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FURNACE AND METHOD OF CONTROLLING THE DRAFT THEREIN

Filed June 13, 1921

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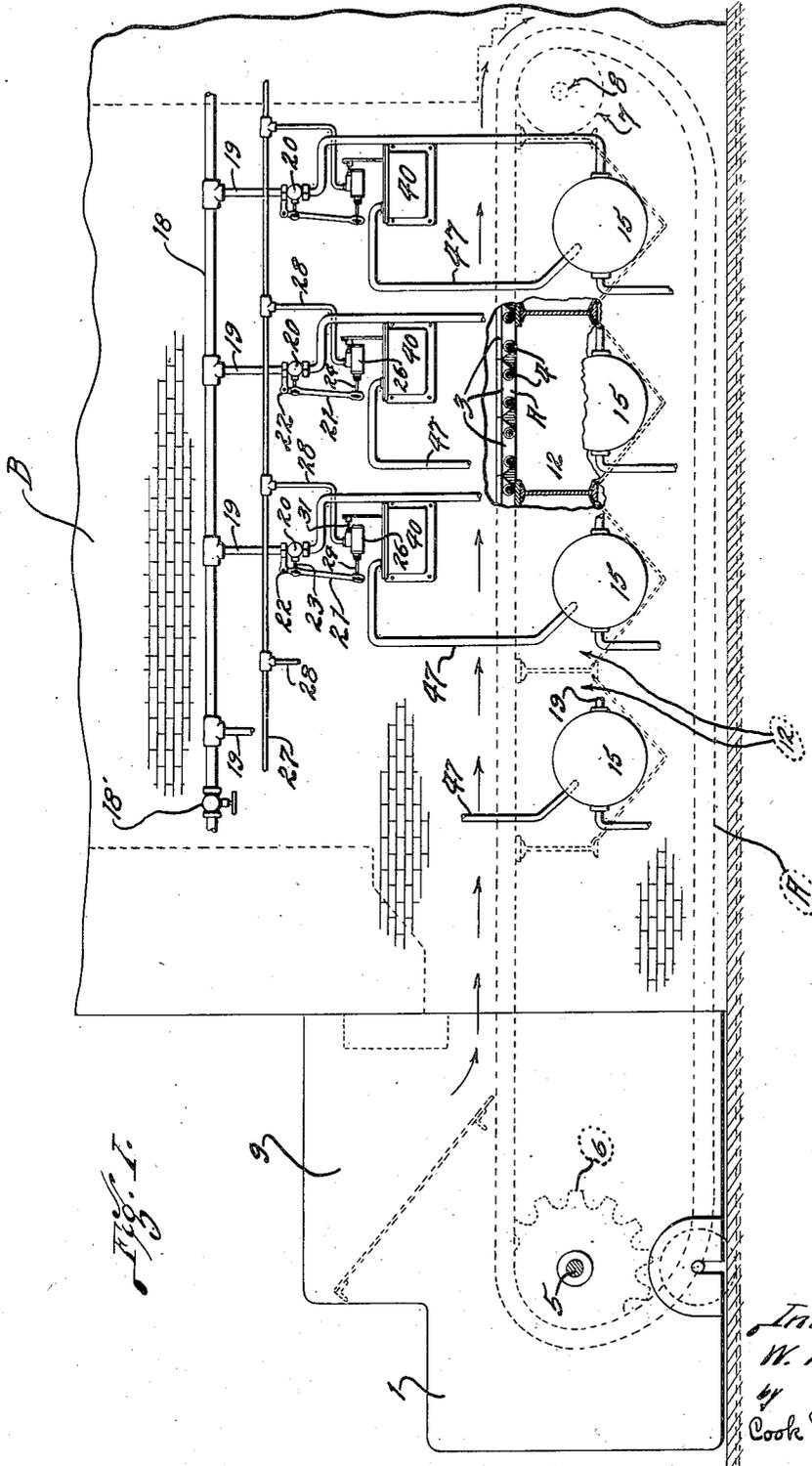


Fig. 1.

