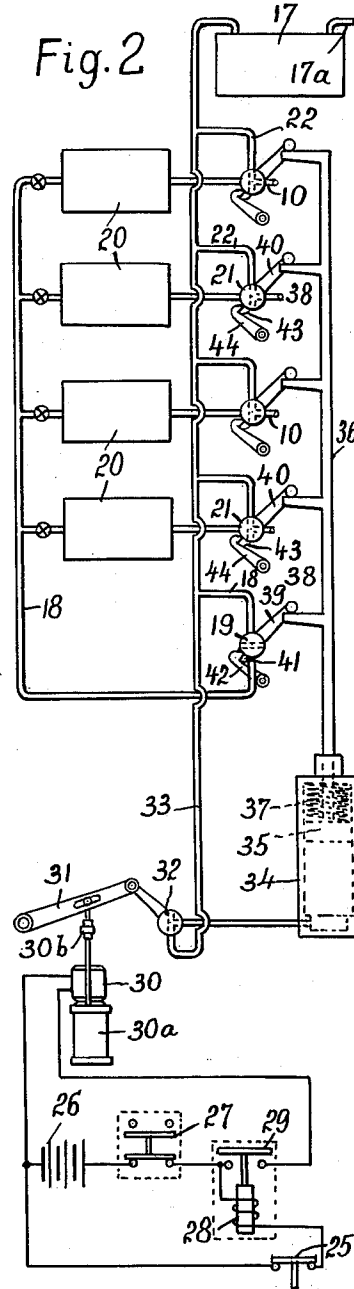
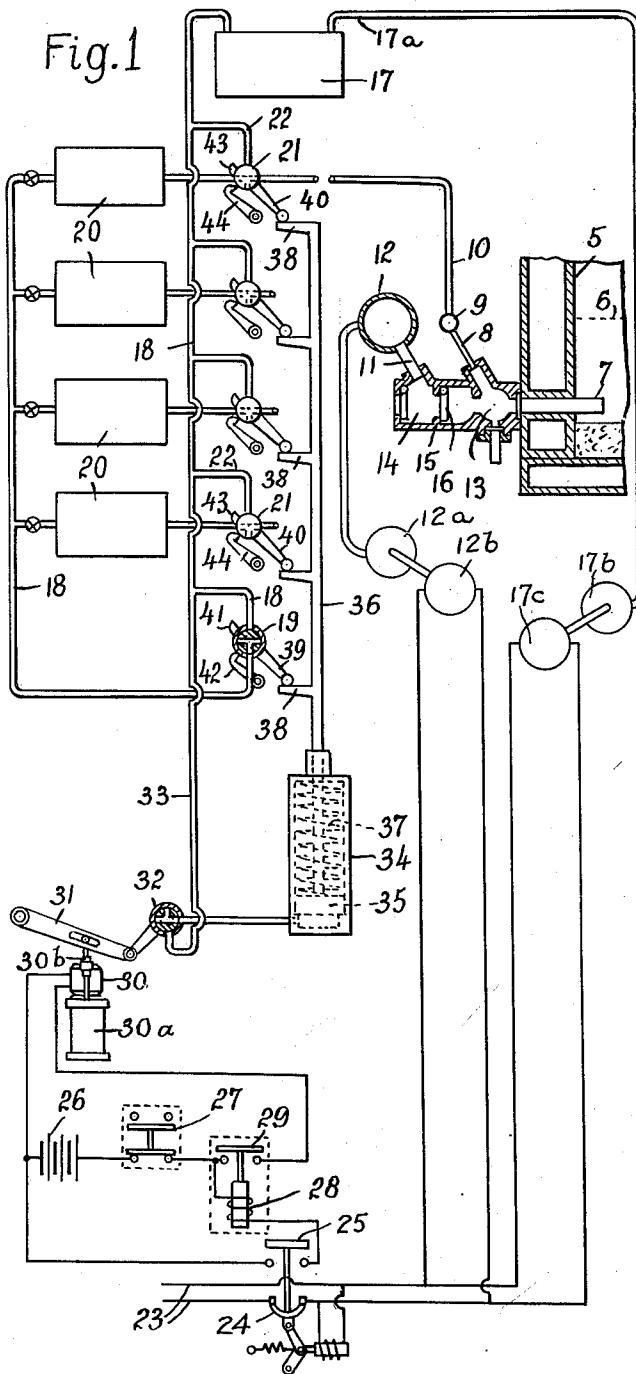


