

June 6, 1939.

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2,160,968

FAN SYSTEM

Filed Aug. 12, 1936

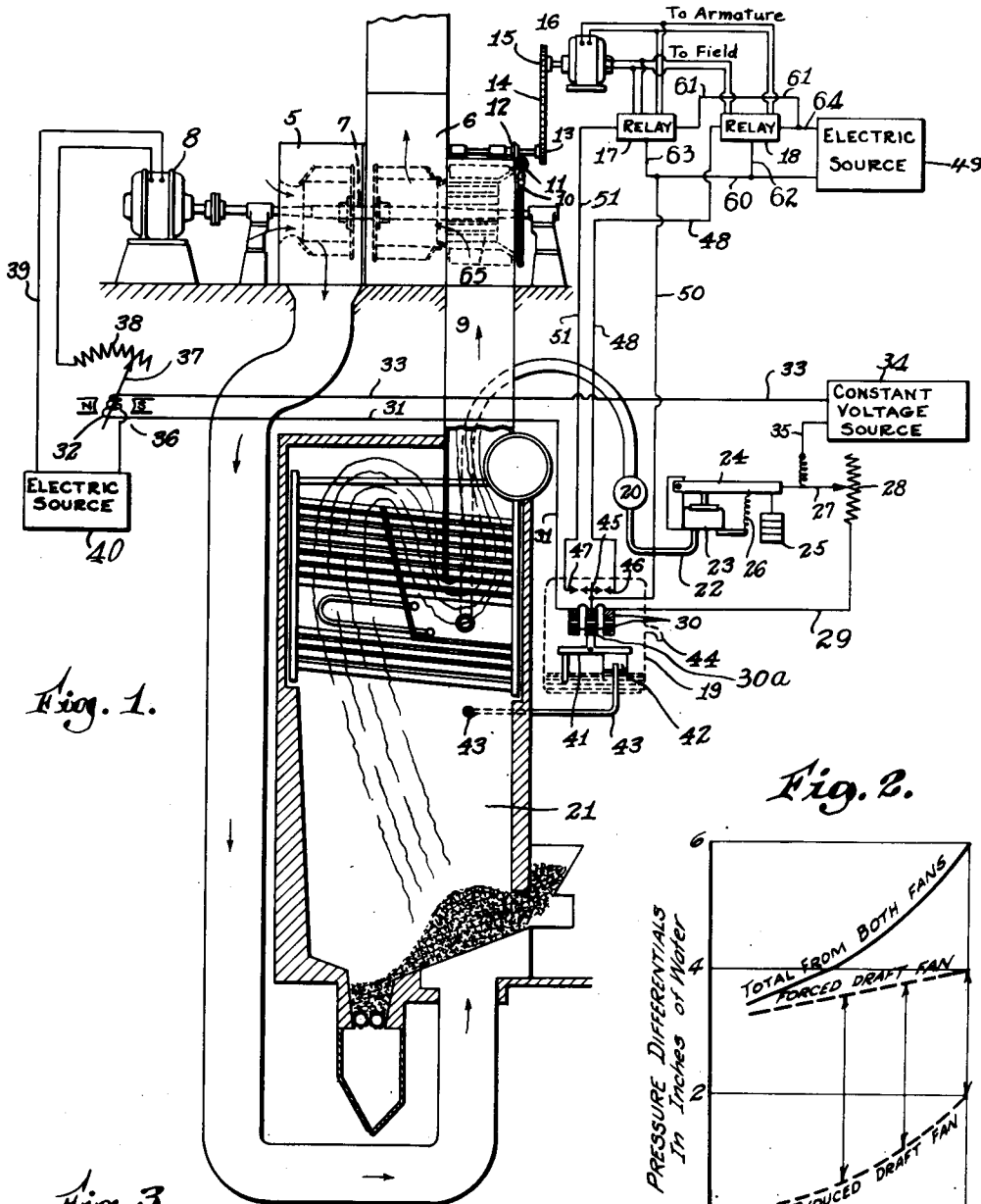


Fig. 1.

Fig. 2.