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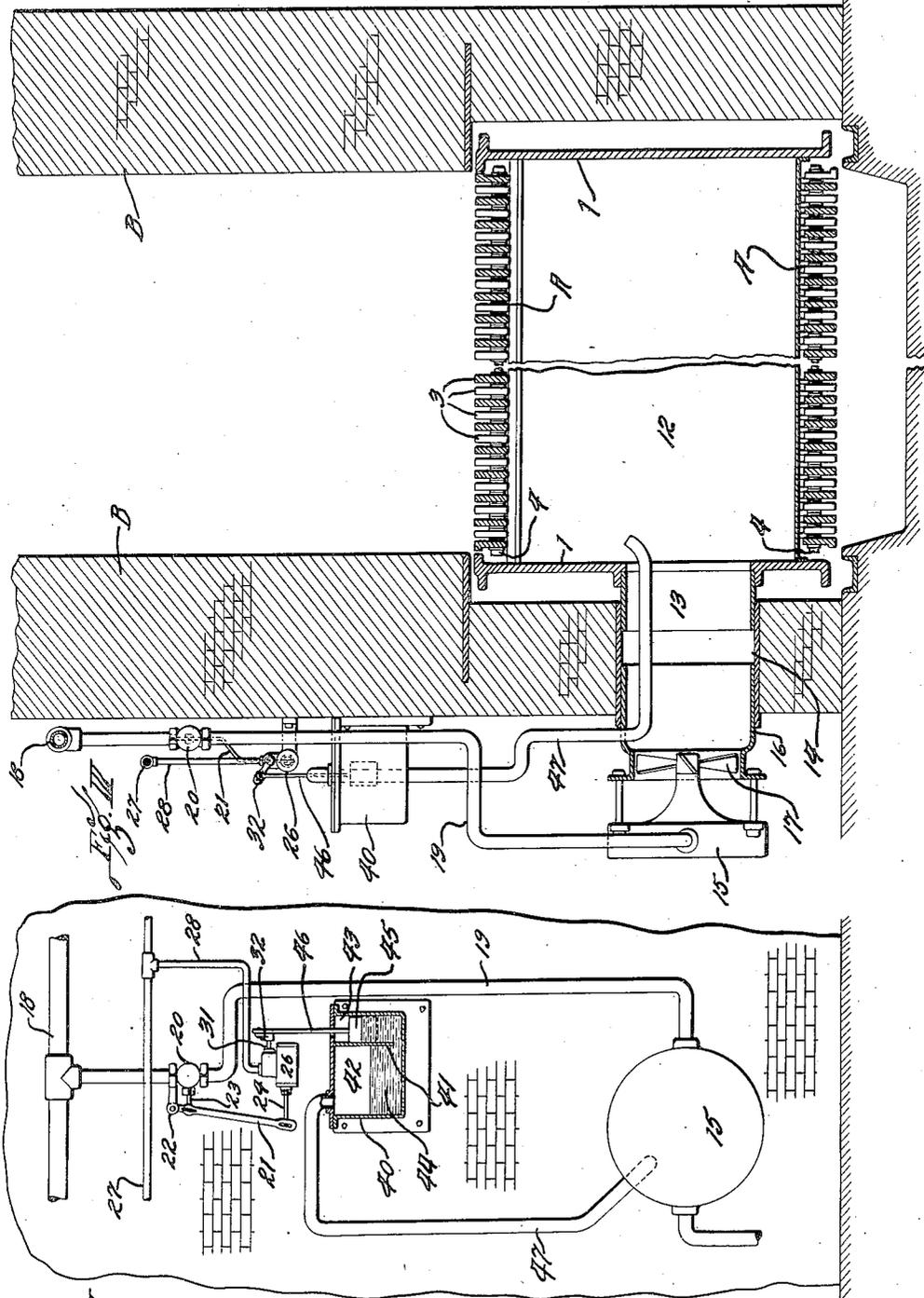


