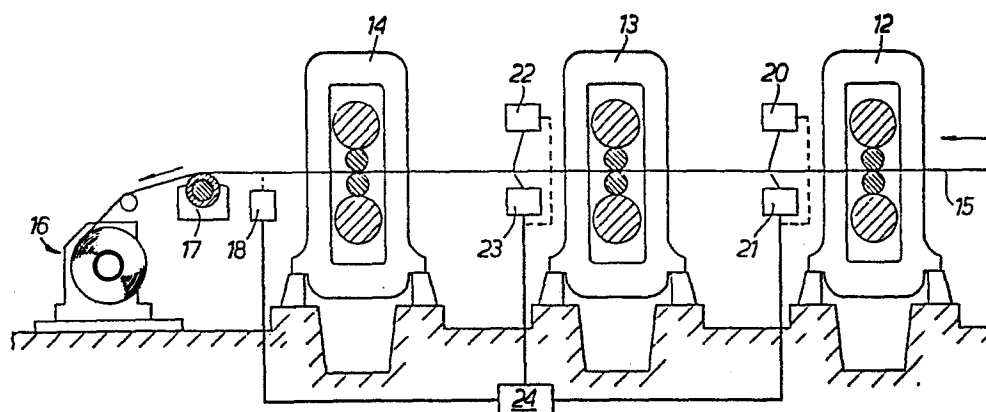


FIG. 1.

ROLLING MILL

The present invention relates to rolling mills and
5 is particularly concerned with rolling mills having means
for giving an indication of the shape or flatness of
metal strip rolled by a rolling mill. More
particularly, the detecting means are of the type which
gives an indication as to shape of the strip by detecting
10 widthwise variations in tension in the strip, e.g. a
"shapemeter" as described in British Patent Specification
No. 1,160,112.

Instances have been reported of "shapemeters" giving
inaccurate readings, with the result that control of the
15 mill to improve the shape, either manually or
automatically, has proved to be difficult. By
experimentation, we have ascertained that the erroneous
indications given by the "shapemeter" are usually
attributable to widthwise variations in the temperature
20 of the strip passing over the shape sensor, possibly due
to temperature variations in the rolls themselves and to
unequal working of the strip across its width.

The present invention resides broadly in the
detection of widthwise temperature variations of the
25 strip prior to arrival at a shape sensor, so as to enable
compensation to be effected.

Thus, in accordance with one aspect of the present
invention, a rolling mill for rolling metal strip,
comprises: a shape sensor for giving an indication of
30 strip shape by detecting widthwise variations in tension
in the strip, a temperature sensor upstream of the shape
sensor for detecting widthwise temperature variations in
the strip, and means for applying coolant to the strip
for differentially cooling the strip across its width to
35 reduce those temperature variations prior to arrival of

the strip at the shape sensor.

The temperature sensor may control the differential cooling automatically, or may give a visual indication by which the cooling may be controlled
5 manually.

Thus, the widthwise temperature variations in the strip may be reduced or eliminated, before the strip reaches the shape sensor, which then gives a more accurate indication of shape.

10 The invention will be more readily understood by way of example from the following description of a rolling mill in accordance therewith, reference being made to the accompanying drawings, in which

Figure 1 diagrammatically represents the final three
15 stands of a tandem mill, and

Figure 2 shows the preferred form of coolant applicator for controlling the widthwise temperature of strip rolled by the mill.

In Figure 1, the three final stands of the tandem
20 mill are indicated at 12, 13 and 14, the strip 15 passing through the stands from right to left and being coiled on a coiler 16. Between the last stand 14 and the coiler 16 is a shape sensor 17 in the form of a "shapemeter" as described in the above mentioned British patent
25 specification. Upstream of the shape sensor is a temperature sensor 18 located below the strip and detecting the temperature of the strip at points spaced across its width.

The mill also has controllable means for cooling the
30 strip, as indicated at 20 and 21 between stands 12 and 13 and 22 and 23 between stands 13 and 14. Those means are coolant applicators which discharge a spray or curtain of coolant on the upper face of the strip 15, in the case of 20 and 22, and on the lower face, in the case of 21 and
35 23. The cooling means 20, 21, 22 and 23 are connected to

a control box 24 from where operation of the cooling means can be controlled. The control box also receives output from the temperature sensor 18. The control box may have an automatic control system for the cooling means or may have a manual control for the cooling means.

The cooling means 20 - 23 are controlled in accordance with the indication given by temperature sensor 18 of the variation of strip temperature across the strip width, so that that temperature variation is reduced or eliminated and the strip passing over the shape sensor 17 has substantially uniform temperature across its width. The control may be automatic, the indication given by sensor 18 being fed to a control system in control box 24 which issues control signals to the cooling means 20 - 23, or may be manual, in which case the sensor 18 gives an indication of the temperature profile of the strip, enabling the operator to adjust appropriately the cooling means 20 - 23 through control box 24. When substantially uniform temperature in the strip reaching sensor 17 has been achieved, the shape sensor 17 gives a substantially accurate profile of the shape, or flatness, of the strip across its width. It is preferred that the majority of the cooling is done by the lower cooling means 21, 23 as the coolant projected on to the strip from below falls away after striking the strip whereas the coolant applied from above can remain on the strip and build up into a wave. Such a wave of coolant is clearly undesirable and application of coolant to the top of the strip preferably minimised.