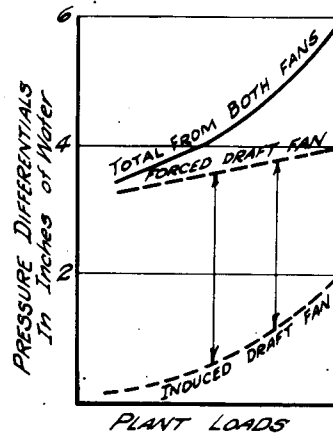
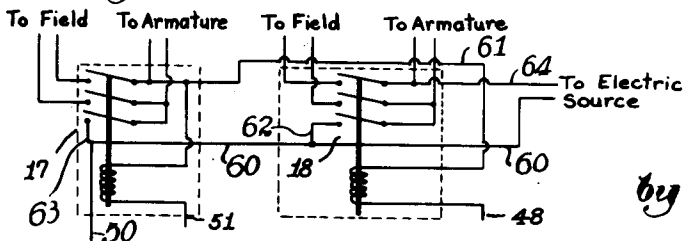


Fig. 3.



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2,160,968

FAN SYSTEM

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Application August 12, 1936, Serial No. 95,675

11 Claims. (Cl. 110—162)

This invention relates to fan systems and relates more particularly to a fan system providing forced and induced draft in balanced relationship.

5 Steam power plants use forced draft fans for supplying air under pressure to the burners for combustion, and use separate induced draft fans usually spaced a substantial distance from the forced draft fans for drawing the furnace gases through the heat exchangers and for discharging the exhaust gases from the stack. The forced draft fan usually takes care of the air resistance of a steam plant as far as the top of the fuel bed. The induced draft fan usually takes care of the resistance from the fire box through the boiler and economizer. In a typical steam plant for a given plant load and corresponding air volume, a pressure corresponding to 4 inches of water may be provided by the forced draft fan and a static suction corresponding to 2 inches of water may be provided by the induced draft fan. The pressure drop or pressure differential through the plant in such a case is 6 inches of water of which 4 inches is provided by the forced draft and 2 inches is provided by the induced draft fan.

For different plant loads, different quantities of fuel are burned and different volumes of air are required for efficient combustion. For supplying different air volumes into the combustion chamber, different pressures are required from the forced draft fan, and different static suctions are required from the induced draft fan for drawing the air with the products of combustion from the chamber. The characteristics of a steam plant are such however, that the proportions of the pressure differential required from the two fans for different loads and air volumes, are not constant. As the plant load decreases and the volume of air required for efficient combustion is conformably decreased, the proportion of the pressure differential required from the forced draft fan increases and the proportion required from the induced draft fan decreases. This is due to adjustment of fuel burning and associated apparatus at reduced loads which result in greater forced draft requirements.

According to this invention, a forced draft fan and its associated induced draft fan are mounted on a single shaft and both are driven by a single motor. Among the advantages of this arrangement are: less space is required; smaller and cheaper foundations may be used; two bearings, two pedestals and one coupling may be eliminated; the flue arrangement may be simplified,

and the first cost and cost of maintenance are less.

It is desired to vary the volumes of air supplied to the plant conformably with changes in the load on the plant by adjusting the pressures supplied by the forced draft fan. This may be accomplished, for example, by varying the speed of the single motor driving both fans to provide the pressure required from the forced draft fan. But, as explained in the foregoing, the proportions of the pressure differential required from the forced draft fan and from the induced draft fan for overcoming the plant resistance, vary with the total air volume. For a given air volume which may be, for example, the maximum air volume to correspond to the maximum plant load, the fans may be designed to exactly handle their duties without adjustment of either. But, for loads below the maximum, the proportion of the pressure differential required from the forced draft fan is reduced a smaller percentage than that required from the induced draft fan, with the result that if the fans are operated so that the pressures required from the forced draft fan are supplied for air volumes below the maximum, the induced draft fan will operate to produce too great a suction in the combustion chamber.

In one embodiment of this invention, a forced draft fan and a matched induced draft fan are rotated by a single motor, and the volumes of air provided by operation of the fans are varied conformably with the load on the steam plant by adjusting the speed of the motor driving both fans, in accordance with the pressure requirements from the forced draft fan. As a result of the difference in the requirements from the two fans at reduced loads, when the total volume is decreased in accordance with the requirements from the forced draft fan, the induced draft fan tends to create too great a suction, and to compensate for this, adjustable spin inducing vanes are provided in the inlet of the induced draft fan, which vanes are adjusted to decrease the effect of the induced draft fan upon the gases it handles so as to maintain the negative pressure or furnace draft in the combustion chamber within the desired limits.

