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(54) Title: METHOD AND DEVICE FOR STRAIGHTENING WIRE OR STRIP MATERIAL

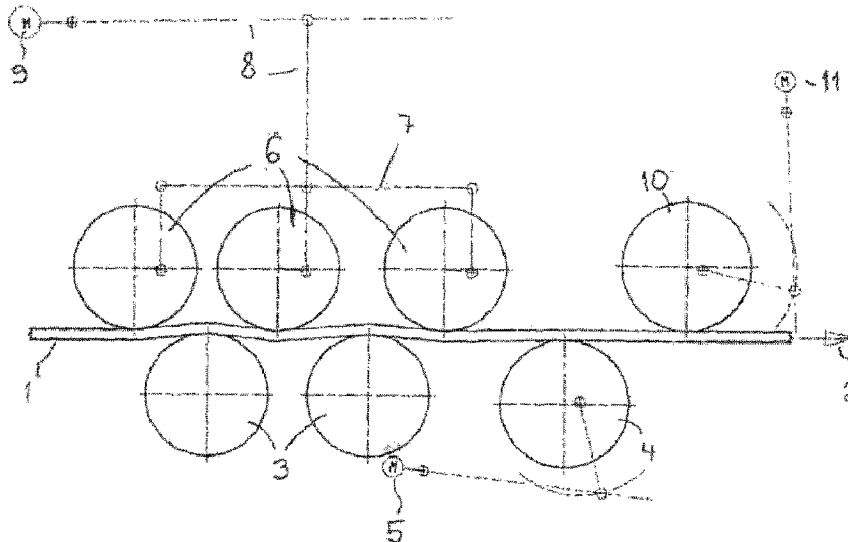


Fig. 1

(57) Abrégé/Abstract:

The invention relates to a method for straightening wire or strip material by means of a straightening device comprising straightening rollers (3, 4, 6, 10) engaging on opposite sides of the passing-through material (1) in an offset manner, some of which



(57) Abrégé(suite)/Abstract(continued):

are automatically adjusted according to a model which has been stochastically determined on the basis of input data of the material and data relating to the wire and the straightening device that is determined during the passing of the material through the straightening device, such that requirements of straightness are met, wherein the position of at least one straightening roller is continuously adapted on the basis of said data detected during the passage through the straightening device, which data is representative of the target straightness, wherein (i), the size and direction of the forces acting on the straightening rollers and/or (ii) the temperature of the material before and after passing through the assembly of straightening rollers and/or (iii) the position of the material are measured after each of the straightening rollers and the obtained measurement values are input into the model controlling the adjustment of the adjustable straightening rollers. The invention also relates to a device for carrying out said method.

ABSTRACT

The invention relates to a method for straightening wire or strip material by means of a dressing device comprising straightening rollers (3, 4, 6, 10) engaging on opposite sides of the passing-through material (1) in an offset manner, of which, some are automatically activated according to a model which has been stochastically determined on the basis of input data of the material and data relating to the wire and the dressing device that is determined during the passing of the material through the dressing device, such that requirements for straightness are met, wherein the position of at least one straightening roller is continuously adapted on the basis of said data detected during the passage through the dressing device, which data are representative of the target straightness, wherein (i), the size and direction of the forces acting on the straightening rollers and/or (ii) the temperature of the material before and after passing through the assembly of straightening rollers, and/or (iii) the position of the material is measured at each of the straightening rollers and the obtained measurement values are input into the model controlling the adjustment of the adjustable straightening rollers.

METHOD AND DEVICE FOR STRAIGHTENING WIRE OR STRIP MATERIAL

5 The invention relates to a method for straightening wire or strip material by means of a dressing device comprising straightening rollers engaging on opposite sides of the passing-through material in an offset manner, of which, some are automatically activated according to a model which has been stochastically determined on the basis of input data of the material and data of the material and of the dressing device determined during the passing of the material through the dressing device such that requirements for straightness are met, wherein the position of at least one
10 straightening roller is continuously adapted on the basis of said data recorded during the passage through the dressing device, which data are representative of the target straightness.

Such a method is described in DE-A-196 53 569. However, this document only addresses product and/or process data only very generally measured during the ongoing straightening process, which data are incorporated online into the model and which change without specifying the
15 measurements necessary for this. It is also not clear whether or to what extent the model enables an inference to be made of the precise geometry of the straightened end product.

The object of the invention is to provide a closed control circuit for an autonomous method in order to straighten the material to be straightened of unknown, variable curvature. The method is intended to ensure the targeted straightness of the straightened wire with greater reliability.

