United States Patent

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[72] Inventors **John A. Makuch**
Granby;
Richard D. Brown, Newington, Conn.

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[73] Assignee **Combustion Engineering, Inc.**
Windsor, Conn.

[54] **COAL SLURRY FEED SYSTEM**
10 Claims, 2 Drawing Figs.

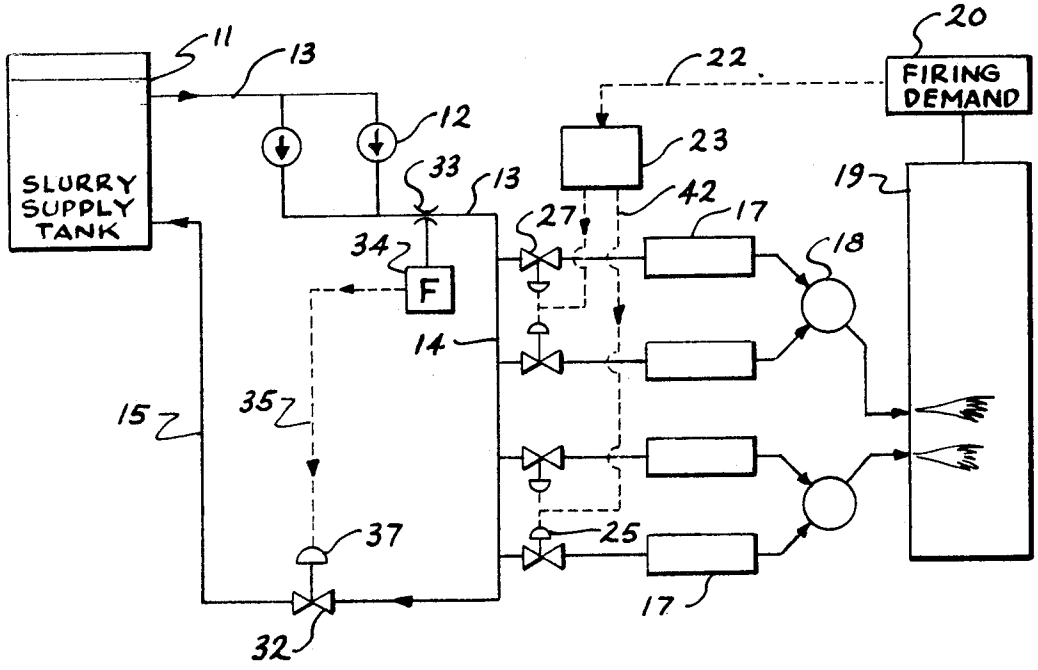
[52] **U.S. Cl.** **110/7-S,** 110/101
[51] **Int. Cl.** **F23d 1/00**
[50] **Field of Search** 110/7, 8, 28, 101; 302/14

[56] **References Cited**
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Primary Examiner—Kenneth W. Sprague
Attorneys—Carlton F. Bryant, Eldon H. Luther, Robert L. Olson, John F. Carney, Richard H. Berneike, Edward L. Kochey, Jr. and Lawrence P. Kessler

ABSTRACT: A slurry supply for supplying coal to a steam generator from a coal slurry tank. A slurry supply header has a plurality of valved offtakes supplying dewatering machines which in turn supply the dewatered coal to the steam generator. A supply line from the tank to the header includes a constant speed centrifugal pump. A return line from the supply header to the tank includes a variable throttling valve which is operated to maintain a constant velocity in the supply line and also a constant pressure in the supply header across the load range of a steam generator.



