

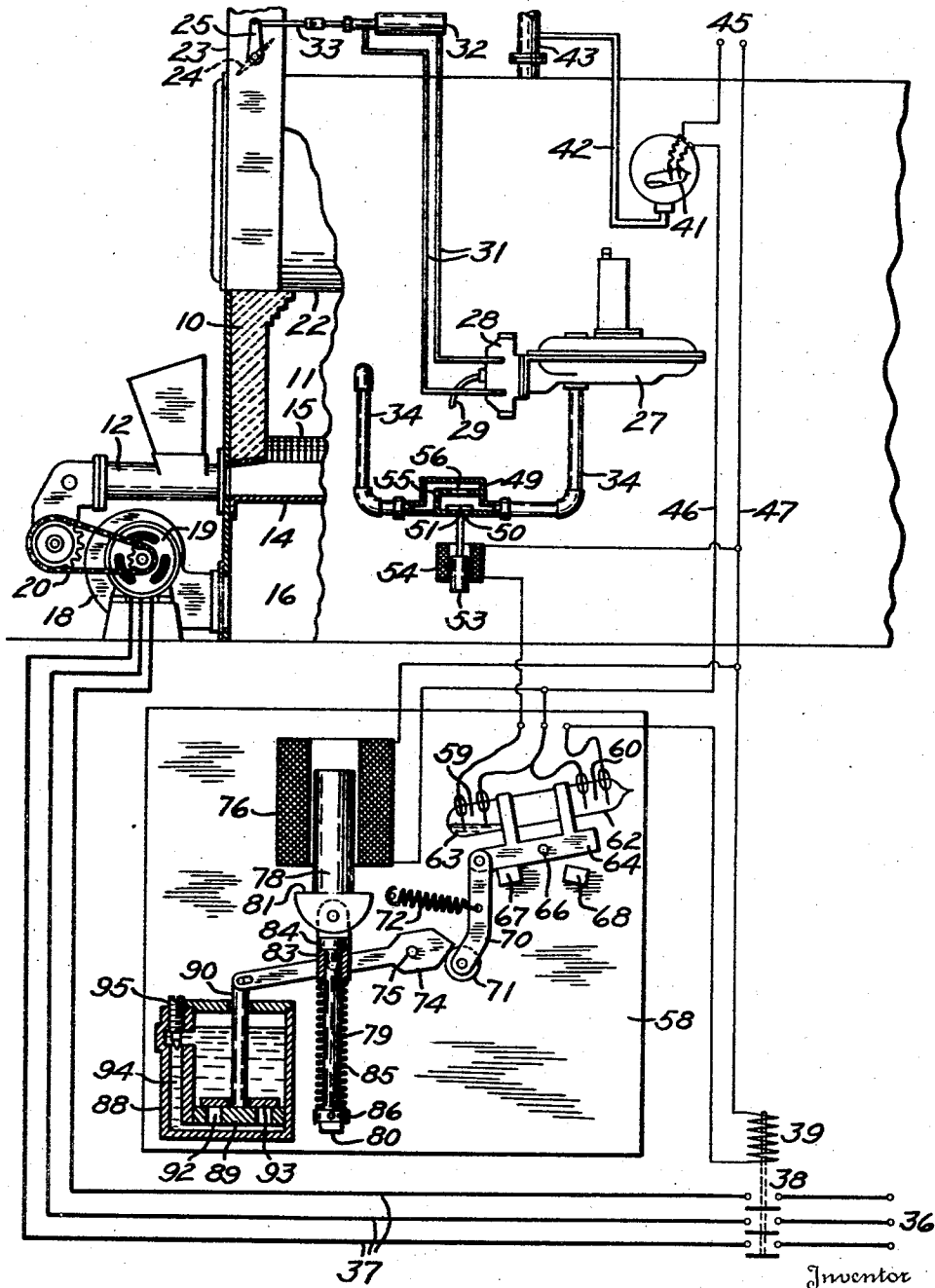
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FURNACE PRESSURE REGULATION

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## FURNACE PRESSURE REGULATION

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This invention relates to furnace pressure regulation, and more particularly to the regulation of pressure in a furnace having a forced draft air supply which is started automatically in response to a demand for heat.

