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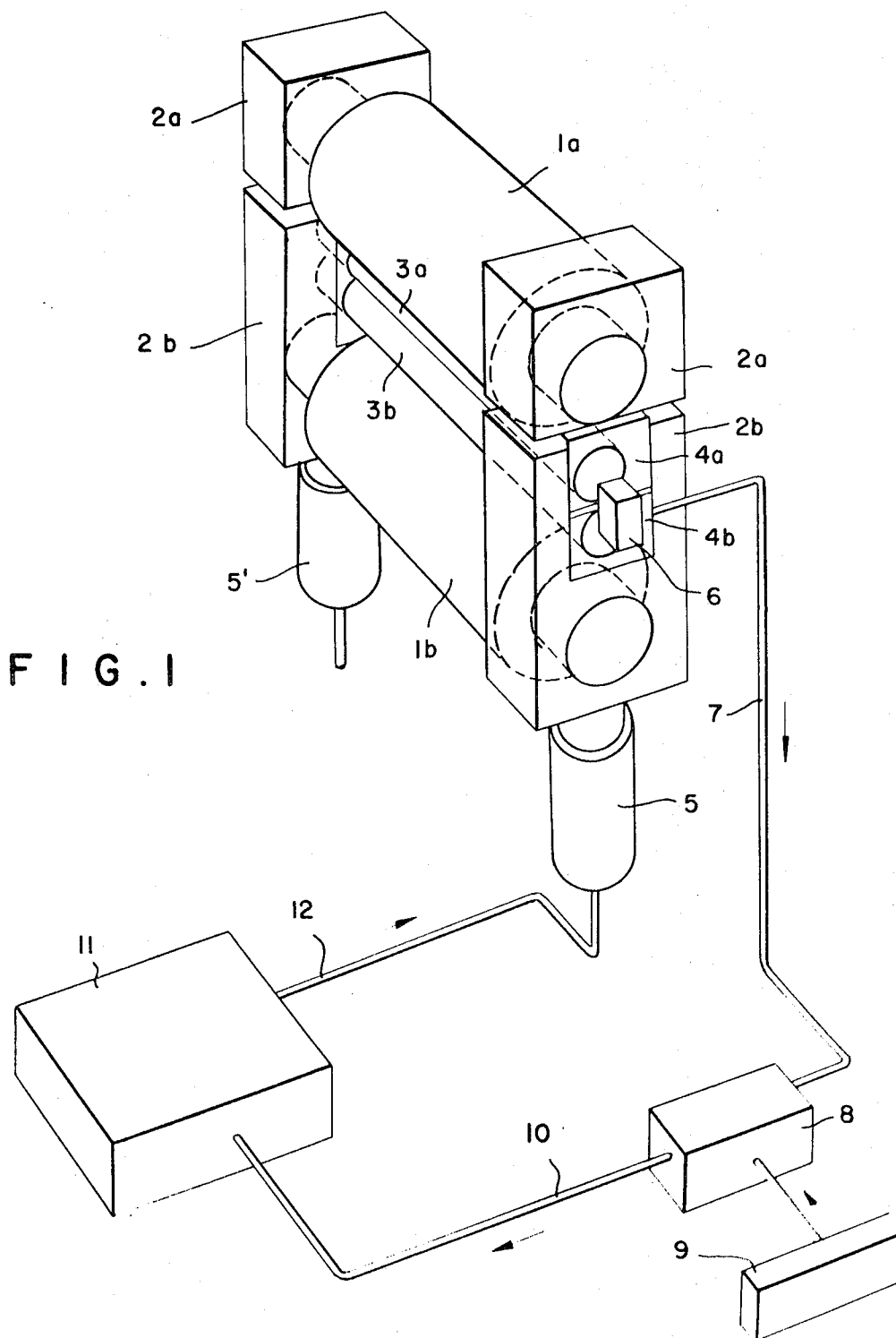
F. FISCHER ET AL