One of the lower cooling means 20, 21 is illustrated in Figure 2. In the example of Figure 2 a row of spray nozzles 41 is arranged beneath the strip 15, across the width of the strip. The spray nozzles 41 are mounted on a coolant manifold 42. Each spray nozzle 41 has a supply conduit 43 which has an opening 44 in the

manifold 42. The opening 44 can be closed by pneumatically controlled diaphragm valve 45. In each valve 45, a flexible diaphragm 46 is mounted adjacent the opening 44. Behind the diaphragm 46 is a chamber 47

5 which can be selectively connected to a source of pressurised air which will, when applied, sufficiently deform the diaphragm 46 to close the opening 44, see for example the second nozzle from the right in Figure 4. In use, coolant under pressure supplied in manifold 42 is

10 applied via spray nozzles 41 to the underside of the strip 15. The area of application, or field of spray, of coolant, can be varied by selectively closing certain of the valves 45. By using a row or array of spray nozzles which can have a supply of coolant selectively connected

15 or disconnected not only can the field or area of coolant application be adjusted but two or more areas on the strip can be cooled separately. As pointed out above, because the coolant applying means is beneath the strip, once coolant has been sprayed onto the strip, the coolant

20 can fall away and not build up as might be the case when coolant is applied to the top of the strip.

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CLAIMS:

1. A rolling mill for rolling metal strip, comprising: a shape sensor (17) for giving an indication
5 of strip shape by detecting widthwise variations in tension in the strip (15), a temperature sensor (18) upstream of the shape sensor (17) for detecting widthwise temperature variations in the strip, and means (21-24; Figure 2) for applying coolant to the strip for
10 differentially cooling the strip across its width to reduce those temperature variations prior to arrival of the strip at the shape sensor.
2. A rolling mill as claimed in claim 1 wherein
15 the cooling means includes means (Figure 2) for applying an adjustable field of cooling fluid to the strip (15).
3. A rolling mill as claimed in claim 2, wherein the cooling means (Figure 2) has a number of spray
20 nozzles (41) arranged across the width of the strip (15), and control means (45, 24) regulates the supply of coolant to each nozzle.
4. A rolling mill as claimed is claim 3, wherein
25 the spray nozzles (41) are mounted on a manifold (42) for carrying a common supply of coolant.
5. A rolling mill as claimed in claim 3 or 4,
wherein the control means for each nozzle (41) or group
30 of nozzles is a diaphragm valve (45).
6. A rolling mill as claimed in any preceding claim, wherein the cooling means (21-24; Figure 2) operate under the control of an automatic control system
35 (24) which receives output from the temperature sensor

(18) and adjusts the supply of cooling fluid accordingly.

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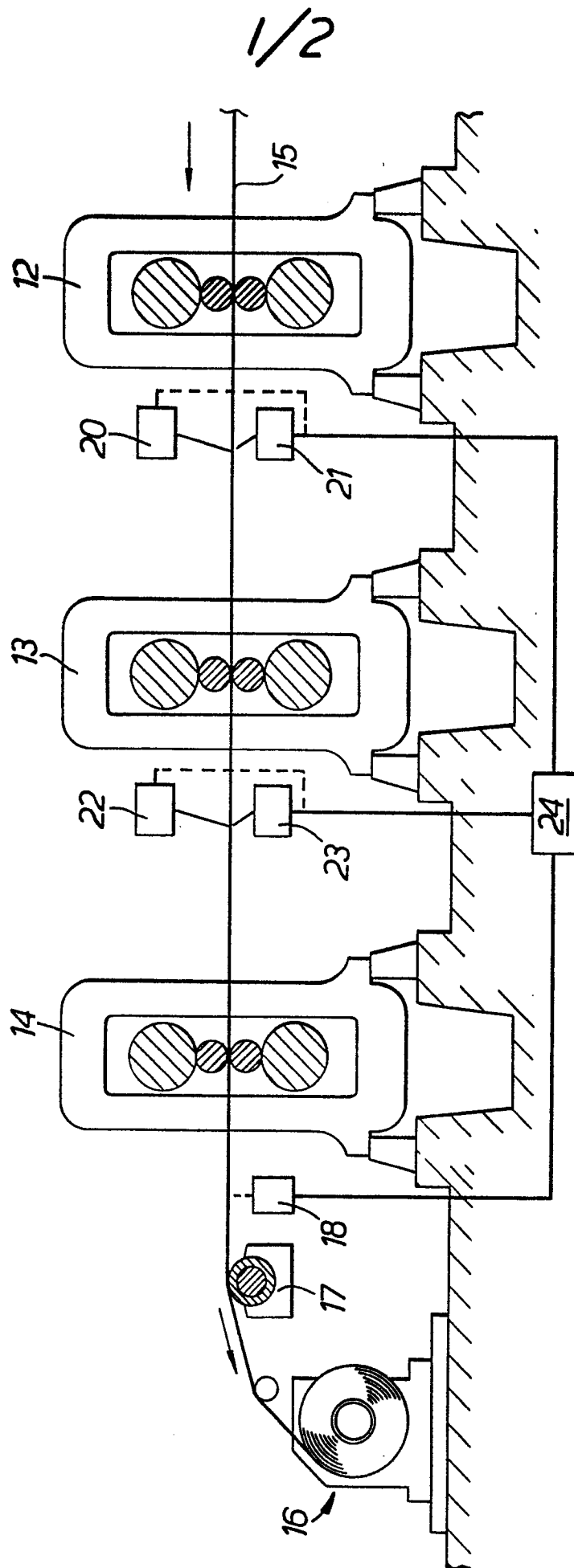


FIG. 1.

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