No. 661,451. Patented Nov. 6, 1900.

A. G. JONES & C. H. PHILBROOK.

SMOKE CONSUMER.

(Application filed Apr. 18, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

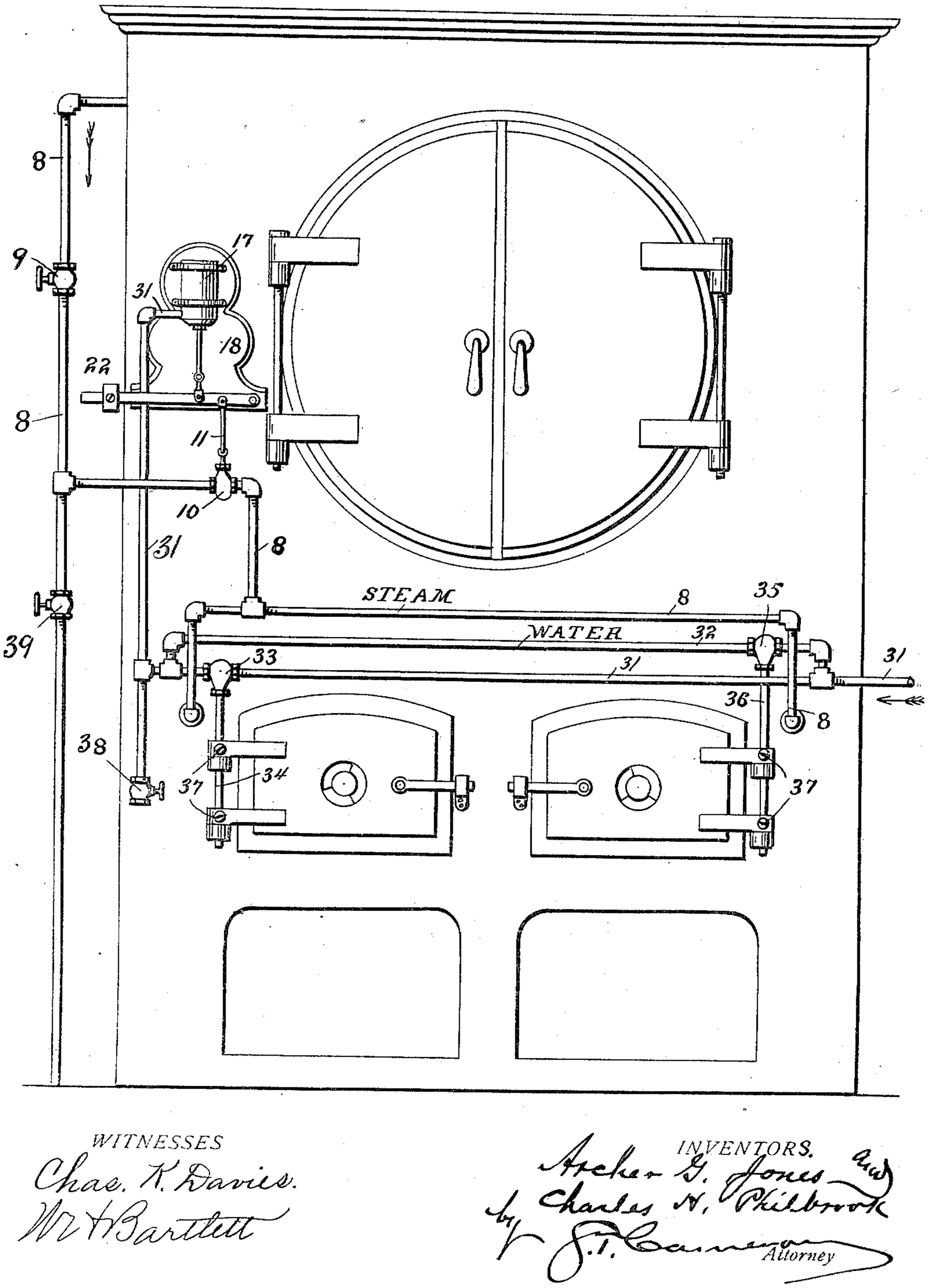

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Fig. 5.

