May 10, 1938. M. FRISCH 2,116,601

PULVERIZING SYSTEM

Filed Dec. 29, 1933 2 Sheets-Sheet 1

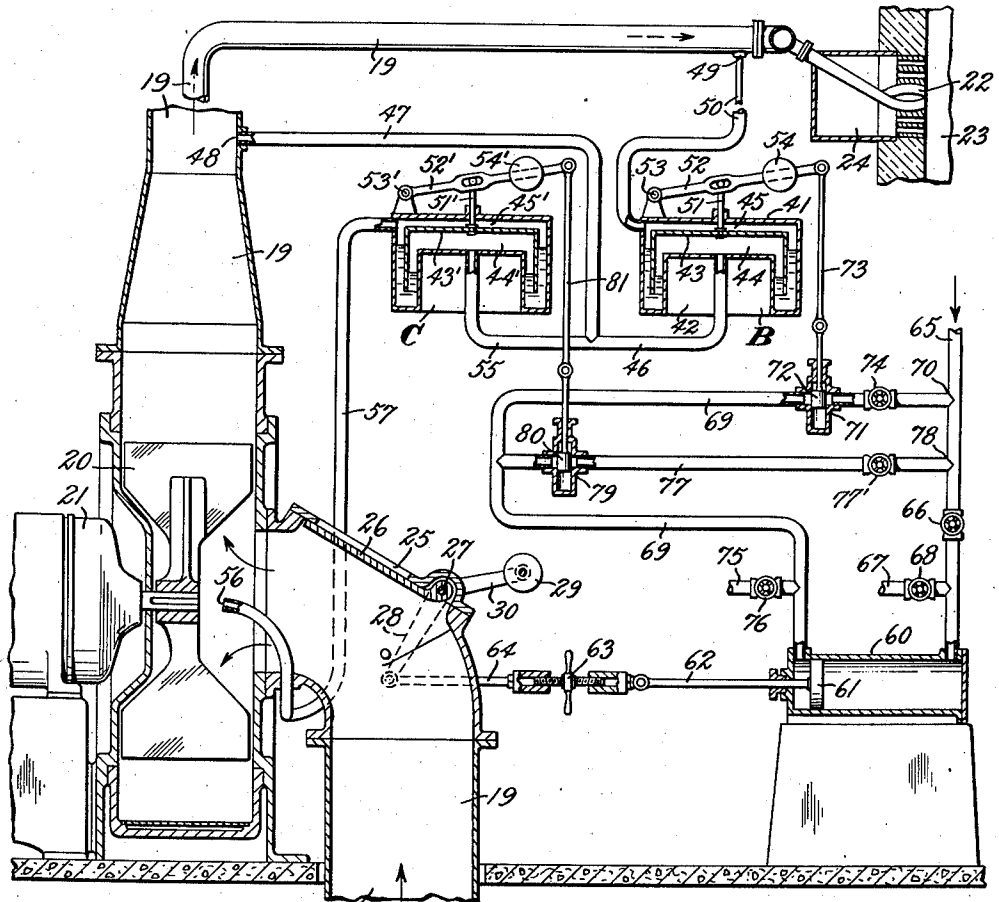
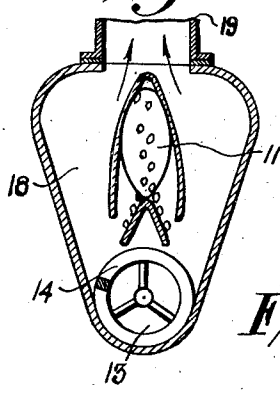


Fig. 1.



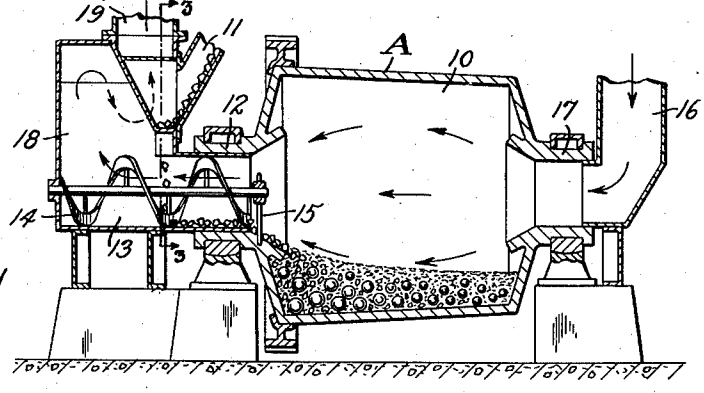


Fig. 3.