An object of the invention is to mount the wheels of a forced draft and of an induced draft fan on a single shaft.

Another object of the invention is to compensate for the difference in the requirements by a steam plant at different loads, from forced and induced draft fans driven by a single motor.

Another object of the invention is to drive in a

steam plant, similarly rated forced and induced draft fans at the same speed; to adjust the total volume of air provided by the operation of the fans, in accordance with the plant requirements from the forced draft fan at different loads, and to independently adjust the effect of the induced draft fan upon the gases it handles to compensate for the difference in the requirements by the plant from the forced draft and induced draft fans at different loads.

Other objects of the invention will be apparent from the following description taken together with the drawing.

The invention will now be described with reference to the drawing, of which:

Fig. 1 is a diagrammatic view of a fan system with controls embodying this invention;

Fig. 2 is a chart illustrating the requirements of the steam plant of Fig. 1 from the forced draft fan and from the induced draft fan at different plant loads, and

Fig. 3 is a circuit scheme illustrating relay switching for reversing the vane adjusting motor of the induced draft fan.

Referring first to the chart of Fig. 2, the abscissa entitled "Plant loads" represents the loads under which it is expected the steam plant of Fig. 1 will be operated. The ordinate entitled "Pressure differentials" represents the pressure differentials required by the plant from the two fans at different plant loads. The curve entitled "Total from both fans" represents the pressure differentials required by the plant from both fans at different plant loads. The curve entitled "Forced draft fan" represents the pressure differentials required by the plant from the forced draft fan at different plant loads. The curve entitled "Induced draft fan" represents the pressure differentials required by the plant from the induced draft fan at different plant loads. For the purpose of illustration, at the maximum plant load, the forced draft fan is shown to provide 4 inches and the induced draft fan to provide 2 inches, of a total of 6 inches of pressure differential required for providing the volume of air required to efficiently burn the fuel supplied to the plant.

Under lighter loads, less fuel is burned, reduced volumes of air and lower pressure differentials are required. But, for reduced loads the forced and induced draft fans do not provide the same proportions of the pressure differentials through the plant that they do at maximum plant load. The chart of Fig. 2 shows that for loads below the maximum, the forced draft fan is required to provide greater proportions and the induced draft fan is required to provide less proportions of the pressure differentials. If the total volume is adjusted in accordance with forced draft requirements as is preferred, without independent adjustment of the induced draft fan, the induced draft fan would be operated to produce too great a suction in the combustion chamber. This invention provides broadly for adjusting the air volume supplied to the plant, in accordance with the requirements by the plant and for adjusting the volume handled by one of the fans for compensating for the difference in the proportions of the pressure differential required by the plant from the two fans at different loads, and provides specifically for adjusting the air volume supplied to the plant, in accordance with the forced draft requirements at different loads, and for additionally adjusting the suction of the induced draft fan for compensating for

the reduced duty required from it at the reduced loads. In other words, this invention provides for causing the performances of the two fans to follow the two lower curves of Fig. 2 to overcome their tendency to follow curves which would be substantially equidistant along their lengths.

In the embodiment illustrated, the changes in plant load cause the forced draft fan to provide the pressure differentials along the curve entitled "Forced draft fan" for providing variable volumes of air for forced draft. A suction control preferably mounted in the combustion chamber then causes the induced draft fan to provide the pressure differentials along the curve entitled "Induced draft fan".

The forced draft fan 5, without inlet vanes, is preferably of the general type disclosed by my Patent No. 1,989,413 with a single inlet. The induced draft fan 6 with inlet vanes 65 is preferably similar to the one disclosed by my Patent No. 1,846,863 with the exception that in the present case, a fan with a single inlet is illustrated. The two fans 5 and 6 have their wheels mounted for rotation upon the same shaft 7, which is rotated by the variable speed electric motor 8.

