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PULVERIZING SYSTEM WITH INDICATOR AND CONTROL

Filed Aug. 10, 1959

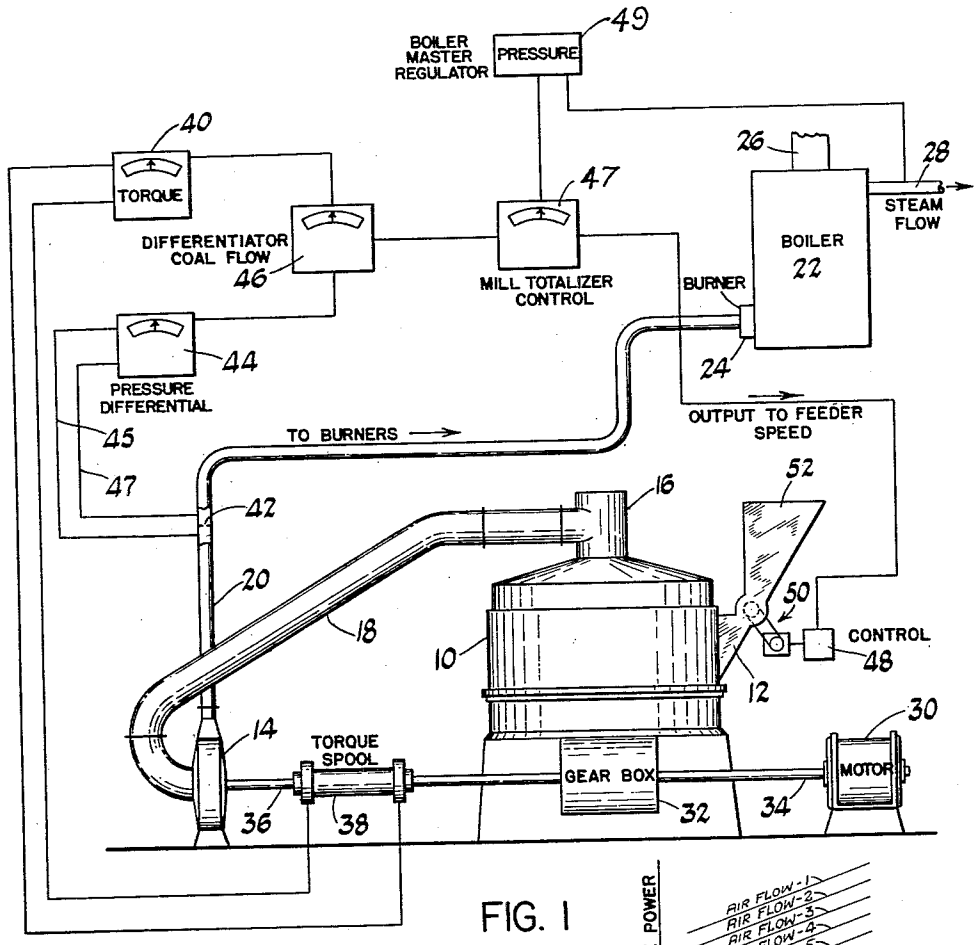


FIG. 1

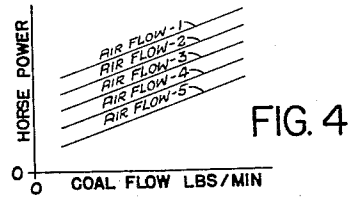


FIG. 4

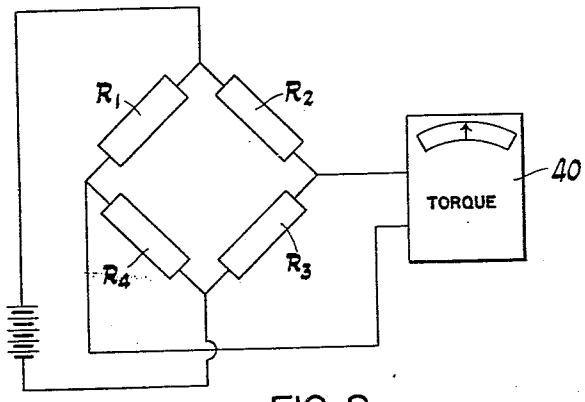


FIG. 2

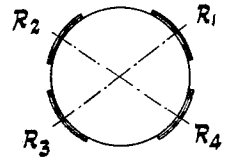


FIG. 3

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PULVERIZING SYSTEM WITH INDICATOR AND CONTROL

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This invention relates generally to pulverizing systems and particularly to a system that employs a pulverizing mill utilizing an exhauster through which the air and pulverized material from the mill pass with the system embodying an indicator and control organization for providing a continuous and instantaneous indication of the pulverized material flow issuing from the mill and a control of the input to the mill in response to this flow.

The invention utilizes the experimentally obtained knowledge that the work or power (work per unit time) input of the exhauster of one of these pulverizing mills varies in accordance with and in proportion to the pulverized material flow and the air flow through the exhauster. Accordingly this work input to the exhauster provides an indication of the combination of pulverized material flow and air flow. Therefore if the air flow is known the pulverized material flow may be determined by combining the air flow indication with the pulverized material flow-air indication obtained from the exhauster.

One system in which it is very desirable to be able to have an instantaneous indication of the pulverized material flow is in a pulverizing system supplying pulverized coal to the furnace of a boiler. The input to the pulverizing mill in such a system is generally controlled primarily by the output of the boiler, as for example a steam pressure responsive device will respond to the steam pressure at the outlet of the boiler and will control the feed to the pulverizer to maintain this stream pressure substantially constant. However ,in such a system there will occur for one reason or another variations in the pulverized material flow from the pulverizer to the furnace which having nothing to do with adjustments of the steam pressure responsive device. In other words, the pulverized coal flow may vary for a number of reasons with the control as adjusted by the steam pressure responsive device and operative to control the input to the pulverizer remaining stationary. In such a case there is of course a substantial delay between the variation in the coal flow and a variation in the steam pressure which provides a signal to readjust the input to the pulverizing mill to overcome this variation in flow and return the flow to its desired value. By having an instantaneous indication of the coal flow this indication may be utilized in a suitable control organization to maintain the coal flow constant for a particular setting of the feed control as established by the master regulator of the boiler.

