

[54] **DRIFT CORRECTOR FOR
TRANSDUCERS**

[75] Inventors: **Earl R. Berkey**, Franklin Twsp.,
Westmoreland County; **Everett L.
Keener**, Monroeville Borough, both
of Pa.

[73] Assignee: **United States Steel Corporation**

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[58] Field of Search **72/8, 19, 35; 73/15.6, 88.5**

[56] **References Cited**

UNITED STATES PATENTS

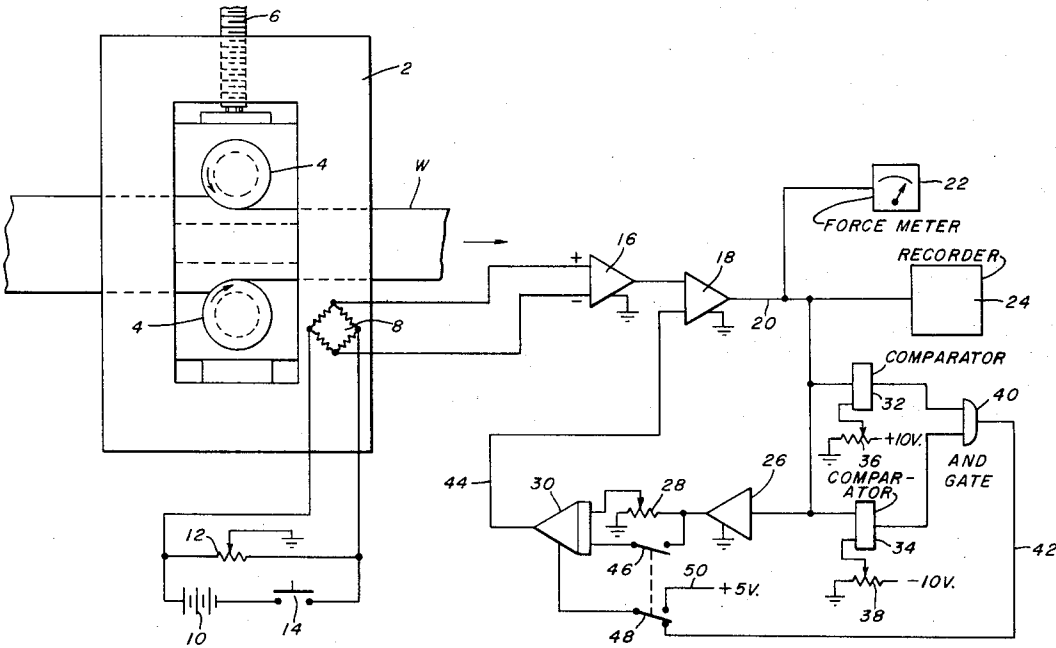
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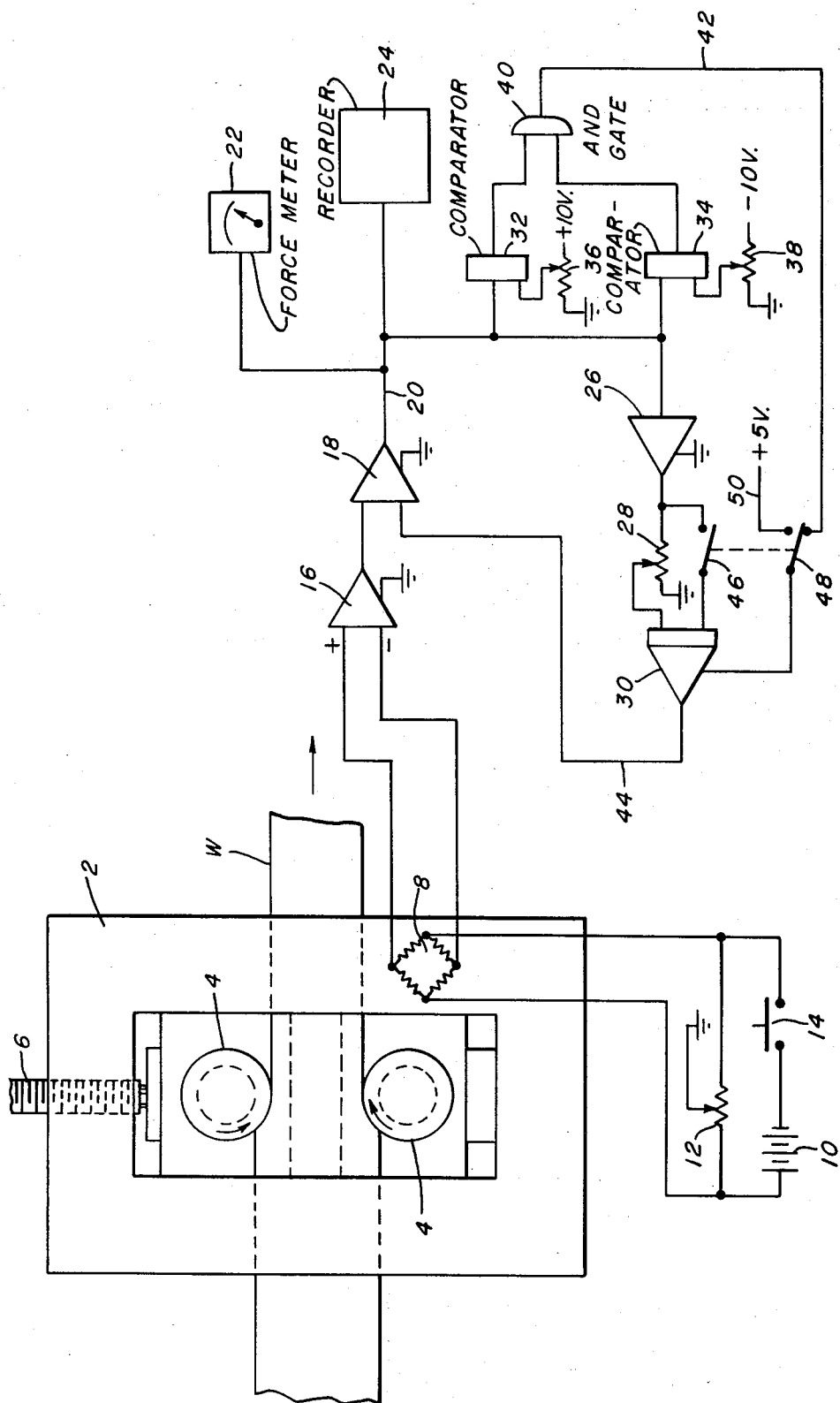
Primary Examiner—Milton S. Mehr
Attorney—Martin J. Carroll

