Sept. 9, 1952 J. A. WILSON ET AL 2,609,834

AIR VOLUME REGULATOR FOR STOKERS

Filed June 26, 1946 2 SHEETS—SHEET 1

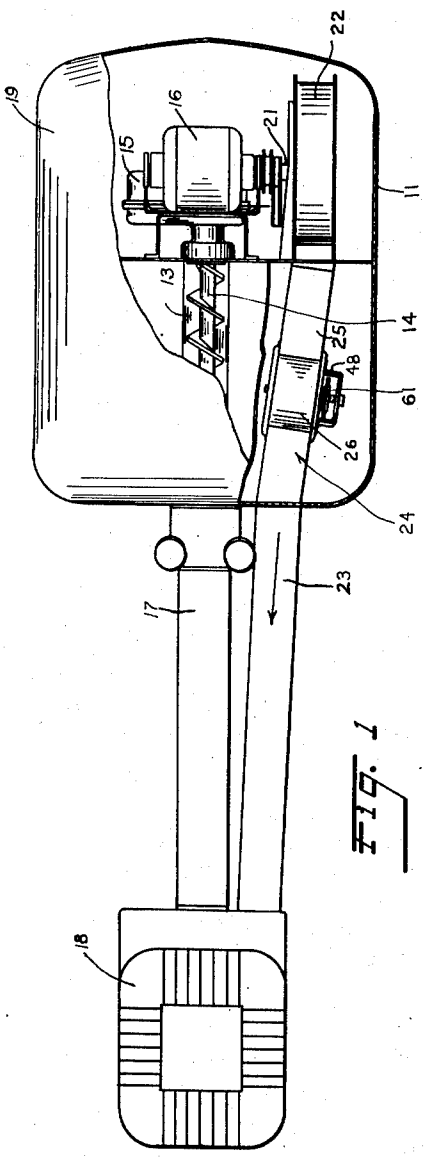

FIG. 1

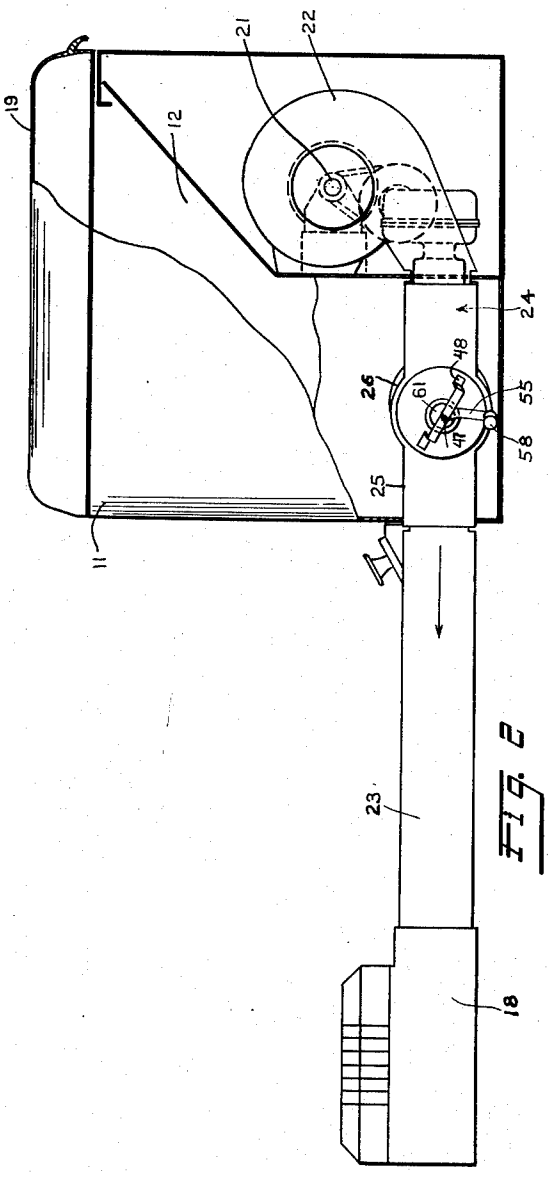

FIG. 2

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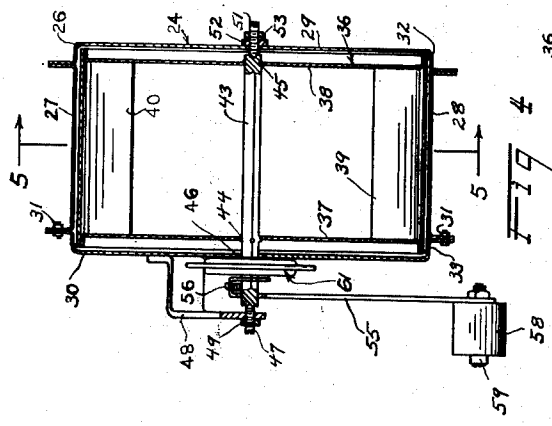