Fig. II

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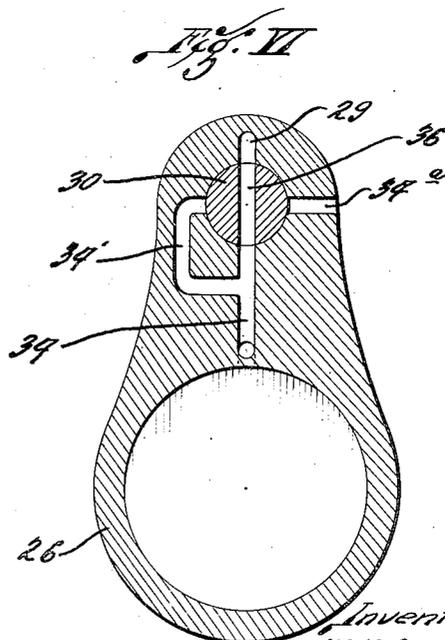
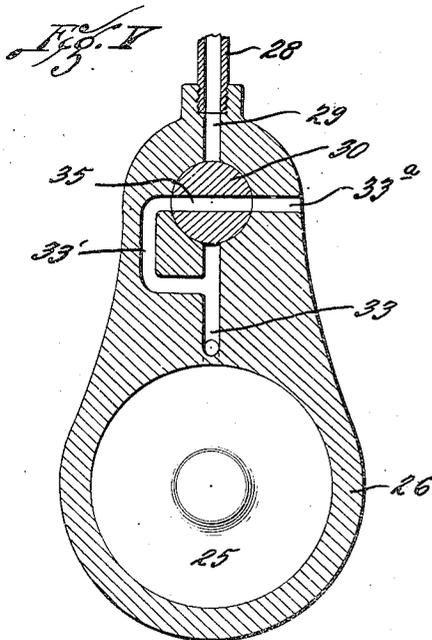
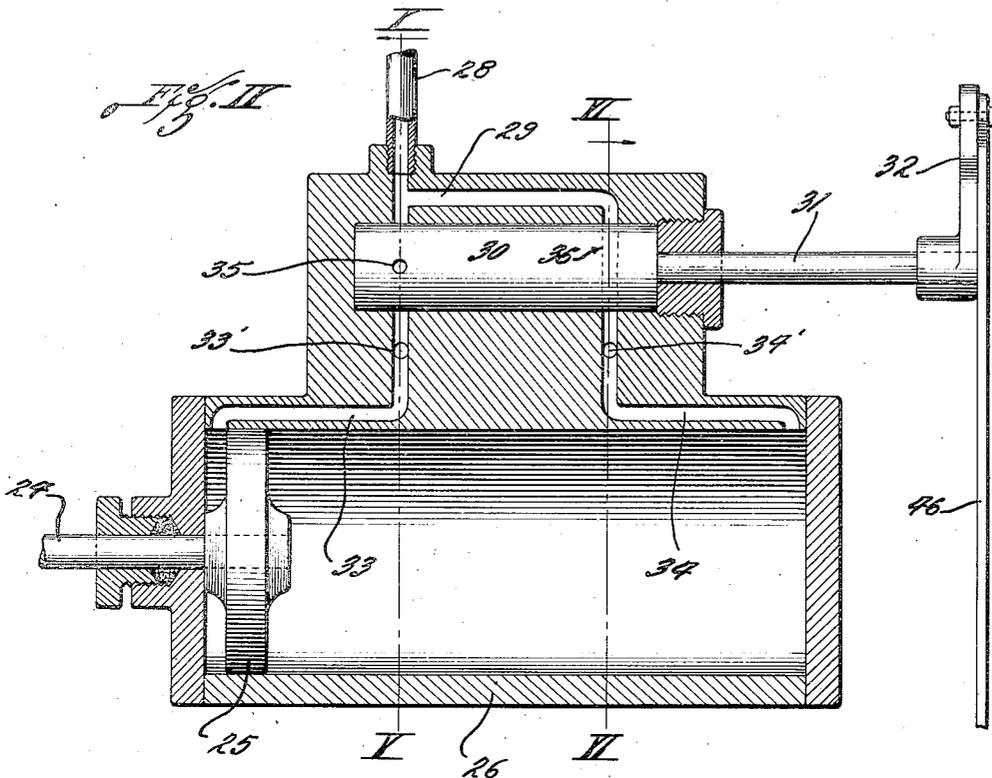
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE.

