

UNITED STATES PATENT OFFICE.

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SMOKE-CONSUMING FURNACE.

SPECIFICATION forming part of Letters Patent No. 750,786, dated January 26, 1904.

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To all whom it may concern:

Be it known that I, JAMES A. WILLARD, a citizen of the United States, residing at Chattanooga, in the county of Hamilton and State of Tennessee, have invented new and useful Improvements in Smoke-Consuming Furnaces, of which the following is a specification.

This invention relates to a smoke-consuming furnace; and it has for its object to provide an improved automatic device of simple and relatively inexpensive construction for reducing the emission and effecting the consumption of smoke in steam-boiler furnaces and also for increasing the efficiency of steam-boilers by utilizing the gases which would otherwise in a large measure escape through the stack or chimney.

To these ends my invention consists in the features and in the construction, combination, and arrangement of parts hereinafter described, and particularly pointed out in the claims following the description, reference being had to the accompanying drawings, forming a part of this specification, wherein—

Figure 1 is a perspective view of a steam-boiler furnace equipped with my improved apparatus, portions thereof being shown in section. Fig. 2 is a detail sectional view, on an enlarged scale, of the valves for controlling the admission of and the eduction of steam to the cylinder. Fig. 3 is a similar view of the valve for controlling the admission of the unconsumed gases and atmospheric air to the rotary blower or fan.

In carrying my invention into practice I employ a pressure-blower, so arranged that it draws the gases and unconsumed products of combustion from the rear end of the boiler through an intake having an air-inlet valve automatically controlled and delivering the same to the under side of the fire in the combustion-chamber of the furnace. Thence it is forced through the fire, and the gases are ignited and consumed. Furthermore, I provide an automatic device for controlling the stack-damper, an air-valve, and a gas-valve, and sim-

ple and novel mechanism for automatically actuating said damper and valves.

Referring to the drawings, the numeral 1 indicates the steam-boiler, and 2 the boiler-furnace, both of which may be constructed in any usual well-known or preferred manner. The numeral 3 indicates the combustion-chamber of the furnace, in which are arranged grate-bars 4. The grate-bars are preferably hollow and are provided with lateral openings 5, for a purpose hereinafter explained. In rear of the fire-grate is a bridge-wall 6, as usual, and beneath the grate is an ash-pit 7, which is closed air-tight by a door 8.

The numeral 9 indicates a rotary blower of any suitable construction and driven from any suitable source of power. Leading from the blower 9 is an eduction-pipe 10, which is connected by branch pipes 11 to the hollow grate-bars. It is not necessary that all the grate-bars be hollow, as in the example herein illustrated I have shown only each alternate grate-bar as being made hollow, the intervening grate-bars being provided with apertures 12, through which the air, smoke, and gases which are conveyed to said hollow grate-bars are discharged.

Arranged in the rear end of the furnace, preferably in rear and near the top of the boiler, is an intake consisting of an inverted metallic trough-shaped casing 13, open at its bottom and extending transversely across the rear end of the furnace.

Connected to one end of the intake 13 is a suction-pipe 16, which communicates at its other end with a settling-chamber 16^a. The upper end of the suction-pipe 16 is provided with an air-inlet 14, which is controlled by a supplemental valve 15.

Leading from the settling-chamber 16^a is a pipe 16^b, which communicates with said settling-chamber intermediate the top and bottom of the latter, and said settling-chamber is provided at its lower end with a door 16^c, which is normally closed, but which may be opened for cleaning out the soot.

The pipe 16^b communicates at its other end with a combined air and gas feed casing 17, comprising a tubular section which is fitted at one end in the blower and at its other end to the suction-pipe 16^b.

Formed in the upper side of the tubular section or casing 17 is an aperture 18, over which is formed a flaring or bell-mouthed hood 19, which communicates at its outer end with the atmosphere. Pivoted to the tubular casing, at one side of the aperture, is a valve 20, which when raised to a horizontal position closes the aperture 18, so as to exclude the air and establish an unobstructed communication between the suction-pipe 16^b and the blower. When said valve is lowered, it rests on the bottom of the said section and shuts off communication between the suction-pipe 16^b and the blower and establishes communication between the latter and the atmosphere through the hood 19.

