

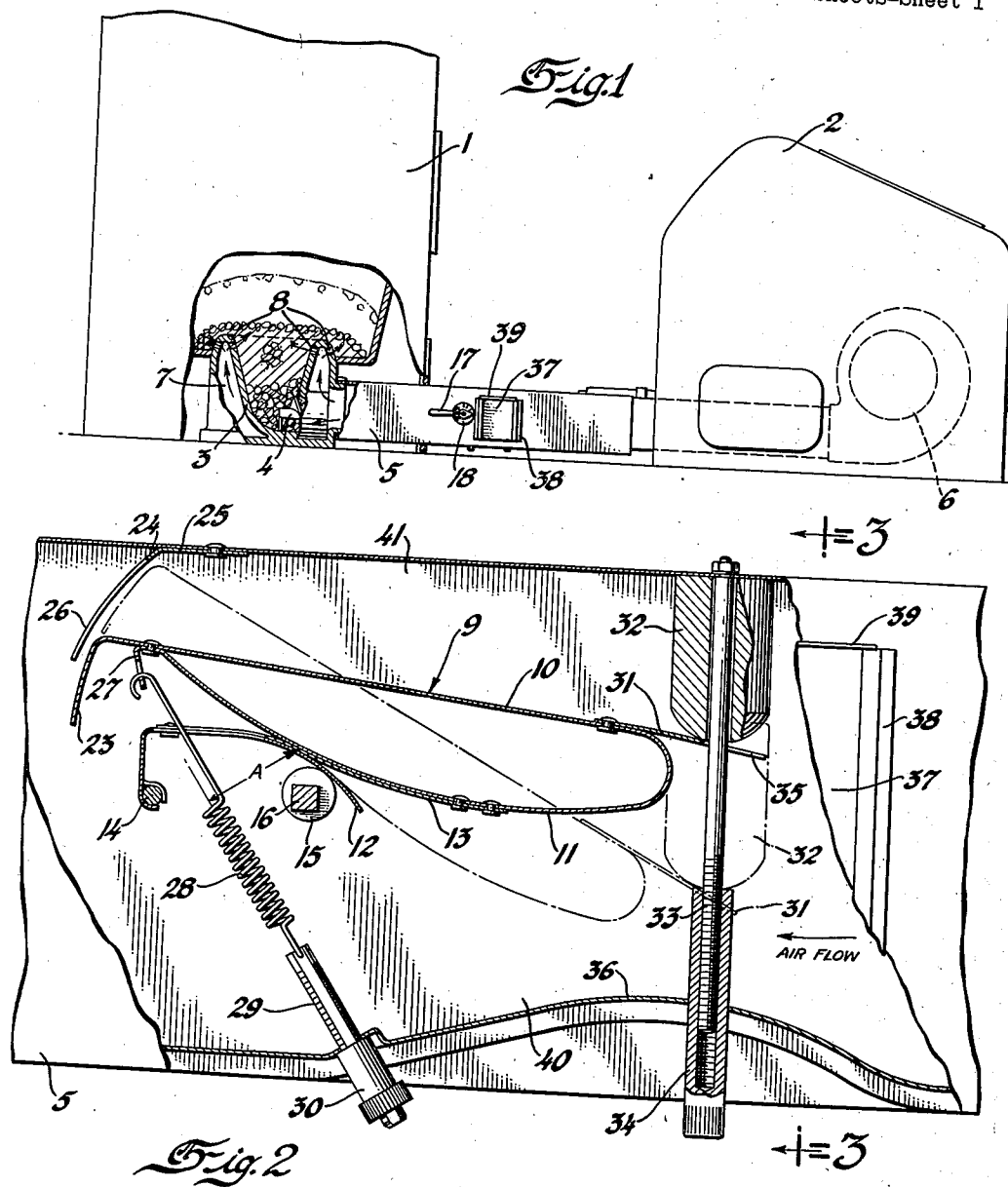
Nov. 25, 1941.