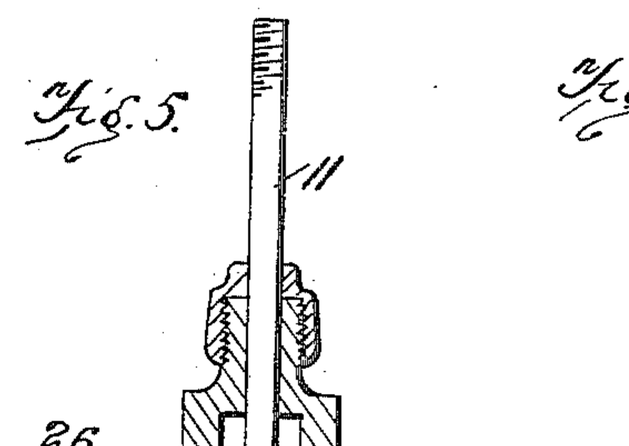

Fig. 6.

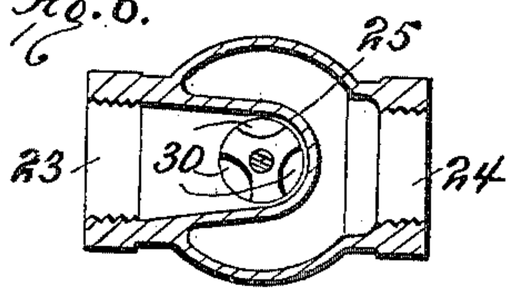

Fig. 4.

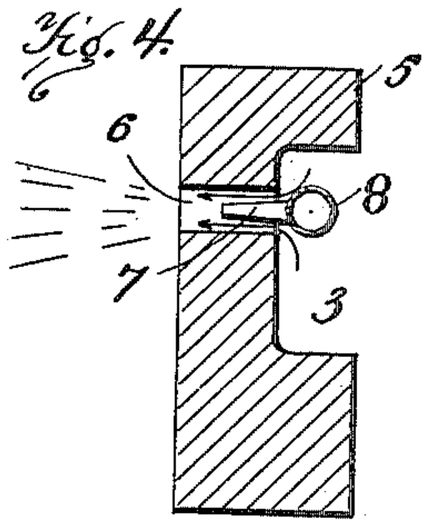

Fig. 7.

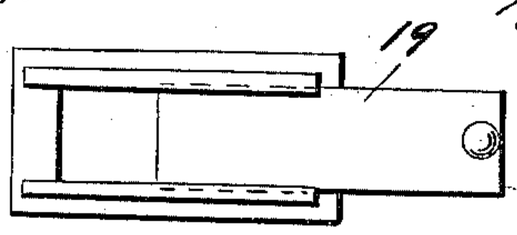

Fig. 8.

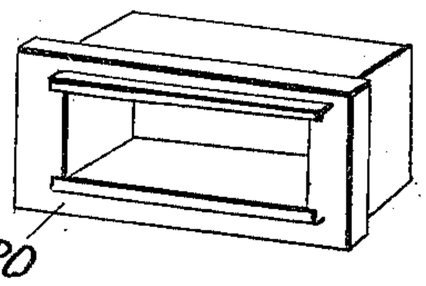

Fig. 3.