3,570,288

ROLLING-MILL ASSEMBLY WITH IMPROVED CONTROL SYSTEM

Filed Oct. 18, 1968

3 Sheets-Sheet 1



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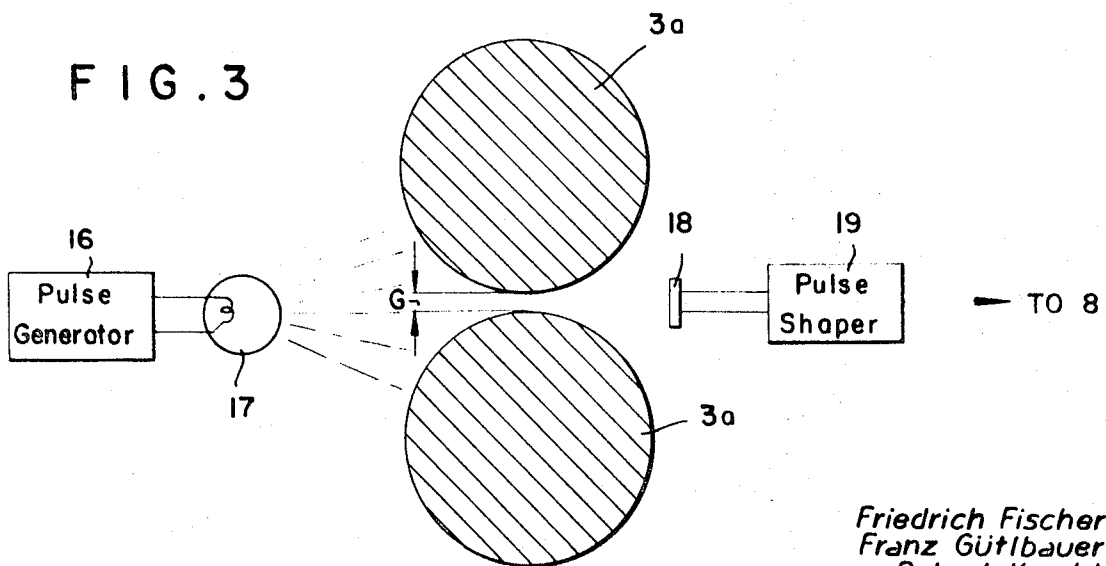
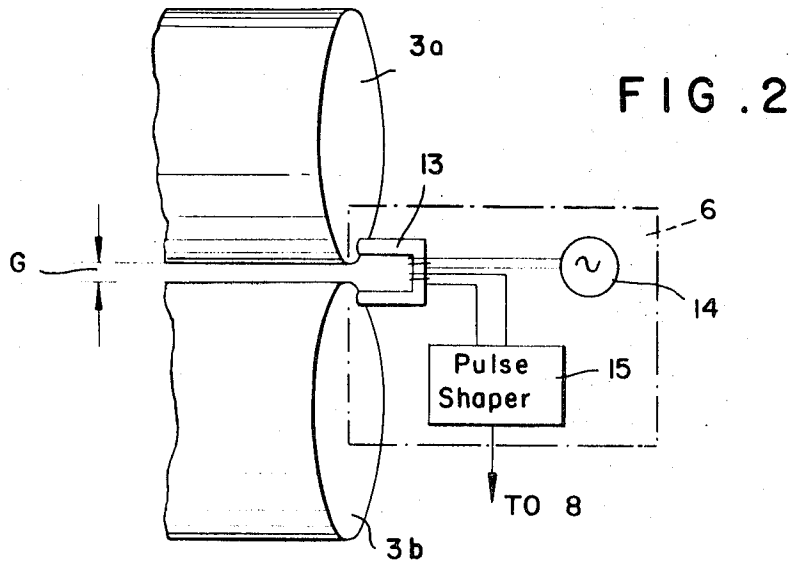
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FIG. 4