The valve 20 is mounted at one edge on a pintle 21, journaled transversely in the said section, and on the outer end of said pintle is fixed a crank-arm 22, weighted at its free end, as at 23, whereby said valve under normal conditions will be lowered, so as to shut off communication between the suction-pipe 16^b and the blower and open communication between the latter and the atmosphere.

The supplemental air-valve 15 before referred to is connected to a pivoted lever 24, the free end of which is weighted, as at 25, whereby said valve is normally held closed to exclude the atmosphere from the intake 13. To said free end of the lever 24 is connected one end of a cable 26, which passes around a guide-pulley 27 and is connected at its other end to a crank-arm 28.

Arranged in the stack 29 of the furnace is a damper-valve 30, which is mounted on a pivoted rod 31, which passes transversely through the stack and to one end of which is affixed a crank-arm 36.

To the crank-arm 28 is also attached a cable 32, which passes around a guide-pulley 33 and is connected to one end of a connecting-rod 34, the free end of which is attached to the weighted end of the crank-arm 22, before referred to. The end of the cable 32 is weighted, as at 35. Instead of attaching the cable 32 to the crank-arm 28 of the damper-valve it may be attached to the cable 26 at any suitable point between the guide-pulley 33 and said crank-arm 28.

To the free end of the crank-arm 36 is attached one end of a connecting-rod 37, the other end of which is attached to a piston-rod 38, provided at its lower end with a piston 39, which is adapted to reciprocate in a vertically-arranged cylinder 40. To the upper end of said cylinder is connected one end of a steam-pipe 41, the other end of which has fitted thereon a three-way valve 42, said valve being

connected to the steam-space of the boiler by a steam-pipe 43. Said three-way valve 42 is provided with a minute escape-aperture 42^a, which, when the valve is closed, operates to permit the steam to escape very slowly from the cylinder.

Fixed on the stem of the valve 42 is a lever 44, by means of which said valve may be turned to place the cylinder 40 in communication with the boiler and to cut it off therefrom.

The lever 44 projects downwardly in the path of a catch 45, formed on or attached to the furnace-door 46, that controls the feed-opening 47 of the furnace, the arrangement being such that when the door 46 is opened the catch 45 will oscillate or swing to one side of the lever 44, and thereby open the valve 42 in such manner as to place the cylinder 40 in communication with the steam-space of the boiler.

It is a fact of universal knowledge that the greatest amount of smoke is generated in a steam-boiler when the firing takes place and for several minutes thereafter. This is due to the gases being driven out of the fresh coal or coming in contact with the hot fire or coke-bed. When fresh coal is thrown into the furnace, it deadens the fire and prevents this gas from igniting, the result being that until the fire blazes up sufficiently to ignite such gases they pass up and out of the stack, producing dense smoke and resulting in the loss of heat that would otherwise be generated if such gases were burned. This result is avoided and the gases consumed and utilized in the following manner, the operation being entirely automatic and requiring no attention on the part of the furnace-stokers.

When the fire-door 46 is opened, it turns the lever 44 in the manner hereinbefore described and opens the valve 42, thus admitting steam into the cylinder 40 above the piston and the steam-pressure drives the piston down, and through the medium of the connecting-rod 37 the crank-arm 36 closes the damper-valve 30, preventing the escape of the hot gases and smoke through the stack. As the damper is closed the air and gas valve 20 is raised to nearly a horizontal position through the medium of the crank-arm 28, cable 32, and connecting-rod 34, thus excluding to a certain extent atmospheric air from the blower and establishing an unobstructed communication between said blower and the suction-pipe 16^b.