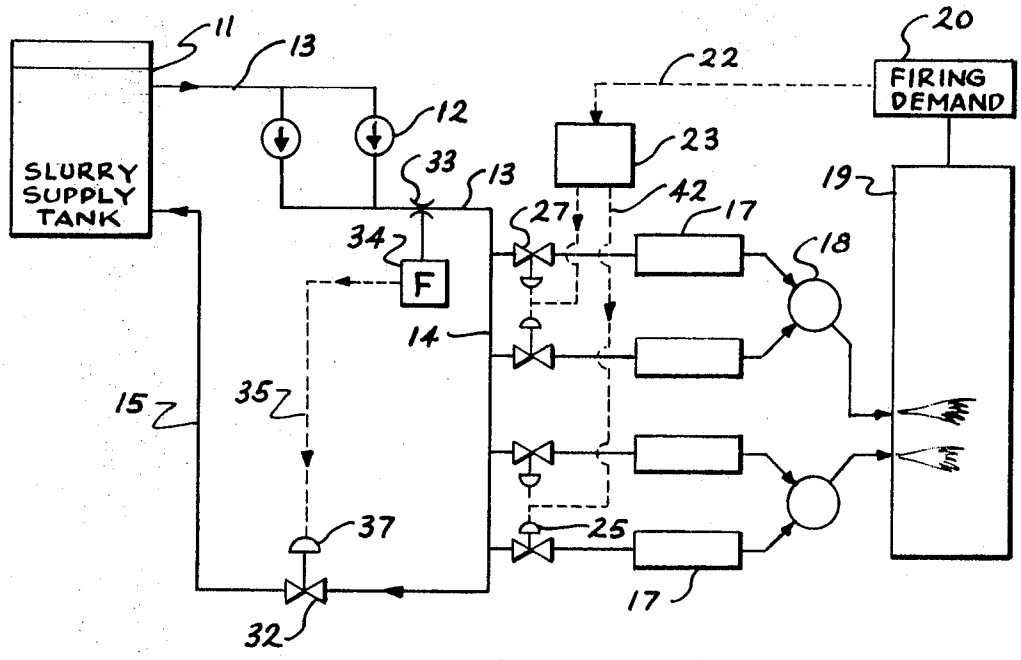


FIG-1

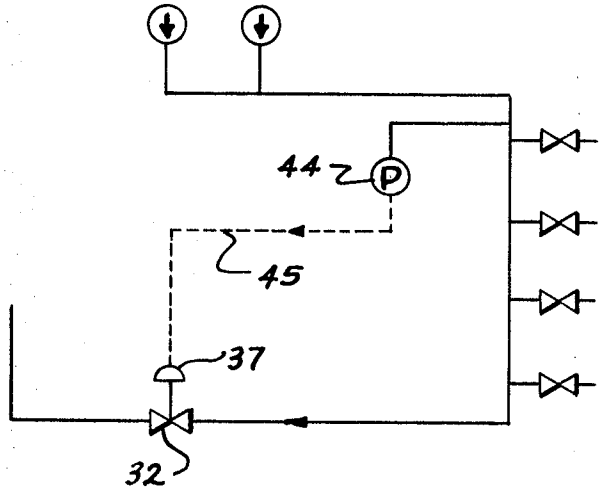


FIG-2

INVENTOR.
JOHN A. MAKUCH
RICHARD D. BROWN
BY
C. L. Kirchey
ATTORNEY

COAL SLURRY FEED SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to supplying coal to coal fired equipment and in particular to apparatus wherein the coal is supplied in slurry form.