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FURNACE AND METHOD OF CONTROLLING THE DRAFT THEREIN.

Application filed June 13, 1921. Serial No. 477,055.

To all whom it may concern:

Be it known that I, WILLIAM M. DUNCAN, a citizen of the United States of America, and a resident of Alton, in the county of Madison and State of Illinois, have invented certain new and useful Improvements in Furnaces and Methods of Controlling the Draft Therein, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

This invention relates to improvements in furnaces and methods of controlling the draft therein, and the novel features of the invention are adapted for use in a furnace provided with a traveling grate. The object of the invention is to regulate or control the flow of draft through openings in the bed of fuel supported on the grate.

It is difficult to maintain a uniform bed of fuel on a grate, and this is especially true in a furnace provided with a traveling grate. Actual experience has shown that openings are frequently formed in the fuel bed on a traveling grate, and the forced draft is then permitted to freely escape through the openings. The efficiency of the draft is thus greatly reduced by the free escape of forced draft through an opening in the fuel which chills the combustible gases in the combustion chamber, and the opening is gradually enlarged by rapid combustion resulting from the draft at this point.

The draft pressure below the grate is reduced by the free escape of draft through an opening in the fuel, and in the preferred form of the invention I take advantage of this reduction to determine the location of the opening. I then prevent a rapid delivery of draft through the opening. After the location of the opening has been determined, the draft can be retarded or otherwise prevented from escaping freely through the opening.

Assuming that a blower, or other suitable blast device, is used to maintain an approximately constant normal pressure under a portion of the grate, when an opening appears in the fuel above this portion of the grate a rapid escape of draft at the opening will result in a reduction in the pressure. When this occurs, I preferably effect a still greater reduction of the pressure at that portion of the grate, thereby preventing delivery of excess draft through the opening. More specifically stated, the herein de-

scribed method consists in reducing the draft at the portion of the fuel in which an opening is formed, without changing the draft at other portions of the fuel. I will hereafter point out how this is accomplished in a bed of fuel supported by a traveling grate.

Fig. I is a side elevation of a furnace equipped with a draft regulating means embodying the features of this invention, a portion of the furnace wall being broken away to show the chain grate.

Fig. II is an enlarged fragmentary side elevation, partly in section, showing one of the draft regulating devices.

Fig. III is a vertical section taken approximately through the middle of Fig. II, the middle portion of the furnace structure being broken away.

Fig. IV is an enlarged section of one of the valve operating devices.

Fig. V is a section on the line V—V in Fig. IV.

Fig. VI is a section on the line VI—VI in Fig. IV.

To illustrate the invention, I have shown a mechanical stoker comprising an endless chain grate A supported between side frame members 1. The chain grate comprises many grate links 3 connected by means of pivot rods 4 arranged transversely of the grate. A power shaft 5 (Fig. I), supported by the side frames 1, is provided with any desired number of sprocket wheels 6 for transmitting movement to the endless chain grate. The chain grate passes around the sprocket wheels 6 and also around a plain idle wheel, or roll 7, the latter being mounted on a shaft 8. The fuel passes from a hopper 9 to the top face of the grate, as indicated by arrows in Fig. I.

The furnace is provided with suitable side walls B, located adjacent to the side margins of the grate. 12 designates draft boxes surrounded by the traveling grate and extending from a side frame 1 at one side of the grate to the frame 1 at the other side. All of these draft boxes are open at the top to provide for the delivery of draft to the grate. The several draft boxes 12 are located adjacent to each other, as shown by Fig. I, and the fuel-supporting portion of the grate travels over their upper edges.