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AIR CONTROL MECHANISM

2,263,980

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2 Sheets-Sheet 1



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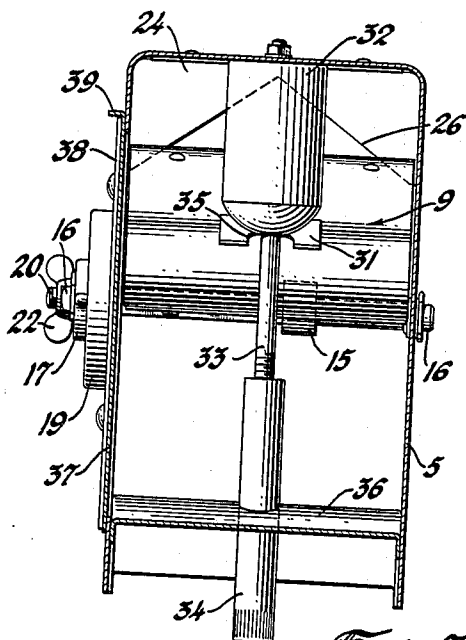


Fig. 3

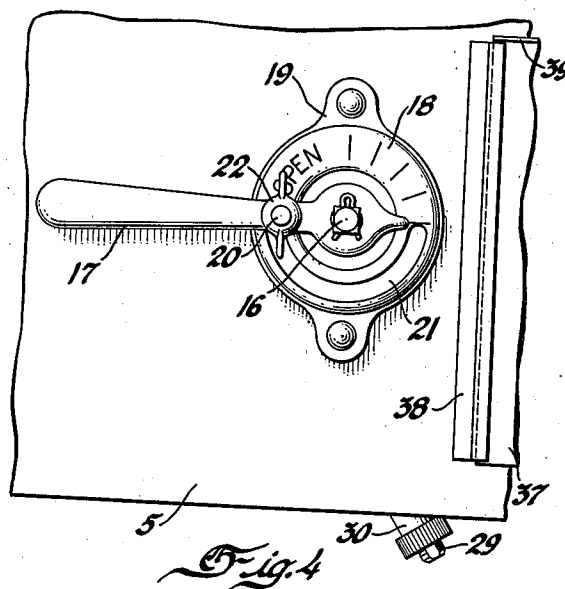


Fig. 4

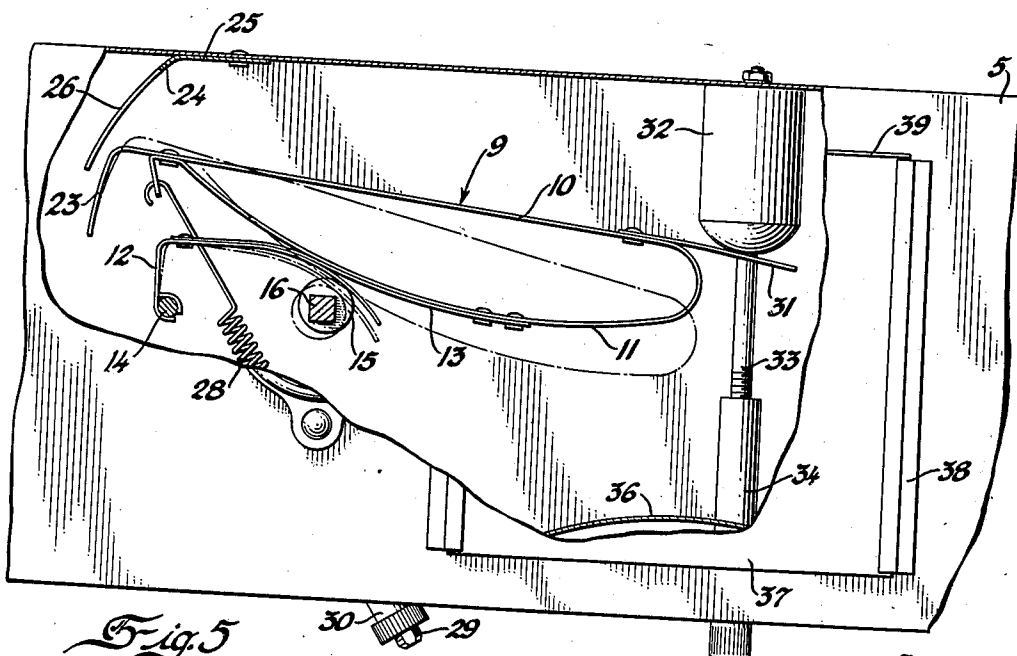


Fig. 5

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UNITED STATES PATENT OFFICE

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AIR CONTROL MECHANISM

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This invention relates generally to an air control mechanism and more particularly to a mechanism which is adapted to automatically regulate or control the flow of a forced draft of air to the fuel or fire bed of a mechanical stoker.

In the usual types of domestic stokers, it is customary to provide for the intermittent feeding of fuel and the supply of air under pressure to the fuel bed only during the fuel feeding period and rely upon a natural draft to maintain combustion during the intervals between the feeding periods. The frequency and length of the feeding periods are generally controlled primarily in accordance with the varying demands for heat with means to also provide for intermittent operation at predetermined intervals to maintain combustion when there is no demand for heat.

Under such varying conditions of operation as are set forth above, it will be apparent that there may be considerable variation in the thickness of the fuel bed and the amount of resistance which is offered thereby to the air flow through the bed, and to assure sufficient air to obtain proper combustion when the fuel bed is thick and prevent excessive draft when the fuel bed is thin, it has been found desirable to provide some means to regulate the air flow in accordance with the resistance offered by the fuel bed.

It has also been determined that there is both a predetermined thickness of fuel bed and a certain rate of combustion with a definite relation between the fuel and air feed which will provide the maximum efficiency during the operating periods of the stoker. Although this predetermined thickness of the fuel bed cannot be constantly maintained because of the varying conditions of operation, it has been found that such thickness may be obtained during the fuel and air feeding periods by so controlling or regulating the air supply that an excess volume of air is provided when the bed is too thick to increase the rate of combustion and thereby reduce the thickness of the fuel bed and a deficient volume of air is provided when the bed is too thin to reduce the rate of combustion and thereby increase the thickness of the fuel bed.

