

March 8, 1932.

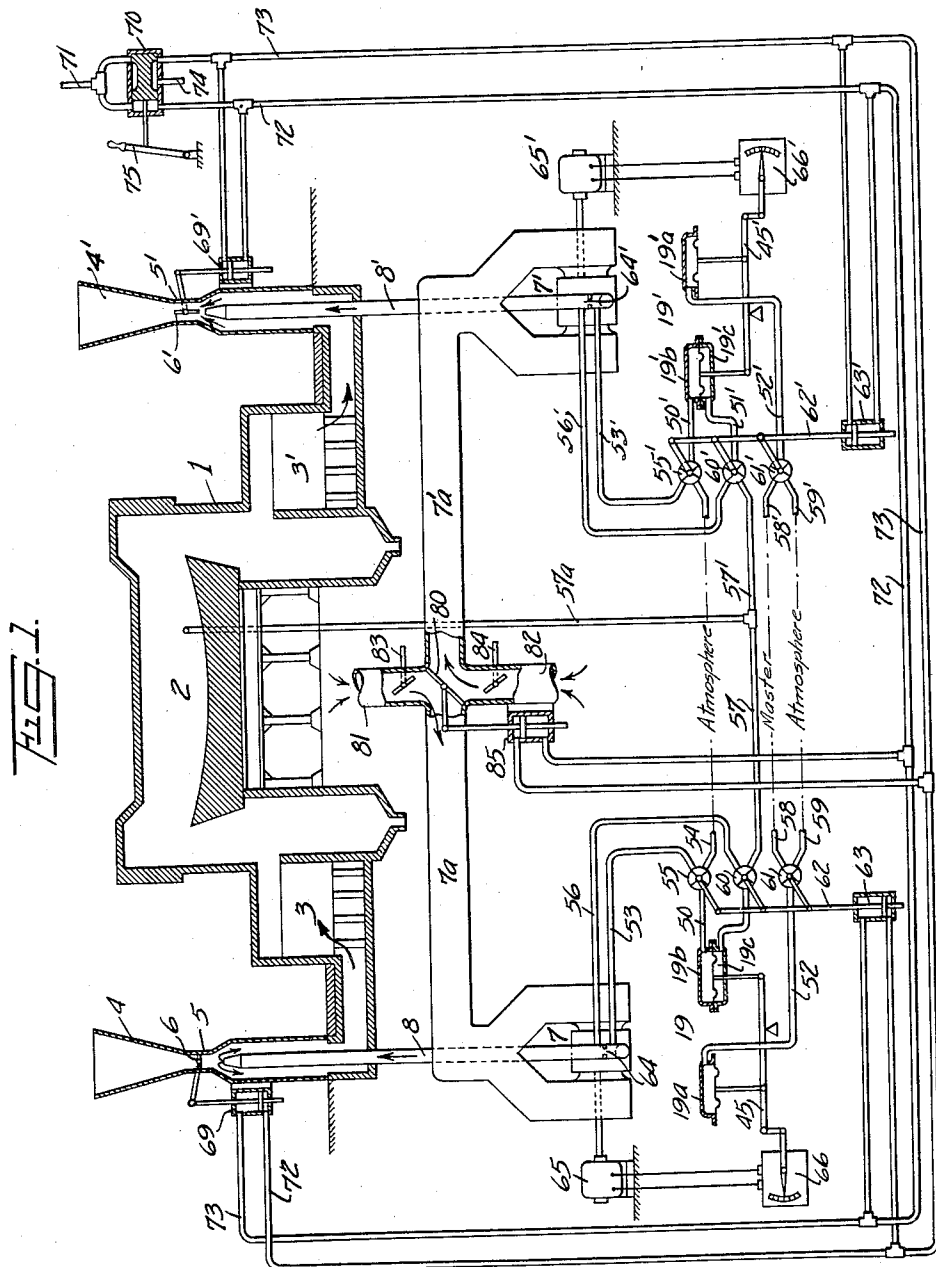
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OPEN HEARTH FURNACE CONTROL