It is common practice to control the pressure in a combustion chamber or furnace by regulating the discharge of the gaseous products of combustion from the furnace. This is ordinarily accomplished through the medium of an automatic regulator responsive to variations in furnace pressure and arranged to actuate a damper at the furnace outlet. The forced draft air supply to such a furnace is sometimes started automatically, usually by a thermostatic device or by a device responsive to variations in steam pressure. The sudden inrush of air causes the furnace pressure to increase, and the automatic regulator immediately starts to open the damper, which has remained nearly closed while the forced draft was shut down. In many cases the automatic regulator cannot open the damper with sufficient rapidity to avoid a considerable increase in furnace pressure, and as a result flame and smoke issue into the room from all cracks and openings in the furnace walls.

It is accordingly the main object of the present invention to overcome this difficulty and provide simple and reliable means to ensure a free discharge of gases from the furnace when the forced draft air supply is started.

It is a further object of the invention to provide simple and reliable means to move the furnace outlet damper automatically to open position just prior to each automatic starting of the forced draft air supply.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

Referring to the drawing illustrating one embodiment of the invention, and in which like reference numerals indicate like parts,

The single figure is a diagrammatic elevation, partly in section, of a forced draft furnace having automatic means for regulating the pressure therein.

The embodiment illustrated comprises walls 10 forming a furnace combustion chamber 11 fired by means of an underfeed stoker 12 having a retort 14 and tuyere blocks 15. Air is supplied to the space 16 beneath the retort by means of a forced draft fan 18 driven by a motor 19. The motor illustrated is an electric motor directly

connected to the fan, and it also serves to actuate the stoker 12 through a chain-and-sprocket drive 20. The heat from the furnace 11 is utilized to generate steam in a boiler 22 mounted thereabove. The furnace gases flow in contact with the boiler heating surfaces and then escape through a gas outlet or uptake 23 to a suitable stack (not shown). The gas outlet 23 is provided with an adjustable damper 24 having an operating arm 25.

The damper 24 is controlled automatically by a suitable regulator responsive to variations in the pressure in the furnace 11. For this purpose I preferably utilize an automatic regulator 27 of the type disclosed in the patent to Temple No. 1,992,048 granted February 19, 1935. This regulator comprises a pilot valve mechanism 28 supplied with a suitable fluid under pressure through a pipe 29 and connected by tubes 31 to a hydraulic motor 32. This motor 32 is connected to the damper operating arm 25 by means of a rod 33. The regulator 27 is connected to the furnace 11 by means of a pipe 34, so that the furnace pressure is effective to actuate the regulator. The regulator is adjusted to maintain a furnace pressure slightly below atmospheric pressure, say a negative pressure of one-tenth inch water column.

The electric motor 19 is connected to a suitable electrical supply 36 by means of conductors 37 which lead through an electro-magnetically actuated switch 38. This switch is provided with a holding coil 39, and the parts are so arranged that upon energization of this coil the switch will be closed and the motor 19 will start.

In order to control the rate of steam generation automatically, means is provided for starting and stopping the motor 19 at intervals in accordance with the demand for steam. For this purpose I have shown a pressure-actuated master switch 41 of the well-known mercury tube type connected by a pipe 42 to the steam delivery pipe 43 of the boiler 22, and arranged to close at a predetermined minimum steam pressure and open at a predetermined maximum steam pressure. This switch 41 serves to control the supply of electricity from a suitable source 45 to a pair of power leads 46 and 47. The source 45 is shown as independent of the source 36, but it will be understood that this is not necessarily the case.

It will now be apparent that if the holding coil 39 is connected directly across the power leads 46 and 47, as has been customary in the past, certain difficulties will arise. With the fan 18 shut down, combustion will be very slow, and the regulator 27 will hold the damper 24 in a nearly

closed position to maintain the desired pressure in the furnace 11. If now the steam pressure drops sufficiently to close the switch 41, and the fan motor 19 is immediately started, the regulator will be unable to open the damper fast enough to prevent a considerable increase in the furnace pressure, with attendant emission of flame and smoke.

In order to overcome this difficulty I provide means to vent the regulator 27 to atmosphere immediately upon closure of the pressure-actuated switch 41, and I provide means to interpose a slight time delay between closure of the switch 41 and closure of the switch 38. Since the regulator is adjusted for a slightly negative pressure, it will start to open the damper 24 immediately after being vented to atmosphere, and the time delay will allow completion of the opening movement before the forced draft supply is started.