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FURNACE APPLIANCE

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FURNACE APPLIANCE

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This invention relates to furnace appliances, and more particularly to appliances for preventing the clogging of the tuyères of a metallurgical furnace in which air and fuel are blown through the tuyères into a molten charge when the blowing engine or air compressor stops because of an interruption or failure of power. Such furnaces are used, for example, for recovering volatile metals such as zinc from lead smelter slags. Air and fuel, usually powdered coal, are blown through the tuyères into the molten slag in the furnace. The zinc is reduced to the metallic form and volatilized, and the zinc vapor passing out of the furnace is immediately burned to zinc oxide and is collected in a bag-house or the like. Power failures, particularly of electric power, occur frequently in smelting districts, and cause serious and costly trouble in the furnace operation. The molten slag stands about four feet above the tuyères in the furnace, and when the air pressure goes off because of a power failure, the molten slag runs back into the tuyères and connecting pipes, burning any rubber hose connections, injuring valves and causing a shutdown of the furnace for several hours. Various expedients have heretofore been resorted to in attempts to minimize the operating troubles due to power interruptions, such as the provision of check valves or the like in the tuyère connections, and while such expedients have given some improvement they have not eliminated the troubles, particularly with large furnaces.

The object of the present invention is to provide a novel and improved appliance for preventing the back flow of slag into the tuyères whenever the blowing engine or the like stops because of power interruptions. In its broad aspect, the invention involves the provision of a source of compressed air normally connected to the compartment supplying the air and fuel to the tuyères, and means responsive to power interruptions for disconnecting the compressed air source from the air-fuel compartment and for directly connecting the tuyères to the compressed air source whenever the power is interrupted. The normal operating connection between the tuyères and the air-fuel compartment is manually or automatically restored when power returns. In its more complete aspect, the appliance of the invention includes valves in the connections between the compressed air source, the air-fuel compartment and the tuyères which by a combination of electrical and pneumatic agencies are automatically actuated to effect the contemplated emergency connections be-

tween the compressed air source, the air-fuel compartment and the tuyères. These and other novel features of the invention will be best understood from the following description taken in conjunction with the accompanying drawing, in which

Fig. 1 is a diagrammatic view of the appliance of the invention in the normal operation of the furnace, and

Fig. 2 is a diagrammatic view of the appliance following a power interruption.

The drawing illustrates, in Fig. 1, the lower corner of a furnace 5 in which the molten slag level is indicated at 6. A plurality of spaced tuyères 7 extend into the furnace, on opposite sides, well below the slag level 6. Powdered coal and high pressure air, say about 80 pounds per square inch, are blown into each tuyère through a branch pipe 8 connected to a distributing pipe which in turn is connected to the air-fuel feed pipe 10. For the sake of simplicity, only one tuyère is shown in the drawing, and only one of the feed pipes 10 is shown connected to its cooperating distributing pipe 9. In the actual furnace structure one feed pipe 10 supplies air and fuel to half of the tuyères on one side of the furnace, and hence four such feed pipes are provided. Additional combustion air at a lower pressure is supplied to each tuyère through a branch pipe 11 connected to a bustle pipe 12. The branch pipes 8 and 11 discharge into chambers 13 and 14 in the tuyère fitting 15. A check valve 16 between the chambers 13 and 14 prevents the high pressure air from escaping through the low pressure air pipes when the low pressure air is cut off by a power interruption, as explained in United States Letters Patent 1,769,146, patented July 1, 1930.

The appliance of the invention provides an adequate supply or reservoir of high pressure air to force against the slag immediately upon the occurrence of any power interruption. To this end, we provide one or more sources of high pressure air in the form of one or more receivers 17. High pressure compressed air is introduced into the receiver (or receivers) 17 through a pipe 17a from any conventional air compressor or blowing engine 17b, which in turn is driven by a conventional electric motor 17c. The motor receives its electrical power from any suitable source of power such as the distributing mains 23 of a utility company.