Filed Oct. 13, 1930

2 Sheets-Sheet 1



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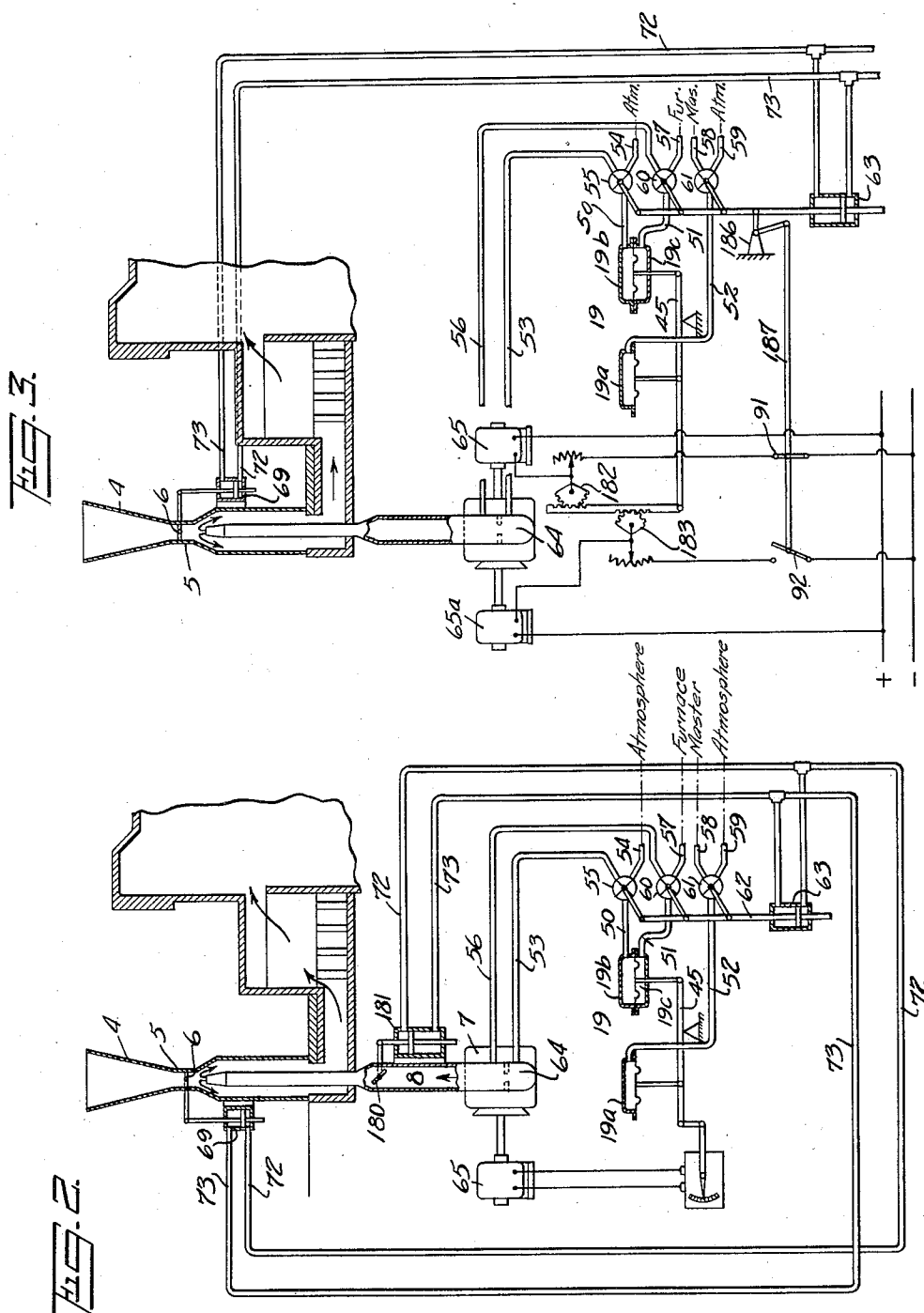
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OPEN HEARTH FURNACE CONTROL

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2 Sheets-Sheet 2



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OPEN HEARTH FURNACE CONTROL

Application filed October 13, 1930. Serial No. 488,316.

My invention relates to the control of air supplied to open hearth furnaces of the reversible type and is equally applicable to furnaces burning liquid fuel, or gas, or a combination of both.

In certain types of regenerative furnaces two stacks are provided each including a section made in the form of a Venturi pipe and provided with a control damper in the neck of the Venturi section. In these furnaces air is delivered into each stack, in one stack the damper in the Venturi section is closed and the air is deflected into the furnace as forced draft, in the other the damper being open, the air passes through the Venturi section creating an induced draft withdrawing the gases of combustion. Upon reversal of the furnace, the stack dampers are reversed and the air supply to each reverses its function.