The transporting of coal in slurry form has in the past been used for steam generators. For proper operation of the system, two velocity limits are inherently imposed on it. If the velocity in the pipe line becomes too low, the coal particles will settle out leading to erratic coalwater ratios, pluging of the lines, and possible slug flow on an intermittent basis. When the velocity becomes too high, not only is pressure drop and the concomittant power increased but erosion becomes a serious problem. A system for supplying slurry to a steam generator is illustrated in British Pat. No. 1,059,266 wherein a flow is continuously recirculated from a slurry supply tank through a slurry supply location. Slurry extracted from this location is dewatered with the coal being supplied to a steam generator. The excess slurry is returned through a return line to the slurry supply tank. A constant velocity is maintained in the supply line to avoid settling of the coal. The pumps located in the supply line are regulated in such a manner as to maintain this constant rate of flow. The return pipe is sized and the constant supply quantity selected so as to maintain a minimum preselected velocity in the return line to avoid settling of coal in the return line. This minimum velocity occurs at full load when a minimum amount of slurry is being supplied to the return line. The flow in the return line increases with decreasing load. Since the pressure in the slurry tank is fixed, the pressure at the extraction location increases with decreasing load. This presents a difficult problem in accurately controlling the supply of slurry to the dewatering machines since the smaller flow must be controlled with higher pressure drop across the dewatering machine as load drops. This throttling requires that the valves be operated in the nearly closed position where control movement is very sensitive and the high velocity produces substantial erosion in these valves.

SUMMARY OF THE INVENTION

According to our invention a constant speed pump is included in the supply line to a slurry supply header. A varying throttling valve is located in the return line with this valve being operated to maintain a constant velocity in the supply line. This operation also simultaneously and inherently maintains a constant pressure in the supply header across the load range. This improves the control characteristics of the valves used to extract the slurry from the supply header and decreases the erosion on these valves.

It is an object of our invention to improve the control characteristics of coal fired equipment operating with a slurry feed over a load range. It is a further object to improve the controlability of the steam generator and to reduce wear on the control valves.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates the embodiment wherein the control valve in the return line is responsive to flow measurements in the supply line; and

FIG. 2 illustrates the embodiment wherein the control valve and the return line is responsive to pressure in the supply header.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Slurry supply tank **11** contains a supply of crushed coal and water in a mixture suitable for pumping and flowing through a pipe. Constant speed centrifugal pumps **12** are located in supply line **13** and operate to pump the slurry to and through slurry supply header **14**. Return line **15** conveys flow from the supply header back to the supply tank.

A plurality of centrifuges or other dewatering machines **17** are arranged to supply a plurality of pulverizers **18**. These pulverizers directly supply pulverized coal to steam generator **19**. A firing demand controller **20** is supplied on the steam generator which may operate from steam pressure, steam temperature, gas temperature, or any other parameter of the steam generator which is to be automatically controlled by the amount of fuel being fired. A control signal indicating the fuel demand passes through control line **22** where the signal may be modified if desired. A signal is then passed through control lines **24** to control valve actuators **25** which operate supply valves **27**. These valves are modulated as desired to extract a flow of slurry to the dewatering machines **17**.

Accordingly it can be seen that pumps **12** operate to convey slurry to the supply line **13** where the amount required for the steam generator operation is extracted through valves **27** with the remainder being returned to the supply tank through return line **15**.

The amount of slurry to be supplied through valves **27** for full load operation of the steam generator is readily calculated. The supply line **13** is sized to convey 150 percent of this quantity at sufficient velocity to avoid settling and also to minimize the pressure drop through the line. The return line **15** is then sized to convey 50 percent of the full load quantity of slurry.

At full load operation, 150 percent of the boiler requirement is supplied to the supply header with 100 percent being extracted to supply the steam generator and the remaining 50 percent being returned through the return line. As load on the steam generator is decreased, the quantity of slurry supply through supply line **13** is maintained constant with the valves **27** extracting less slurry and an increased amount of slurry being returned to return line **15**. Control valve **32** is located in the return line **15** at any location between the slurry supply header **14** and the slurry supply tank **11**. This throttling valve is opened to decrease the resistance in the return line as load on the steam generator decreases at which time more slurry is passing through the return line. If there were no valve in this line, pressure drop through the line would increase with decreasing load since the return of slurry flow increases. This would result in a pressure in the slurry supply header **14** which increases with decreasing load. By opening the valve **32** as load decreases, the pressure in slurry supply header **14** remains constant.