[57] **ABSTRACT**

Apparatus for measuring the roll separating force produced by a workpiece includes a strain gage bridge, and an amplifier having a first input connected to the output of the bridge, a second input and an output. A first circuit including a polarity reversal means and an integrator connected in series is arranged between the output and second input of the amplifier. The integrator has an input connected to the output of the amplifier, an output connected to the second input of the amplifier, and a control connection. A second circuit between the control connection and the first circuit on the input side of the integrator includes switch means operable when there is no workpiece in the mill to provide a signal to the control connection to cause the integrator to be in its operative mode and operable when there is a workpiece in the mill to provide a signal to the control connection to cause the integrator to be in its hold mode. This provides a signal to the amplifier from the integrator which is equal and opposite to the voltage from the bridge when there is no workpiece in the mill which voltage remains constant when the workpiece is in the mill. Thus, a true reading of the roll separation force is obtained regardless of the amount of drift present.

14 Claims, 1 Drawing Figure





DRIFT CORRECTOR FOR TRANSDUCERS

This invention relates to a drift corrector for transducers and more particularly to correcting drift associated with a resistance strain gage for measuring roll separating forces on a metal rolling mill. Rolling mills are used to reduce steel ingots or the like to slabs, plates, strip, or other shapes. In a slabbing mill the ingot is reduced to a slab of the desired width and thickness. This is usually done by passing the ingot through a rolling mill in several passes. The fewer the number of passes the greater the production. However, the reduction per pass is limited by the rolling mill design and drive motor capacities. It is desirable to adjust the mill to obtain maximum reduction per pass without exceeding the safe roll separating force. Thus, it is important to know the roll separating force during the rolling operation. Various types of transducers such as strain gages; load cells and pressductors have been used for this purpose. The use of strain gages is limited because of excessive drift and the use of load cells and pressductors has been limited because they are expensive and difficult to install and maintain. The drift referred to herein relates to changes in the force signal due to extraneous factors. In rolling mills this is mainly due to temperature changes in the mill stand. The presence of drift is a well recognized phenomena and many attempts have been made to compensate for drift. The art of which we have knowledge is as follows:

Messinger	2,152,556	Mar. 28, 1939
Stone	2,180,176	Nov. 14, 1939
Bagno	2,276,817	Mar. 17, 1942
Crawford	2,322,418	June 22, 1943
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Shayne et al.	2,336,371	Dec. 7, 1943
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Rendel	2,659,154	Nov. 17, 1953

However, all these devices have various shortcomings. They maybe expensive, unreliable, difficult to maintain, and/or inaccurate.

It is therefore an object of our invention to provide a drift corrector for strain gages or the like which is relatively inexpensive, accurate, simple to maintain, and readily adjustable.

This and other objects will be more apparent after referring to the following specification and attached drawings, in which:

The single FIGURE is a schematic drawing of our invention as incorporated in a rolling mill.

Referring more particularly to the drawing, reference numeral 2 indicates a roll housing having work rolls 4 rotatably supported therein with a screw down 6 for varying the roll pass and hence the roll pressure as a workpiece W passes therethrough. The parts so far described are conventional and form no part of the present invention.

According to the specific form of our invention a strain gage bridge 8 is installed on one leg of the housing 2. Voltage power supply 10 supplies the voltage across the bridge 8. A balance control 12 is provided across the power supply 10. Flow of power to the bridge 8 is controlled by a switch 14. Strain on the housing 2 caused by a separating force on the rolls 4 during the rolling operation causes the housing 2 to stretch. This stretch of the housing causes the resistance of the strain gage bridge 8 to change propor-

tional to the stretch. The resistance change in the bridge 8 causes the output voltage of the bridge to change proportional to the roll separating force. Balance control 12 is used to adjust the bridge output to zero when no force load is present. Stretch in the housing 2 due to temperature also causes the output voltage of the bridge 8 to change. This voltage output change is the drift referred to above. A differential amplifier 16 is connected to the output of the bridge 8. This is preferably an Electronic Associates, Inc. (EAI) Type 6.0777 having a gain of 1,000. The output of amplifier 16 is connected to an amplifier 18 which is preferably an EAI Type 6.0864. Output 20 of the amplifier 18 is connected to a force meter 22 and/or a force recorder 24. The output 20 is also connected to an amplifier 26 which acts to reverse the polarity and preferably has a gain of one. The output of amplifier 26 is connected through a potentiometer 28 to an integrator or amplifier 30 which is preferably an EAI Type 12.1780. The output 20 is also connected to comparators 32 and 34 which are preferably EAI Type 0.40.0729. An input voltage is supplied to comparators 32 and 34 through potentiometers 36 and 38, respectively. The comparators 32 and 34 are connected to the inputs of a logical NAND gate 40 which is preferably a Texas Instrument Type SN-7410N. The comparator 34 is optional and, if omitted, the gate 40 is also omitted. The output of gate 40 or the output of comparator 32, if comparator 34 and gate 40 are omitted, is connected through line 42 as a control connection input to integrator 30. The output of integrator 30 is connected through line 44 as an input to amplifier 18. A normally open switch 46 is connected in parallel with potentiometer 28 and a normally closed switch 48 is connected in line 42 for simultaneous operation. The switch 48 is also connectable to a voltage supply 50 which preferably is of 5 volts.

