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(54) IMPROVEMENTS IN OR RELATING TO APPARATUS FOR DETERMINING THE DEGREE OF PLANENESS OF METAL STRIP

(71) We, HOESCH WERKE AKTIENGESELLSCHAFT, of Eberhardstrasse 12, 4600 Dortmund, Federal Republic of Germany, a German Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an apparatus for determining the degree of planeness of metal strip. The apparatus is applicable in particular to measuring the degree of planeness of steel strip under tension during the rolling thereof.

Methods and devices for measuring the planeness, and deviations from planeness, of steel strip are already known, for example in "Stahl and Eisen" 1976 No. 1 'pages 11/12. In these known arrangements the planeness of cold rolled strip is determined in the one case by means of the magnetic measurement of internal strip tensions, and in the other case by performing a measurement of the distribution of the specific tensile stresses over the width of the strip by means of a measuring roller. By means of these known methods and devices it is indeed possible to perform the measurement of the planometry of cold rolled strip during the cold rolling operation, but such measurements are not possible upon strip during the hot rolling thereof. In the case of the hot rolling strip, the magnetic measuring methods fail because the Curie point is exceeded, whilst in the case of the further known methods and the related measuring apparatus, the rotary measuring value sensors associated with the measuring roller are either not suitable or are too sensitive for making a measurement in a hot rolling mill on account of the rough condition of operation, not least on account of the high temperatures obtaining.

The present invention is concerned with avoiding the disadvantages of known apparatus, and with the provision of an apparatus whereby the planeness, or deviations from the plane condition of metal strip, in particular steel strip, can be measured during a hot rolling operation and which will also function satisfactorily during roughing operations carried out in a hot rolling mill.

This invention accordingly provides an apparatus for determining the degree of planeness of a metal strip during hot rolling thereof, said apparatus comprising means for guiding said strip under tension along a non linear path including a plurality of individual sensing rollers arranged substantially side-by-side across said path to define a non-linear portion thereof and each rotatably journalled in an associated support arm means, and means for moving the support arm means together about a common axis to urge the rollers into engagement with said strip, each said support arm means including means for measuring the stress arising therein, whereby stress variations within the portion of the metal strip passing over the rollers due to lack of planeness of the strip are indicated by variations in stress in the individual ones of said support arm means. The arm support means may each comprise side arms and bearings for the associated roller, the stress measuring means being carried by the side arms. Preferably the measuring means for each said roller is located in a cavity in an associated side arm.

According to a further preferred feature of the invention each arm support means includes a side arm comprising a substantially T-shaped member pivotally mounted to the rigid casing at each end of the bar of the T and a link pivotally connected to the T-shaped member and the casing and carrying the measuring element. The rigid casing which is referred to here is advantageously that which is already available for the loop lifting rollers in rolling mills.

The advantages of the apparatus of the invention are particularly to be seen in the fact that it offers a simple method of measuring the planeness of steel strip even during the hot rolling thereof, thereby making it possible to remove any deviations from the plane condition during the rolling process,

for example by means of bending devices already known in the rolling mill art. The result achieved is that a plane metal strip can be delivered from the rolling mill for further processing.

The invention is further explained below by way of illustration, reference being made to the accompanying drawing, in which:

Figure 1 is a side view of an apparatus embodying the invention;

Figure 2 is a plan view of the apparatus of figure 1, omitting a metal strip under test;

Figure 3 is a side view of a second apparatus embodying the invention; and

Figure 4 is a plan view of a further embodiment of the invention.

As shown in figures 1 and 2, a metal strip 1 being rolled passes over roller means 2 rotatably mounted in side support arms 4 by means of a roller bearings 3. The side support arms 4 are pivotable together about the fixed axis of a common shaft 5, for example, by means of an electric drive arrangement not shown in the drawings. At a point approximately midway between the roller bearing 3 and the axis of the shaft 5, each side support arm 4 is provided with an open sided cavity 6, in which is arranged a measuring element 7, preferably an expansion strip or strain gauge.

As shown in figure 2, the measuring roller means 2 is sub-divided over the width of the strip into roller units 2*a* of equal width; when not under the roller units 2*a* are in line with each other. Moreover, when under the load imposed by a flat metal strip 1, the roller units 2*a* remain in the parallel position. On the other hand, when a non-planar strip section passes over the roller units 2*a*, then the metal strip 1, which is under tensile stress, applies force components of different magnitudes to the individual roller units 2*a*. These force components are measured by the measuring elements 7. Electrical conductors, (not shown) extend from the measuring elements 7 to the shaft 5, and thence to a device by means of which the measured values are recorded. The recording device may, for example, be installed in the control stand of the rolling mill in which the metal strip 1 is being rolled.

In the embodiment of figure 3, each measuring roller means 2*a* is mounted in T-shaped side support arms 4 and bearings 3, one end of the bar of the T of each side support arms 4 being pivotally mounted on a rigid casing or box 8, and the other end thereof being pivotally coupled, by a joint 9, to a link 10, which is pivotally connected to the box 8. Moreover the rigid box 8 is pivotable about the shaft 5.

