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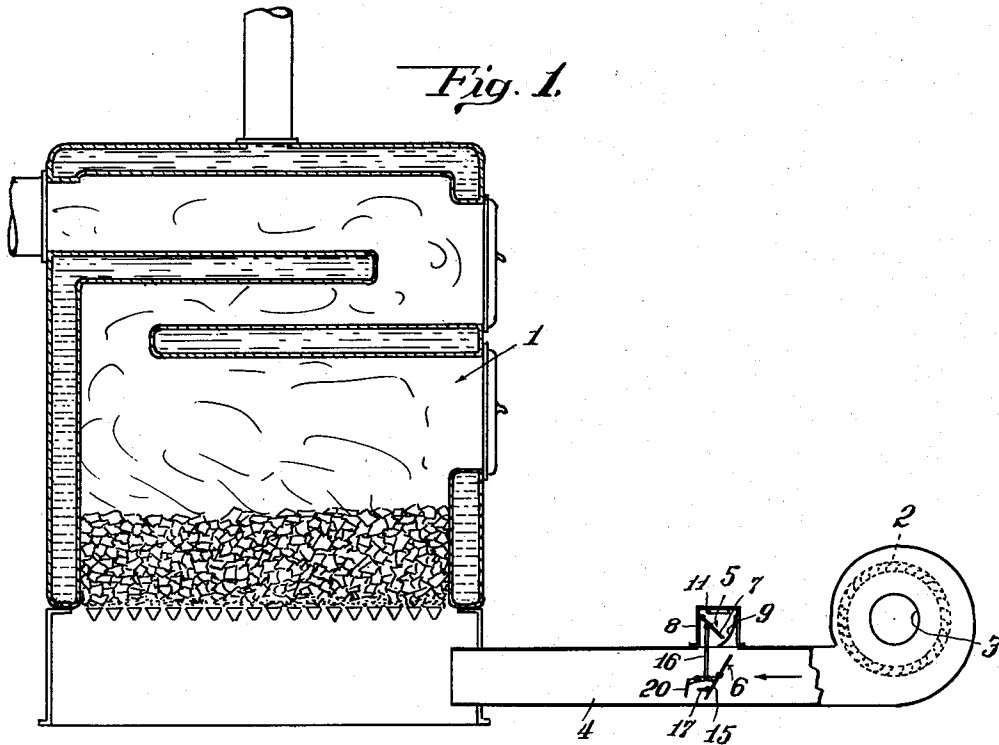
N. CUNNINGHAM