Mounted within the inlet chamber 9 of the induced draft fan 6 are the adjustable vanes 65, the function, arrangement and adjustment of which, are identical with the disclosure of my said Patent No. 1,846,863, and so will not be described in detail here. It is believed sufficient to state that the cranks and links etc., indicated generally by 10 are adjusted by the rotation of the gear 11, corresponding to the gear indicated by 48 in my said patent. The gear 11 is in turn rotated by the gear 12 mounted on the same shaft as the gear 13 which is rotated by the gear 15, mounted on the shaft of the motor 16, through the intermediary of the chain or belt 14. Rotation of the armature of the motor 16 in one direction adjusts the vanes 65 towards their full open position and rotation of the armature in the other direction adjusts the vanes towards their closed position. The operation and direction of rotation of the motor 16 are controlled by the relays 17 and 18 which in turn are controlled by the furnace pressure controller indicated generally by 19, as will be explained in more detail in the following.

The header 20 of the steam plant indicated generally by 21 is connected by the pipe 22 to the pressure chamber 23 which acts upon increases in pressure to move the lever arm 24 against the force of the weights 25 and spring 26, upwardly to cause its contact 27 to adjust the value of the resistance 28 in the circuit including the wire 29, the three solenoid coils 30 of the furnace pressure controller 19, the wire 31, the armature 32 of the galvanometer indicated generally by 36, the wire 33, the constant voltage source 34 and the wire 35.

A diaphragm of the chamber 23 raises and lowers the lever 24 in accordance with changes in the steam pressure in the header 20, which are a measure of the boiler load. As the load decreases and the pressure increases, more of the resistance 28 is placed in the above described circuit causing a decreased current to flow through the solenoids 30 and the coil 32 of the galvanometer 36.

This causes the coil 32 to adjust the contact arm 37 to increase the volume of the resistor 38 included in the circuit including the arm 37, the resistor 38, the wires 39, the motor 8 and the electric source 40. This causes the motor 8 to

operate at a lower speed so as to drive the fans 5 and 6 at reduced speeds.

The furnace pressure controller 19 is preferably similar to that disclosed in U. S. Patent No. 1,870,984 to Edward S. Bristol, and illustrated in detail by Figs. 2 and 3 thereof. As shown by Fig. 1 hereof, the pivoted lever 41 has mounted upon an upright extension, the movable magnetic coil 30a. The lever 41 has mounted at one end on its underside the bell 42, the interior of which communicates through the pipe 43 with the combustion chamber of the boiler. Air, at atmospheric pressure is introduced through the pipe 44 to the exterior of the bell. As explained in said patent to Bristol, the position of the movable coil 30a will depend upon the strength of current flow through the coils and upon the difference in pressure between the upper and lower sides of the lever 41. The upper side of the lever is exposed through the pipe 44 to atmospheric pressure which may be assumed to be constant so that the conflicting forces acting to unbalance the lever 41 are the suction in the bell 42 caused by the furnace draft, and the current flow through the coils caused by changes in plant load. The lever 41 carries the contact 45, which when the forces exerted by the bell 42 and the solenoids 30 and 30a are balanced, is midway between the contacts 46 and 47. When the forces are unbalanced, the contacts carried by the arm 45 will contact with one or the other of the contacts 46 and 47, causing one or the other of the relays 17 and 18 to become energized to cause the motor 16 to adjust the inlet vanes of the induced draft fan 6 to restore the balanced condition between furnace draft and load by adjusting the suction in the combustion chamber.

The current flow through the solenoid coils 30 and 30a varies with the boiler load and it is desired to adjust the air volume through the furnace accordingly. Too great an increase in the furnace vacuum caused by too great a suction being applied by the induced draft fan 6, causes the force exerted by the bell 42 to overcome the opposing force caused by the current flow through the solenoids 30 and 30a, and the lever 41 tilts to the right (facing the drawing) causing the circuit including the contact 46, the contact on the arm 45, the wire 48, the solenoid of the relay 18, the electric source 49 and the wire 50 to be completed causing the solenoid of the relay 18 to close circuits to connect the armature and field of the motor 16 together and to the current source 49 to cause the motor to rotate in a direction to adjust the vanes in the inlet chamber 9 of the induced draft fan 6 towards closed position. The motor will rotate until the vanes are adjusted to cause the proper decreased vacuum in the combustion chamber.

Too small a suction in the combustion chamber results in the force caused by the current flow through the solenoids 30 being greater than the force exerted by the bell 42 so that the lever 41 tilts to the left causing the circuit including the contact 47, the wire 51, the relay 17, the electric source 49, the wire 50 and the contact 45 to be closed causing the relay 17 to become energized and the relay 18 to become deenergized. The relay 17 then closes contacts as shown by Fig. 3, connecting the armature and field of the motor 16 to the source 49 but in reverse relation to each other so that the motor 16 rotates in reversed direction to adjust the vanes in the inlet chamber 9 of the induced draft fan

6 towards their open position. The motor will again continue to adjust the vanes until the proper vacuum is established in the combustion chamber.

