

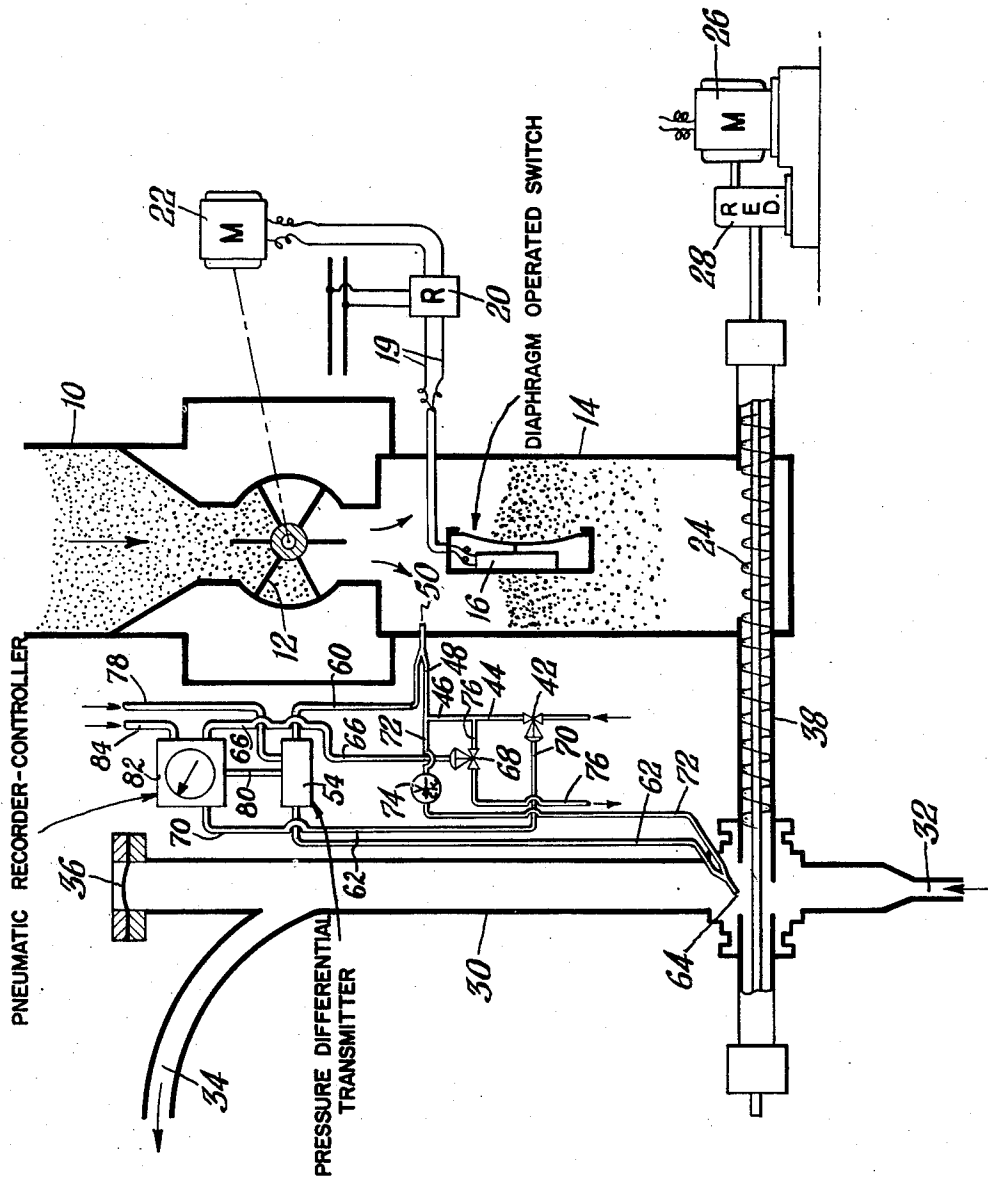
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PULVERIZED COAL FEEDING AND PRESSURIZING SYSTEM

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PULVERIZED COAL FEEDING AND PRESSURIZING SYSTEM

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This invention relates to a process and apparatus for introducing pulverized coal at atmospheric pressure into a stream of oxygen under pressure.

As part of an overall process of coal gasification, a fluidized mixture of coal and oxygen is fed into a reactor. In order to provide such a mixture, it was necessary to devise a process and apparatus for delivering a steady stream of free flowing coal, from a source of coal at atmospheric pressure, into a stream of oxygen gas at pressures up to five pounds per square inch gauge. Under such a pressure, the coal and oxygen are mixed in a vessel operating on the "fluidized solids" principle to produce a mixture having the characteristics of a "fluidized solid" which can then be delivered at high velocity into a reactor.