2,218,930

AUTOMATIC DRAFT CONTROL

Filed March 11, 1940

2 Sheets-Sheet 1



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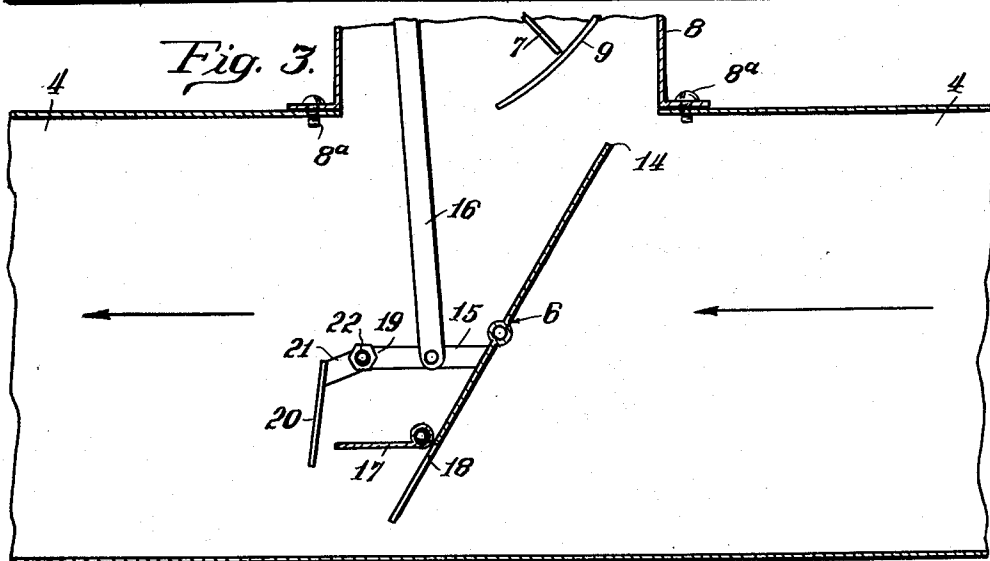
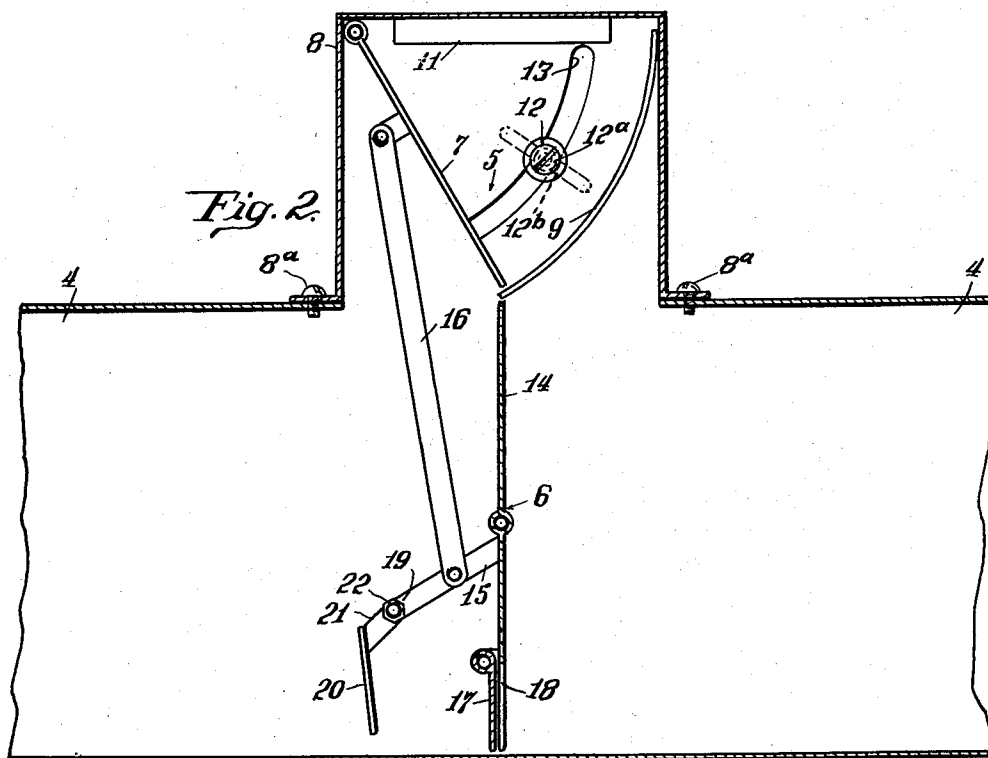
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AUTOMATIC DRAFT CONTROL

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5 Claims. (Cl. 236—45)

My invention is directed to apparatus for automatically controlling the air supply in forced draft firing of solid fuels. More specifically, it is directed to apparatus that will facilitate the proper proportioning to fuel bed requirements of the amount of air delivered by the blower or fan used in such forced draft firing. Also, it assures a minimum of useless combustion during the periods when the fan or blower producing the forced draft is not in operation.

In the firing of solid fuels it is impossible to maintain at all times uniform fuel bed textures and, as the textures of fuel beds vary, so does the air permeability of such fuel beds.

Where forced draft is used, it is customary to maintain uniform the rate of rotation of fans used in producing the forced draft and, at any particular rate of rotation, volume of air varies in inverse relation to the static back pressure against which such fans are required to deliver. When air permeability of any fuel bed increases, the static back pressure against the fan decreases and, unless fan output is controlled by manual or automatic means, the volume of air from the fan increases and the fuel bed is consumed at an excessive rate. Conversely, when a fuel bed becomes less air permeable, static pressure increases and the fan delivery, if uncontrolled, decreases thereby causing rate of combustion within the fuel bed to be reduced. Either of these conditions is undesirable.

It is not practicable to control closely the proper rates of air delivery from fans used in forced draft firing by manual regulation and a variety of automatic means are utilized for the purpose. These consist of devices which respond, either directly or indirectly, to changing static back pressures against which fans currently operate. In one type of such controls, impulses from varying static pressures within the duct leading from the fan to the windbox below the fuel bed provide the means for regulation. These pressure variations act upon pressure responsive mechanisms which in turn operate dampers to effect the desired control.

The regulating member of an automatic air control is customarily a butterfly damper, that is, one which opposes to the flow of air equal surfaces on either side of an axis about which it may rotate. Such butterfly dampers may be either single blades effective over entire duct cross-sections or multiple blades, each centrally balanced and interconnected to act in unison. To properly position such dampers there must be provided an actuating means which is responsive

to changes in static back pressures which occur in the windbox below the fuel bed.

In forced draft firing, the periods during which the fan is inoperative are herein referred to as "off periods" while the periods during which the fan is supplying forced draft are referred to as "on periods." During "on periods" in any forced draft system, the true static back pressure of a fuel bed which is receiving adequate air for combustion is the resultant of fan pressure and fuel bed air permeability. When an "on period" occurs after an "off period" there should be an immediate build-up of static pressure below the fire and this necessitates a flow of air from the fan to the windbox. Without such flow of air the actuating member will not receive sufficient impulse to cause proper response and there will not occur a correct setting to fuel bed requirements of the regulating member of an automatic control.