Each draft box 12 may be provided at one end with an intake nipple 13 (Fig. III) telescoping with a nipple 14 in one of the

furnace walls B. As an illustration of a suitable means for creating a forced draft, I have shown a series of individual turbines or rotary engines 15 each associated with one of the draft boxes 12, as shown by Figs. I and III, and each supported by a tubular member 16 telescoping with one of the nipples 14. Each engine, or turbine, 15 is provided with a rotary fan 17 located in a tubular member 16. When one of the turbines is operated, its fan is rotated to create a forced draft in one of the draft boxes 12. Since there is a separate turbine and fan for each draft box, it will be noted that the draft in any one of the draft boxes can be regulated without varying the draft in the other draft boxes.

Fluid under pressure, preferably steam, is delivered to the several turbines through the medium of a main supply pipe 18 having branches 19 leading to the respective turbines. Each branch 19 is provided with a regulating valve 20, so the turbines can be regulated independently of each other for the purpose of varying the draft in any selected draft box without changing the draft pressure in the other draft boxes. A valve 18' in the main supply pipe (Fig. I) may be adjusted to simultaneously regulate all of the turbines.

When an opening is formed in the traveling bed of fuel, one of the regulating valves 20 is adjusted to reduce the draft pressure in the box below the opening, the valve 20 being selected to reduce the speed of the turbine associated with the individual draft box below the opening. It will be apparent that this involves the problem of determining where the opening is located and thereafter selecting the particular valve 20 associated with the draft producing means for the particular draft box below the opening. I will now describe a means whereby all of this can be automatically accomplished.

Each valve 20 is equipped with an operating lever 21 fulcrumed at 22 and connected to a valve operating stem 23. The means for actuating the levers 21 includes piston rods 24 connected to the respective levers, each rod 24 (Fig. IV) being fixed to a piston 25 mounted in a cylinder 26. The several pistons are operated by means of fluid under pressure, such as compressed air, transmitted through a supply pipe 27 having branches 28 leading to the several cylinders 26.

As shown most clearly by Figs. IV, V and VI, each cylinder 26 is provided with an intake passageway 29 leading from the pressure supply pipe 28 to points near the ends of a valve 30, said valve having an operating stem 31 provided with an operating arm 32 whereby the valve is rocked to control the admission and discharge of fluid. Passageways 33 and 34 lead from the end por-

tions of the valve 30 to the opposite ends of the cylinder 26. The passageway 33 is in communication with a discharge passageway 33' (Figs. IV and V) leading to the valve 30 and adapted to communicate with a discharge port 33^a. The passageway 34 (Figs. IV and VI) likewise communicates with a discharge passageway 34' leading to the valve 30 and adapted to communicate with a discharge port 34^a. The valve 30 is provided with transverse passageways 35 and 36, formed at a right angle to each other, as shown in Figs. IV, V and VI.

When the valve 30 occupies the position shown by Figs. IV, V and VI, the pressure supply pipe 28 and the intake passageway 29 are in free communication with the valve passageway 36 and the passageway 34 leading to the right hand end of the cylinder. The piston 25 is therefore subjected to the fluid pressure transmitted through these passageways. At this time, the fluid pressure cannot be transmitted through the valve passageway 35 for the reason that this passageway is not in communication with the inlet passageway 29. This is illustrated by Figs. IV and V, which show that the valve passageway 35 is in communication with the passageways 33 and 33' leading from the left hand end of the cylinder to provide for the discharge of fluid through the exhaust port 33^a.

If the valve 30 is turned about one quarter of a revolution from the position shown by Figs. IV, V and VI, the conditions just pointed out will be reversed. Fluid will then be permitted to flow from the supply pipe 28, through passageways 35 and 33 to the left hand end of the cylinder, so as to force the piston 25 and the rod 24 to the right from the position shown in Fig. IV, and at the same time the valve port 36 will be so located that the fluid displaced from the right hand side of the piston will be permitted to pass out through the passageways 34 and 34', 36 and 34^a.