In order for the fluidizing vessel to operate properly in mixing the coal and oxygen, it must receive a steady flow of free flowing coal which is at a slightly higher pressure than the pressure under which the oxygen is introduced into the fluidizing vessel, or "fluidizer". If this pressure differential is not maintained with the higher pressure on the coal side, the oxygen will blow back and force the coal back into the supplying mechanism with an explosion the probable result. Thus, the pressure on the coal side must be immediately responsive to any changes or surges in the oxygen, both to insure proper mixing of the coal and oxygen and to prevent explosion.

We have discovered a method and apparatus for introducing the coal into the fluidizer, while controlling the pressure with carbon dioxide or other inert gas, by employing automatically controlled valves in such a manner that the coal is delivered at a steady rate into the fluidizing chamber and any change in the pressure of the oxygen coming in is immediately and automatically compensated for by a corresponding change in the pressure of the carbon dioxide or other inert gas on the coal in the coal chamber from which it is conveyed to the fluidizer.

The invention will be described in detail by reference to the accompanying drawing which illustrates an apparatus embodying the invention.

The drawing is a partially sectioned view of the apparatus.

In the drawing is shown a coal supply hopper 10 where the pulverized coal which is to be processed is stored at atmospheric pressure. From the supply hopper, the coal is delivered through communicating means, in this case a rotary feeder 12, into a pressurized chamber, herein called the coal chamber 14, which is under pressure. In order that the pressure of the weight of the coal itself in the coal chamber may be kept constant, a relatively uniform quantity of coal is maintained in the coal chamber by means of a diaphragm operated switch 16 which is responsive to the level of the coal. The switch 16 is connected through wires 19 to a relay 20, through which it controls the motor 22 which rotates the rotary feeder 12. When the coal level in the coal

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chamber 14 falls below a predetermined minimum level, the pressure of the coal on the diaphragm switch 16 lessens and the motor 22 is actuated, causing the rotary feeder 12 to deliver more coal from the supply hopper 10 into the chamber until the maximum level is reached and there is again sufficient coal pressure on the switch 16 to halt the motor 22.

The coal at the bottom of the coal chamber 14 is picked up by means communicating between the coal chamber 14 and the fluidizing chamber 30, which in the embodiment shown comprises a constant pitch screw 24 revolving in a cylinder 38 and driven at a low constant speed by a motor 26 through reduction gears 28. The screw 24 is relatively tight against the walls of the cylinder 38 in order to prevent coal being blown back through the screw. The feed screw 24 delivers the pulverized coal into the fluidizer chamber 30. Oxygen is admitted to the fluidizer 30 through an inlet 32 at the bottom and moves up through the chamber, picking up the pulverized coal delivered by the feed screw 24. In the fluidizer 30, the pulverized coal and oxygen form a mixture having the properties of a fluidized solid and leave the fluidizer in that form through one or more exit pipes 34. A rupture disk 36 is provided in the fluidizer as a safety precaution against any accidental build-up of a pressure of explosive force.

A pressure differential between the fluidizer and coal chamber is registered through interconnecting pipes between a pressure differential transmitter 54 and a port 64 in the fluidizer and a gas port 50 in the coal chamber. A pipe 62 connects the fluidizer port 64 to one side of the pressure differential transmitter 54, thus allowing the oxygen pressure from the fluidizer to affect the transmitter. The other side of the pressure differential transmitter is connected to the coal chamber port 50 by the pipe 60, whereby the pressure in the coal chamber 14 affects the transmitter 54. Instrument air is supplied to the pressure differential transmitter 54 through instrument air conduit 78. The pressure differential transmitter 54 is responsive through a diaphragm to the difference between the pressure in the fluidizer 30 and the pressure in the coal chamber 14 and as this difference in pressure changes the transmitter 54 proportionately varies the pressure of instrument air which it permits to flow through the tubing 80 to a pneumatic recorder-controller 82. The pressure differential transmitter used in our embodiment of the invention was a Republic Pneumatic Pressure Transmitter, model P-0308, manufactured by the Republic Flow Meters Company, of Chicago, Illinois.