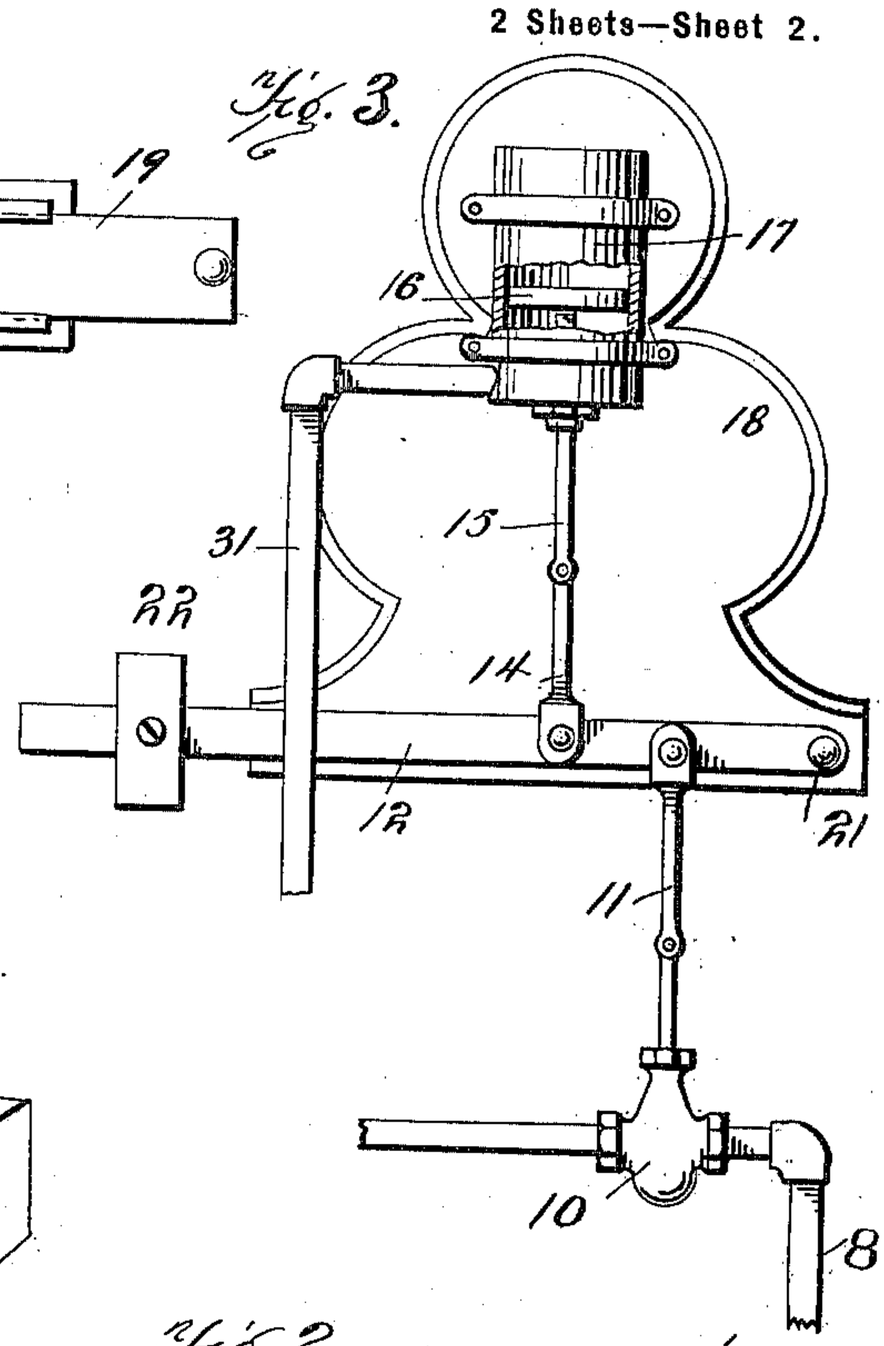

Fig. 2.

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UNITED STATES PATENT OFFICE.

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SMOKE-CONSUMER.

SPECIFICATION forming part of Letters Patent No. 661,451, dated November 6, 1900.

Application filed April 18, 1900. Serial No. 13,364. (No model.)

To all whom it may concern:

Be it known that we, ARCHER G. JONES, a resident of Richmond, State of Virginia, and CHARLES H. PHILBROOK, a resident of New York, State of New York, have invented a new and useful Improvement in Smoke-Consumers, which invention is fully set forth in the following specification.

Our invention relates to furnaces, and more particularly to devices designed to be employed with any desired form of furnace for the purpose of promoting complete combustion of the fuel, and thus preventing the formation of smoke. In devices of this character it has heretofore been proposed to automatically supply heated air or air and steam to the furnace-chamber simultaneously with each charge of fresh fuel and to automatically cut off such supply of air or air and steam after a predetermined time. Various means have been designed for heating the air and conducting it to the furnace-chamber, some of which are inefficient in operation while others are exceedingly expensive to construct originally or are of such a character that they necessarily deteriorate rapidly under the high heat to which they are subjected, thereby causing the expenditure of large sums for repairs and requiring the furnace to remain idle while such repairs are being made. With some classes of fuel—as bituminous coal, for example—large amounts of unconsumed carbon are carried off by the gases of combustion and emitted from the stack or chimney in dense clouds of smoke. The amount of unconsumed carbon thus given off is the greatest when the fuel is first placed on the fire, and as the coking action of the coal proceeds the amount of unconsumed carbon thus given off in the form of smoke becomes less and less until the coking action of the coal is completed, when it entirely ceases. Smoke-consuming devices of the class heretofore mentioned are designed to afford an extra supply of oxygen to promote complete combustion of the unconsumed carbon, such extra supply of oxygen being furnished when the coal is placed on the fire and cut off at about the time when the coal becomes coked.