20 This is achieved with the aforementioned method in that

- (i) the size and direction of the forces engaging the straightening rollers on the straightening rollers themselves and/or
- (ii) the temperature of the material before and after passing through the arrangement of straightening rollers and/or
- 25 (iii) the position of the material subsequent to each of the straightening rollers are measured and the measured values obtained are entered into the model controlling the adjustment of the adjustable straightening rollers.

Advantageously, (ii) the temperature of the material is measured at the output of each straightening roller or each straightening block.

30 The measurement (i) of the forces engaging at the straightening rollers expediently takes place by means of strain gauges arranged at the bearing bolts of the straightening rollers, which strain gauges measure the bending moments in the axial, vertical, and/or horizontal direction.

The measurement (ii) of the temperature records the deformation energy incorporated into the material to be straightened. Material properties flowing into the model can optionally be corrected by means of this measurement. It is possible that this measurement is only implemented at the start of a straightening process or to calibrate a straightening device.

5 The measurement (iii) of the position of the material expediently takes place following each of the straightening rollers by means of measurement of the deviation of the material from the pass-through axis in the positioning direction of the straightening rollers. Known optical or contactless (e.g. magnetic) measuring methods are used for this. This also applies to the vibrations occurring in addition for the expedient measurement of the wire material passing through, the measured value of
10 said vibrations likewise being entered into the model controlling the adjustment of the adjustable straightening rollers. It is conceivable that the position measurement (iii) is implemented only at the start of the method for calibration purposes, while the measurement of the forces engaging at the straightening rollers in order to implement the method according to the invention is sufficient in ongoing operation.

15 Advantageously, the material passes through two dressing devices, as mentioned previously, in which one dressing device has horizontally arranged straightening rollers and the other has vertically arranged straightening rollers.

The invention moreover relates to a device for implementing the method according to the invention with a dressing device having two rows of non-driven straightening rollers arranged
20 longitudinally offset opposite one another, which straightening rollers engage a wire passing between the rows during operation in order to straighten said wire, in which some straightening rollers are automatically controllably adjustable to the material depending on a model such that the requirements for straightness of the material exiting from the dressing device are met, in which the model has been stochastically determined on the basis of entered input data of the wire and on the
25 basis of data of the dressing device and of the material recorded in the dressing device. Such a device is mentioned in the previously cited DE-A.

The invention comprises such a device that the straightening rollers first acting on the material have a row of fixed axes and the straightening roller subsequently engaging the material on the same side of the material is individually adjustable to the passing-through material, and that the
30 straightening rollers of the opposite row are all adjustable to the material, in which the straightening rollers of this row first acting on the material are jointly adjustable and the straightening roller of the same row subsequently engaging the material is individually adjustable, and in which the size and direction of the forces engaging the straightening rollers are measurable by means of these autonomously arranged measuring devices, such as strain gauges, and the temperature of the

material is measurable by means of measuring devices arranged at the input and output of the dressing device, in which all obtained measured values are supplied to the model controlling the adjustment of the adjustable straightening rollers.

In an alternative of the invention, the temperature of the material subsequent to one or several straightening rollers is measurable by means of measuring devices respectively arranged there, in which likewise all obtained measured values can be supplied to the model controlling the adjustment of the adjustable straightening rollers.

In a further embodiment, the position of the material subsequent to one or several straightening rollers is measurable by means of measuring devices respectively arranged there, in which likewise all obtained measured values can be supplied to the model controlling the adjustment of the adjustable straightening rollers.

The invention is explained in more detail by means of the drawing, in which Figure 1 shows a dressing device with a wire passing through it, Figure 2 shows the same dressing device with indicated measuring points of the forces occurring at the individual straightening rollers and the wire temperature, and Figure 3 shows a straightening roller with a strain gauge arranged thereon.

The dressing device from Figures 1 and 2 has two rows of horizontal straightening rollers 3, 4, 6, 10 arranged horizontally offset as relates to each other. One row engages the wire to be straightened from below and the other row engages the wire to be straightened from above. The material 1 to be straightened may also be strip material (not shown); the term material in the following characterizes the wire or the strip material. The straightening rollers 3, 4, 6, 10 do not have a rotary drive; a wire as the material 1 passes through the dressing device, which material is moved in the direction of the arrow 2 by the feed rollers, which are not shown. Normally, the wire passes through two dressing devices in succession, each of which is offset by 90° as relates to one another, in which one dressing device has the horizontal straightening rollers and the other dressing device has the vertical straightening rollers. The main working range of the invention comprises wire diameters between about 4 mm and about 20 mm.