The motor control mechanism comprising the constant voltage source 34, the chamber 23, lever 24 and resistance 28, as well as the furnace pressure controller 19 may be of the well known type manufactured by the Leeds & Northrup Company, and described in their Bulletin No. 660.

While, one embodiment of the invention has been described for the purpose of illustration, it should be understood that the invention is not limited to the exact arrangement described, since many departures will suggest themselves to those skilled in the art, after having had access to this disclosure.

What is claimed is:

1. A steam plant comprising in combination, a combustion chamber, a forced draft fan for forcing air into said chamber, a matched induced draft fan for drawing the exhaust gases from said chamber, a single shaft supporting the wheels of both of said fans, a motor for rotating said shaft, means for adjusting the speed of said motor in accordance with the load on said plant, spin inducing vanes in the inlet to said induced draft fan, and means for adjusting said vanes to vary the suction of said induced draft fan in accordance with changes in the suction in said chamber.

2. A steam plant comprising in combination, a combustion chamber, forced draft fan for forcing air into said chamber, a matched induced draft fan for drawing the exhaust gases from said chamber, a single shaft supporting the wheels of both of said fans, a motor for rotating said shaft, means responsive to changes in the load on said plant for adjusting the speed of said motor in accordance with the load on said plant, spin inducing vanes in the inlet to said induced draft fan, and means for adjusting said vanes to vary the suction of said induced draft fan in accordance with changes in the suction in said chamber.

3. A steam plant comprising in combination, a combustion chamber, a forced draft fan for forcing air into said chamber, a matched induced draft fan for drawing the exhaust gases from said chamber, a single shaft supporting the wheels of both of said fans, a motor for rotating said shaft, means responsive to changes in the load on said plant for adjusting the speed of said motor in accordance with the load on said plant, spin inducing vanes in the inlet to said induced draft fan, and means responsive to pressure in said chamber for adjusting said vanes to vary the suction of said induced draft fan in accordance with changes in the suction in said chamber.

4. A fan system for a steam plant adapted to be operated under different loads and including a boiler having a combustion chamber adapted to receive air volumes varying conformably with said loads comprising in combination, a forced draft fan for supplying air into said chamber, an induced draft fan for drawing the air with the products of combustion through said plant, the wheels of said fans being mounted on a common shaft, said fans cooperating to provide variable pressure differentials for moving variable volumes of air through said plant, the proportions of the pressure differentials required by said plant from said induced draft fan decreas-

ing more than the proportions required from said forced draft fan for decreasing plant loads, means for varying the pressure differential provided by said fans, means responsive to a change in the plant load for actuating said last mentioned means, volume control means in the inlet to one of said fans, and means including means responding conformably to changes in pressure in said chamber for adjusting said volume control means to provide the pressure differential required from said one of said fans by said plant by said change in load.

5. A fan system for a steam plant adapted to be operated under different loads and including a boiler having a combustion chamber adapted to receive air volumes varying conformably with said loads comprising in combination, a forced draft fan for supplying air into said chamber, an induced draft fan for drawing the air with the products of combustion through said plant, the wheels of said fans being mounted on a common shaft, said fans cooperating to overcome the resistance of said plant for moving variable volumes of air therethrough, the suctions required by said plant from said induced draft fan decreasing more in proportion than the pressures required from said forced draft fan for decreasing plant loads, means for varying the pressure provided by said forced draft fan for varying the volume of air supplied into said chamber, means responsive to a change in the plant load for actuating said last mentioned means, volume control means in the inlet to said induced draft fan, and means including means responding conformably to changes in suction in said chamber for adjusting said volume control means to provide the suction required from said induced draft fan by said plant by said change in load.