In many of the pulverizers as presently constructed the drive shaft of the exhauster is connected to and driven by the same motor that drives the mill itself. In such a case the output of the motor, i.e., the horsepower output or the amperes input, does not provide an indication of the work input or power input to the exhauster. In accordance with the invention a torque meter is applied to the shaft to the exhauster which gives an indication of the torque input to the exhauster. This indication together with an indication of the air flow through the exhauster is combined to provide an indication of the coal flow which in turn is utilized as a control function.

The air flow indicator may advantageously take the form of an orifice in the supply or exhaust line of the exhauster with a differential pressure measuring instrument being connected across this orifice. The indication thus obtained as is evidenced from experimental results is a measure only of the air flow in the air-pulverized material mixture.

Accordingly it is an object of this invention to provide an improved pulverizing system.

It is a further object of this invention to provide such a system employing an exhauster and which includes an indicator and control system that provides an instantaneous indication of the pulverized material output and control responsive thereto.

Other and further objects of the invention will become apparent to those skilled in the art as the description proceeds.

With the aforementioned objects in view, the invention comprises an arrangement, construction and combination of the elements of the inventive organization in such a manner as to attain the results desired as hereinafter more particularly set forth in the following detailed description of an illustrative embodiment, said embodiment being shown by the accompanying drawings:

FIG. 1 is a diagrammatic representation of a pulverizing system embodying the present invention;

FIG. 2 is a diagrammatic representation of the torque meter that forms a part of the organization of FIG. 1;

FIG. 3 is a schematic indication of a transverse section through the torque spool;

FIG. 4 represents a series of curves showing that the power input of the exhauster varies both with air flow and coal flow.