The principal object of the present invention is the provision of a mechanism which will automatically regulate or control the flow of a forced draft of air to the fuel bed of a mechanical stoker.

A further object of the invention is to provide such a mechanism as will regulate the air flow automatically in accordance with the re-

sistance offered by the fuel bed and function as described above to obtain and maintain a predetermined thickness of the fuel bed within practical limits.

A further object is to provide such a mechanism in the form of a self-adjusting damper placed in the air delivery duct extending from the outlet of the forced draft fan or blower to the fuel bed, and which is so constructed and mounted as to automatically regulate the air flow to the fuel bed in the desired manner.

A still further object is to provide a self-adjusting damper of this character which incorporates manually operable adjusting means to permit adjustment of the automatic operating characteristics and adjustment of the range of operation to compensate for variations in the quality of the fuel or changes in the rate of fuel feed.

Other objects and the advantages of the present invention will be apparent from the following description of an embodiment thereof which is illustrated in the accompanying drawings in which:

Figure 1 is a diagrammatic side elevation, with parts in section, of a furnace provided with a stoker embodying the present invention.

Figure 2 is a longitudinal cross section, with parts in elevation, of the stoker air duct and the self-adjusting damper.

Figure 3 is a transverse cross section on the line 3—3 of Figure 2.

Figure 4 is a side elevation of the air duct showing an adjusting means for the damper.

Figure 5 is a side elevation of a portion of the air duct with part of the wall broken away to illustrate the damper in side elevation.

Referring first to Figure 1 for a diagrammatic showing of one application of the invention, a furnace 1 is shown as provided with an underfeed stoker 2 which is adapted to feed fuel to the fire pot 3 as by a motor driven screw 4. The air for combustion is supplied by a duct 5 connected to a forced draft fan or blower 6; to an air chamber 7 and to the fuel bed through the ports 8.