In practice the cable 32 is so connected to the rod 34 that when the damper 30 is closed the valve 20 will close only about three-quarters of the passage in which it is arranged. The smoke, hot gases, and unconsumed products of combustion will then be gathered into the intake 13 and the blower 9 will operate to withdraw said gases, smoke, and the like through the pipes 16, settling-chamber 16^a, pipe 16^b, and casing 17 and will discharge

the same through the pipes 10, 11, and 7 into and out of the hollow grate-bars and up through the fire, where they will be consumed, preventing the emission of dense smoke from the stack and utilizing the unconsumed products of combustion to aid in the generation of steam in the boiler. At the same time that the crank-arm 28 operates to raise the valve 20 in the manner described it also, through the medium of the cable 26 and lever 24, operates to raise the supplemental air-valve 15 from its seat, thereby admitting a quantity of air through the valve 14 into the suction-pipe 16, where it meets and mingles with the smoke, hot gases, and the like, and in its passage through the blower is thoroughly intermixed therewith, the smoke and gases being thus supplied with a sufficient amount of oxygen to secure perfect combustion.

When the fire-door 46 is closed, the lever 43 is turned to close the valve 42 to shut off the supply of steam from the steam-boiler to the cylinder 40, and when the valve is closed to this position the minute aperture 42^a permits the steam to escape slowly from the cylinder 40, whereupon the weights 23, 25, and 35 will operate to lower the valve 20 and close the valve 15 and will operate, through the medium of the cables 26 and 32 and the crank-arm 28, to open the damper-valve 30 in the stack and put the latter into free communication with the atmosphere. This will not occur, however, until after the elapse of two or three minutes after the fire-door has been closed, so that it will at least consume the period of time above mentioned to permit the weights above referred to to raise the piston 39 in the cylinder against the back pressure of the slowly-escaping steam. When this operation has been completed, the valve 20 will be in its lowermost position, and the blower 9 will then operate to draw in atmospheric air through the flaring hood 19 and deliver it through the pipes 10 and 11 to the hollow grate-bars, and from the latter to and through the fire, thus promoting the combustion of the fuel.

From the foregoing it will be observed that when the fire-door is opened to throw fresh coal on the fire the smoke and gases cannot escape through the stack, as the damper will be closed, and the gas-valve 20 is set so as to complete the passage-way from the intake to the blower, and the latter then drives said gases and smoke from the rear end of the furnace and delivers them into the hollow grate-bars, from which they are forced through the fire, where they are ignited and eventually consumed.

As before stated, the cable 32 is in practice so adjusted as to cause the valve 20 to simultaneously admit to the blower both air and furnace-gases in any proportion desired, the precise means for effecting this result being immaterial.

The blower is herein shown and described as discharging the air and gases into the fire-bed through the hollow grate-bars; but it will be obvious that these gases may be discharged directly into the ash-pit beneath a grate of ordinary construction.

In Fig. 1 of the drawings I have shown but a single fire-door, which controls but a single valve for admitting steam to the cylinder; but it will, of course, be understood that the furnace may be provided in the usual manner with a number of such doors, and in practice there will be provided as many valves 42 and levers 44 as there are fire-doors, there being one such valve and lever provided for each fire-door, whereby when any one of the fire-doors is opened the damper will be automatically closed and the air and gas valve 20 and the supplemental air-valve 15 will be automatically raised, so as to prevent the escape of the smoke and gases from the stack and cause the same to be fed to the combustion-chamber of the furnace.

In the passage of the smoke and gases from the suction-pipe 16 to the suction-pipe 16^b they enter the top of the settling-chamber 16^a and then pass downward to about the middle of said chamber to effect their passage through the pipe 16^b, and the soot and similar heavy materials will drop down to the bottom of said settling-chamber, from whence they may be removed from time to time through the door 16^c.

I do not wish to be understood as confining myself to the taking of the gases and smoke from the back part of the furnace or from the rear of the boiler, as they could be taken from the stack; but this last-named arrangement is open to the objection that the gases are apt to be chilled, and experience has proven that the best result is obtained by feeding the gases to the fire while they are in a hot condition.

Various alterations in the details of construction and arrangement of parts will suggest themselves to those skilled in the art, and I do not limit myself to such details, excepting as hereinafter specifically set forth in the appended claims.