Referring now to the drawing, wherein like reference characters identify like elements, the illustrative and preferred embodiment of the invention depicted therein includes a pulverizer 10 which may be any one of a number of well known types of pulverizing mills. The mill operates by having coarse material that is to be pulverized fed thereinto through inlet chute or passage 12. This material is pulverized within the mill with there being an upwardly directed air flow through the mill and with the pulverized material being entrained in the upwardly flowing air stream. This air stream is produced by exhauster fan 14 which is connected with the converter head 16 of the mill through duct or conduit 18. The pulverized material-air mixture leaves the pulverizer through converter head 16 passes down through duct 18 and through fan 14 with the material passing through the outlet conduit 20 of the exhauster fan and being introduced into the furnace of boiler 22 through one or more burners 24.

In the illustrative system of FIG. 1 coarse coal is fed to the pulverizer and is introduced and burned in the furnace of the boiler in a pulverized condition. Combustion gases pass from boiler 22 through stack 26 and steam under a predetermined pressure leaves the boiler through conduit 28. The pulverizer 10 is driven by means of motor 30 which is connected with the gear box 32 of the pulverizer. The motor shaft 34 extends through this gear box and is connected with the shaft 36 of exhauster fan 14 by means of the torque spool coupler 38. The coupler 38, which is only diagrammatically represented in FIGS. 1, 2 and 3, is a strain gage torque meter which is a commercially available piece of equipment and is effective to measure the torque of fan 14 or in other words the torque input to the fan with this giving an indication of the power and work input of the fan. The torque meter consists of four electric resistance strain gages mounted on a special spool piece or coupling that is inserted in the drive shaft connection. The four gages R_1, R_2, R_3 and R_4, are mounted generally as shown in FIGS. 2 and 3 and are connected electrically in a bridge circuit which is organized to compensate for temperature effects. The output of the bridge circuit is connected to a torque meter through a suitable slip ring arrangement. Since this organization to provide an in-

dication of the torque of exhauster fan **14** is well known, a further detailed description is not believed necessary with reference being made to "The Strain Gage Primer" by Perry and Lissner, Chapter 10, McGraw-Hill Book Co., Inc., 1955 for the details of these torque measuring devices. Accordingly torque meter **40** provides an indication of the torque and accordingly the work or horsepower input of fan **14**.

The air flow through the fan is measured by an orifice organization in combination with a differential pressure responsive device. As embodied orifice plate **42** is positioned in conduit **20** and differential meter **44** is connected across the orifice through the connections **45** and **47**. The meter **44** responds only to the air flow through conduit **20** with this having been found a characteristic of such an orifice, differential measuring device. Notwithstanding that the flow through conduit **20** is a mixture of pulverized coal and air the meter **44** will respond to the air flow and will not respond to variations in the pulverized material flow per se. Accordingly meter **44** provides a signal which is responsive to the air flow and provides an indication of the air flow.

As previously mentioned it has been found by experimentation that the work input of fan **14** responds both to coal flow and air flow or in other words, to the combination of the coal flow-air flow mixture that passes through the fan. The torque applied or work input to fan **14** is a precise indication of this combination flow and is virtually a linear function of coal flow at a given air flow. The curves of FIG. 4 clearly indicate that the horsepower is dependent upon coal flow and air flow. These curves are performance curves of exhauster fan **14** and the air flow lines represent five different constant rates of air flow, No. 1 being the highest air flow illustrated and No. 5 being the lowest with Nos. 2, 3 and 4 representing intermediate air flow rates. For higher air flows the horsepower input increases and for increases in the coal flow horsepower input also increases.

Accordingly, torque meter **40** provides a signal that is responsive to and that indicates combined air flow and coal flow and differential meter **44** provides a signal that represents and indicates only air flow. These two signals can then be combined to provide an instantaneous indication of coal flow. The output signal of meter **44** will of course be a square root function of the air flow since the differential across the orifice is proportional to the square of the velocity. The outputs of these two measuring instruments must be combined in a differentiating meter or biasing meter which subtracts the square root function air flow signal of meter **44** from the torque or work input signal of meter **40**. In the illustrative organization this differentiator is identified as **46** and is effective to receive the outputs of meters **40** and **44** and provide a signal that is an instantaneous indication of control flow with virtually no time lag being involved.

The make up of differential meter **44** and the differentiator meter **46** are not shown and described since these are known pieces of equipment to provide the desired results and the details of these meters do not form part of the invention.