The objects of the present invention are to provide durable and economically-constructed means for efficiently heating the air to be supplied to the furnace-chamber and to feed or inject such heated air or steam or air and steam to the furnace in maximum amount when the fuel is first placed on the fire, gradually reducing the amount of air thus injected until it ceases entirely.

With these objects in view the invention consists in a furnace or series of furnaces having an air-duct, preferably of fire-brick, extending along the bridge-wall and provided with branch ducts leading, preferably, along both sides of the furnace-chamber above the grate, combined with steam-injectors for injecting the air from said side ducts into the furnace-chamber, and means automatically operable when the furnace-door is opened to supply steam to said injectors, and cut-off devices which begin when the door is closed to gradually cut off the supply of steam to the injectors, so that the supply of air to the furnace gradually decreases as the amount of smoke becomes less.

More specifically stated, the invention consists of a furnace or furnaces having an air-duct constructed as above described, combined with steam-injectors, as stated, and a valve controlling the passage of steam to said injectors, which valve is opened by water-pressure admitted when the furnace-doors are opened to a cylinder having a piston whose rod is connected to the valve-stem and shut off when the door is closed by an adjustable power device, as a weight, which operates in opposition to the water-pressure in the cylinder, the water being permitted to escape from the latter through a petcock provided for that purpose.

One of the important features of the invention lies in the means for admitting the water-pressure to the cylinder when either of the furnace-doors is opened and cutting off the pressure when the door is closed. The action of the device is to positively turn on the water-pressure by the opening movement of the door and positively turn off the pressure by the closing movement thereof. When a plurality of furnace-doors are employed, each door is operatively connected to a separate valve for controlling the water-pressure.

Furthermore, the invention consists in certain improvements in details of construction, which will be hereinafter described and then pointed out in the claims.

The inventive idea may receive various mechanical expressions, one of which is embodied in the accompanying drawings, in which—

Figure 1 is a front elevation of a furnace with the invention applied thereto. Fig. 2 is a perspective view of the furnace-chamber, parts being broken away to show the air-ducts. Fig. 3 is an enlarged view of the automatic device for controlling the steam-injectors. Fig. 4 is a vertical section on the line 4 4, Fig. 2. Fig. 5 is a vertical section of the casing of the steam-cut-off valve, the latter being in elevation. Fig. 6 is a horizontal section on the line 6 6 of Fig. 5, and Figs. 7 and 8 are detail views showing the damper for controlling the air-duct.