In the normal operation of the furnace, a pipe line 18 including a two-way main air valve 19 conducts the high pressure air to the air-fuel

compartments 20. These compartments or bins are hermetically tight, and are charged with powdered coal in any appropriate manner. The mixture of high pressure air and powdered coal is blown through the feed pipe 10 and the distributing pipe 9 to the branch pipes 8 of the individual tuyères.

A three-way tuyère valve or cock 21 is included in each of the feed pipes 10. A pipe 22 connects each of the tuyère valves 21 to the high pressure pipe line 18. The tuyère valves 21 are adapted to occupy either of two positions, the first of which is the normal operating position connecting the compartment 20 to the tuyères fed by the co-operating feed pipe 10, and the second of which is the emergency position connecting the tuyères directly to the high pressure air source 17.

The main source of electric power 23 is connected in the conventional manner through an oil switch 24 to the electric motor 12b for operating the blowing engine 12a which supplies low pressure air to the bustle pipe 12. This switch 24 advantageously is equipped with undervoltage and overload trips so that it is opened upon the occurrence of any abnormal power condition such as a power failure. It may be an oil circuit breaker of common construction. A relay switch 25 is mechanically connected to and actuated by the switch 24 so that it is normally open but closes (when the switch 24 opens) upon any failure or interruption of the power circuit. The switch 25 is included in an auxiliary electric circuit with a storage battery 26, or other suitable source of electric energy, a manually operated switch 27, and the relay winding 28 of a magnetic switch 29. The magnetic switch 29 is included in a second auxiliary electric circuit, which includes the switch 27, the battery 26 and a motor or equivalent electro-magnetic motive means 30.

The motor 30 is operatively connected, by a thruster mechanism 30a and linkage 30b to a lever or equivalent mechanism 31 for actuating an air control valve 32 included in a pipe 33 connected to the high pressure pipe line 18. The motor 30 and associated thruster mechanism may be built together as a unit. The valve 32 controls the supply of compressed air from the pipe 33 to the pneumatic cylinder or motor 34 having a movable piston or equivalent member 35 operatively connected to a pusher rod 36 for operating the main air-valve 19 and the tuyère valves 21. When the air control valve 32 is closed as in Fig. 1, the piston 35 is biased to its lower position (as diagrammatically illustrated in Fig. 1), with the rod 36 in its normal operating position, by means of a compression spring 37. The main air valve 19 and the tuyère valves 21 then are in their respective normal operating positions connecting the pipe line 18 to the compartments 20 and the compartments 20 to their respective co-operating feed pipes 10. When the control valve 32 is open as in Fig. 3, high pressure air is admitted to the cylinder 34 and the resulting movement of the piston 35 actuates the rod 36 (upwardly as shown in the drawing). Arms 38 on the rod 36 thereupon move the valve actuating lever 39 of the main valve 19 and similar levers 40 of the tuyère valves 21 to close the main air valve (disconnecting the pipe line 18 from the compartments 20) and to move the tuyère valves to their emergency positions in which the tuyères are directly connected to the reservoir 17.

The main valve 19 is provided with a catch 41 which engages with a latch 42 when this valve is

thrown to its emergency position. The tuyère valves 21 are provided with corresponding catches 43 and latches 44. These catches and latches hold the main and tuyère valves in their emergency position when once they are so thrown, and insure against accidental return of any of the valves to their normal operating positions.

The operation of the appliance is as follows:

With the tuyères blowing compressed air and fuel (from the feed pipes 10) and combustion air (from the bustle pipe 12) into the body of molten slag, or the like, in the furnace, the appliance is in its normal operating position diagrammatically illustrated in Fig. 1. Upon an interruption or failure of the power circuit 23, the switch 25 immediately closes the auxiliary electric circuit including the battery 26 and relay winding 28, thereby closing the magnetic switch 29 and connecting the motor 30 to the battery 26. The motor 30, through the lever 31, moves the air control valve 32 to connect the cylinder 34 to the receiver 17, and the resultant movement of the piston 35 and rod 36 closes the main air valve 19 and moves the tuyère valves 21 to their emergency positions directly connecting the tuyères to the reservoir 17. The emergency position of the appliance is illustrated in Fig. 2. The high pressure air directly supplied to the tuyères prevents molten slag running back into the tuyères, and a sufficient reserve of the high pressure air is available from tank 17 to meet any normal power interruption. During the period of the emergency the check valve 16 operates to disconnect the bustle pipe 12 from the furnace. The motor 30 may also, if necessary, shut off the coal feeding apparatus by actuating a switch for stopping the motor that runs it. When the supply of power is resumed, the switches 25 and 29 open, as in Fig. 1 thereby de-energizing the motor 30 and permitting the control valve 32 to return to its normal or open position. The return of the valve 32 to its normal position releases the air pressure on the piston 35, enabling the spring 37 to return the piston 35 and pusher rod 36 to their normal operating positions, following which the main air valve 19 and tuyère valves may be reset manually in their normal operating positions (Fig. 1).