As the pneumatic recorder controller 82 receives varying pressures of instrument air from the transmitter 54 corresponding to variances in the pressure differential between the fluidizer 30 and the coal chamber 14 it records the pressure differential on a graph. When the pressure differential falls below or exceeds present limits the controller 82 acting on a source of instrument air supplied through instrument air conduit 84, operates one or the other of the two motor valves 68 and 42 by regulating the flow of air through conduits 66 and 70, thereby controlling the supply of carbon dioxide or other inert gas into or out of the coal chamber 14. The pneumatic controller used in our embodiment of the invention was Foxboro Pneumatic Recorder-Controller, model 40, manufactured by the Foxboro Company, of Foxboro, Massachusetts. The pressure differential transmitter 54 and the pneumatic controller 82, together with the motor-operated valves 42 and 68, an instrument air supply and the necessary connecting conduits, comprise a control means for maintaining a difference in pressure between the fluidizer 30 and the pressurized coal chamber 14.

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We have found that a pressure in the coal chamber 14 about one inch of water above that in the fluidizer 30 is preferable. When the oxygen pressure in the fluidizer 30 increases, so as to require a higher corresponding pressure in the chamber 14 to maintain the necessary differential, the controller 82 acts through line 70 to open the motor valve 42, thereby allowing the inert gas to flow into the coal chamber 14 through the port 50 by means of pipes 44, 46 and 48 until the necessary pressure is built up in the chamber 14, whereupon the valve 42 closes again.

When the pressure in the fluidizer 30 begins to fall below the maximum differential with the pressure in the coal chamber 14, the controller 82 works through line 66 to open a motor valve 68 which allows inert gas to leave the chamber 14 through the port 50 and pipes 48, 46 and 76, until the pressure in the chamber is reduced to the proper level, whereupon the valve 68 closes again.

In the event that the oxygen pressure in the fluidizer 30 was lowered very suddenly, a large quantity of coal would be forced into the fluidizer before the controller 82 and valve 68 could cooperate to reduce the pressure in chamber 14. To prevent this from happening, the chamber 14 and fluidizer 30 are connected by pipes 48 and 72, pipe 72 having in it a check valve 74. In the event of a sudden and excessive drop in the oxygen pressure in the fluidizer resulting in a pressure differential of more than five inches of water, valve 74 opens and permits the inert gas to flow directly from the coal chamber 14 to the fluidizer 30, thus rapidly restoring the proper differential in pressure between the two chambers.

The apparatus has proven highly successful in operation and has provided a constant and uninterrupted supply of a fluidized mixture of coal and oxygen in the proper proportions. The coal supply can be readily renewed by simply leading coal at atmospheric pressure into the open-top supply hopper. There is no problem of batch loading through pressure tight doors; the rotary feeder provides the necessary pressure tight seal. The rotary feeder operates intermittently, as controlled by the diaphragm operated switch, and at very low speeds, five to seven revolutions per minute having been found ample. This low speed means low wear on the feeder and cooperating parts and hence low maintenance costs.

Because the pressure differential is maintained by an automatic control means controlling the inert gas pressure, there is no opportunity for a sudden oxygen pressure build-up to force the coal back against the feed screw. Therefore, the feed screw can be of constant pitch, that is non-compressive and non-tapered in design, and can rotate at relatively low speed. Previously, when it was desired to feed a granular material against a pressure, it was customary to make the screw feed compressive in design and rotate it at high speeds. This meant that the granular material compacted at the smaller delivery end of the screw. While such a design does resist blow back pressures to some extent, it results in an undesirable lumpy deaerated feed and high abrasive wear on the working parts, causing excessive maintenance problems and expense. Thus, the screw feed of the invention has the advantage of delivering free flowing coal, as well as that of operating with low abrasion and at low speed, thereby greatly reducing maintenance problems.

For the successful operation of the invention, it is necessary to control the differential pressure across the screw feeder, between the fluidizer and the coal chamber, at a value not exceeding one inch of water. Differentials greater than this tend to cause excessive variations in the rate of coal feed. Such control has been made possible by the use of the motor valves, controlled by the pneumatic controller, to regulate the flow of inert gas in and out of the coal pot, and thus the pressure in the coal pot. This system compensates for all normal variations in the pressure of the oxygen supply.

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An additional advantage of the invention is the provision against any extreme downward fluctuation in the oxygen supply pressure. The direct line between the coal chamber and fluidizer, with a check valve in it, serves to rapidly equalize the pressures in such a case, and prevents the coal from being forced through the screw feeder too rapidly.

Equivalents of some individual elements of the invention can be substituted within the spirit of the invention. For instance, a conveyor belt or drag conveyor, if sufficiently enclosed, might be used in place of the screw feeder shown, and another type of switch responsive to the level of the coal in the coal chamber might be substituted for the diaphragm-operated switch as shown.