Any other suitable means could be used to control the admission and discharge of fluid at the cylinder 26, the object being to produce a simple means for transmitting motion to any selected valve operating lever 21, and the desired result can be accomplished by merely rocking the valve 30 at the cylinder 26 so as to transmit fluid pressure to the piston 25.

When the parts occupy the positions shown by the drawings, all of the turbine-regulating valves 20 are entirely open, and they can be partly closed, but not entirely closed, by operating the arms 32 associated with the valves 30 of the cylinder 26. These regulating valves 20 are normally open for the delivery of steam to the turbines 15, but when an opening appears in the fuel above one of the draft boxes, the regulating valve

20 associated with said draft box is adjusted to reduce the speed of the turbine for this particular draft box, thereby reducing the draft below the opening in the fuel.

5 The automatic means for selecting and regulating the valves 20 preferably includes pressure-responsive devices controlling the delivery of fluid under pressure to the cylinders 26, whereby the piston rods 24 and
10 levers 21 are actuated to regulate said valves 20. As an illustration of this feature of the invention I have shown a series of pressure chambers 40 each of which is associated with one of the draft boxes 12 and also with
15 one of the cylinders 26, as will be presently described. Each pressure chamber 40 (Fig. II) contains a partition 41 whereby it is divided into a pressure compartment 42 and a float compartment 43. The partition 41
20 extends from the top wall of the chamber 40 to a point near the bottom wall thereof to provide for the flow of liquid 44 from one compartment to the other. A float 45 (Fig. II) is located in the float compartment 43 and connected to a valve operating arm 32 by
25 means of a rod 46. 47 designates pressure pipes leading from the interior of draft boxes 12 to the upper portions of the respective pressure chambers 40, each pipe 47 being in
30 free communication with the upper end of a pressure compartment 42, as shown by Fig. II, and the pressure compartment being otherwise closed above the liquid therein, so the liquid will be subjected to the draft pressure
35 in the draft box. Each pressure compartment 42 is thus associated with one of the draft boxes, and the liquid level in the compartment 42 will rise and fall in response to the variations of the draft pressure
40 the draft box. Each pressure compartment 42 is therefore normally under pressure, so the liquid level of the compartment 42 will be lower than that of the float compartment 43. As a consequence, each float 45 (Fig. II)
45 will normally occupy its elevated position to retain the adjacent valve-operating arm 32 and its valve 30 in the positions shown by Figs. II, IV, V and VI. The piston 25 is therefore normally retained at the left hand
50 end of the cylinder, as shown by Fig. IV, and the valve operating lever 21 is normally retained in the position shown by Fig. II, so as to permit free passage of steam through the regulating valve 20.

55 When the pressure in a compartment 42 (Fig. II) is decreased to a degree materially below the normal pressure, the liquid will rise in compartment 42 and the adjacent float 45 will fall in the compartment 43 so as to
60 transmit motion to the valve operating arm 32 to which the float is connected. If the drop in pressure is great enough, the displacement of float 45 and arm 32 will cause the valve 30 to move about one quarter of a
65 Δq μ ν ω ρ σ τ θ η ζ ξ γ β α

Figs. IV, V and VI. In this event, fluid under pressure will be admitted through the passageway 33 leading to the left side of piston 25, with the result of moving the
70 piston rod 24 and lever 21 to the right from the positions shown by Fig. II, thereby partly closing the regulating valve 20 to decrease the speed of the turbine 15 associated
75 with said valve. Thereafter, when the pressure in compartment 42 is increased, the float 45 will rise in the float compartment 43 to restore the valve 30 to the position shown by Figs. IV, V and VI.