In the case of a large furnace, the emergency connection of the tuyères directly to the compressed air reservoir must be effected immediately and automatically upon the interruption of power, since a delay of even a few seconds may cause such damage as to require a furnace shut-down of several hours. The restoration of the appliance to its normal operating position, when power is resumed, requires no special haste, and hence may be effected by manual operation of latches 42 to 44 inclusive. The switch 27 is used to open the auxiliary circuits when the furnace is shut down for repairs.

We claim:

1. The combination with a furnace having tuyères, an air-fuel compartment normally connected to said tuyères for blowing air and fuel therethrough into a molten charge in the furnace, a source of compressed air normally connected to said compartment, and a source of power for providing the compressed air, of means responsive to interruptions of said power source for disconnecting said reservoir from said compartment and directly connecting said tuyères to the reservoir whenever the supply of power is interrupted.

2. The combination with a furnace having tuyères, an air-fuel compartment, a source of compressed air, and a source of power for provid-

ing the compressed air, of means including a main valve for connecting said source of compressed air to said compartment, means including a tuyère valve for selectively connecting the tuyères to either said compartment or directly to said source of compressed air, and means responsive to interruptions of said power source for closing said main valve to disconnect the source of compressed air from said compartment and for actuating said tuyère valve to connect said tuyères directly to said reservoir whenever the supply of power is interrupted.

3. The combination with a furnace having tuyères, an air-fuel compartment, a source of compressed air, and a source of power for providing the compressed air, of means including a main valve for connecting said source of compressed air to said compartment, means including a tuyère valve for connecting the tuyères to either said compartment for normal operation or directly to said compressed air source for emergency operation, and means responsive to an interruption of power from said source for closing said main valve to disconnect said compartment from said compressed air source and for actuating said tuyère valve to connect said tuyères directly to said compressed air source.

4. The combination with a furnace having tuyères, an air-fuel compartment, a source of compressed air, and a source of power for providing the compressed air, of means including a main valve for connecting said source of compressed air to said compartment, means including a tuyère valve for connecting the tuyères either to said compartment for normal operation or directly to said compressed air source for emergency operation, valve operating means for simultaneously closing said main valve to disconnect the source of compressed air from said compartment and for positioning said tuyère valve for emergency operation, and electrically operated means connected with said source of power for actuating said valve operating means upon interruption of power from said power source.

5. The combination with a furnace having tuyères, an air-fuel compartment, a source of compressed air, and a source of power for providing the compressed air, of means including a main valve for connecting said source of compressed air to said compartment, means including a tuyère valve for connecting the tuyères either to said compartment for normal operation or directly to said compressed air source for emergency operation, and means operatively associated with said source of power for automatically closing said main valve to disconnect said compartment from said compressed air source and for actuating said tuyère valve to connect said tuyères directly to said reservoir whenever power from the power source is interrupted.

6. The combination with a furnace having tuyères, an air-fuel compartment, a source of compressed air, and a source of electric power for providing the compressed air, of means including a main valve for connecting said source of compressed air to said compartment, means including a tuyère valve for selectively connecting the tuyères either to said compartment or to said compressed air source, and means operatively associated with said source of power and said valves and operated by an independent source of electric energy for immediately and automatically closing said main valve to disconnect said compartment from said compressed air source and for actuating said tuyère valve to con-

nect said tuyères directly to said reservoir whenever the supply of power from said power source is interrupted.