While the elements of the invention have been described and detailed with respect to specific embodiments, it is to be understood that the substitution of equivalents for specific elements of the invention will not constitute a departure from the true spirit and scope of the invention as claimed.

We claim:

1. An apparatus for continuously forming under pressure an oxygen and pulverized coal mixture having the characteristics of a fluidized solid, comprising a closed fluidizing chamber having at least one outlet for said mixture and an inlet for oxygen; a pressurized coal chamber having a gas port for admitting inert gas into and out of said chamber; means communicating between said coal chamber and said fluidizing chamber for conveying pulverized coal under pressure from said coal chamber into said fluidizing chamber; an open pulverized coal hopper adjacent to said coal chamber for receiving and storing pulverized coal at atmospheric pressure; means communicating between said coal hopper and said coal chamber for conveying pulverized coal from said coal hopper into said coal chamber; means responsive to the level of coal in said coal chamber and controlling said communicating means from said coal hopper into said coal chamber so as to maintain a constant predetermined level of pulverized coal in said coal chamber; and control means for controlling the pressure in said coal chamber relative to the pressure in said fluidizing chamber by regulating the flow of an inert gas into and out of said coal chamber through said gas port so as to maintain the pressure in said coal chamber above the pressure in said fluidizing chamber by a predetermined value.

2. An apparatus in accordance with claim 1, wherein said means communicating between said coal chamber and said fluidizing chamber for conveying pulverized coal from said coal chamber to said fluidizing chamber comprises a rotating, constant pitch, constant speed screw feed mechanism.

3. An apparatus in accordance with claim 1, wherein said means communicating between said coal hopper and said coal chamber for conveying pulverized coal from said hopper to said coal chamber comprises a rotary feeder means having an inlet and an outlet, and pressure sealing means between said inlet and said outlet.

4. An apparatus in accordance with claim 3 wherein said means responsive to the level of coal in said coal chamber and controlling said rotary feeder means comprises a motor driving said rotary feeder means and electric circuit control means for said motor comprising a pressure responsive switch positioned within said coal chamber responsive to the level of coal therein, operable to periodically actuate said motor to cause the operation of said rotary feeder means whenever the coal in said coal chamber falls below said constant predetermined level.

5. An apparatus in accordance with claim 1, wherein said means responsive to the level of pulverized coal in said coal chamber comprises a pressure operated switch, including a diaphragm, said switch being so positioned within said coal chamber as to be actuated by changes in

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the level of pulverized coal in said coal chamber, and said switch controlling a driving means rotating said rotary feeder.

6. An apparatus in accordance with claim 1, additionally comprising a relief conduit communicating between said coal chamber and said fluidizing chamber having therein a check valve, said check valve regulated so as to open automatically when the pressure in said coal chamber exceeds the pressure in said fluidizer by a predetermined value and to remain open until the pressure in said coal chamber no longer exceeds the pressure in said fluidizer by more than a predetermined value.

7. An apparatus in accordance with claim 1, additionally comprising a rupture disk positioned in the wall of said fluidizer chamber, said rupture disk being of such strength that it will rupture when the pressure in said fluidizer exceeds a predetermined value.

8. An apparatus in accordance with claim 1, wherein said control means for controlling the pressure in said coal chamber with respect to the pressure in said fluidizing chamber comprises an oxygen conduit connecting said fluidizing chamber to a pressure differential transmitter; an inert gas conduit connecting said coal chamber gas port to said pressure differential transmitter; a motor operated valve positioned in an inlet conduit conveying inert gas from an outside source into said coal chamber through said gas port and responsive through an instrument air control conduit to said pneumatic recorder-con-

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troller, said motor operated valve opening by the action of said pneumatic recorder-controller when the pressure in said coal chamber falls below the pressure in said fluidizing chamber by a predetermined value and said valve being held open by the action of said pneumatic recorder-controller until the pressure in said coal chamber again exceeds the pressure in said fluidizer chamber by a predetermined value; a second motor operated valve positioned in an outlet conduit for exhausting inert gas from said coal chamber through said gas port, said second motor operated valve being responsive through an instrument air conduit to said pneumatic recorder-controller, said motor operated valve adapted to open by the action of said pneumatic-recorder controller when the pressure in said coal chamber exceeds the pressure in said fluidizing chamber by more than a predetermined value and said valve adapted to remain open by the action of said pneumatic recorder-controller until the pressure in said coal chamber no longer exceeds the pressure in said fluidizer by more than said predetermined value.

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