Having described my invention, what I claim is—

1. In a furnace, the combination with a blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, a suction-pipe connecting the intake with the blower, a valve arranged in the suction-pipe and operating to control the connection between the blower and the intake and between the blower and the atmosphere, and means controlled by the movement of the fire-door for actuating said valve to regulate the admission of both air and furnace-gases to the fire, substantially as described.

2. In a furnace, the combination with a blower having a discharge-pipe leading to the furnace, of an intake for collecting the fur-

nace-gases, a suction-pipe connecting the intake with the blower, a valve in the suction-pipe arranged to control the communication between the blower and the intake and between
 5 the blower and the atmosphere, a damper in the furnace-stack, and means actuated by the opening movement of the fire-door for actuating said valve, substantially as described.

3. In a furnace, the combination with a
 10 blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, a suction-pipe connecting the intake with the blower, a valve in the suction-pipe arranged to control the communication
 15 between the blower and the intake and between the blower and the atmosphere, a damper in the furnace-stack, and means actuated by the opening movement of the fire-door for closing the damper in the stack and for turning
 20 the said valve to place the blower in communication with the intake and simultaneously cut off the admission of air to said valve, substantially as described.

4. In a furnace, the combination with a
 25 blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, a suction-pipe connecting the intake with the blower, a valve in the suction-pipe arranged to control the communication
 30 between the blower and the intake and between the blower and the atmosphere, a damper in the furnace-stack, means actuated by the opening movement of the fire-door for actuating said valve, and a supplemental valve
 35 for admitting air to the suction-pipe substantially as described.

5. In a furnace, the combination with a blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, a suction-pipe connecting the intake with the blower, a valve in the suction-pipe arranged to control the communication between the blower and the intake, means actuated by the movement of the fire-door for
 40 actuating said valve, a damper in the furnace-stack, and means actuated by the closing movement of the damper for automatically admitting air to the suction-pipe, substantially as described.

6. In a furnace, the combination with a blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, a suction-pipe connecting the intake with the blower, a valve in the suction-pipe arranged to control the communication
 55 between the blower and the intake, a damper in the furnace-stack, means actuated by the opening movement of the fire-door for turning said valve to establish communication between the blower and the intake, means for
 60 automatically turning said valve to cut off the intake from the blower when the damper is open, and means for retarding the opening movement of the damper, substantially as described.

7. In a furnace, the combination with a blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, a suction-pipe connecting the intake with the blower, a valve in the suction-pipe arranged to control the communication
 70 between the blower and the intake, a damper in the furnace-stack, a supplemental air-inlet valve in the suction-pipe, means actuated by the opening movement of the fire-door for simultaneously closing the damper and turning
 75 the valves to establish communication between the intake and the blower and admit air to the suction-pipe, and means for automatically turning said valves to shut off the intake
 80 from the blower and prevent the air from entering the suction-pipe through the supplemental air-valve when the damper is opened, substantially as described.

8. In a furnace, the combination with a
 85 blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, a suction-pipe connecting the intake with the blower, a valve in the suction-pipe arranged to control the communication
 90 between the blower and the intake and between the blower and the atmosphere, a damper in the furnace-stack, a supplemental air-inlet valve in the suction-pipe, means actuated by the opening movement of the fire-door for simultaneously closing the damper and turning
 95 the valves to admit air to the suction-pipe and place the blower in communication with said intake, and means for automatically turning the said valves to shut off the intake from the
 100 blower and place the blower in communication with the atmosphere and prevent the air from entering the suction-pipe through the supplemental air-valve when the damper is opened, substantially as described.

9. In a steam-boiler, the combination with a blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, a suction-pipe connecting the intake with the blower, a valve in the suction-pipe arranged to control the communication
 110 between the blower and the intake, a damper in the furnace-stack, a cylinder connected with the boiler, a piston in the cylinder, means actuated by the movement of the piston for controlling said damper and valve, and means
 115 actuated by the movement of the fire-door for putting the cylinder into and out of communication with the boiler, substantially as described.