It is, of course, of primary importance to maintain the minimum preselected velocity in supply line **13**. However, in our system this is simultaneously accomplished while constant pressure is maintained in header **14**. A flow nozzle **33** is located in supply line **13** with the flow being sensed by flow transmitter **34**. A control signal indicative of any flow error is passed through a control line **35** to throttling valve controller **37**. This controller then operates valve **32** to maintain a constant flow in supply line **13**. Since a constant flow is being maintained in supply line **13** and the density of the slurry flowing is essentially constant, the pressure drop through that line remains constant. Since centrifugal pumps **12** are operating with constant density fluid at constant speed and are also passing a constant volume of flow, they produce constant pressure increase. It, therefore, follows that pressure in the supply header **14** remains constant across the load range. So long as this pressure is sufficient to supply full load slurry demands through supply valves **27**, the particular pressure level is not critical.

If the return line **15** were sized so as to have sufficient restriction to produce a desired pressure in supply header **14** during full load operation with only 50 percent flowing through the return line **15**, the pressure drop through that line would be excessive at reduced loads. Maintaining a constant flow in the supply line results in an increased flow in the return line and the pressure in supply header **14** would increase as the square of the flow through the return line. By using a variable throttling valve located in this return line to maintain the constant velocity in the supply line, the pressure existing in supply header **14** is kept constant and at a reasonable value.

Because of the intimate relation between the pump characteristic and the pressure drop characteristic through supply line **13** the pressure existing in the slurry supply header **14** is a function of and a measure of the flow through supply line **13** so long as the control to maintain this flow is done with valve **32** in the return line.

FIG. **2**, therefore, illustrates an embodiment wherein a pressure at the supply header is sensed by pressure transmitter **44** with a pressure error signal passing through control line **45** to controllor **37**. The control valve **32** operates in response to this pressure measurement to maintain constant the pressure at supply line **13** over the load range. Because of the interrelation between the flow characteristics through line **13** and the pressure in supply header **14** briefly described, this inherently results in a constant flow through the supply line **13**.

While we have illustrated and described a preferred embodiment of our invention, 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. We, therefore, do not wish to be limited to the precise details set forth but desire to avail ourselves of such changes as fall within the purview of our invention.

We claim:

1. A coal slurry feed system for variably supplying coal to coal fired equipment comprising: a coal supply tank; a coal slurry supply pipe; a pump located in said supply pipe; a coal slurry supply header having a first end connected to the discharge end of said supply pipe; a coal slurry return line connected to the second end of said header and to said coal slurry tank; a plurality of dewatering machines connected to receive slurry from said header and connected to deliver coal to said coal fired equipment and to discharge the excess water; a control valve connected between said header and each of said dewatering machines; and variable throttling means located in said slurry return line.

2. An apparatus as in claim **1** wherein said pump is a constant speed centrifugal pump.

3. An apparatus as in claim **1** having also sensing means for sensing a measure of the flow in said coal slurry supply pipe, and said varying throttling means being responsive to said sensing means.

4. An apparatus as in claim **2** having also sensing means for sensing a measure of the flow in said coal slurry supply pipe, and said varying throttling means being responsive to said sensing means.

5. An apparatus as in claim **3** wherein said sensing means comprises flow measuring means located in said coal slurry supply pipe.

6. An apparatus as in claim **4** wherein said sensing means comprises flow measuring means located in said coal slurry supply pipe.

7. An apparatus as in claim **4** wherein said sensing means comprises means for sensing the pressure in said coal slurry supply header.

8. An apparatus as in claim **1** wherein said coal fired equipment has control means for automatically determining the coal requirements of said coal fired equipment and said control valves are responsive to said control means.

9. An apparatus as in claim **6** wherein said coal fired equipment has control means for automatically determining the coal requirements of said coal fired equipment and said control valves are responsive to said control means.

10. An apparatus as in claim **7** wherein said coal fired equipment has control means for automatically determining the coal requirements of said coal fired equipment and said control valves are responsive to said control means.