The air control mechanism which is the subject of the present invention includes the damper indicated generally at 9 which is located in the air duct 5 intermediate the blower 6 and the air chamber 7 and which is constructed and arranged in the manner now to be described in detail.

The damper is in the nature of a vane which is formed of sheet metal to the configuration

shown in Figures 2 and 5 with a substantially flat upper surface 10 and a curved lower surface 11 for purposes to be hereinafter set forth. There is no fixed pivot for the damper but it is supported by and adapted to roll upon a curved pivot or fulcrum plate 12 to which the damper is secured against longitudinal shifting by a thin flexible metallic strap or hinge 13 which may be interposed between the curved lower surface 11 of the damper and the plate 12 with one end of said strap riveted to the damper and the other end riveted to the plate.

The curved plate 12 is pivotally supported adjacent one end on the shaft 14 extending between the side walls of the air duct 5 and is supported adjacent its other end by a cam 15 fixed on the shaft 16 which also extends between the side walls of the air duct. The shaft 16 is formed with a squared portion extending outside of one of the side walls to provide for the connection thereto of a handle 17 by means of which the shaft 16 and cam 15 may be rotated to adjust the position of the plate 12 about the pivot shaft 14. The handle 17 is formed with a pointer operating over a graduated indicating scale 18 on a plate 19 secured to the side wall of the air duct, and any known means may be provided to hold the handle at any desired point of adjustment such as the means indicated in Figure 4 which consists of a bolt 20 extending through the handle 17 and an arcuate slot 21 in the plate 19 with its head positioned between the plate 19 and the adjacent side wall of the air duct 5 and with a wing nut 22 on said bolt whereby the handle 17 may be frictionally secured to the plate 19.

At one end, the damper is bent downwardly to provide a transverse depending curved wall 23 and associated therewith is a depending curved wall 24 on the sheet metal plate 25 which is secured to the upper wall of the air duct 5. This wall 24 is formed with a V-shaped notch 26 and during movement of the damper on the curved fulcrum plate 12, the wall 23 moves closely adjacent to the wall 24 and functions as a valve controlling the passage of air through the V-shaped notch for a purpose to be hereinafter described.

Adjacent this end, the damper is also formed with a depending ear or lug 27 having an opening to receive the upper hooked end of a tension spring 28 which extends diagonally downwardly through a slot in the strap 13 and an opening in the plate 12 as shown in Figure 2. The lower end of the spring 28 engages with a screw-threaded stud 29 which extends through an opening in an angularly offset portion of the bottom wall of the air duct 5 and is provided exteriorly thereof with the nut 30 to afford manual adjustment of the spring tension.

The opposite end of the damper is provided with an extension in the form of a plate 31 which is adapted to be engaged by a weight 32 which slides vertically on the guide rod 33 extending between the upper and lower walls of the air duct 5. The lower end of the guide rod 33 is screw threaded to receive the elongated nut 34 extending through the lower wall of the air duct and provides a manually adjustable stop to limit the downward movement of the weight 32. The free end of the plate 31 is formed with an open slot 35 to receive the guide rod 33 and this slot is also of sufficient width to prevent contact of the plate with the upper end of the stop nut 34.

The bottom wall of the air duct 5 is curved upwardly adjacent the guide rod 33 as indicated at 36 in Figure 2 for a purpose to be hereinafter set

forth, and a portion of the side wall of the air duct is cut away adjacent the damper to provide an inspection opening which may be normally closed by the plate or cover 37 mounted to slide in the vertical guides 38 with the upper edge of said plate or cover bent outwardly to provide a flange 39 thereon to limit downward movement of the cover by contact with the upper ends of the guides 38 and afford means to grasp said cover to open or remove the same when desired.