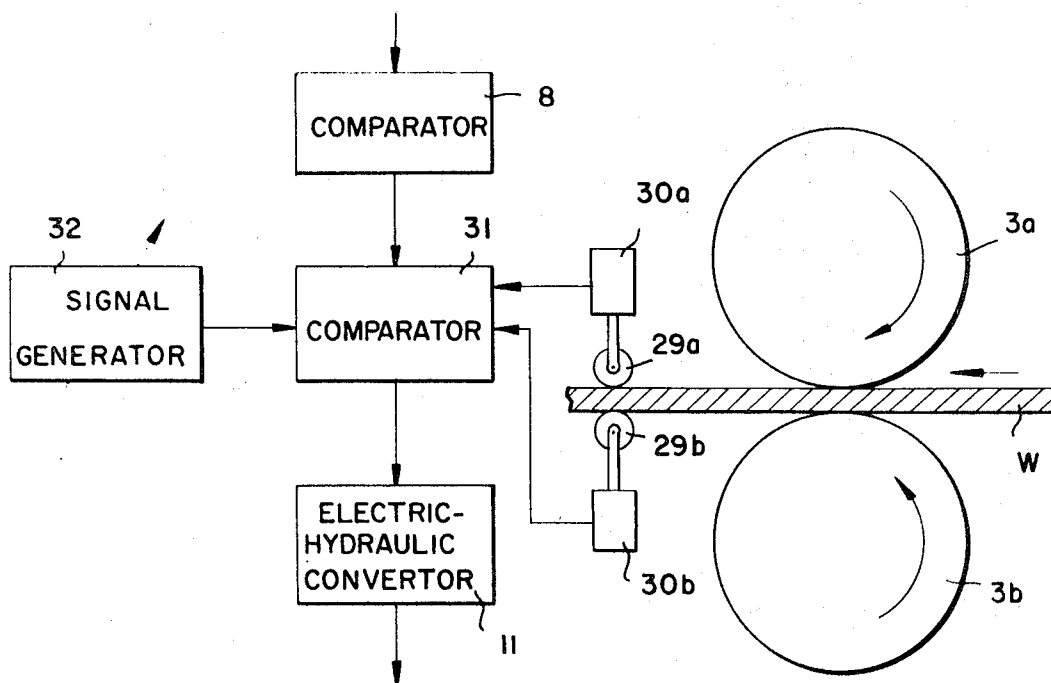
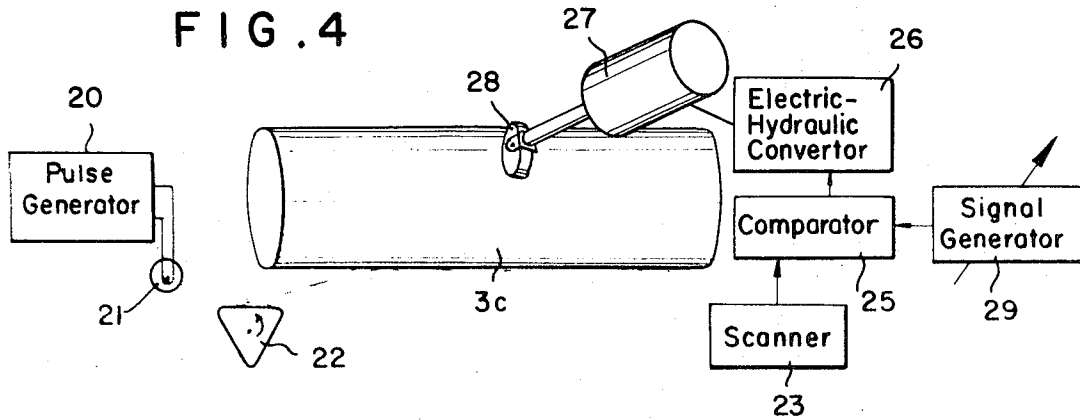


FIG. 5

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ROLLING-MILL ASSEMBLY WITH IMPROVED CONTROL SYSTEM

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U.S. Cl. 72—8

8 Claims

ABSTRACT OF THE DISCLOSURE

A rolling mill with two rolls has an improved control assembly which comprises electromagnetic or photoelectric sensors which meter the gap between the rolls while remaining out of contact with them. The output of this sensing arrangement is compared with a reference value to yield an error signal which is fed to an adjustment mechanism to change the roller gap if necessary. Further sensors for metering a bending in the rolls can be provided and coupled with a device for straightening the roll. In addition a gauge measuring the thickness of the rolled workpiece can be used to provide a cross check on the functioning of the apparatus.