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PULVERIZING SYSTEM

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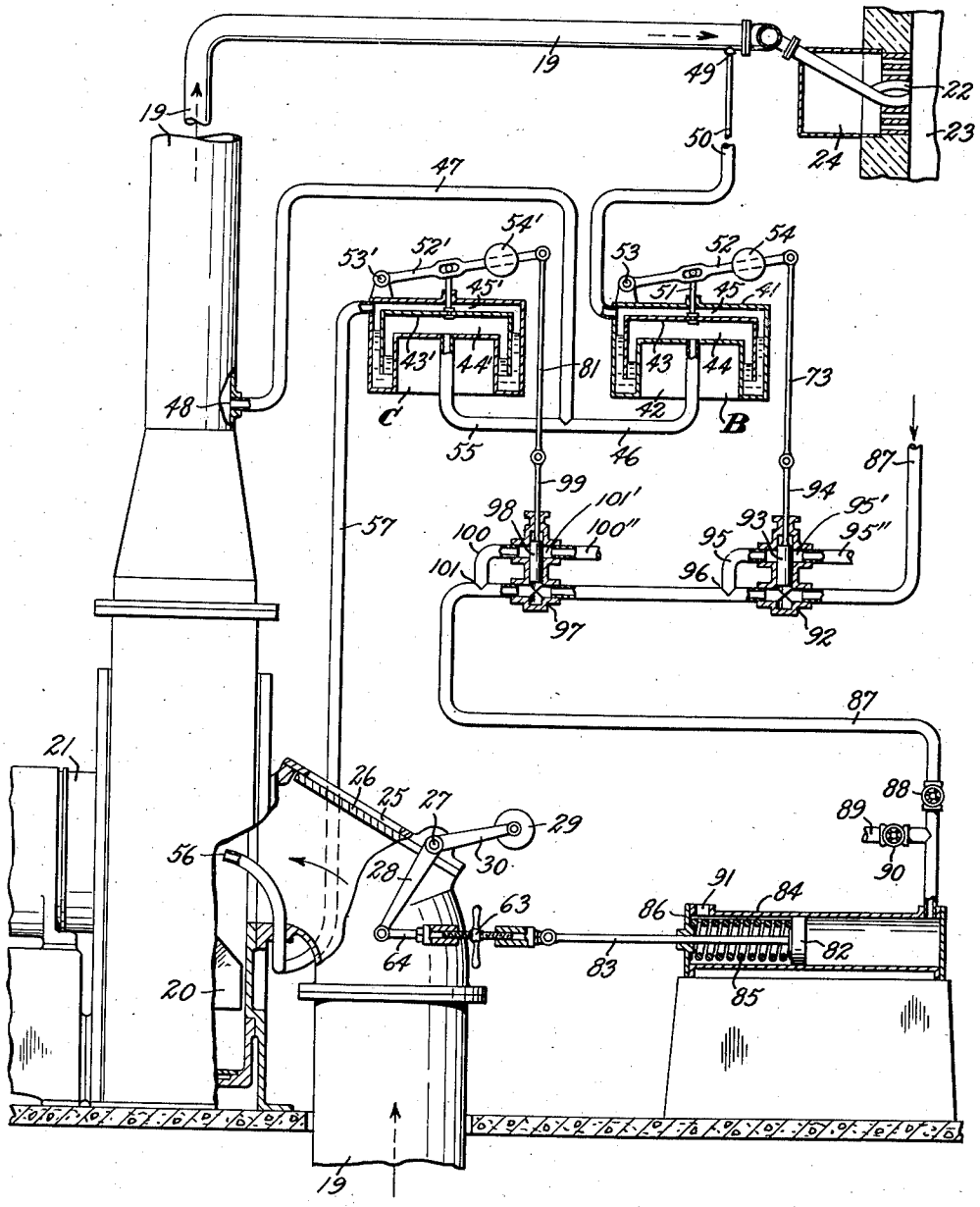


Fig. 2.

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PULVERIZING SYSTEM

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16 Claims. (Cl. 110—104)

This invention relates to pulverizing systems and more particularly pertains to systems for pulverizing fuel such as coal, and feeding the fuel to a furnace or other place where combustion of the fuel will occur.

In systems of this character, the fuel after pulverization, is ordinarily carried by a current of air moving through a conduit directly to a furnace where combustion takes place, rather than to a storage bin. The pulverized fuel and air mixture is combustible and under certain conditions explosive and in the event the velocity of the air and fuel mixture moving from the pulverizing means to the furnace is materially reduced below a normally safe velocity for any reason, such as the stopping or breakage of the exhauster fan or the plugging of the burners or the fuel conduit, combustion and under certain conditions, an explosion in the conduit or pulverizing means or both is likely to occur due to the propagation of flames from the furnace to the pulverizer.