The operations may be briefly described as follows:

80 Under normal operating conditions, all of the turbine-regulating valves 20 are wide open, and all of the turbines and their draft producing fans are then operated at the normal speeds. A predetermined normal draft
85 pressure is thus maintained in each draft box 12 below the fuel-supporting portion of the grate. Of course, the pressure will not be maintained precisely at any predetermined degree, for even under the normal
90 conditions there will be some slight variations resulting from slight variations in the fuel bed, but this will not materially affect the automatic pressure-responsive device. However, when there is
95 an opening in the fuel bed at a point above one of the draft boxes, the draft will freely and quickly escape through this opening so as to reduce the draft pressure in this particular draft box, and there will be a
100 corresponding reduction of the pressure in the pressure compartment 42 (Fig. II) communicating with said draft box. As a consequence, the liquid will rise in this particular compartment 42 and fall in the adjacent
105 float compartment 43. The float 45 will then move downwardly to actuate the valve 30 (Fig. IV) to which it is connected. When this occurs, the valve 30 will be turned about one quarter of a revolution
110 from the position shown by Figs. IV, V and VI, and the piston 25 will be actuated to partly close the particular valve 20 associated with the pressure compartment 42 and draft box 12 to which I have just referred.
115

120 It will now be understood that when an opening appears in the fuel above a draft box, the draft pressure in this box will be decreased as a result of the free outlet, or vent, formed by the opening, and immediately thereafter the speed of the draft producing fan associated with this draft
125 box will be reduced. This prevents the rapid escape of draft through the opening which would chill the combustible gases in the combustion chamber and at the same time enlarge the opening by rapid combustion of the fuel around the opening.

130 Assuming now that there is an opening in

the fuel above one of the draft boxes, and that the draft pressure has been decreased below the opening, as just pointed out. The fuel is supported by a traveling grate, so the portion of the fuel in which the opening is formed will slowly move to a point over the next adjacent draft box, and then on over the other draft boxes. Whenever this open portion of the fuel is located over one of the draft boxes, the draft pressure below the opening will be reduced by one of the automatic pressure-responsive controlling devices, as previously pointed out. Although the pressure in each successive draft box is reduced when an open portion of the fuel is located above the same, the normal pressure should be restored when the open portion of the fuel passes away from the draft box. This is accomplished as follows:

It is to be understood that all of the turbines are driven constantly, although the speed of a turbine is reduced when an opening appears in the fuel above the draft box to which the turbine is connected. Therefore, when an open portion of the fuel passes away from a draft box, the pressure in this draft box is gradually increased for the reason that there is no large open draft outlet in the fuel above the draft box, and as the draft pressure increases in the draft box there will be a corresponding increase of pressure in the pipe 47 and pressure chamber 40 communicating with said draft box. Owing to this increase of pressure in the pressure compartment 42 (Fig. II) the adjacent float 45 will be elevated to restore the float actuated valve 30 to the position shown by Figs. IV, V and VI, thereby restoring the piston 25, piston rod 24 and valve-operating lever 21 to permit free delivery of the steam through the regulating valve 20 controlled by the float.

This automatic selection and regulation of the draft producing devices may be accomplished as a result of variations in the pressure of the draft itself, and although the draft pressure is not very great, any desired degree of power can be obtained for the automatic adjustment of the apparatus. The draft pressure acts upon a very sensitive device comprising the pressure chambers 40 each containing a body of liquid having a large surface area exposed to the draft pressure, and each containing a float adapted to readily move in response to variations in the liquid level. However, the float merely actuates a readily movable valve 30 to control the delivery of compressed air to an operating device from which an almost unlimited degree of power could be obtained to actuate the regulating device.

A further advantage of the invention herein disclosed lies in the fact that the several draft boxes direct the draft to different portions of the fuel, and whenever an

opening appears in one of these portions, the draft is reduced at this particular portion of the fuel without in any way affecting the draft at the other draft boxes, and this result is accomplished throughout the apparatus as the fuel travels from one draft box to another.