Referring to the drawings, 1 is the bridge-wall of the furnace, having formed therein the transversely-extending air-duct 2, which duct may be formed of recessed tiles, as shown, or otherwise constructed of refractory material. If a bank or series of furnaces is built, said duct 2 will have a cross-section proportionate to the requirements of combustion and will extend along the bridge-walls of the entire series of furnaces, as indicated by dotted lines in Fig. 2. This duct 2 is connected with branch ducts 3, formed in the side walls of each furnace-chamber, which branch ducts 3 are preferably formed by the use of recessed tiles 5, set in the side walls of the furnace-chamber, as will be understood from an inspection of Figs. 2 and 4; but the ducts may be constructed of fire-brick or other refractory material. Leading from the side ducts 3 into the furnace-chamber are a series of openings 6, within each of which is a nozzle 7, leading from a steam-pipe 8, lying within the duct 3. This steam-pipe 8 leads from any suitable source of steam-supply along the face of the furnace and by suitable branches enters the ducts 3 from the front of the furnace, as will be understood by an inspection of Fig. 1. The passage of steam through the pipe 8 is controlled by two valves 9 and 10, valve 9 being a hand-operated valve normally open and valve 10 being an automatically-operated valve normally closed. For the purpose of automatically controlling the operation of valve 10 the valve-stem 11 is connected to a lever 12 and the lever 12 is also connected, preferably, by a link 14 to the piston-rod 15 of a piston 16, playing in a cylinder 17. For convenience of construction the cylinder may be mounted upon a suitable base 18, to which the lever 12 may be pivoted at 21. The link 13 is connected to the lever between the pivot 21 and the link 14, and a weight 22 is adjustably supported by the outer end of the lever. Any valve which operates to gradually and progressively lessen the area for the passage of steam during the entire closing movement of the valve may be employed, but preferably the construction of valve shown in Figs. 5 and 6 is used. In said figures, 23 is the inlet to the valve-casing and 24 the outlet, and between said inlet and outlet is a partition 25, having openings 26 and 27 formed therein, which openings are normally closed by the balanced valve members 28 29 on the valve-stem 11. Each of the members 28 29 is cut away at 30, said cut-away portions gradually narrowing from the bottom toward the top of the members, the top portion of the members being entire and serving to completely close the openings 26 and 27 in the partition 25. The cylinder 17 has connected thereto, below the piston 16, a water-pipe 31, which extends therefrom across the face of the furnace in proximity to the furnace-doors and connects with any suitable source of water-pressure. If the furnace has two doors, this water-pipe 31 is provided with a by-pass pipe 32, which extends across the face of the furnace, as shown. The passage of water through the pipe 31 is controlled by a valve 33, operated by the pintle 34, and the passage of water through by-pass pipe 32 is controlled by a valve 35, operated by the pintle 36, the respective doors being secured to their respective pintles in any suitable manner, as by set-screws 37. The valves 33 and 35 are so adjusted on the pintles 34 and 36 that when a door is closed its valve is closed and when a door is open its valve is open. The pipe 31 is provided with a petcock or valve 38, through which water may be permitted to escape from the pipe at any desired rate, and the pipe 8 has a blow-off valve 39 to permit the escape of condensed steam. The entrance of air to the duct 2 is controlled by a damper 19, sliding in a casting 20, Figs. 7 and 8, set in the mouth of the duct.

The operation of the device is as follows: Both furnace-doors being closed, valve 33 is closed to the passage of water through pipe 31 and valve 35 is closed to the passage of water through by-pass pipe 32, and hence no pressure exists in the cylinder 17, and the weight 22, acting through the lever 12, closes the valve 10 in the steam-pipe 8—that is, it holds said valve in the position shown in Fig. 5, it being understood, of course, that the petcock 38 is slightly open to allow the slow escape of water from the pipe 31. If now either one of the furnace-doors be opened, its pintle will be turned and the valve connected thereto opened and permit water under pressure to pass to the cylinder 17 and elevate the piston, thereby opening the valve 10 in the steam-pipe 8 and permitting steam to pass through the injector-nozzle in the openings 6 into the furnace-chamber. The steam thus forced through the openings 6 acts to inject the highly-heated air from the ducts 3 into the furnace-chamber, and this injecting action continues as long as steam is permitted to pass through the pipe 8, the amount of

air thus injected depending upon the amount of steam passing through the pipe and the position of the damper 19 at the mouth of duct 2. The fuel having been placed upon the fire and the door being closed, the supply of water-pressure to the cylinder 17 is thereby cut off, and the leakage of water from the petcock 38 permits the weight 22, acting through the lever 12, to slowly force valve 10 downward, thereby gradually and progressively diminishing the area for the passage of steam, and hence gradually and progressively decreasing the amount of air and steam injected into the furnace-chamber and finally shutting it off altogether. This progressive decrease in the amount of air and steam injected into the furnace-chamber is a matter of much importance, as it renders it possible to suply the maximum amount of oxygen to the furnace at the time when the unconsumed carbon given off by the new charge of fuel is greatest and then gradually decrease the supply of oxygen as the amount of unconsumed carbon or smoke decreases. It is apparent that the rate of decrease may be regulated by means of the petcock 38 and the position of the weight 22 on the lever 12. The importance of decreasing the injection of the air and steam lies in the fact that oxygen forms only about twenty per cent. by volume of the air, while about eighty per cent. is nitrogen, and only the oxygen is useful in supporting combustion, the nitrogen being an inert gas so far as combustion is concerned, and escaping up the chimney after being heated by the gases of combustion, so that if a larger quantity of air is injected than is required to supply the oxygen necessary to produce complete combustion a large quantity of nitrogen is set free and escapes up the chimney after absorbing heat units that should have gone to the generation of steam. By the improved construction the injection of air and steam is permitted to continue only so long and to so great an extent as may be necessary to secure the amount of oxygen requisite to promote the complete combustion of the unconsumed carbon given off by the fuel, and thus prevent its issuance from the stack in the form of smoke. It is to be noted that the system for heating the air lends itself with equal facility to a single furnace or to a bank or series of furnaces, in which latter case the duct 2 (being made larger or smaller, according to requirements) simply extends from furnace to furnace, as indicated by dotted lines in Fig. 2. Furthermore, the air-ducts 2 and 3 may be cheaply constructed of durable material, thereby greatly lessening the initial cost, the expense of repairs, and the loss of valuable time.