The present invention provides novel means for avoiding the propagation of flames to a pulverizer from a furnace or burner served by it. In general, such means comprises one or more devices which respond to the pressure conditions existing in the system and which serve to operate, when the pressure conditions in the system approach or reach the point where an explosion is likely to occur, means for closing the conduit connecting the pulverizer and furnace and for scavenging with clear air the exhauster and the conduit between the conduit closing means and the furnace, thus substituting a non-combustible atmosphere incapable of propagating flame for the combustible fuel mixture in said conduit and exhauster by the operation of the pressure responsive devices. In the particular embodiments of the invention disclosed in this application, the devices which respond to the pressure conditions in the system control a fluid pressure actuated device which in turn operates the conduit closing means and permits clear air to be introduced into the conduit. In one form of the invention, the fluid pressure actuated device will operate the conduit closing means to close the conduit when the pressure of the actuating fluid fails for any reason.

The nature of the invention will be clearly understood from the following description considered in connection with the accompanying drawings forming a part thereof and in which:

Fig. 1 is a more or less diagrammatic view in elevational section of pulverizing and feeding equipment embodying one form of the present invention;

Fig. 2 is a view similar to Fig. 1 showing another form of the invention, and

Fig. 3 is a sectional view taken on line 3—3 of Fig. 1.

Like characters of reference refer to like parts throughout the several views.

Referring to the drawings, particularly Fig. 1, reference letter "A" indicates generally a ball mill pulverizer comprising a cylindrical shell 10 rotatable about a horizontal axis, which contains the material to be pulverized and grinding or pulverizing balls of various desired sizes. The material to be pulverized is introduced into the mill through a feed conduit 11 and through trunnion 12. The material from the feed conduit 11 drops into a conveyor conduit 13 and is introduced into the shell 10 by means of a helical conveyor 14 connected to the shell 10 by connection 15 for rotation by the shell. Air in sufficient quantity and at the proper temperature is introduced into the shell through an air duct 16 and trunnion 17. The pulverized material is picked up by the air current flowing through the mill and is carried through trunnion 12 into a classifier 18 where the desired classification of the fine and coarser particles of the material takes place. The coarser particles are separated from the finer particles and the former drop down into the conveyor conduit 13 and are returned to the mill through trunnion 12 by the conveyor 14. The material which has been pulverized to the desired extent is carried by the air current through the feed conduit 19 to the point of use. It will be understood that the particular type of pulverizing equipment or apparatus disclosed herein is not essential to the carrying out of the invention. Other forms or types of pulverizing apparatus may be employed, if desired.

The invention as disclosed is applied particularly to the pulverization of coal and the feeding thereof to one or more burners in a furnace for firing a boiler or still or the like. The pulverized coal is drawn from the mill through the classifier 18 and the feed conduit 19 by an exhauster fan 20 of any suitable type or kind. Fan 20 is mounted in the feed conduit 19 and is driven or rotated by any suitable means such as the electric motor 21 indicated. Fan 20 draws the air and the pulverized coal carried thereby from the mill and forces it through the feeding conduit 19 into one or more burners 22 in a furnace 23. Air is supplied to the burners 22 through an air conduit 24.

As shown, on the suction side of the exhauster fan 20, feed conduit 19 is provided with an air opening 25 which is adapted to be closed by a damper 26 secured as shown, at one end thereof to an oscillatable shaft 27 so as to provide for the movement of the damper into a position to entirely or to substantially entirely close the feed conduit 19 and to open the conduit to the atmos-

phere or other source of clear air, so that fresh air may be drawn in through the opening 25 by the fan and forced into the burners 22 and furnace 23. Damper 26 is provided with an operating lever 28 which is secured at one end to the shaft 27 and which is disposed outside of the feed conduit 19. A counter-weight 29 is mounted on the end of a counter-weight arm 30 which is secured to the shaft 27. The damper 26 during operation of the pulverizing system is normally in the position shown in Fig. 1, that is to say, so that the feed conduit 19 is entirely open and the opening 25 is completely closed. However, it will be understood that the damper 26 may be utilized as a capacity controlling device by causing it to assume any position intermediate its fully open position shown in Fig. 1 and its fully closed position wherein it entirely cuts off the feed conduit 19.