It is the general practice to associate a blower with each stack, its function alternately being to supply air for forced or induced draft depending upon the position of the stack's dampers. Difficulty has been experienced in varying the speed of the motors through the range required to alternately supply either forced or induced draft and maintain the proper proportioning of the two for efficient operation of the furnace. My invention is mainly concerned with means for correlating the blower speeds and control of the air supply to insure at all times a supply of air to the furnace in proper proportion to the fuel supply thereto and an exhaust of gases from the furnace such that the proper pressure conditions will be maintained within the furnace chamber.

For a better understanding of my invention reference may be had to the accompanying drawings, of which—

Fig. 1 illustrates diagrammatically my air control wherein the orifices of the blower intake ducts may be varied;

Fig. 2 illustrates my air control wherein the orifices of the blower discharge ducts may be varied; and

Fig. 3 illustrates my air control wherein the fans are alternately operated by a high or low speed motor.

In each instance the air control may be

combined with the fuel control and a master control governing the ratio of the two, but for simplicity these have been omitted. Likewise the regulators are diagrammatically illustrated as comprising a balancing lever arranged for direct control of the associated damper or valve in response to forces varying as a function of the element controlled and in response to a force transmitted to the lever by the master controller. Preferably these controllers would be of the anti-hunting balanced type employing auxiliary power fluid for operating the controlled elements. As such regulators are now well known in the art, it is not considered necessary to illustrate or describe them in detail. For example these regulators may take the form illustrated in Fig. 2 of Smoot Reissue Patent No. 16,507, dated December 21, 1926.

The open hearth furnace 1 is diagrammatically illustrated in Fig. 1, as having a furnace chamber 2 and regenerative checker brick passages 3 and 3' leading to stacks 4 and 4' respectively. Stacks 4 and 4' are each fitted with Venturi sections 5 and 5' and dampers 6 and 6' fitted to tightly close or completely open the passage through the Venturi sections. A blower 7 supplies air through conduit 8 terminating in the stack under damper 6. When 6 is closed the air is deflected and acts as a forced draft through the furnace 1. Simultaneously air is being discharged by blower 7' through conduit 8'. The damper 6' is open and the air jet serves as an exhauster withdrawing the gases from furnace 2. The dampers 6 and 6' are suitably interconnected to be simultaneously reversed with the air supplied by each performing the opposite function.

In a furnace of this type an accurate control of the air supplied through conduits 8 and 8' is essential for efficient operation. Referring to Fig. 1, I obtain this result by providing two variable speed blowers 7 and 7', their intakes 7a and 7a' leading to an intersection where due to the position of damper 80 they interconnect with the air supply inlets 81 and 82 respectively, 7a—81 serving as the intake to blower 7 and 7a'—82 serving as the intake to blower 7'. Dampers 83 and

84 are installed in branches 81 and 82 and are manually adjusted to increase or reduce the inlet orifice cross section area to meet the required operating conditions. If damper 80 is reversed intake 7a will connect with inlet 82 and 7a' will connect with inlet 81. This arrangement permits the giving of a definite function to ducts 81 and 82, serving either as a forced draft inlet or induced draft inlet and the dampers 83 and 84 when once set will remain so, until a change is desired to meet new operating conditions. Blowers 7 and 7' are driven by variable speed motors 65 and 65', the speed of the motors being varied by controlling the field resistances through rheostats 66 and 66', which are regulated by arms 45 and 45' of regulators 19 and 19'. Chamber 19a of regulator 19 is connected to the two-way valve 61 which alternately connects it to the master controller (not shown) through pipe 58, or opens to atmosphere through pipe 59. Chamber 19b may through valve 55 receive a pressure transmitted from conduit 8 through pipe 53 or be open to atmosphere through pipe 54 and chamber 19c may receive a pressure transmitted from conduit 8 through pipe 56 or by reversing valve 60 receive a pressure transmitted from the furnace through pipe 57—57a. Valves 55, 60 and 61 are interconnected by rod 62 for simultaneous operation. Regulator 19' and its various connections correspond to 19 and its connections, similar parts being identified by the same number primed.