The first two straightening rollers 3 of the bottom row shown in Figures 1 and 2 have fixed axes of rotation. The bottom straightening roller 4 attached thereto is individually adjustable to the passing-through material 1 by means of an adjusting device 5 as indicated. The three first straightening rollers 6 of the top row are jointly adjustable to the material 1 and are mounted on a common support 7 for this purpose, which support is height-adjustable using a servomotor 9 by means of a lever 8. The top straightening roller 10 attached to the two top straightening rollers 6 is individually adjustable to the material by means of an adjusting device 11 as indicated.

Figure 2 shows the measurements, designated as f , of the various forces engaging the individual straightening rollers as well as the temperature measurements on the material 1 before and after passing through the arrangement of straightening rollers. In general, the material 1 heats up during straightening by a straightening roller fitting. The temperature-measuring devices are indicated at the points 16. The temperature measurement can also take place at the output of each of the straightening rollers 3, 4, 6, 10.

The measuring devices arranged subsequent to each of the straightening rollers 3, 4, 6, 10 for determining the position of the wire are not shown in Figure 2. These are known optical or magnetic measuring devices which measure the deviation of the material 1 from the pass-through axis or parallel to the adjusting direction of the straightening rollers 6, 4, 10, i.e. in the vertical direction in the case shown. Also not shown is a vibration-measurement device which measures vibrations occurring on the wire in the case of straightening corrugated wires in order to eliminate the resulting interference variables.

All of the mentioned measurement variables are entered into the model controlling the adjustment of the adjustable straightening rollers 6, 4, 10.

Figure 3 shows a straightening roller 13 on a larger scale with a strain gauge 17 arranged on its bearing bolt 12 in a respective groove 15. For an improved measurement of forces and force directions acting on a roller, up to four strain gauges 17 are provided in the bearing bolt 12 of a straightening roller. In this case, the strain gauges 17 are arranged parallel to one another in the bearing bolt 12. Furthermore, they are arranged about the axis of the bearing bolt 12 in quadrant intervals (offset by 90°). Instead of the strain gauges 17 which have the advantage of being simply constructed and sufficiently measurement-precise, other pressure- or bending-measurement sensors can be used in or on the bearing bolts 12, e.g. likewise simply constructed Piezo sensors.

Claims:

1. A method for straightening wire or strip material by means of a dressing device comprising straightening rollers (3, 4, 6, 10) engaging on opposite sides of the passing-through material (1) in an offset manner, of which, some are automatically activated according to a model
5 which has been stochastically determined on the basis of input data of the material (1) and data of the material (1) and of the dressing device determined by the dressing device during the passing of the material through the dressing device such that requirements for straightness are met, wherein the position of at least one straightening roller is continuously adapted on the basis of said data recorded during the passage through the dressing device, which data are
10 representative of the target straightness, characterized in that
 - (i) the size and direction of the forces engaging the straightening rollers (3, 4, 6, 10) on the straightening rollers themselves and/or
 - (ii) the temperature of the material (1) before and after passing through the arrangement of straightening rollers (3, 4, 6, 10) and/or
 - 15 (iii) the position of the material (1) subsequent to each of the straightening rollers are measured and the measured values obtained are entered into the model controlling the adjustment of the adjustable straightening rollers (6, 4, 10).
2. The method according to claim 1, characterized in that the temperature of the wire or the strip
20 material is measured at the output of each straightening roller (3, 4, 6, 10).
3. The method according to claim 1 or 2, characterized in that the forces engaging the straightening rollers (3, 4, 6, 10) are measured by means of strain gauges (17) arranged on the bearing bolts (12) of the straightening rollers (3, 4, 6, 10), which strain gauges measure the
25 bending moments in the axial, vertical, and/or horizontal direction.
4. The method according to any of claims 1 to 3, characterized in that the measurement of the position of the wire or of the strip material subsequent to each of the straightening rollers (3, 4, 6, 10) is a measurement of the deviation of the material (1) from the pass-through axis in or
30 parallel to the adjusting direction of the straightening rollers (3, 4, 6, 10).
5. The method according to any of claims 1 to 4, characterized in that vibrations occurring on the wire or strip material passing through are also measured and the measured value is

likewise entered into the model controlling the adjustment of the adjustable straightening rollers (4, 6, 10).