Having thus described the invention, what is claimed is—

1. In a furnace, the combination of a main air-duct built wholly within the bridge-wall and extending transversely across said wall and opening to the atmosphere through a port in the side wall of the furnace, with a lateral air-duct connecting with the main duct and having openings into the furnace-chamber, and automatic mechanism injecting air from said lateral duct into the furnace-chamber when the furnace-door is opened, and gradually and progressively decreasing the amount of air injected after the door is closed.

2. In a furnace the combination of an air-duct leading through the side wall of the furnace from the outer air transversely across the furnace in the bridge-wall, a side duct connecting therewith and having openings into the furnace-chamber, a steam-pipe located in said side duct and having injector-nozzles in said openings, a valve controlling said steam-pipe, a cylinder, a piston in said cylinder having a stem operatively connected to said valve, a water-pipe leading into said cylinder, a valve controlling said water-pipe, and a furnace-door having a pintle operatively connected to said last-named valve.

3. In a furnace provided with two doors, the combination of a hot-air duct communicating with the furnace-chamber, a steam-pipe conducting steam thereto, a valve controlling said steam-pipe, a cylinder having a piston therein connected to said valve, a water-pressure pipe leading past the furnace-doors to said cylinder, a by-pass pipe connected to said water-pressure pipe, a valve in said last-named pipe connected to the pintle of one of the furnace-doors, a valve in the by-pass pipe connected to the pintle of the other door, and a leak-valve attached to the water-pressure pipe.

4. In a smoke-consuming furnace, the combination of a hot-air duct leading through the side wall of the furnace from the outer air along the bridge-wall, lateral ducts connecting therewith and opening into the furnace-chamber, a steam-pipe in said lateral ducts and having injector-nozzles communicating with the furnace-chamber, a valve controlling the passage of steam through said pipe, a cylinder, a piston therein operatively connected to the stem of said valve, a water-pressure pipe leading to said cylinder, a normally-closed valve in said pressure-pipe connected to the pintle of one of the furnace-doors, a by-pass pipe around said valve, a normally-closed valve in said by-pass pipe connected to the pintle of the other door, a petcock connected to said pressure-pipe and a weighted lever connected to said piston and steam-valve.

5. In a smoke-consuming furnace, the combination of a hot-air duct communicating with the furnace-chamber, a steam-pipe in said duct having injector-nozzles, a gradually and progressively closing valve controlling said steam-pipe, means controlling the time consumed in closing said valve, means controlling the amount of air passing through said duct, a cylinder, a piston therein, a water-pressure pipe leading to said cylinder, a valve controlling said pressure-pipe and connected to a pintle of one furnace-door, a by-

pass pipe around said valve, and a valve in said by-pass and connected to the other furnace-door.

6. In a smoke-consuming furnace, the combination of a steam-pipe leading to the furnace-chamber, with a water-motor operatively connected to a valve in said pipe, a water-pressure pipe leading to said motor, a valve directly connected to the pintle of one of the furnace-doors and controlling the transmission of pressure through said pipe, a by-pass pipe around said valve and a valve in said by-pass pipe and connected directly to the pintle of the other furnace-door.

In testimony whereof we have signed this specification in the presence of two subscribing witnesses.

ARCHER G. JONES.
C. H. PHILBROOK.

Witnesses:
S. T. CAMERON,
REEVE LEWIS.