Furthermore the link 10 is provided with an open sided cavity 6, in which is arranged a measuring element 7. The measured values are delivered to the recording device by means of electrical conductors, not shown in the drawings.

In the embodiment of figure 4, the side support arms 4, which are provided with cavities for the measuring elements 6, are connected by rigid joints 11 to the shaft 5, which is reinforced by a rigid box 8.

WHAT WE CLAIM IS:—

1. Apparatus for determining the degree of planeness of a metal strip during hot rolling thereof, said apparatus comprising means for guiding said strip under tension along a non-linear path including a plurality of individual sensing rollers arranged substantially side-by-side across said path to define a non-linear portion thereof and each rotatably journalled in an associated support arm means, and means for moving the support arm means together about a common axis to urge the rollers into engagement with said strip, each said support arm means including means for measuring the stress arising therein, whereby stress variations within the portion of the metal strip passing over the rollers due to lack of planeness of the strip are indicated by variations in stress in the individual ones of said support arm means.

2. Apparatus as claimed in claim 1 in which the support arm means each comprise side arms and bearings for the associated roller, the stress measuring means being carried by the side arms.

3. Apparatus as claimed in claim 2 in which a stress measuring means for each said roller is located in a cavity in an associated side arm.

4. Apparatus as claimed in claim 1, 2, or 3, in which the support arm means are mounted for pivotal movement about a common fixed axis for engagement with the metal strip.

5. Apparatus as claimed in claim 1, 2, 3 or 4 in which the arm support means for the plurality of rollers are supported on a shaft reinforced by a rigid casing, the shaft axis being a fixed axis about which the arm support means can pivot for engagement with a metal strip.

6. Apparatus as claimed in claim 5 in which the arm support means are connected to the rigid casing by rigid joints.

7. Apparatus as claimed in claim 5 in which each arm support means includes a side arm comprising a substantially T-shaped member pivotally mounted to the rigid casing at each of the bars of the T and a link pivotally connected to the T-shaped member and the casing and carrying the measuring element.

8. Apparatus as claimed in any preceding

claim in which each roller is provided with a measuring means.

9. Apparatus as claimed in any preceding claim in which each measuring means comprises a strain gauge.

10. Apparatus for determining the degree of planeness of a metal strip substantially as herein described with reference to figures 1 and 2 or figure 3 or figure 4 of the accompanying drawings.

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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG. 1

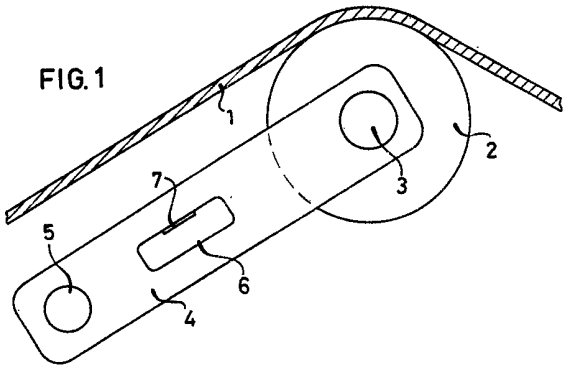

FIG. 2

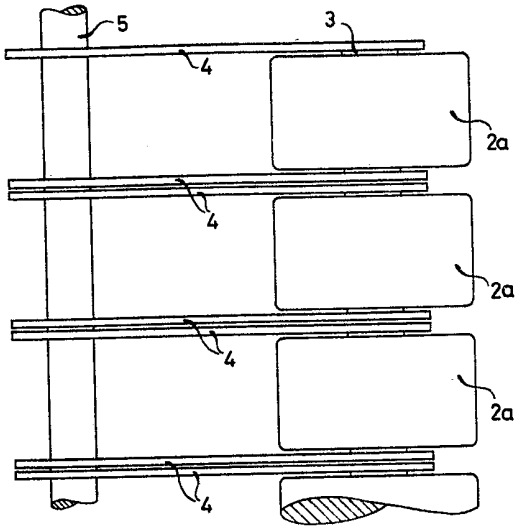

FIG. 3

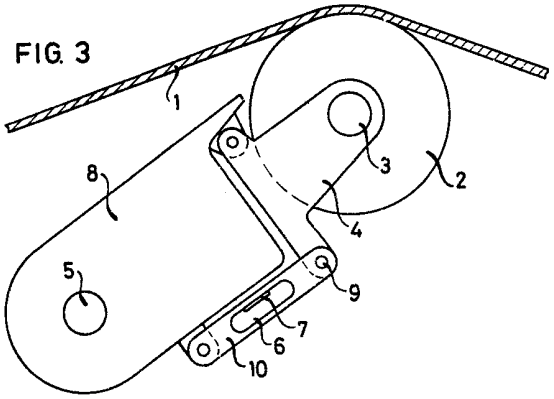

FIG. 4