The proper functioning of an automatic air control is two-fold: it should assure minimum fuel bed combustion during "off periods" and also correctly proportion air delivery during "on periods." In the past it has been found that, if the regulating member of an automatic air control was effective in minimizing air flow to the fuel bed during "off periods" it failed to allow the passage of sufficient air to develop against the actuating medium the true static back pressure represented by the depth and air permeability of the fuel bed. It has heretofore been impossible to provide an air regulating member to be both effective in minimizing air flow during "off periods" and also to allow air pressure sufficient to cause a proper build-up of static back pressure when "on periods" occur.

Since optimum conditions both during on and off periods could not be secured and, as correct air proportionment during "on periods" is the more important of the two, it has been customary to design the regulating members of such automatic air controls to fit loosely even though in so doing much of their effectiveness during "off periods" is sacrificed.

Coal is the normal fuel used where forced draft firing is practiced. Air permeability of fuel beds is chiefly determined by coal caking and coking characteristics. Some coals form coke which is hard and relatively air impermeable whereas the coke which forms when another type of coal is used is soft and readily air permeable. Still other coals form a surface cake during "off periods" and, until this cake is broken, it is resistant to passage of air. Due to variations in

fuel bed characteristics of coal from various producing areas, it is necessary that a control system have means for adjustment and regulation in order to properly meter air in forced draft firing.

The primary object of my invention is to provide an automatic air control having a close fitting regulating damper which will allow a minimum of air passage during "off periods" but will permit immediately an "on period" operation occurs, a stream of air to be directed against a lifting member to preliminarily open the damper so that a sufficient amount of air quickly reaches the fuel bed to build up the static pressure in the air conduit to actuate the pressure responsive member.

Another object of this invention is to provide a lifting member on the fuel bed side of the damper that may be adjusted relative to the damper to increase or decrease its lifting effect.

Still another object is to provide such a lifting member that also functions as a counter-weight to oppose the full opening of the damper depending upon its position relative thereto.

A further object is to provide an adjustable stop member for limiting the damper opening.

Further objects and advantages will be apparent from an examination of the following detailed description.

The full nature of my invention will be understood from the accompanying drawings and the following description and claims.

Fig. 1 is a sectional view showing a forced draft firing system embodying my automatic air control.

Fig. 2 is an enlarged sectional view of the air control shown in Fig. 1 during "off operation."

Fig. 3 is a sectional view showing the air control in initial opening position during "on operation."

In the drawings, 1 indicates a furnace or boiler, 2 a fan controlled by thermostatic means (not shown) as is well known in the art, 3 is an air inlet opening to the fan through which it draws the air which it moves to the wind-box below the fuel bed and 4 is an air duct leading from the fan to the wind-box. The air control is shown attached to the air duct; it is positioned between the fan and the wind-box and comprises generally a pressure responsive actuating member 5 and a regulating member 6 operably controlled by member 5.

In detail the actuating member 5 comprises a pressure responsive plate 7 pivotally mounted in a housing 8, the free end of which moves adjacent the curved plate 9; housing 8 is open into the air duct from the bottom of plate 9 to wall of the housing toward the wind-box and is vented to the atmosphere by a fixed opening 11 adjacent the upper end of plate 9. Housing 8 is removably secured to the air duct 4 by means of screws 8a. A stop member 12 comprising a bolt 12a and nut 12b is adjustably fastened in a curved slot 13 in a side wall of housing 8 to control the maximum upward swing of the free end of plate 7 which in turn controls the maximum opening of damper 14.

The regulating member comprises a butterfly damper 14 pivotally mounted within the duct 4 and adapted to effectively close said duct. Secured to damper 14 below the point of pivot on the wind-box side of the damper is a rigid extension 15. A connecting arm 16 is pivotally joined to plate 7 at its upper end and to extension 15 at its lower end to operably join the pressure

responsive plate 7 with damper 14. A swinging plate 17 provides a closure for an air passageway 18 positioned in damper 14, said plate being of sufficient weight to close opening 18 during "off periods" and to be moved to open position during "on periods." A lifting blade 20 having a rigid arm 21 is adjustably attached by a screw and nut 22 to the end 19 of the extension 15, lifting blade 20 being positioned to receive the force of the jet of air from air passageway 18, the resultant lifting effect being conditioned upon the angularity of blade 20 in the air jet. It will be apparent that during "on periods" of forced draft firing the extent to which damper 14 opens will determine the amount of air which the fuel bed will receive from the fan and that the opening of this damper is controlled by the static back pressure of the fuel bed exerted against the pressure responsive plate 7 in combination with the lifting effect exerted by the lifting blade 20, the maximum opening of damper 14 being determined by the positioning of the stop 12.