In the preferred construction illustrated, a valve 49 is mounted in the pipe 34 to provide an atmospheric vent 50 controlled by a valve member 51. The valve member normally rests by gravity in a position to close the vent. The valve member 51 is directly connected to the plunger 53 of a solenoid 54, the parts being so arranged that upon energization of the solenoid, the plunger and valve member will be raised and the vent 50 opened. It is also desirable to close communication with the furnace 11 upon opening of the vent 50, so as to avoid a rush of air through the vent and into the furnace. For this purpose I provide a partition wall 55 which extends across the interior of the valve 49 between the vent and the furnace. This wall is provided with a port 56 located directly above the vent 50 and in a position to be closed by the valve member 51 when latter is raised by energization of the solenoid 54. It will be seen that this construction provides means whereby the regulator 27 may be connected to the furnace 11 when it is desired to control the furnace pressure, and to the atmosphere when it is desired to open the damper 24 fully and obtain a high draft in the furnace while the forced draft air supply is started.

An automatic switch mechanism 58 is provided to cooperate with the various other parts and ensure the desired time delay between energization of the solenoid 54 and closure of the switch 38. This mechanism 58 comprises a switch 59 connected in series with the solenoid 54 across the power leads 46 and 47, and a switch 60 connected in series with the holding coil 39 across the power leads 46 and 47. The parts are so arranged that when the switch 59 is closed, the switch 60 will be open, and vice versa. In the preferred construction both the switches 59 and 60 are formed in a single glass tube 62 containing a small amount of mercury 63. The tube 62 is supported in a clip 64 which is pivotally mounted on a pin 66, suitable stops 67 and 68 being provided to limit the pivotal movement of the clip. When the clip rests against the stop 67 the mercury 63 will close the switch 59, and when the clip rests against the stop 68 the mercury will close the switch 60.

In order to actuate the switches 59 and 60, I provide a link 70 pivoted at its upper end to the clip 64 and having a roller 71 at its lower end. A coiled tension spring 72 is connected to the link and holds the roller 71 in contact with the V-shaped end of a lever 74 which is pivotally supported on a pin 75. The movements of the lever 74 are controlled by means of a solenoid 76 connected across the power leads 46 and 47 and pro-

vided with a plunger 78 having a rod 79 pivotally suspended from its lower end. A stop 80 limits the downward movement of the rod, and a shoulder 81 on the plunger 78 limits the upward movement thereof by engaging the solenoid. The lever 74 is pivotally connected to a collar 83 slidably supported on the rod 79. This collar is urged upwardly into contact with a shoulder 84 on the rod by means of a coiled compression spring 85 surrounding the rod and supported at its lower end by a collar 86 fixed to the rod.

Movement of the lever 74 following energization of the solenoid 76 is retarded by a suitable dash pot 88 having a piston 89 connected by a piston rod 90 to the lever. The piston 89 is formed with ports 92 controlled by an annular valve 93 resting on the upper surface of the piston. A passage 94 connects the space above the piston with the space therebeneath, and a manually adjustable valve 95 is provided to control the flow in this passage. The dash pot is filled with a suitable liquid, such as oil.

The operation of the invention will now be apparent from the above disclosure. During the "off" period the parts will be in the positions shown in the drawing, with switches 41, 38 and 59 open, and switch 60 closed. The fan 18 and stoker 12 will be shut down, and the valve member 51 will close the vent 50. Under these conditions the regulator 27 will control the position of the damper 24 and maintain a pressure in the furnace 11 slightly below atmospheric pressure. If now the steam pressure drops to a predetermined value, the switch 41 will close, energizing the solenoids 54 and 76. The solenoid 54 will lift the valve member 51, closing the port 56 and opening the vent 50, whereupon the regulator 27 will start to move the damper 24 toward open position. At the same time, the solenoid 76 will lift the rod 79 and compress the spring 85, which will thereupon slowly raise the collar 83 and turn the lever 74 against the resistance of the dash pot 88.

After a time delay which can be adjusted by means of the dash pot valve 95 to allow the damper 24 to reach its open position, the lever 74 will have moved its V-shaped point slightly past the roller 71, whereupon the spring 72 will pull the roller down the other slope of the V and throw the clip 64 against the stop 68 with a snap action. This will close the switch 60, energizing the holding coil 39, closing the switch 38, and starting the motor 19, fan 18 and stoker 12. At the same time, the switch 59 will be opened, de-energizing the solenoid 54 and dropping the valve member 51 into position to close the vent 50. The regulator 27 will then control the damper 24 and maintain the desired pressure in the furnace 11.

Upon increase in the steam pressure to a value sufficient to open the switch 41, the solenoid 76 and the holding coil 39 will be de-energized. This will open the switch 38 and shut down the motor 19. At the same time, the plunger 78 and rod 79 will drop against the stop 80, and the clip 64 will snap into the position shown in the drawing, with the switch 60 closed and the switch 59 open. The valve 93 will open the ports 92 and allow the dash pot piston 89 to descend freely. The regulator 27 will continue to maintain the desired furnace pressure.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A control system for a furnace having a

forced draft air supply comprising a regulator normally responsive to the furnace pressure and arranged to maintain said pressure at a value slightly below atmospheric pressure by controlling the discharge of the gaseous products of combustion from the furnace, a device to start the forced draft air supply automatically in response to a demand for heat, and means to vent the regulator to atmosphere for a short time just prior to the starting of the forced draft air supply.