Proceeding now to a description of the operation, it has been stated that the damper mechanism is adapted to automatically regulate the air flow in the air delivery duct from the fan or blower to the fuel bed in accordance with the variations in the resistance to the flow of air through the fuel bed.

It may be generally stated that the operation of the damper to change the volume of air which may pass through the duct is primarily regulated by the velocity of the air in the duct which will vary in accordance with the back pressure caused by the fuel bed resistance. The static pressure in the duct between the damper and the fuel bed is a function of the velocity of the air flow and the resistance interposed by the fuel bed and it is desired to obtain by the damper a substantially linear change in the volume of air with the linear change of static pressure.

Referring now to Figure 2, the damper 9 has been shown in full lines in the idle position which it assumes when adjusted for a high rate of coal feed in which the maximum volume of air may flow through the duct to the fuel bed. In order to obtain effective regulation, this maximum volume of air is equal to or in excess of the amount that would be required at any time, and as will be explained hereinafter, the damper will roll on the fulcrum plate 12 and occupy some position during normal operation which is between the full line position and that shown in dotted lines in which substantially the minimum volume of air may flow through the duct to the fuel bed.

It will first be apparent that the adjustable tension spring 28 exerts a force to hold the damper in the idle position when the stoker feed screw and blower are not operating and offers a regulatable resistance to closing of the damper during operation of such stoker mechanism. The anchorage end of the spring 28 is so located as to position such spring at an acute angle to the longitudinal axis of the damper 9, and this angle is such, in relation to the variable fulcrum, that the ultimate result of the damper movement is to maintain a substantially constant torque arm on the damper and provide resistance to closing of the damper which increases by the stretch of the spring only.

The effective length of the spring arm is represented by the dotted line A in Figure 2, and it will be seen that the spring 28 can be so placed with reference to the fulcrum plate 12 that this length A is substantially constant over the working range of the damper. If the spring 28 was, for example, anchored at a point so that a greater angle was formed between the axis of the spring and the upper surface 10 of the damper, the length of A would increase as the damper closes. While it has been found that for application to domestic coal stokers the length of A should be maintained reasonably constant, conditions may arise on other applications where it would be desirable to have the length of A or the effective length of the spring arm increase

or decrease as the damper closes which may readily be achieved by changing the anchorage point of the spring 28.

To provide for the proper operation of the damper by the air forces in the manner hereinafter described, it is necessary that the initial tension of the spring 28 be just sufficient to overcome the force exerted by the damper and hold the damper in the idle position shown in full lines in Figure 2. If no weight (such as 32) is provided, the initial tension of the spring 28 would have to be so low that the damper would be subject to oscillations of a high period and to hunting or fluttering because of the practically frictionless mounting of the damper on the curved fulcrum plate 12.

Such hunting or fluttering would arise if the damper momentarily overshoots its normal operating position at any time such as would occur on a sudden movement of the damper when its inertia would carry it past its normal operating position thereby storing extra energy in the spring 28 which would cause a movement in the reverse direction past its normal operating position and the resulting surges in the air flow would tend to sustain this hunting or fluttering of the damper.

To overcome this unstable condition, the weight 32 is provided to exert a force tending to close the damper and permit an increase in the initial tension of spring 28 and thereby reduce the periodicity of the damper oscillations, and this weight 32 is so mounted as to function also as a dampening means to prevent hunting or fluttering.

If the weight 32 were attached directly to the damper its only effect would be to reduce the periodicity of the oscillations and the damper would still be unstable and subject to hunting or fluttering. The weight is, however, mounted as shown to slide vertically on the guide rod 33 and rest upon the damper extension plate 31, and the friction which is thereby introduced between the weight 32 and the guide rod 33 and between the weight and the plate 31 functions to dampen out and prevent this hunting or fluttering of the damper. Since the weight 32 is free to move independently of the damper 9, it also does not respond to the same frequency and thus acts to dampen out any oscillation or hunting action.