In operation the position of the elements of the air control as shown in Fig. 2 is for "off periods" of forced draft operation, during which the passage of air through duct 4 induced by natural draft is minimized by the close fitting of damper 14 and swing plate 17. However, when an "on period" occurs, immediately the air moved by the fan will strike plate 17 causing it to open and the stream of air moving through passageway 18 will contact blade 20 to exert a lifting force on it, which will resultantly open damper 14 to admit more draft to the fuel bed. At once a resistance is encountered dependent upon the permeability of the fuel bed. This resistance produces a static pressure in the furnace side of conduit 4 of definite value. This pressure will actuate pressure responsive plate 7 to open damper 14 partially or wholly depending upon the amount of the static pressure. The amount of static pressure which must be exerted against 7 in order to obtain any desirable opening of 14 is controlled by the angularity of lifter 20 with reference to the jet of air passing the opening 18. Further, as the extent of opening of damper 14 increases, the weight of the arm and blade structure, 19, 20 and 21, causes a progressively increasing counter-weighting effect which, in combination with the paralleling of the blade 20 with the air flow, retards the tendency of the damper 14 to fly to full open position.

Under certain conditions generally variable with the type of coal used as fuel it is desirable to restrict the damper opening so that at no time may it be full open. The adjustable stop 12 controls this and may be positioned at any desired point along curved slot 13 to so restrict the amount of forced draft directed to the fuel bed.

The relative position of blade 20 to the air stream passing through 18 determines its lifting power and under similar varying conditions its angle may be changed to determine the extent of the preliminary opening of damper 14. It is clear that if adjusted so as to be parallel to the direction of the air stream it will not be affected by the air jet but as the angle is increased the amount of its lifting movement will be increased. The adjusting means 22 are accessible by removing housing 8.

By the use of air passage-way 18 and closure plate 17 conduit 4 is practically closed to air passage during "off periods" of forced draft firing but the damper 14 is almost immediately opened the correct distance when "on" oper-

ation occurs due to the air jet passing through 18 and striking lifting blade 20. This feature is used in my invention for actuating a regulation of air flow characteristics as well as for the purpose above stated. Hence the invention consists in a combination of the following elements: A by-pass to allow a close fitting damper, a non-variable static pressure responsive element, a member regulable to produce variable auxiliary lifting and counter-weighting effects depending upon the angularity of its setting relative to an air jet and a quantitative adjustment for air flows consisting of an adjustable stop limiting maximum damper opening. The manner of combining, arranging and applying these elements as disclosed is changeable to secure similar effects and it is understood that my invention applies to the use of the elements stated in any combination which secures qualitative and quantitative air adjustment in forced draft firing of solid fuels substantially as described.

I claim:

1. In an automatic air control for use in forced draft firing comprising an air conduit, a damper positioned in the conduit, means responsive to static pressure for opening said damper, an air passageway from one side of said damper to the other and a valve normally closing said passageway but adapted to open when forced draft is directed against the closed damper, the improvement that comprises a lifting member operably joined to said damper and positioned adjacent said passageway whereby air passing there-through will strike said lifting member to open said damper.

2. In an automatic air control for use in forced draft firing comprising an air conduit, a damper positioned in the conduit, means responsive to static pressure for opening said damper, an air passageway through said damper and a door normally closing said passageway but adapted to open under pressure of forced draft, the improvement that comprises a lifting member secured to said damper and adapted to be struck

by the air jet passing through said air passageway and means for adjusting said lifting member to vary its angle relative to the direction of the air jet to regulate its lifting effect.

3. In an automatic air control for use in forced draft firing comprising an air conduit, a damper positioned in the conduit, means responsive to static pressure for opening said damper, and an orifice through said damper the improvement that comprises a blade positioned in the path of air flowing through said orifice, said blade being connected to said damper so as to exert a turning effect on said damper in the direction of its opening.

4. Automatic air control for use in forced draft firing comprising an air conduit, a damper positioned in the air conduit, means responsive to static pressure in the conduit for opening the damper, an air passageway leading from one side of the damper to the other, a valve normally closing said passageway but adapted to open under forced draft, a lifting blade joined to said damper and normally positioned adjacent and opposing the air passageway and adapted to be moved by forced draft passing therethrough, and adjustable means for limiting the maximum opening of said damper.

5. Automatic air control for use in forced draft firing comprising an air conduit, a damper positioned in the air conduit, means responsive to static pressure in the conduit for opening the damper, an air passageway through said damper, a swinging door normally closing said passageway, means for effecting a movement of air against said damper to open said door, a lifting blade secured to the damper on the side opposite the draft effecting means and positioned so as to be in the path of the air jet passing through the passageway, means for regulating the angle of said blade relative to the direction of the air jet to vary the degree it will open the damper and an adjustable stop member for limiting the maximum opening of the damper.

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