Means responsive to the pressure conditions existing in the pulverizing system, or more specifically pressure conditions existing in the feed conduit 19, are utilized for operating the damper 26 at such times as it becomes necessary to cut off the mill from the fan and furnace to prevent the propagation of flames back from the furnace to the mill with resultant danger of an explosion in the mill. As shown in Fig. 1, such means consists of a pressure responsive device indicated generally "B" which is responsive to pressure conditions existing at spaced points between the fan and the furnace and a pressure responsive device indicated generally "C" which is responsive to the pressures developed by the exhauster 20 on its suction and pressure sides. Pressure responsive device "B" as shown consists of a cylindrical casing 41 having a centrally disposed cylindrical recess 42 in its lower portion thereby providing a casing having a cross-section in the form of an inverted U. Casing 41 is partly filled with a liquid such as mercury, which serves to support a bell float 43 in the casing. Bell float 43 divides casing 41 into a lower chamber 44 and an upper chamber 45. The lower chamber 44 is connected by a tube 46 to a tube 47 which communicates with the feed conduit 19 at a point 48 adjacent the pressure side of exhauster fan 20. The upper chamber 45 is connected to the feed conduit 19 at a point 49 adjacent the furnace 23 by the tube 50. Bell float 43 is connected by a rod 51 secured thereto, to the intermediate portion of a lever 52 pivoted at one end 53 to the casing 41. A weight 54 is adjustably mounted on the lever 52 adjacent the other end so as to urge the bell float downwardly as viewed in Fig. 1. The pressure responsive device "C" is similar in all respects to the pressure responsive device "B" so that it is deemed unnecessary to describe device "C" in detail. The parts thereof are designated by the same reference characters which designate the corresponding parts of the pressure responsive device "B" but with the addition of a prime to each character. Chamber 44' of device "C" is connected to point 48 in the feed conduit 19 by pipes 55 and 47. Chamber 45' of device "C" is in communication with a point 56 adjacent the suction side of the exhauster fan 20 through a tube 57. It will be understood that any suitable form of pressure responsive device may be utilized in lieu of the floating bell device shown in Fig. 1. Such other devices may be of the diaphragm, sylphon, piston or other suitable types.

In the form of the invention shown in Fig. 1, pressure responsive devices "B" and "C" control a pressure actuated device of any suitable character which is connected to the damper 26 to operate the same and thereby move the damper to closed position, or to a position wherein it will close the feed conduit 19, at such times as the pressure conditions in the system fall below the predetermined minimum. As shown in Fig. 1, the pressure actuated device consists of a cylinder 60 and a piston 61 movable therein. Piston rod 62 is connected at its outer end to a hand wheel or other adjusting device 63 which in turn is connected through a link 64 to the damper operating lever 28. The adjusting device 63 serves to adjust the position of the damper 26 with respect to the piston 61 so that the damper may be maintained either in fully open position as shown in Fig. 1, or in any intermediate position between its fully open and fully closed positions so that it will serve as a capacity control device in addition to a cut-out or cut-off device. Any suitable fluid such as oil, steam, air or gas is supplied to the cylinder 60 through a pipe 65 connected to the source of fluid pressure. As shown, pipe 65 is connected with the right hand end of cylinder 60 as viewed in Fig. 1. This pipe is provided with a valve 66 and with a branch pipe 67 controlled by a valve 68, through which pipe fluid is exhausted from cylinder 60 when damper 26 is moved to conduit closing position by piston 61. A pipe 69 is connected at one end 70 to the pipe 65 and at its other end to the left hand end of cylinder 60, as viewed in Fig. 1. Pipe 69 is provided with a piston valve 71, the piston 72 of which is connected through a link 73 to the outer end of lever 52 which is actuated by the bell float 43 in pressure responsive device "B". As shown pipe 69 is also provided with a valve 74 intermediate the valve 71 and pipe 65 and is further provided with a branch pipe 75 controlled by valve 76 adjacent the end of pipe 69 which is connected to the cylinder 60. Pipe 75 conducts to the atmosphere any leakage past valves 71 and 79 and fluid is exhausted through this pipe from cylinder 60 when the apparatus is reset, or when the damper 26 is returned to the position in which the conduit 19 is fully open, as shown in Fig. 1. A pipe 77 is connected at one end 78 to pipe 65 and at the other end to the pipe 69 and is controlled by a piston valve 79, the piston 80 of which is connected through a link 81 to the outer end of lever 52' which is connected to bell float 43' of pressure responsive device "C". Pipe 77 also has a suitable valve 77' disposed intermediate the valve 79 and pipe 65.

The operation is as follows: Upon the occurrence of an accident such as the plugging up of the burners 22 or of the feed conduit 19 or of the mill or of any accident causing a reduction in velocity of flow of air and fuel through the conduit 19 to a dangerous degree, the difference in pressure between points 48 and 49 in conduit 19 will be varied so that a greater pressure than normal will exist at point 49 or a lesser pressure than normal will exist at point 48, or both, as a result of which bell float 43 will be moved downwardly as seen in Fig. 1, under the action of weight 54 and will move piston 72 in valve 71 downwardly, thereby opening the valve and permitting the fluid under pressure from pipe 65 to enter the left hand end of cylinder 60. It will be understood that during normal operation of the system the damper 26 will be either fully closed with respect to the conduit or in a position intermediate its fully open and fully closed positions with respect to the conduit and piston 61 will be near the left hand end of the cylinder as viewed