In the furnace illustrated damper 6 is closed, blower 7 draws air through conduit 7a—81, damper 83 being set to obtain the desired size of orifice, and discharges it as forced draft into conduit 8. Valves 55, 60 and 61 in the position shown permit chambers 19a, 19b and 19c to connect with pipes 58, 53 and 56 respectively, regulator 19 tending to maintain a fixed relation between the pressure transmitted from the master to chamber 19a through pipe 58 and the differential across constriction 64 in conduit 8 transmitted to chambers 19b and 19c through pipes 53 and 56. Thus an increase in air flow across 64 will cause 19 to move 45 in a direction to slow the motor and reduce the flow, and a pressure from the master calling for an increase will cause arm 45 to move to speed the motor. Simultaneously blower 7' is supplying the air for induced draft, the air being drawn through 7a'—82, damper 84 being adjusted to its proper setting for the furnace requirements, valves 55', 60' and 61' permitting chambers 19a', 19b' and 19c' to connect to pipes 59', 54' and 57'—57a. In this position regulator 19' tends to maintain a fixed relation between the furnace pressure transmitted to chamber 19c through pipes 57a—57' and atmospheric pressure. Thus an increase in furnace pressure will cause regulator 19' to move 45' in a direction

to speed the blower increasing the air flow through the Venturi section, withdrawing the gases from the furnace and reducing the furnace pressure to normal.

The stack dampers, 6—6' are interconnected to open or close simultaneously with each other. Rod 62 and rod 62' actuating valves 55, 60, and 61, and 55' 60' and 61', and the damper 80, may be operated manually or mechanically, but are preferably connected to operate in conjunction with 6—6' as shown. Cylinders 69—69' and 63—63' and 85 are all interconnected to operate by moving the relay valve 70 from one position to the other. As illustrated pressure is transmitted through pipe 71, through pipe 72 to the cylinders, pipe 73 being open to the drain pipe 74. To reverse the furnace 75 is thrown over connecting pipe 73 to pressure pipe 71 and pipe 72 to the drain 74. In this position stack damper 6' is open and 6 is closed, so that fan 7' now supplies forced draft and 7 induced draft, and damper 80 having been reversed the air for forced draft is drawn through the same inlet 81 which now connects with 7a' and air for induced draft is drawn through the same inlet 82 now connected to 7a. Simultaneously rods 62 and 62' reverse the two-way valves, interchanging the functions of the regulators. Regulator 19' now controls the forced draft blower and 19 controls the induced draft blower.

The installation of the dampers restricting the sizes of the orifices and arranging the inlets to always serve one function eliminates the wide speed variation required when the fan alternately supplies forced or induced draft using an equally sized orifice for both, and results in closer volume range regulation with a narrower speed range.

Fig. 2 combines a damper in the discharge conduit 8 with the variable speed motor to control the air volume. It differs from Fig. 1 in that the damper is on the discharge side rather than the suction side of the fan. As both sides of the furnace and control are similarly arranged a half view only is shown. In the illustration blower 7 is supplying the air for forced draft, its speed controlled by regulator 19 as explained for Fig. 1. A damper 180 is inserted in the discharge conduit 8 and restricts the discharge, its partially closed position being predetermined by the conditions under which the furnace operates. The damper opens to permit an unrestricted passage when blower 7 is acting as an induced draft fan. This change may be made manually but preferably is interconnected to act in conjunction with damper 6, when 6 is open, damper 180 is likewise wide open, thus permitting it to work automatically after being set to obtain the desired result. The insertion of the damper restricting the flow enables wide volume to be ob-

tained at the required pressure without a wide speed range.

Fig. 3 shows another embodiment of my invention. Fan 7 is coupled to two motors, a high speed motor 65a and a low speed motor 65 the speed of each being independently variable through adjustment of rheostats 183 and 182, respectively. In the illustration fan 7 is supplying forced draft being operated by the low speed motor 65. Arm 45 of regulator 19 is arranged to control the field rheostats 182 and 183 to vary the speed of the motor on the line with regulator 19 responsive to the same functions as explained for Fig. 1. When the furnace cycle is reversed and rod 62 changes the two-way valves it simultaneously operates arm 187 connected thereto through proper linkage, throwing switch 91 out of contact cutting out motor 65 and throwing switch 92 into contact cutting in the high speed motor 65a. This arrangement eliminates the wide speed range required when one motor drives the fan for both forced and induced draft.