The operation of our device is as follows:

Before starting in operation the setting of the potentiometer 28 is adjusted to obtain the desired rate of change of the drift compensation. Normally when the rate of change in drift is relatively slow the adjustment for drift is also made relatively slow and when the rate of change of drift is relatively fast the adjustment will be made relatively fast. It will be understood that the potentiometer 28 may be omitted when it is not desired to vary the speed of drift compensation. Assuming that the comparator 34 and gate 40 have been omitted the potentiometer 36 will be adjusted to provide a voltage to comparator 32 that is above the normal extraneous noise signals and below the lowest expected force signal level. In one particular embodiment this is normally 1 volt. With the switch 14 closed the gage is ready for operation.

With no workpiece in the mill, but with some heat in the housing there will be a voltage output from bridge 8 proportional to the drift force. At this time the output from the bridge 8 and the output from amplifier 18 will be either positive or negative and the output from integrator 30 will be zero. If the voltage is positive it will ordinarily be less than the voltage from potentiometer 36 and a signal from comparator 32 will be delivered to integrator 30 through the normally closed switch 48 to place it in the operate mode. The voltage on 44 will then gradually increase until it is equal and opposite to

the voltage from amplifier 16 so that the output from amplifier 18 will be zero. However, amplifier 30 continues to remain in operate mode with the voltage on line 44 being equal and opposite to the voltage from amplifier 16. Thus, the voltage on line 44 represents the level of drift. In some instances, due to unusual conditions, the signal from amplifier 18 will be greater than the voltage of potentiometer 36. This will show on meter 22 and recorder 24 and in order to quickly balance the system, switch 46 is closed and switch 48 moved to open line 42 and to connect integrator 30 to voltage control input supply 50. After the system is balanced the switches 46 and 48 are returned to their original position. When a workpiece W then enters the mill the voltage generated by bridge 8 is proportional to the combined strain due to drift and roll pressure and also the output from amplifier 18 goes positive. This causes the signal from comparator 32 to put the integrator 30 in the hold mode so that the signal on line 44 remains constant and equal and opposite to the drift force. Thus, the signal from amplifier 18 appears on meter 22 and recorder 24 as a measurement of the rolling force since the voltage proportional to drift is subtracted from the total voltage. When the workpiece W leaves the mill the signal from comparator 32 reverses polarity and causes integrator 30 to be in its operate mode. Thus, if there has been any change in drift during rolling, such as may be caused by increased housing temperature, the voltage on line 44 will change until it balances the output from amplifier 16. Each time a workpiece enters the mill the true force measurement will be made as before.

The comparator 34 and gate 40 are used only when there are extraneous negative signals present which may cause error in the recorded force signal. When used, the potentiometer 38 is adjusted to give a negative voltage greater than any negative voltage from an extraneous signal. When no workpiece W is in the rolls the operation will be the same as in the first embodiment except that the integrator 30 will be in the operate mode if the output of amplifier 18 is less than the threshold level set on either potentiometer 36 and 38. In either case this causes the output voltage of gate 40 to be positive thus putting the integrator 30 in its operate mode.

While we have described our invention as applied to a particular installation it may be used with any type of measuring instrument having a D.C. signal including a voltage proportional to the desired characteristic being measured plus a voltage proportional to drift due to any cause. It is particularly applicable where the duration of the desired characteristic signal is short as compared to the duration of the drift signal. The amplifier 16 may be omitted if the generated voltage is of sufficient magnitude for operating the circuit. The polarity of the various voltages may be reversed from that described. It is necessary that the generated voltage signal to amplifier 18 be of opposite polarity to that of the voltage from integrator 30. The sole purpose of amplifier 26 is to act as a voltage polarity reversal means and it may be located anywhere in the circuit between the output of amplifier 18 and the input of amplifier 18. The comparators 32 and 34 act as switch means to control the operation of integrator 30.