Differentiator **46** as previously mentioned provides a signal and indication of the coal flow. This signal may in turn be fed to a mill totalizer control **47** which additionally receives a signal from the master boiler regulator **49**. This regulator, among other things, responds to the output pressure of the boiler, being effective to maintain this pressure constant. The operation of the control is as follows: as the pressure at the outlet of boiler **22** changes regulator **49** feeds a signal to the mill totalizer control, which provides an output signal which in turn is received by the control device **48** for the variable feed **50**. This variable feed includes a variable drive and a star feeder disposed at the lower end of the supply hopper **52**. The signal received from the totalizer control causes control **48** to adjust the feeder **50** to adjust

the feed to the mill so as to cause the pressure of the boiler to return to its desired value. Once this pressure is at its desired value the master boiler regulator will not supply any varying signal to the mill totalizer control. However, should there be a variation in pulverized fuel flow the differentiator **46** would immediately detect this and through the totalizer control **47** a signal would be sent to control **48** to readjust the mill feed so as to return the pulverized fuel flow to its desired predetermined value.

Accordingly, it will be appreciated that the present invention provides an instantaneous indication of pulverized coal flow and a control signal responsive thereto to control the coil flow from the pulverizer.

If, in lieu of providing a single drive, both the pulverizer and the exhauster have separate motor drives then means other than a torque spool may be employed to provide a signal responsive to the work input of the exhauster. For example, the amperage utilized by the motor that would connect only to the exhauster or the horsepower output of the motor connected only to the exhauster could be utilized for this purpose.

While I have illustrated and described a preferred embodiment of my novel organization it is to be understood that such is merely illustrative and not restrictive and that variations and modifications may be made therein without departing from the spirit and scope of the invention. I therefore do not wish to be limited to the precise details set forth but desire to avail myself of such changes as fall within the purview of my invention.

What is claimed is:

1. In a pulverizing system for supplying a pulverized material to a desired location the combination of a pulverizing mill, means for feeding a material to the mill to be pulverized, an exhauster fan connected with the outlet of the mill and through which the air passing through the mill and the pulverized material leaving the mill introduced in this air are drawn, driving means for the fan including motor means operating said fan, means providing a signal responsive to and indicative of the air flow through the fan, means associated with the fan driving means including means providing a signal responsive and proportional to the work imparted to the exhauster fan by the motor means so as to provide an indication of said work, and means receiving these two signals and operative to produce an instantaneous and continuous signal indicative of the pulverized material flow.

2. The organization of claim 1 including means operative to controllably feed material to be pulverized to said mill, and means responsive to variations in said pulverized material flow signal to regulate this means to control the fuel feed.

3. The organization of claim 1 wherein a common motor operates the fan and the pulverizer and wherein the means providing a signal responsive and proportional to the work imparted to the exhauster comprises a torque meter secured to the shaft of the exhauster and operative to respond to the torque input thereof.

4. The organization of claim 1 wherein the air flow is measured by means of a differential presure device connected across an orifice disposed in the air flow path.

5. In a pulverizing system the combination of a pulverizing mill, an exhauster connected with the outlet thereof to receive the pulverized material-air mixture therefrom, a common motor drive for the mill and the exhauster, a torque meter associated with the exhauster operative to provide a signal responsive and proportional to the torque input thereof, an orifice in the flow path of said mixture and differential pressure response means associated with said orifice to provide a signal responsive solely to the air flow in the mixture, and differentiating means responsive to these signals and operative to provide a signal responsive to and indicative of pulverized material flow.

6. The organization of claim 5 including control means responsive to the signal that is responsive to and indicative of pulverized material flow, said control means being operative to control the feed to the pulverizing mill.

References Cited in the file of this patent

UNITED STATES PATENTS

1,677,691 Smith ---------- July 17, 1928
2,172,317 Dickey ---------- Sept 5, 1939
2,352,312 Donaldson ---------- June 27, 1944
2,439,721 Dickey ---------- Apr. 13, 1948
2,439,723 Engdahl ---------- Apr. 13, 1948

FOREIGN PATENTS

465,659 France ---------- June 6, 1950