6. A fan system for a steam plant adapted to be operated under different loads and including a boiler having a combustion chamber adapted to receive air volumes varying conformably with said loads comprising in combination, a forced draft fan for supplying air into said chamber, an induced draft fan for drawing the air with the products of combustion through said plant, the wheels of said fans being mounted on a common shaft, said fans cooperating to provide variable pressure differentials for moving variable volumes of air through said plant, the proportions of the pressure differentials required by said plant from said induced draft fan decreasing more than the proportions required from said forced draft fan for reduced plant loads, means for varying the pressure differential provided by said fans, means responsive to a change in the plant load for actuating said last mentioned means, spin inducing vanes in the inlet to one of said fans, and means including means responding conformably to changes in pressure in said chamber for adjusting said vanes to provide the pressure differential required from said one of said fans by said plant by said change in load.

7. A fan system for a steam plant adapted to be operated under different loads and including a boiler having a combustion chamber adapted to receive air volumes varying conformably with said loads comprising in combination, a forced draft fan for supplying air into said chamber, an induced draft fan for drawing the air with the products of combustion through said plant, the wheels of said fans being mounted on a common shaft, said fans cooperating to overcome the resistance of said plant for moving variable vol-

umes of air therethrough, the suctions required by said plant from said induced draft fan decreasing more in proportion than the pressures required from said forced draft fan for decreasing plant loads, means for varying the pressure provided by said forced draft fan for varying the volume of air supplied into said chamber, means responsive to a change in the plant load for actuating said last mentioned means, spin inducing vanes in the inlet to said induced draft fan, and means including means responding conformably to changes in suction in said chamber for adjusting said vanes to provide the suction required from said induced draft fan by said plant by said change in load.

8. A fan system for a steam plant adapted to be operated under different loads and including a boiler having a combustion chamber adapted to receive air volumes varying conformably with said loads comprising in combination, a forced draft fan for supplying air into said chamber, an induced draft fan for drawing the air with the products of combustion through said plant, the wheels of said fans being mounted on a common shaft, said fans cooperating to provide variable pressure differentials for moving variable volumes of air through said plant, the proportions of the pressure differentials required by said plant from said induced draft fan decreasing more than the proportions required from said forced draft fan for decreasing plant loads, means for varying the air volume supplied into said chamber by varying the total pressure differential provided by both of said fans to provide the pressure required by said plant from said forced draft fan, means responsive to a change in the plant load for actuating said last mentioned means, volume control means in the inlet to said induced draft fan, and means responding conformably to changes in pressure in said chamber for adjusting said volume control means to provide the pressure differential required from said induced draft fan by said plant by said change in load.

9. A fan system for a steam plant adapted to be operated under different loads and including a boiler having a combustion chamber adapted to receive air volumes varying conformably with said loads comprising in combination, a forced draft fan for supplying air into said chamber, an induced draft fan for drawing the air with the products of combustion through said plant, the wheels of said fans being mounted on a common shaft, said fans cooperating to provide variable pressure differentials for moving variable volumes of air through said plant, the proportions of the pressure differentials required by said plant from said induced draft fan decreasing more than the proportions required from said forced draft fan for reduced plant loads, means for varying the air volume supplied into said chamber by varying the total pressure differential provided by both of said fans to provide the pressure differential required by said plant from said forced draft fan, means responsive to a change in the plant load for actuating said last mentioned means, spin inducing vanes in the inlet to said induced draft fan, and means including means responding conformably to changes in pressure in said chamber for adjusting said vanes to provide the pressure differential required from said induced draft fan by said plant by said change in load.

10. A fan system for a steam plant having a combustion chamber, comprising a forced draft fan for forcing air into said chamber, an induced

draft fan for drawing the air with the products of combustion from said chamber, the wheels of said fans being driven by common means, means responsive to changes in the load upon said plant
5 for varying the pressures provided by said forced draft fan for varying the volumes of air supplied to said chamber, volume control means in the inlet of said induced draft fan, and means including means responding conformably to suction
10 changes in said chamber for adjusting said volume control means for varying the suction of said induced draft fan conformably with changes in the suction in said chamber.

11. A fan system for a steam plant having a
15 combustion chamber, comprising a forced draft

fan for forcing air into said chamber, an induced draft fan for drawing the air with the products of combustion from said chamber, the wheels of said fans being driven by common means, means responsive to changes in the load upon said plant
5 for varying the pressures provided by said forced draft fan for varying the volumes of air supplied to said chamber, spin inducing vanes in the inlet of said induced draft fan, and means including
10 means responding conformably to suction changes in said chamber for adjusting said spin inducing vanes for varying the suction of said induced draft fan conformably with changes in the suction in said chamber.

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