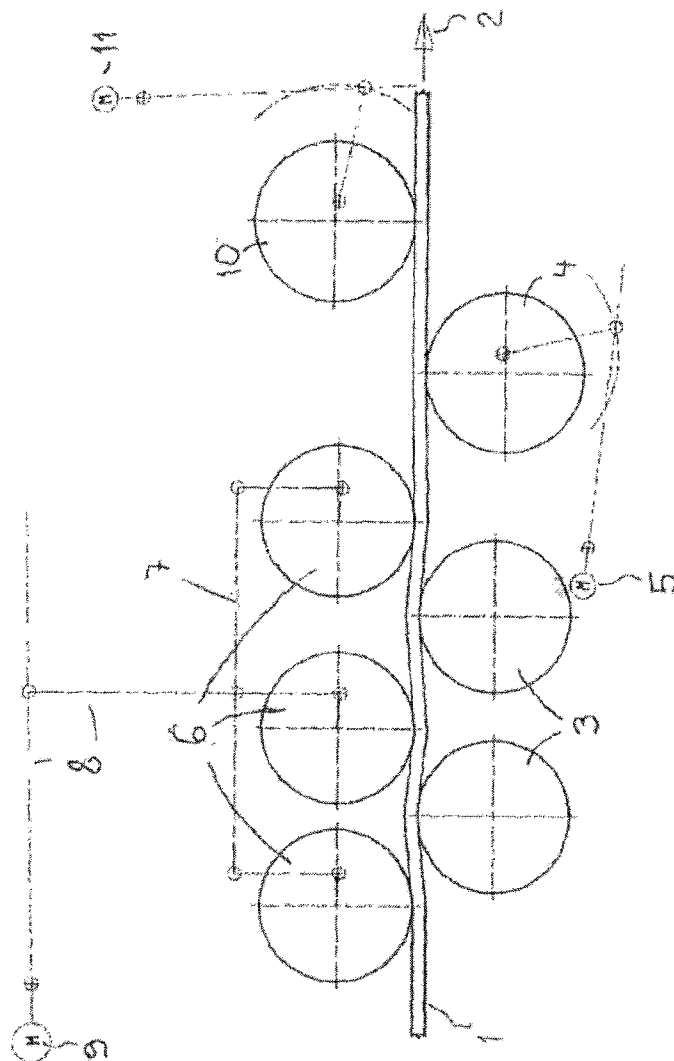
6. The method according to any of claims 1 to 5, characterized in that the wire or strip material passes through two dressing devices in succession, wherein one dressing device has horizontally arranged straightening rollers (3, 4, 6, 10) and the other has vertically arranged straightening rollers.

7. A device for implementing the method for straightening wire or strip material according to any of claims 1 to 6, comprising a dressing device with two rows of non-driven straightening rollers (3, 4, 6, 10) arranged longitudinally offset as relates to one another, which straightening rollers, during operation, engage a material (1) passing between the rows in order to straighten said material, wherein some straightening rollers (6, 4, 10) are automatically controllably adjustable to the material (1) depending on a model such that the requirements for straightness of the material exiting from the dressing device are met, wherein the model has been stochastically determined on the basis of entered input data of the material (1) and on the basis of data of the dressing device and of the material recorded in the dressing device, characterized in that the straightening rollers (3) first acting on the material (1) have a row of fixed axes and are subsequently adjustable individually for the passing-through material (1) on the same side of the straightening roller (4) engaging the material (1), and in that the straightening rollers (6, 10) of the opposite row are all adjustable to the material (1), wherein the straightening rollers (6) of this row first acting on the material (1) are jointly adjustable and the straightening roller (10) of the same row subsequently engaging the material (1) is individually adjustable, and wherein the size and direction of the forces engaging the straightening rollers (3, 4, 6, 10) are measurable by means of these autonomously arranged measuring devices, such as strain gauges (17), and the temperature of the material (1) is measurable by means of measuring devices (16) arranged at the input and output of the dressing device, wherein all obtained measured values are supplied to the model controlling the adjustment of the adjustable straightening rollers (6, 4, 10).

8. The device according to claim 7, characterized in that the temperature of the material (1) subsequent to one or several straightening rollers (3, 4, 6, 10) is measurable by means of measuring devices respectively arranged there, wherein likewise all obtained measured values

can be supplied to the model controlling the adjustment of the adjustable straightening rollers (6, 4, 10).

- 5 9. The device according to claim 7 or 8, characterized in that the position of the material (1) subsequent to one or several straightening rollers (3, 4, 6, 10) is measurable by means of measuring devices respectively arranged there, wherein likewise all obtained measured values can be supplied to the model controlling the adjustment of the adjustable straightening rollers (6, 4, 10).