10. In a steam-boiler furnace, the combination with a blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, a suction-pipe connecting the intake with the blower, a valve in the suction-pipe arranged to control the communication
 125 between the blower and the intake, a damper in the furnace-stack, an air-inlet valve in the suction-pipe, a cylinder connected with the boiler, a piston in the cylinder, means ac-

tuated by the movement of the piston for controlling said damper and valve, and means actuated by the movement of the fire-door for putting the cylinder into and out of communication with the boiler, substantially as described.

11. In a steam-boiler furnace, the combination with a blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, a suction-pipe connecting the intake with the blower and provided with an aperture opening to the atmosphere, a valve arranged to alternately open and close said aperture and open and close the communication between the blower and the intake, a damper in the furnace-stack, and means actuated by the movement of the fire-door for actuating said damper and valve, substantially as described.

12. In a steam-boiler furnace, the combination with a blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, a suction-pipe connecting the intake with the blower and provided with an aperture opening into the atmosphere, a flaring open-ended hood arranged over the end of the aperture, a valve arranged to alternately open and close said aperture and open and close the communication between the blower and the intake, a damper in the stack, and means actuated by the movement of the fire-door for actuating said damper and valve, substantially as described.

13. In a steam-boiler furnace, the combination with a blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, of a suction-pipe connecting the intake with the blower and provided with an aperture opening into the atmosphere, a valve arranged to alternately open and close said aperture and open and close the communication between the blower and the intake, a weighted arm normally holding said valve open to admit air, a damper in the furnace-stack, a crank-arm on the damper for turning the latter, a cylinder connected with the boiler, a piston in the cylinder, a valve controlling the communication between the cylinder and the boiler, a lever arranged to be turned to open the valve by the opening movement of the fire-door, a connection between the piston and damper for closing the latter when the fire-door is open, and a connection between the crank-arm on the damper and the said weighted arm for actuating the valve in the suction-pipe, substantially as described.

14. In a steam-boiler furnace, the combination with a blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, a suction-pipe connecting the intake with the blower and provided with an aperture opening into the atmosphere,

a valve arranged to alternately open and close said aperture and open and close the communication between the blower and the intake, a weighted arm normally holding said valve open to admit air to the blower, a damper in the furnace-stack, a crank-arm on the damper for turning the latter, a cylinder connected with the boiler, a piston in the cylinder, a valve controlling the communication between the cylinder and boiler, a lever arranged to be turned to open the valve by the opening movement of the fire-door, a connection between the piston and damper for closing the latter when the fire-door is open, a connection between the crank-arm on the damper and the said weighted arm for actuating the valve in the suction-pipe, a supplemental air-inlet valve in the suction-pipe, a weighted lever normally holding said valve closed, and a connection between said lever and the crank-arm on the damper for opening the supplemental air-inlet valve when the damper is closed, substantially as described.

15. In a furnace, the combination with a blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, a suction-pipe connecting the intake with the blower, a settling-chamber interposed in said suction-pipe between the intake and the blower, a valve arranged in the suction-pipe operating to control the connection between the blower and the intake and between the blower and the atmosphere, and means controlled by the movement of the fire-door for actuating said valve to regulate the admission of both air and furnace-gases to the fire, substantially as and for the purpose specified.

16. In a furnace, the combination with a blower having a discharge-pipe leading to the furnace, of an intake for collecting the furnace-gases, a suction-pipe connecting the intake with the blower, a settling-chamber interposed in said suction-pipe between the intake and the blower, the inlet portion of the suction-pipe communicating with the upper portion of the settling-chamber and the outtake portion of said suction-pipe communicating with said settling-chamber between its ends, a valve arranged in the suction-pipe and operatively controlling the connection between the blower and intake and between the blower and the atmosphere, and means controlled by the movement of a fire-door for actuating said valve to regulate the admission of both air and furnace-gases to the fire, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

JAMES A. WILLARD.

Witnesses:

C. TURNER,

MILTON RUSSELL.