2. A control system for a furnace having a forced draft air supply comprising a regulator normally responsive to the furnace pressure and arranged to maintain said pressure at a value slightly below atmospheric pressure by controlling the discharge of the gaseous products of combustion from the furnace, means providing a vent through which atmospheric pressure may be effective on the regulator, a valve member normally closing the vent, a device to start the forced draft air supply automatically in response to a demand for heat, and means to move the valve member and open the vent for a short time just prior to the starting of the forced draft air supply.

3. A control system for a furnace having a forced draft air supply and a damper to control the discharge of the gaseous products of combustion from the furnace comprising a regulator normally responsive to the furnace pressure and arranged to maintain said pressure at a value slightly below atmospheric pressure by controlling the damper, a device to start the forced draft air supply automatically in response to a demand for heat, and means to vent the regulator to atmosphere for a short time just prior to the starting of the forced draft air supply.

4. A control system for a furnace having a forced draft air supply comprising a regulator normally responsive to the furnace pressure and arranged to maintain said pressure at a value slightly below atmospheric pressure by controlling the discharge of the gaseous products of combustion from the furnace, means providing a vent through which atmospheric pressure may be effective on the regulator, a valve member normally closing the vent, means to move the valve member and open the vent in response to a demand for heat, means to start the forced draft air supply a short time after the vent is opened, and means to move the valve member and close the vent when the forced draft air supply is started.

5. A control system for a furnace having a forced draft air supply comprising a regulator normally responsive to the furnace pressure and arranged to maintain said pressure at a value slightly below atmospheric pressure by controlling the discharge of the gaseous products of combustion from the furnace, a conduit arranged to transmit the furnace pressure to the regulator, said conduit having a port therein and an atmospheric vent between the port and the regulator, a valve normally closing the vent, a device to start the forced draft air supply automatically in response to a demand for heat, and means to move the valve into a position to open the vent and close the port for a short time just prior to the starting of the forced draft air supply.

6. A control system for a furnace having a forced draft air supply comprising a regulator normally responsive to the furnace pressure and arranged to maintain said pressure at a value slightly below atmospheric pressure by controlling the discharge of the gaseous products of combustion from the furnace, means providing a vent through which atmospheric pressure may be effective on the regulator, a valve member normally closing the vent, a solenoid to move the valve member and open the vent, a device to start the forced draft air supply automatically in response to a demand for heat, and means to energize the solenoid for a short time just prior to the starting of the forced draft air supply.

7. A control system for a furnace having a forced draft air supply comprising a regulator normally responsive to the furnace pressure and arranged to maintain said pressure at a value slightly below atmospheric pressure by controlling the discharge of the gaseous products of combustion from the furnace, means providing a vent through which atmospheric pressure may be effective on the regulator, a valve member normally closing the vent, a solenoid to move the valve member and open the vent, a starting mechanism for the forced draft air supply, a coil to actuate the starting mechanism, two electrical power leads, a device to energize the power leads in response to a demand for heat, a switch connected in series with the solenoid across the power leads, a switch connected in series with the coil across the power leads and arranged when energized to open the first switch and close the second switch, and means to provide a short time delay between energization of the last mentioned solenoid and actuation of the switches.

8. A control system for a furnace having a forced draft air supply comprising a regulator normally responsive to the furnace pressure and arranged to maintain said pressure at a value slightly below atmospheric pressure by controlling the discharge of the gaseous products of combustion from the furnace, means providing a vent through which atmospheric pressure may be effective on the regulator, a valve member normally closing the vent, a solenoid to move the valve member and open the vent, a starting mechanism for the forced draft air supply, a coil to actuate the starting mechanism, two electrical power leads, a device to energize the power leads in response to a demand for heat, a pivotally supported glass tube containing mercury and arranged to provide two switches one of which is open when the other is closed and vice versa, means connecting one switch in series with the solenoid across the power leads, means connecting the other switch in series with the coil across the power leads, a solenoid connected across the power leads and arranged when energized to tip the tube and close the switch which is connected with the coil and open the other switch, and a dash pot to provide a short time delay between energization of the last mentioned solenoid and tipping of the tube.

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