I claim:

1. The method of transmitting and controlling draft in a traveling bed of fuel so as to reduce the flow of draft through an opening in the fuel, said method consisting in transmitting draft from separate sources and through successive portions of the traveling bed of fuel, utilizing the draft pressures at said separate portions of said fuel bed to successively reduce the flow of draft from said different sources, so as to maintain a reduced draft pressure below said opening, and at the same time maintaining a higher draft pressure below other portions of the traveling fuel bed.
2. The method of controlling the delivery of draft through an opening in a fuel bed which consists in transmitting draft from separate independent sources to successive portions of the fuel bed, moving the fuel bed to successively place the open portion of the fuel in communication with said sources, and utilizing the pressures at said separate portions of the fuel bed to successively regulate the flow of draft from said separate sources so as to maintain a reduced flow of draft at the open portion of the fuel.
3. A furnace provided with a fuel-supporting grate, and means for regulating the flow of draft to openings in the fuel on said grate, said means including a series of automatic draft controllers responsive to draft pressures below different portions of the grate.
4. A furnace provided with a fuel-supporting grate, and means for regulating the flow of draft through openings in the fuel on said grate, said means including a series of draft-ducts between the grate and the source of the draft, said draft-ducts being located below and transversely of the bottom of said grate, and automatic regulating means controlling the draft in said draft-ducts.
5. A furnace provided with a fuel-supporting grate, and means for regulating the flow of draft through openings in the fuel on said grate, said means including a series of draft-ducts between the grate and the source of the draft, said draft-ducts being located below and transversely of the bottom of said grate so that any of said ducts may be located below an opening in the fuel, and automatic draft controllers each associated with one of said ducts to automatically regulate the delivery of draft therefrom.
6. A furnace provided with a traveling fuel-supporting grate, and means for regu-

lating the flow of draft through openings in the fuel on said traveling grate, said means including a succession of draft-ducts located
 5 of the draft, and a succession of automatic draft controllers for regulating the flow of draft from said ducts, each of said draft controllers being responsive to variations of the draft pressure in one of said ducts.

10 7. A furnace provided with a traveling fuel-supporting grate, and means for regulating the flow of draft through openings in the fuel on said traveling grate, said means including a succession of draft-ducts below
 15 and adjacent to the fuel-supporting portion of said traveling grate, and independently operable draft controllers for the respective draft ducts, each of said draft controllers being associated with one of said ducts and
 20 responsive to variations of the draft pressure therein.

8. A furnace provided with an endless traveling fuel-supporting grate, draft boxes arranged transversely of and surrounded by
 25 said endless traveling grate, said draft boxes being open at the top to provide for the delivery of draft through the upper portion of said endless traveling grate, and means for
 30 controlling the flow of draft through openings in the fuel supported on said traveling grate, said means including a separate draft regulator for each draft box, and pressure-responsive means controlling the draft regulators, said pressure-responsive means being
 35 in communication with the respective draft boxes and under the control of the draft pressure therein.

9. A furnace provided with an endless traveling fuel-supporting grate, draft boxes

arranged transversely of and surrounded by 40 said endless traveling grate, said draft boxes being open at the top to provide for the delivery of draft through the upper portion of said endless traveling grate, and means
 45 for controlling the flow of draft through openings in the fuel supported on said traveling grate, said means including an individual blast device for each of said draft boxes, an individual regulating device for
 50 each blast device, and individual pressure-responsive controlling devices each associated with one of said draft boxes and one of said regulating devices, each pressure-responsive controlling device being in
 55 communication with one of said draft boxes and provided with an operating member for one of said individual regulating devices.

10. A furnace provided with an endless traveling fuel-supporting grate, draft boxes arranged transversely of and surrounded by 60 said endless traveling grate, said draft boxes being open at the top to provide for the delivery of draft through the upper portion of said endless traveling grate, an individual fan for each of said draft boxes, an
 65 individual fluid-actuated motor for each of said fans, an individual regulating valve for each motor, an individual operating device for each valve, and an individual pressure-responsive controlling device for each operating device, each of said pressure-responsive controlling devices being in
 70 communication with one of the draft boxes and movable in response to variations in the draft pressure therein. 75

In testimony that I claim the foregoing I hereunto affix my signature.

WILLIAM M. DUNCAN.