Our invention relates to an improved control system for a rolling-mill assembly, in particular to a system for maintaining the two work rolls of such an assembly at an exact gap spacing.

Rolling-mill assemblies are known wherein pressure gauges are connected to the hydraulic means for adjusting the gap between the rolls. These pressure gauges are connected to the hydraulic feed to maintain a constant and even pressure on the rolls. However, irregularities in the roundness of the rolls and in the homogeneity of the material being rolled are not compensated for by such an arrangement; indeed, often they are only worsened. Furthermore, arrangements as above described are at best sluggish and insensitive.

It is therefore the principal object of our invention to provide a control system for a rolling-mill assembly which overcomes these above-mentioned disadvantages while providing added benefits of safety, sensitivity and accuracy.

We do this by providing a rolling-mill assembly with noncontact or contactless sensing means which meters the gap between the two rolls directly and without depending on touching the rolls or their journal blocks. This means can be electromagnetic or photoelectric i.e. an electromagnetic-wave field.

The sensing means produces an output signal which, according to a main feature of the invention, is compared with a reference signal (representing the ideal gap spacing) to produce an error signal which is used to regulate a hydraulic adjustment mechanism which accordingly varies the gap between the rolls to correct deviation.

To further improve the quality of the rolled material, further means for detecting or metering a bending of the rolls can be provided and coupled with an arrangement for straightening out the bent roll.

According to a further feature of our invention a gauge for metering the thickness of the rolled material after rolling is connected with the above-described system for providing a check on same.

The above and other features, objects and advantages of our invention will be described in the following with reference to the drawing in which:

FIG. 1 is a perspective view showing a rolling-mill assembly with a control system according to our invention;

FIG. 2 is a diagrammatic detail of FIG. 1;

FIG. 3 is a side view of a further embodiment of a sensing means according to our invention;

FIG. 4 is a partly perspective view of an arrangement for correcting a bend in a roll; and

FIG. 5 is a side view of an arrangement for checking the functioning of the control system of FIG. 1.

FIG. 1 shows a rolling-mill assembly as described in the commonly assigned application Ser. No. 731,802 entitled "Rolling-Mill Assembly" filed by Robert Kracht on May 24, 1968. Two support rollers 1a and 1b mounted in journal blocks 2a and 2b, respectively, support work rollers 3a and 3b mounted in blocked 4a and 4b, respectively. Below the blocks 4a and 4b are powerful hydraulic cylinders 5 and 5' which serve as the adjustment mechanism for a gap G between the rollers 3a and 3b.

At one end of the rollers 3a and 3b is a sensing device 6 which meters the gap G between these two rolls. This device 6 is connected through a line 7 to a comparator or error detector 8 where its output signal is compared with a reference signal coming from a signal generator 9. An error signal is produced in comparator 8 (see pages 4 ff. of Servomechanism Practice, McGraw-Hill, 1960) and is sent through a line 10 to control a hydraulic control device or valve 11 which actuates the cylinder 5 through a line 12. A similar arrangement can be provided for the cylinder 5'.

The control device 11 may be any of the electrical input/fluid-pressure output devices shown and described at pages 394 ff. of Servomechanism Practice, Ahrendt & Savant, McGraw-Hill, New York, Second edition, 1960.

FIG. 2 shows an electromagnetic embodiment of the sensor 6. Here the gap G between the rolls 3a and 3b is metered by a magnetometer 13 (see U.S. Pat. No. 3,398,360 and those of the same class) which is connected to an AC source 14 and whose output is fed through a pulse shaper 15 to the comparator 8 (FIG. 1). The output is here converted to pulses by the shaper 15 to make it easier to work with.