It has been found desirable to relieve the damper of any controlling force from the weight 32 when the damper approaches its lowest position and the adjustable stop nut 34 is adapted to engage and limit the downward movement of the weight 32 while permitting continued closing movement of the damper until it contacts with the walls of the air duct 5. With the force exerted by the weight removed by the engagement of the weight 32 with the stop nut 34, it will be seen that the downward motion of the damper 9 will be rapidly checked by the spring 28.

Considering now the air forces acting on the damper which are adapted to automatically regulate its position in accordance with the resistance offered by the fuel bed, it will first be noted that the air flow in the air duct 5 is in the direction indicated by the arrow in Figure 2. The damper 9 is of generally airfoil shape and the movement thereof about the curved fulcrum plate 12 is a result of the reaction on its surfaces of the air flow through the air duct.

The curved lower surface 11 of the damper is so arranged with reference to the upwardly

curved portion 36 of the air duct 5 as to form a Venturi passage 40 between the damper and the bottom wall of the air duct which functions to exert a suction or vacuum tending to pull the damper downwardly or in a direction to close the air duct. The suction force exerted by this Venturi action varies in accordance with the air velocity and the area of the Venturi passage. The air velocity is determined by the resistance of the fuel bed. When the fuel bed is thick the air velocity will be low and the suction effect of the venturi will be low. When the fuel bed is thin the air velocity will be high and the suction effect will be high which will tend to close the damper and reduce the area of the Venturi passage 40, which in turn reduces the total volume of air which may pass through this passage.

This Venturi action is however not sufficient to operate the damper and is supplemented by the application of air pressure above the damper. In the position of the damper shown in full lines in Figure 2, the air flow is divided by the damper into two paths with the air flowing through the Venturi passage 40 below the damper and through a passage 41 between the upper surface 10 of the damper and the upper wall of the air duct. The air which flows through the passage 41 passes through the V-shaped notch 26 in the wall 24 and the amount of air flow through this passage and therefore the pressure differential between the top and bottom of the damper will be determined by the size of this notch 26. It has been heretofore noted that the wall 23 on the damper functions as a valve across the wall 24 and it will be apparent that the effective area of the notch 26 during operation will be dependent upon the position of the damper, and that as the damper moves in a direction to reduce the size of the Venturi passage 40, the area of the notch 26 will also be reduced to lower the volume of air flow through the passage 41.

The air flow in the passage 41 exerts a pressure on the upper surface 10 of the damper which, in effect, may be divided into two components, acting in opposition to one another on opposite sides of the fulcrum point of the damper on the curved fulcrum plate 12. The air pressure acting on that portion of the damper surface 10 between the fulcrum point and the end of the damper with the wall 23 exerts an opening force or a force tending to rotate the damper in a counter-clockwise direction and open the damper, whereas the air pressure acting on that portion of the damper surface 10 between the fulcrum point and the end of the damper with the plate 31 exerts a closing force or a force tending to rotate the damper in a clockwise direction and close the damper. The relative magnitudes of these components, acting as opening and closing forces on the damper, are dependent upon the relative areas of the damper surface 10 on each side of the fulcrum point.

As will be apparent from the showing in Figure 2, the fulcrum of the damper is closer to one end of the damper when in its full line position so that the closing force is greater than the opening force, but the fulcrum shifts during closing movement of the damper towards the longitudinal center of the damper resulting in an increase in the opening force and a decrease in the closing force until such forces are substantially balanced when the damper is practically closed.

Summarizing the several forces acting on the damper, it will be seen that both the spring 28 and the air pressure on the upper surface of the

damper between the fulcrum point and the end of the damper with the wall 23 exert forces tending to open the damper, whereas the dampening weight 32, Venturi passage 40, and the air pressure on the upper surface of the damper between the fulcrum point and the end of the damper with the plate 31 exert forces tending to close the damper.

These several forces are so related and proportioned that when the fuel bed is relatively thick and offers a high resistance, the relatively low velocity of the air flow through the air duct will cause only a slight closing movement of the damper from the idle position and permit the flow of a relatively large volume of air (which is in excess of the volume of air normally required) through the passages 40 and 41 to thereby increase the normal rate of combustion and reduce the thickness of the fuel bed.