in Fig. 1. It will also be understood that during normal operation valves 74 and 77' in pipes 69 and 77 will be open and valve 76 in branch pipe 75 will be closed and that valve 66 in pipe 65 will be closed and valve 68 in branch pipe 67 will be opened. When fluid under pressure is admitted to the left hand end of cylinder 60 through pipe 69, piston 61 will be moved toward the right and will move damper 26 from its open to its closed position thereby closing the feed conduit 19 and cutting off communication between the furnace and the mill and opening conduit 19 to the atmosphere or other source of clear air thus preventing propagation of flames from the furnace to the mill and preventing a possible explosion in the mill. The movement of the damper toward conduit closing position opens opening 25 and permits clear air to be drawn into the conduit from the atmosphere by the fan, if it is still operating. Upon the occurrence of an accident such as the stalling or stopping of the means for propelling the exhauster fan, or the stripping of the blades from the exhauster fan without stopping the fan, or of a plugging up of the exhauster fan, the pressure responsive device "C" will be actuated as a result either of an increase in pressure at point 56 or a decrease in pressure at point 48 in conduit 19, or both. Such variations in pressure will cause bell float 43' to move downwardly, as shown in Fig. 1, which will move piston 80 of valve 79 downwardly and connect the source of fluid pressure with the left hand end of cylinder 60 through pipe 69. The admission of fluid under pressure to the left hand end of cylinder 60 will move piston 61 to the right as previously described and will move the damper 26 to closed position to close the conduit 19. It will be apparent that the operation of either the pressure responsive device "B" or the device "C" or both will cause the pressure actuated device to move the damper to closed position with respect to the conduit and open the conduit to clear air through opening 25 whenever the pressure conditions in the system, or more specifically whenever the pressure conditions in the feed conduit 19, fall below predetermined minimum values. It will be understood that when the damper is moved to closed position to close the conduit as a result of any condition which will tend to stop the exhauster fan, the momentum of the fan will cause it to run sufficiently long after the damper has moved to closed position with respect to the conduit, so that the conduit 19 becomes scavenged and a non-combustible atmospheric barrier to flame propagation is introduced between the damper and the furnace in addition to the barrier of the damper itself.

To reset the controlling mechanism, valves 74, 77' and 68 are closed and valves 66 and 76 are opened. This will cause the fluid under pressure to be admitted to the right hand end of cylinder 60 and will move piston 61 toward the left to its limit of travel thereby moving the damper 26 to open position with respect to the conduit. When the piston 61 is returned to its normal position and valves 71 and 79 are in their normally closed positions, as shown in Fig. 1, valves 66 and 76 are closed and valves 74, 77' and 68 are again opened. Thereafter valve 76 is slightly opened to permit any leakage past valves 71 and 79 to escape through branch pipe 75.

In the form of the invention shown in Fig. 2, the damper 26 is maintained in its open position with respect to the conduit by a fluid actuated device when the latter is subjected to the pressure of the actuating fluid and the damper is moved to its closed position with respect to the conduit and the conduit is opened to clear air when the pressure fails or is cut off from communication with the pressure actuated device by the operation of one or both of the pressure responsive devices. As shown in Fig. 2, the pressure responsive devices "B" and "C" and their connections to the pulverizing system, specifically to the feed conduit 19, are substantially the same as shown in Fig. 1. In the form shown in Fig. 2, the damper 26 has its operating lever 28 connected to the piston 82 of the pressure actuated device through link 64, adjusting device 63 and piston rod 83. Piston 82 moves in a cylinder 84 and a suitable coil spring 85 is interposed between the piston and the left hand end 86 of the cylinder so as to normally urge the piston 82 toward the right, as viewed in Fig. 1, thereby urging the damper toward closed position to close the conduit. Pipe 87 is connected to a source of fluid pressure and serves to conduct the actuating fluid to the right hand end of cylinder 84. Pipe 87 is provided with a valve 88 and with a branch pipe 89 controlled by a valve 90. Cylinder 84 is provided with an outlet 91 adjacent its left hand end. Pipe 87 is also provided with a piston valve 92, the piston 93 of which is connected through its rod 94 and through link 73 to lever 52, which is connected to the bell float 43 of pressure responsive device "B". Pipe 87 has a pressure release pipe 95 having one end 96 connected to pipe 87 at a point adjacent the valve 92, intermediate the latter and cylinder 84, and the other end connected to a passage 95' in valve 92. Air discharged through pipe 95 is conducted to the atmosphere through pipe 95'' controlled by the piston 93. Pipe 87 is also provided with a piston valve 97, the piston 98 of which is connected through its rod 99 and link 81 to lever 52' which is connected to bell float 43' of pressure responsive device "C". A pressure release pipe 100 has one end 101 connected to pipe 87 adjacent valve 97, at a point intermediate valve 97 and the cylinder 84, and has the other end connected to a passage 101' in valve 97. Air discharged through pipe 101 is conducted to the atmosphere through pipe 100''. During normal operation of the system the pistons 93 and 98 of valves 92 and 97 respectively, will be in the positions shown in Fig. 2 so that pipe 87 is open and the pressure release pipes 95 and 100 are closed and valve 88 will be open and valve 90 in branch pipe 89 will be closed. Piston 82 will be approximately in the position indicated in Fig. 2 in which position the damper is in open position or at some position intermediate its open and closed position.