While several embodiments of our invention have been shown and described, it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

We claim:

1. Apparatus for measuring a desired characteristic comprising means for generating a voltage signal having a component proportional to the desired characteristic and a component proportional to drift, an amplifier having a first input connected to the output of said generating means, a second input and an output, a first circuit including a voltage polarity reversal means and an integrator connected in series between the output and second input of said amplifier, said integrator having an input connected to the output of said amplifier, an output connected to the second input of said amplifier and a control connection, and a second circuit between the first circuit on the input side of said integrator and said control connection, said second circuit including switch means operable when there is no voltage component proportional to the desired characteristic being generated to provide a signal to said control connection to cause said integrator to be in its operate mode and operable when there is such a voltage being generated to provide a signal to said control connection to cause said integrator to be in its hold mode whereby the output of said amplifier is proportional only to the desired characteristic when the component proportional to the desired characteristic is present.

2. Apparatus according to claim 1 including a potentiometer in said first circuit connected to the input of said integrator to control the speed of drift compensation.

3. Apparatus according to claim 2 including a bypass circuit around said potentiometer having a normally open switch therein, a normally closed switch in said second circuit, and a power source connectable to said control connection when said normally closed switch is opened.

4. Apparatus according to claim 1 in which said switch means includes a comparator, and means for supplying a desired voltage to said comparator.

5. Apparatus according to claim 4 including a potentiometer in said first circuit connected to the input of said integrator to control the speed of drift compensation.

6. Apparatus according to claim 5 including a bypass circuit around said potentiometer having a normally open switch therein, a normally closed switch in said second circuit, and a power source connectable to said control connection when said normally closed switch is opened.

7. Apparatus according to claim 6 in which said second circuit includes a second comparator connected in parallel with said first named comparator, means for supplying a desired voltage to said second comparator of opposite polarity to the voltage supplied to said first comparator, and a gate connected to the outputs of said comparators.

8. Apparatus for measuring the roll separating force produced by a workpiece passing between work rolls mounted in a housing which comprises a strain gage bridge mounted on said housing, an amplifier having a

first input connected to the output of said bridge, a second input and an output, a first circuit including a voltage polarity reversal means and an integrator connected in series between the output and second input of said amplifier, said integrator having an input connected to the output of said amplifier, and output connected to the second input of said amplifier and a control connection, and a second circuit between the first circuit on the input side of said integrator and said control connection, said second circuit including switch means operable when there is no workpiece in the mill to provide a signal to said control connection to cause said integrator to be in its operate mode and operable when there is a workpiece in said mill to provide a signal to said control connection to cause said integrator to be in its hold mode whereby the output of said amplifier is proportional only to the roll separating force when a workpiece is in the mill.

9. Apparatus according to claim 8 including a potentiometer in said first circuit connected to the input of said integrator to control the speed of drift compensation.

10. Apparatus according to claim 9 including a bypass circuit around said potentiometer having a normally open switch therein, a normally closed switch in

said second circuit, and a power source connectable to said control connection when said normally closed switch is opened.

11. Apparatus according to claim 8 in which said switch means includes a comparator, and means for supplying a desired voltage to said comparator.

12. Apparatus according to claim 11 including a potentiometer in said first circuit connected to the input of said integrator to control the speed of drift compensation.

13. Apparatus according to claim 12 including a bypass circuit around said potentiometer having a normally open switch therein, a normally closed switch in said second circuit, and a power source connectable to said control connection when said normally closed switch is opened.

14. Apparatus according to claim 13 in which said second circuit includes a second comparator connected in parallel with said first named comparator, means for supplying a desired voltage to said second comparator of opposite polarity to the voltage supplied to said first comparator, and a gate connected to the output of said comparators.

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