If, however, the fuel bed is relatively thin and offers only a slight resistance, the relatively high velocity of the air flow through the air duct will act on the damper to close the passages 40 and 41 to such an extent that a deficient volume of air will be supplied to the fuel bed to reduce the normal rate of combustion and thereby permit the fuel bed to increase in thickness.

The damper will adjust itself automatically during operation in response to changes in the velocity of the air flow in accordance with changes in the thickness of the fuel bed to permit the supply of that volume of air which will tend to establish and then maintain the fuel bed at the desired thickness.

Various adjustments are provided to change the automatic operating characteristics and the range of operation to adapt the damper operation for variations in the quality of the fuel or changes in the rate of fuel feed. The principal adjustment is afforded by the damper handle 17 by means of which the eccentric or cam 15 may be rotated to vary the position of the fulcrum plate 12 about the pivot shaft 14. In the damper position shown in full lines in both Figures 2 and 5, the cam 15 is adjusted for a high rate of coal feed, whereas in Figure 5, the cam 15 is shown in dotted lines as having been rotated to permit the fulcrum plate 12 to assume a lower position for a low rate of coal feed in which the damper would assume the idle position shown in dotted lines in which it is partially closed. It will also be seen that rotation of the cam 15 and the resulting change in position of the fulcrum plate 12 will change the fulcrum point of the damper and thus vary the relative pressures acting on the damper on each side of the damper fulcrum.

A further adjustment is afforded by the adjustability of the tension of the spring 28 to change the force of this spring which opposes the closing movement of the damper under the influence of the velocity of the air flow in the air duct. It will also be apparent that the shape or size of the V-shaped notch 26 can be modified to change the volume of air which may flow through the passage 41 and change the pressure differential between the top and bottom of the damper.

Whereas the automatic air control mechanism of the present invention was designed for use in a domestic underfeed stoker for intermittent operation and has been so illustrated and described herein, it should be understood that the invention is not limited to this particular use but may be generally used with other types of heating

devices wherein it may be desired to automatically regulate a forced draft in accordance with the resistance of the fuel bed, or it may be used to control the fluid flow in the duct of any forced draft system.

It will also be understood that the invention is not to be limited to the details of the mechanism of the single embodiment illustrated and described herein but that many modifications and changes may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. The combination with a duct for conveying air under pressure, of means to regulate the volume of air flow through said duct comprising a damper in said duct, a curved plate to support said damper intermediate its ends and provide a shifting fulcrum therefor, and manually adjustable means to change the position of said curved plate and the fulcrum point of the damper thereon.

2. The elements set forth in claim 1 in which said curved plate is pivotally supported adjacent one end, and said adjustable means comprises an eccentrically adjustable support for the opposite end of said curved plate.

3. The combination with a duct for conveying air under pressure, of means to regulate the volume of air flow through said duct comprising a damper in said duct, means supporting said damper intermediate its ends, a spring connected to one end of said damper and exerting an opening force thereon, and a weight acting upon the opposite end of said damper and exerting a closing force thereon, and means to mount said weight arranged to provide sliding frictional resistance to changes in the position of said damper.

4. The combination with a duct for conveying air under pressure, of means to regulate the volume of air flow through said duct comprising a damper in said duct, means supporting said damper intermediate its ends, a spring connected to one end of said damper and exerting an opening force thereon, and a weight engaging the opposite end of said damper and exerting a closing force thereon, a guide rod on which said weight is mounted to slide vertically, and an adjustable stop on said rod to limit the downward movement of said weight.

5. The combination with a duct for conveying air under pressure, of means to regulate the volume of air flow through said duct comprising a damper in said duct, the bottom surface of said damper being downwardly curved and the bottom wall of said duct being curved upwardly at a point opposite said damper to provide a Venturi passage between said damper and said bottom wall.