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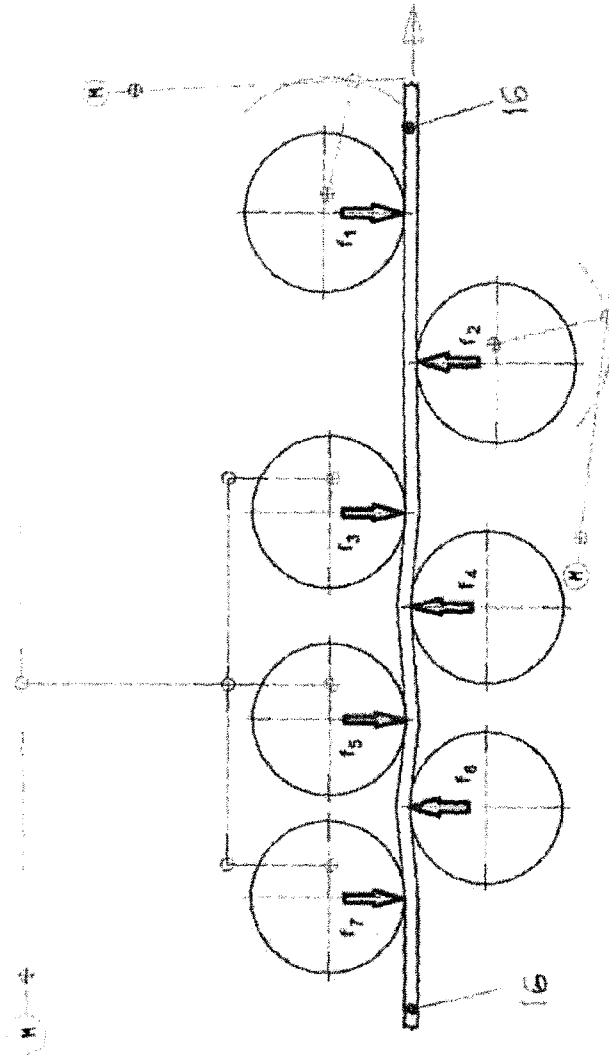


Fig. 2

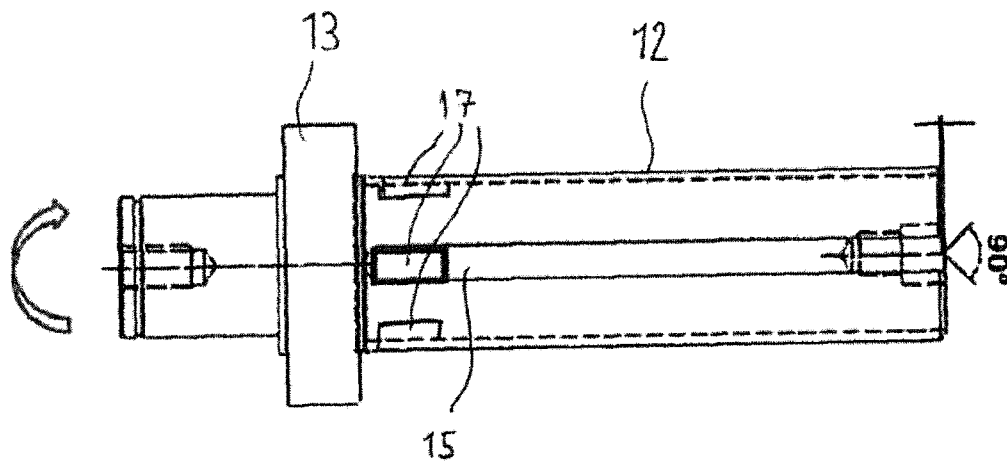


Fig. 3

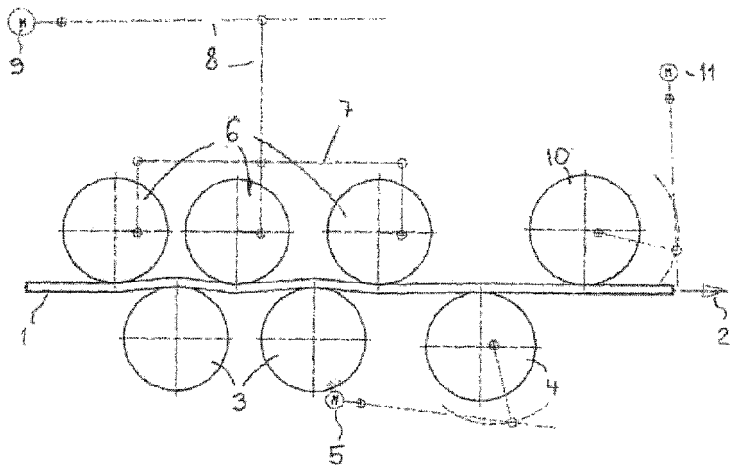


Fig. 1