FIG. 3 shows a photoelectric embodiment of a sensing device where light pulses are generated by a bulb 17 connected to a pulse generator 16 and are picked up on the other side of the gap G between the rolls 3a and 3b by a photocell 18 also connected through a pulse shaper 19 to the comparator 8 (FIG. 1).

In FIG. 2 a change in the gap G makes for a change in the magnetic field of the magnetometer 13 while in FIG. 3 a change in the gap G makes for more or less light received by the photocell 18. Both of these changes can be easily converted into changing pulse trains, which are ideally suited for the control system proposed by our invention.

FIG. 4 shows a roll 3c which is engaged by a small roller wheel 28 of a hydraulic cylinder 27. A pulse generator 20 triggers a light bulb 21 whose light pencil or beam is reflected by a rotating mirror 22 across the length of the roll 3c. A scanner 23 picks up the sequential light pulses reflected by this roll 3c and, e.g. according to principles generally described in U.S. Pat. No. 3,061,731 and the references cited therein, thereby generates a signal, preferably a pulse signal, which is combined in a comparator 25 with a reference signal from a generator 24 to produce an error-signal output dependent on the bending of the roll 3c. This is fed into an electric-hydraulic converter 26 where it is used to feed the cylinder 27 to push on the roll 3c and compensate for the bending.

Downstream of the rolls 3a and 3b a thickness gauge such as rollers 29a and 29b connected to sensors 30a

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and 30b may be provided to measure the thickness of the workpiece W as shown in FIG. 5. The outputs of the two sensors 30a and 30b are compared in a comparator 31 with a signal from an adjustable reference-signal generator 32 as above to determine if the actual width of the workpiece W is more or less than the width which it is supposed to have according to the setting of the cylinders 5 and 5' (FIG. 1) in turn determined by the control system. Thus, should for some reason the rolls 3a and 3b be set wrong, this check-up device can over-ride the signal passing from the comparator 8 and the converter 11 of FIG. 1, and reset the rolls 3a and 3b as is necessary.

The improvement described and illustrated is believed to admit of many modifications within the ability of persons skilled in the art, all such modifications being considered within the spirit and scope of the invention except as limited by the appended claims.

We claim:

1. In a rolling-mill assembly having an upper and a lower roll defining an elongated gap, and an adjustment mechanism for displacing one of said rolls toward and away from the other of said rolls thereby changing the height of said gap, a control system comprising:

sensing means adjacent said gap creating an electromagnetic-wave field between proximal surfaces of said rolls defining said gap at least in the region thereof traversed by a workpiece passing between said rolls for metering said height and generating an output signal representing same; and

control means responsive to said signal and connected to said adjustment mechanism for actuating same to establish a predetermined gap height between said rolls of said region.

2. The control system defined in claim 1 wherein said sensing means includes an electromagnet and said field is a magnetic field.

3. The control system defined in claim 1 wherein said sensing means includes a light source on one side of said gap and said field is a light beam.

4. The control system defined in claim 1 wherein said adjustment mechanism is hydraulic.

5. The control system defined in claim 1 wherein said output signal is a pulse train.

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6. The control system defined in claim 1 wherein said control means comprises means for generating a reference signal representing said predetermined gap width and comparing means connected thereto and to said sensing means for combining said signals and producing an error signal representing the difference between said output and reference signals for operating said adjustment mechanism to set said rolls at said predetermined gap width.

7. The control system defined in claim 1, further comprising means responsive to bending configuration of the said surface of at least one of said rolls along said gap for generating a second output signal representing said configuration, and means responsive to said second output signal for bending said one of said rolls to straighten same.

8. The control system defined in claim 1, further check means for gauging the thickness of a workpiece rolled between said rolls and for generating a third output signal representing said thickness, and second control means connected to said check means and connectable between said sensing means and said adjustment mechanism on a condition of said thickness being substantially different from said predetermined gap width to override same.

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U.S. Cl. X.R.

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