6. The combination with a duct for conveying air under pressure, of means to regulate the volume of air flow through said duct comprising a damper in said duct, said damper being generally of airfoil shape with converging upper and lower surfaces and adapted to assume various positions of adjustment as a result of the reaction on its upper and lower surfaces of the air flow through the said duct.

7. The combination with a duct for conveying air under pressure, of means to regulate the volume of air flow through said duct comprising a damper in said duct, means providing a fulcrum support for said damper intermediate the ends thereof which is variable on movement of said damper, and means to restrict the free flow of air through said duct between said damper and

one of the walls of said duct whereby the air pressure therebetween will exert opening and closing forces, respectively, on the portions of said damper on opposite sides of the fulcrum point thereof, and which portions will vary in relative extent during movement of said damper on said variable fulcrum support causing thereby a relative change in the said opening and closing forces.

8. The combination with a duct for conveying air under pressure to the fuel bed in a combustion chamber, of a damper in said duct, means providing a fulcrum for said damper intermediate the ends thereof and intermediate the upper and lower walls of said duct which is variable on movement of said damper, a spring connected to one end of said damper to exert an opening force thereon, a weight engaging the opposite end of said damper to exert a closing force thereon, a Venturi passage formed between said damper and the lower wall of said duct whereby air flow through said passage exerts a closing force on said damper, and means to restrict the free flow of air through said duct between said damper and the upper wall of said duct whereby the air pressure therebetween will exert opening and closing forces, respectively, on the portions of the upper wall of said damper on opposite sides of the fulcrum point thereof, whereby said damper will function to automatically regulate the volume of air flow through said duct in accordance with the resistance of the fuel bed.

9. The combination with a duct for conveying air under pressure, of means to regulate the volume of air flow through said duct comprising a damper in said duct, and means providing a fulcrum for said damper which is variable on movement of said damper, and a spring connected to one end of said damper and exerting a force opposing the closing movement thereof, said spring being so mounted with reference to said damper and the variable fulcrum thereof as to maintain a substantially constant torque arm on said damper during the movement thereof.

10. The combination with a duct for conveying air under pressure, of means to regulate the volume of air flow through said duct comprising a damper in said duct, means supporting said damper intermediate its ends, a spring connected to one end of said damper and exerting an opening force thereon, and a weight engaging the opposite end of said damper and exerting a closing

ing force thereon, said weight being mounted to slide vertically on a guide rod and merely resting upon said damper whereby said weight functions effectively as a dampening means to prevent hunting or fluttering of said damper during changes in the position thereof.

11. The combination with a duct for conveying air under pressure, of means to regulate the volume of air flow through said duct comprising a damper in said duct, means supporting said damper intermediate its ends, a spring connected to one end of said damper and exerting an opening force thereon, and a weight engaging the opposite end of said damper and exerting a closing force thereon with means to limit the movement of said weight and relieve the damper from the force exerted thereby when the damper closes a predetermined extent.

12. The combination with a duct for conveying air under pressure, of means to regulate the volume of air flow through said duct comprising a damper in said duct, means supporting said damper intermediate its ends and intermediate the upper and lower walls of said duct, and means adjacent one end of said damper to restrict the free passage of air through said duct between said damper and one of the walls of said duct, said last-named means comprising a wall extending across a portion of said duct adjacent one end of said damper with an opening in said wall for the passage of air, and said damper being provided with an end wall which is adapted to vary the size of said opening during movement of said damper.

13. The combination with a duct for conveying air under pressure, of means to vary the volume of air flow through said duct comprising a damper in said duct, means for mounting said damper in said duct in spaced relation to opposite walls thereof so that opposite sides of said damper are exposed to air passing through said duct, said mounting means including a fulcrum for said damper intermediate the ends thereof which is variable on movement of said damper, and said damper being so constructed as to move on said fulcrum in accordance with changes in air velocity in said duct.

14. The elements set forth in claim 13 in which a spring is connected to one end of said damper to exert a force opposing the closing movement thereof.

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