The operation of the form of the invention shown in Fig. 2 is as follows: If for any reason such as set forth in connection with the description of the form of the invention shown in Fig. 1, the pressure conditions in the system, more specifically in the feed conduit 19, or the pressure differentials between the points in the conduit 19 to which the devices "B" and "C" are connected fall below the predetermined desired minimums, either bell float 43 in pressure responsive device "B" or bell float 43' in pressure responsive device "C", or both, will be moved downwardly thereby moving downwardly either piston 93 of valve 92 or piston 98 of valve 97, or both. The movement downwardly of either or both of these pistons will close pipe 87 thereby shutting off the supply of actuating fluid under pressure to cylinder 84 and will open one or both of pressure release

pipes 95 and 100 thereby permitting spring 85 to move piston 82 toward the right as viewed in Fig. 2 and moving damper 26 to its closed position so as to cut off communication between the furnace and the mill and open the conduit to clear air thus preventing the propagation of flames back from the furnace to the mill with possible consequent explosion in the mill. In the event pressure responsive device "B" only is actuated due to the change in pressure conditions in the feed conduit 19, piston 93 only will cut off or close pipe 87 so that the fluid forced from cylinder 84 by the movement of the piston 82 under the action of spring 85 will escape through pressure release pipe 95. If on the other hand pressure responsive device "C" only is actuated, piston 98 only will cut off pipe 87 and the fluid forced from cylinder 84 will escape through pressure release pipe 100. Fluid from cylinder 84 will also escape from pipe 100 where both pressure responsive devices are actuated so as to cause both pistons 93 and 98 to cut off pipe 87.

In order to reset the control mechanism in the embodiment shown in Fig. 2, it is merely necessary to move pistons 93 and 98 to their upper positions as shown in Fig. 2, to open pipe 87 and close pipes 95 and 100, to permit the actuating fluid to again move piston 82 toward the left against the action of spring 85 thereby moving the damper 26 back to its fully open or normally open operative position with the conduit 19 open and the air opening 25 closed.

Should it be desired to operate damper 26 manually instead of automatically through the cylinder 84 and piston 82, pipe 87 may be connected to a source of air or other fluid supply under pressure. With valve 88 open and valve 90 closed, damper 26 will be maintained in the position shown in Fig. 2 with the conduit 19 fully open and the air opening 25 fully closed. To move the damper 26 to a position to close conduit 19 and to open air opening 25, it is merely necessary to close valve 88 and to open valve 90, which will result in cutting off the supply of fluid to cylinder 84 and permitting the fluid under pressure in the cylinder to escape to the atmosphere or to any other convenient place through pipe 89. When it is desired to return the damper to a position wherein conduit 19 is open and air opening 25 is closed, it is merely necessary to close valve 90 and to open valve 88.

It will thus be seen that I have provided a control mechanism for cutting off communication between a furnace and a coal pulverizing mill and opening the conduit connecting the mill and furnace to a source of clear air, at such times as it becomes necessary to do so due to any cause which might result in flame propagation from the furnace to the mill and an explosion in the mill. Although the introduction of clear air into the conduit connecting the mill and furnace is desirable when the damper is moved to closed position, it will be understood that under some conditions, satisfactory operation may be obtained without it. Inasmuch as many variations in the forms or embodiments of the invention herein disclosed or the several parts thereof may be made without transcending the principles of the invention, it will be understood that no intention is entertained to limit the scope of the invention except by the breadth of the claims appended hereto.

What I claim is:

1. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, means operative to remove pulverized fuel and air from the mill and deliver it to the furnace through the conduit, a damper adapted to close the conduit, pressure actuated means connected to the damper constructed and arranged to normally hold the damper in a position so that the conduit is open, and means responsive to pressure conditions at spaced points in the conduit for controlling the pressure actuated means to cause the latter to move the damper to close the conduit when the pressure difference between said spaced points therein changes from a predetermined value.

2. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, means operative to remove pulverized fuel and air from the mill and deliver it to the furnace through the conduit, a damper adapted to close the conduit, pressure actuated means connected to the damper constructed and arranged to normally hold the damper in a position so that the conduit is open, and means responsive to differences in pressure at spaced points in the conduit for controlling the pressure actuated means to cause the latter to move the damper to close the conduit when the difference in pressure between the spaced points in the conduit falls below a predetermined minimum.

3. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, an exhauster fan in the conduit for removing pulverized fuel and air from the mill and delivering it to the furnace through the conduit, a damper adapted to close the conduit, pressure actuated means connected to the damper constructed and arranged to normally hold the damper in a position so that the conduit is open, and means responsive to differences in pressure at spaced points in the conduit between the fan and the furnace for controlling the pressure actuated means to cause the latter to move the damper to close the conduit when the difference in pressure between said spaced points in the conduit falls below a predetermined minimum.

4. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, an exhauster fan in the conduit for removing pulverized fuel and air from the mill and delivering it to the furnace through the conduit, a damper adapted to close the conduit, pressure actuated means connected to the damper constructed and arranged to normally hold the damper in a position so that the conduit is open, and means responsive to differences in pressure at spaced points in the conduit between the suction and pressure sides of the fan for controlling the pressure actuated means to cause the latter to move the damper to close the conduit when the difference in pressure between said spaced points in the conduit falls below a predetermined minimum.

5. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, means operative to remove pulverized fuel and air from the mill and deliver it to the furnace

through the conduit, a damper adapted to close the conduit, pressure actuated means connected to the damper constructed and arranged to normally hold the damper in a position so that the conduit is open, a pressure responsive device in communication with the conduit at spaced points, a second pressure responsive device in communication with the conduit at spaced points one of which is different from those with which the first pressure responsive device is in communication, and means connected with each pressure responsive device for controlling the pressure actuated means to cause the latter to move the damper to close the conduit when the difference in pressure in the conduit between the spaced points with which either of the pressure responsive devices are in communication, falls below a predetermined minimum.

6. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, an exhauster fan in the conduit for removing pulverized fuel and air from the mill and delivering it to the furnace through the conduit, a damper adapted to close the conduit, pressure actuated means connected to the damper constructed and arranged to normally hold the damper in a position so that the conduit is open, a pressure responsive device in communication with the conduit at a point adjacent the furnace and at a point adjacent the pressure side of the fan, a second pressure responsive device in communication with the conduit at the pressure and suction sides of the fan, and means connected with each pressure responsive device for controlling the pressure actuated means to cause the latter to move the damper to close the conduit when the difference in pressure in the conduit between the spaced points with which either of the pressure responsive devices is in communication, falls below a predetermined minimum.

7. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, means operative to remove pulverized fuel and air from the mill and deliver it to the furnace through the conduit, a damper adapted to close the conduit, pressure actuated means connected to the damper constructed and arranged to normally hold the damper in a position so that the conduit is open, a pipe through which fluid under pressure is supplied to the pressure actuated means for operating the same, a valve in the pipe, a device responsive to pressure conditions existing at spaced points in the conduit, and means connecting the valve and said device whereby when the pressure differences between said spaced points in the conduit falls below a predetermined minimum, said device will operate the valve and cause fluid under pressure to be supplied to the pressure actuated means and move the damper to close the conduit.

8. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, means operative to remove pulverized fuel and air from the mill and deliver it to the furnace through the conduit, a damper adapted to close the conduit, pressure actuated means connected to the damper constructed and arranged to normally hold the damper in a position so that the conduit is open, a pipe through which fluid under pressure is supplied to the pressure actuated means for operating the same, a valve in the pipe, a device responsive to differences in pressure between spaced points in the conduit, and means connecting the valve and the device whereby when the difference in pressure in the conduit between said spaced points falls below a predetermined minimum, said device will operate the valve and cause fluid under pressure to be supplied to the pressure actuated means and move the damper to close the conduit.

9. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, means operative to remove pulverized fuel and air from the mill and deliver it to the furnace through the conduit, a damper adapted to close the conduit, pressure actuated means connected to the damper constructed and arranged to normally hold the damper in a position so that the conduit is open, a pipe through which fluid under pressure is supplied to the pressure actuated means for operating the same, a valve in the pipe, a device responsive to differences in pressure between spaced points in the conduit, a second device responsive to differences in pressure in the conduit between spaced points one of which is different from those with which the first mentioned device is in communication, a connection between one of the pressure responsive devices and said valve, a second pipe through which fluid under pressure is supplied to the pressure actuated means, a valve in said second pipe, and a connection between the last mentioned valve and the other pressure responsive device, whereby when the pressure difference between the points in the conduit to which either pressure responsive device is connected falls below a predetermined minimum, fluid under pressure will be admitted to the pressure actuated means and cause the latter to move the damper to close the conduit.

10. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, an exhauster fan in the conduit for removing pulverized fuel and air from the mill and delivering it to the furnace through the conduit, a damper adapted to close the conduit, pressure actuated means connected to the damper constructed and arranged to normally hold the damper in a position so that the conduit is open, a pressure responsive device in communication with the conduit at a point adjacent the furnace and at a point adjacent the pressure side of the fan, a second pressure responsive device in communication with the conduit at the pressure and suction sides of the fan, a pipe through which fluid under pressure is conducted to the pressure actuated means, a valve in said pipe connected to one of the pressure responsive devices, a second pipe through which fluid under pressure is supplied to the pressure actuated means, a valve in said second pipe, and a connection between the last mentioned valve and the other pressure responsive device, whereby when the pressure difference between the points in the conduit to which either pressure responsive device is connected falls below a predetermined minimum, fluid under pressure will be admitted to the pressure actuated means and cause the latter to move the damper to close the conduit.

11. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for sup-

plying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, means operative to remove pulverized fuel and air from the mill and deliver it to the furnace through the conduit, a damper adapted to close the conduit, a cylinder having a piston connected to the damper, means urging the piston in a direction to move the damper to close the conduit, a pipe for supplying fluid under pressure to the cylinder to move the piston to cause the damper to open the conduit and to maintain the damper in open position, a valve in the pipe and normally in a position so that the pipe is open, a pressure responsive device in communication with spaced points in the conduit, a connection between the valve and the pressure responsive device, and means permitting fluid to escape from the cylinder when the valve is moved to close the pipe to cut off the flow of fluid to the cylinder, whereby when the pressure difference in the conduit between said spaced points falls below a predetermined minimum, the damper will be moved to close the conduit.

12. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, means operative to remove pulverized fuel and air from the mill and deliver it to the furnace through the conduit, a damper adapted to close the conduit, a cylinder having a piston connected to the damper, means urging the piston in a direction to move the damper to close the conduit, a pipe for supplying fluid under pressure to the cylinder to move the piston to cause the damper to open the conduit and to maintain the damper in open position, a valve in the pipe and normally in a position so that the pipe is open, a pressure responsive device in communication with spaced points in the conduit, a connection between the valve and the pressure responsive device, and means permitting fluid to escape from the cylinder when the valve is moved to cut off the flow of fluid to the cylinder whereby when the pressure difference between said spaced points in the conduit falls below a predetermined minimum, the damper will be moved to close the conduit.

13. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, an exhauster fan in the conduit for removing pulverized fuel and air from the mill and delivering it to the furnace through the conduit, a damper adapted to close the conduit, a cylinder having a piston connected to the damper, means urging the piston in a direction to move the damper to close the conduit, a pipe for supplying fluid under pressure to the cylinder to move the piston to cause the damper to open the conduit and to maintain the damper in open position, a valve in the pipe and normally in a position so that the pipe is open, a pressure responsive device in communication with the conduit at a point adjacent the furnace and at a point adjacent the pressure side of the fan, a second pressure responsive device in communication with the conduit at the suction and pressure sides of the fan, said valve being connected to one of the pressure responsive devices, another valve in the pipe normally in open position and connected to the other pressure responsive device and a pressure release pipe controlled by each of the valves and connected to said pipe to permit fluid to escape from the cylinder when either of the valves is moved to cut off the supply of fluid to the cylinder, whereby when the pressure difference between the points with which either of the pressure responsive devices are in communication falls below a predetermined minimum, the fluid in the cylinder will be permitted to escape and the damper will be moved to close the conduit.

14. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, means operative to remove pulverized fuel and air from the mill and deliver it to the furnace through the conduit, a damper adapted to close the conduit, a cylinder having a piston connected to the damper, means urging the piston in a direction to move the damper to close the conduit, a pipe for supplying fluid under pressure to the cylinder to move the piston to cause the damper to open the conduit and maintain the damper in open position, and means responsive to pressure conditions at spaced points in the conduit for cutting off the supply of fluid under pressure to the cylinder, whereby when the pressure difference in the conduit between said spaced points falls below a predetermined minimum the means urging the piston in a direction to move the damper to closed position will operate to close the damper.

15. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, means operative to remove pulverized fuel and air from the mill and deliver it to the furnace through the conduit, a damper adapted to close the conduit, the conduit having an opening to clear air, pressure actuated means connected to the damper and arranged to normally hold the damper in a position so that the conduit is open and said opening to clear air is closed, and means responsive to differences in pressure at spaced points in the conduit for controlling the pressure actuated means to cause the latter to move the damper to close the conduit and to permit the introduction of clear air into the conduit when the difference in pressure between the spaced points in the conduit falls below a predetermined minimum.

16. In combination with a furnace for burning pulverized fuel, a pulverizing mill, means for supplying fuel and air to the mill, a conduit connecting the discharge of the mill with the furnace, means operative to remove pulverized fuel and air from the mill and deliver it to the furnace through the conduit, a damper adapted to close the conduit, the conduit having an opening to clear air on the suction side of the fan, said opening being disposed in the conduit so that the damper closes the opening when the conduit is open, pressure actuated means connected to the damper and arranged to normally hold the damper in a position so that the conduit is open and said opening is closed, and means responsive to pressure conditions at spaced points in the conduit for controlling the pressure actuated means to cause the latter to move the damper to close the conduit and open said opening and permit clear air to be drawn into the conduit when the pressure difference between said spaced points therein falls below a predetermined minimum.

MARTIN FRISCH.