I have shown three embodiments of my invention, in each the blowers are driven by variable speed motors in combination with an arrangement for restricting the sizes of the inlet or discharge orifices. These arrangements permit a wide volume range of air supplied at the required pressures without operating the blowers through a wide speed range thus obtaining an accurate proportionment of the air supply to meet the fluctuation within the furnace or due to change of operation. As the dampers and switches are arranged to act simultaneously with the operation of the stack dampers, fluctuations in the blower speeds are eliminated as the blowers are not required to search for a proper operating speed to meet the new conditions.

It may readily be seen that various combinations of the foregoing could be made without departing from the structures illustrated.

I claim:

1. In combination with a reversing furnace of the type wherein a pair of continuously operating blowers supply air under pressure into damper controlled Venturi sections of a pair of stacks and the furnace is reversed by reversing the position of the dampers in the stacks to cause the air delivered by one blower to be deflected at the closed damper and to thereupon pass into the melting chamber to which fuel is supplied and from which the air from the other blower induces withdrawal of the gases of combustion, the combination comprising a regulator associated with each blower and adapted to vary the speed thereof in response to a pressure differential varying with the volume of air delivered by the blower when supplying air for forced draft and in response to the pressure in the melting chamber when supplying air for inducing

draft, means for varying the air discharge supply from the blower comprising a damper closed to a predetermined position in the discharge conduit when the blower is supplying air for forced draft and opened to a predetermined position when supplying air for induced draft, and means acting simultaneously with the reversal of the stack dampers for reversing the position of the conduit damper.

2. In combination with a reversing furnace of the type wherein a pair of continuously operating blowers supply air under pressure into damper controlled Venturi sections of a pair of stacks and the furnace is reversed by reversing the position of the dampers in the stacks to cause the air delivered by one blower to be deflected at the closed damper and to thereupon pass into the melting chamber to which fuel is supplied and from which the air from the other blower induces withdrawal of the gases of combustion, the combination comprising a regulator associated with each blower and adapted to vary the speed thereof in response to a pressure differential varying with the volume of air delivered by the blower when supplying air for forced draft and in response to the pressure in the melting chamber when supplying air for inducing draft, means for varying the air discharge of the blower comprising a high speed motor and a low speed motor associated with each blower, and means acting simultaneously with reversal of the stack dampers for operating the blower with the low speed motor when supplying air for forced draft and with the high speed motor when supplying air for induced draft.

3. In combination with a reversing furnace of the type wherein a pair of continuously operating blowers supply air under pressure into damper controlled Venturi sections of a pair of stacks and the furnace is reversed by reversing the position of the dampers in the stacks to cause the air delivered by one blower to be deflected at the closed damper and to thereupon pass into the melting chamber to which fuel is supplied and from which the air from the other blower induces withdrawal of the gases of combustion, the combination comprising a regulator associated with each blower and adapted to vary the speed thereof, a member when in one position adapted to control the regulator in response to a pressure differential varying with the volume of air delivered by the blower and in another position adapted to control said regulator in response to the pressure in the melting chamber, and means operable synchronously with the movement of said member from one position to the other for changing the output of the blower from one predetermined value to another predetermined value whereby variation of blower speed throughout a predetermined range varies the volume of air delivered by the blower about the dif-

ferent predetermined values depending upon the position of said member.

4. In combination with a reversing furnace of the type wherein a pair of continuously operating blowers supply air under pressure into damper controlled Venturi sections of a pair of stacks and the furnace is reversed by reversing the position of the dampers in the stacks to cause the air delivered by one blower to be deflected at the closed damper and to thereupon pass into the melting chamber to which fuel is supplied and from which the air from the other blower induces withdrawal of the gases of combustion, the combination comprising a regulator associated with each blower and adapted to vary the speed thereof in response to a pressure differential varying with the volume of air delivered by the blower when supplying air for forced draft and in response to the pressure in the melting chamber when supplying air for inducing draft, and means for varying the ratio between the speed of the blower and the volume of air delivered thereby, said last mentioned means including a forced draft air supply intake duct, an inducing draft air supply intake duct and means acting simultaneously with the reversal of the stack dampers for alternately connecting the ducts with the intakes of the blowers.

5. The combination according to claim 4, including adjustable dampers in said ducts.

In testimony whereof, I have signed my name to this specification.

JAMES K. MAWHA.