7. The combination with a furnace having tuyères, an air-fuel compartment, a source of compressed air normally connected to said compartment, and a source of electric power for providing the compressed air, of a main valve for connecting and disconnecting said source of compressed air to said compartment, a tuyère valve between said tuyères and said compartment for selectively connecting the tuyères either to said compartment or directly to said compressed air source, electrically operated means operatively associated with said source of power and said valves for simultaneously actuating said main valve to disconnect said compartment from said compressed air source and operating said tuyère valve to connect said tuyères directly to said compressed air source whenever the supply of power from said power source is interrupted, and restoring the normal connection between said compressed air source and said compartment and the normal connection of said tuyères to said compartment when the supply of power from said source is resumed.

8. The combination with a furnace having tuyères, an air-fuel compartment, a source of compressed air, and a source of electric power for providing the compressed air, of means including a main valve for connecting said compressed air source to said compartment, means including a tuyère valve for selectively connecting the tuyères either to said compartment or to said compressed air source, said valves being arranged to be moved to either of two operating positions in the first of which the main valve is open to connect said compartment to said compressed air source and the tuyère valve connects the tuyères to said compartment and in the second of which the main valve is closed and the tuyère valve connects the tuyères to said compressed air source, and electrically operated means responsive to interruptions of power from said power source for causing said valves to move to their aforesaid second positions whenever the supply of power is interrupted and to be returned to their aforesaid first positions when the supply of power is resumed.

9. The combination with a furnace having tuyères, an air-fuel compartment, a source of compressed air, and a source of electric power for providing the compressed air, of means including a main valve for connecting said compressed air source to said compartment, means including a tuyère valve for selectively connecting the tuyères either to said compartment or to said compressed air source, said valves being arranged to be moved to either of two operating positions in the first of which the main valve is open to connect said compartment to said compressed air source and the tuyère valve connects the tuyères to said compartment and in the second of which the main valve is closed and the tuyère valve connects the tuyères directly to said compressed air source, valve moving means for moving said valves from said first position to said second position, an auxiliary electric circuit including a source of electric energy and an electromagnetic switch for opening and closing the circuit, means operatively associated with said source of power for causing said switch to close said auxiliary circuit whenever the supply of power is interrupted and to open said circuit when the supply of power is resumed, and electromotive means included in

said circuit and operatively connected to said valve moving means and adapted when energized by the closing of said circuit to actuate said valve moving means to move said valves to their aforesaid second positions.

10. The combination with a furnace having tuyères, an air-fuel compartment, a source of compressed air, and a source of electric power for providing the compressed air, of means including a main valve for connecting said compressed air source to said compartment, means including a tuyère valve for selectively connecting the tuyères either to said compartment or to said compressed air source, said valves being arranged to be moved to either of two operating positions in the first of which the main valve is open to connect said compartment to said compressed air source and the tuyère valve connects the tuyères to said compartment and in the second of which the main valve is closed and the tuyère valve connects the tuyères directly to said compressed air source, valve moving means for moving said valves from said first position to said second position, pneumatic means including a control valve for actuating said valve moving means to move said valves to their aforesaid second positions, an auxiliary electric circuit including a source of electric energy and an electromagnetic switch for opening and closing the circuit, means operatively associated with said source of power for causing said switch to close said circuit whenever the supply of power is interrupted and to open said circuit when the supply of power is resumed, and electromotive means included in said circuit and operatively connected to said con-

trol valve and adapted when energized by the closing of said circuit to actuate the control valve and thereby cause said valve moving means to move said main and tuyère valves to their aforesaid second positions.

11. The combination with a furnace having tuyères, an air-fuel compartment, a source of compressed air, and a source of electric power for providing the compressed air, of means including a main valve for connecting said compressed air source to said compartment, means including a tuyère valve for selectively connecting the tuyères either to said compartment or to said compressed air source, said valves being arranged to be moved to either of two operating positions in the first of which the main valve is open to connect said compartment to said compressed air source and the tuyère valve connects the tuyères to said compartment and in the second of which the main valve is closed and the tuyère valve connects the tuyères to said compressed air source, electrically operated means responsive to interruptions of power from said power source for causing said valves to move to their aforesaid second positions whenever the supply of power is interrupted but permitting the valves to be returned to their aforesaid first positions when the supply of power is resumed, and latch means for holding said valves in their aforesaid second positions, upon their being caused to move to such positions by said electrically operated means, until said latch means are released.

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