FIG 4

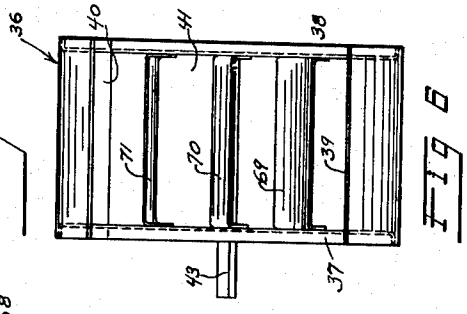

FIG 6

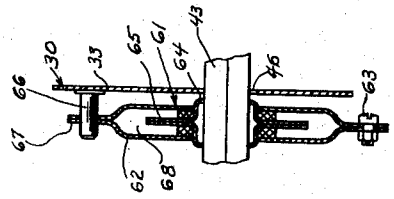

FIG 7

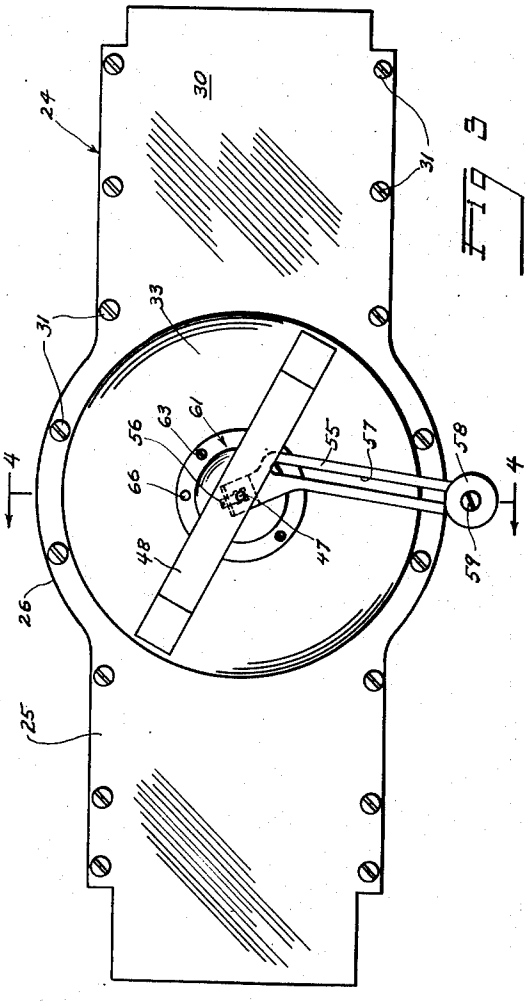

FIG 5

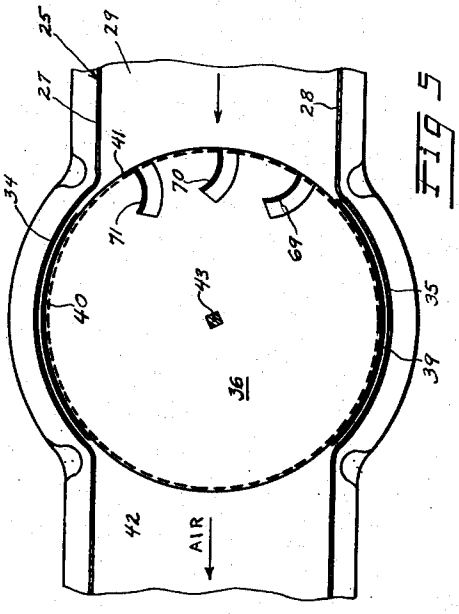

FIG 3

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UNITED STATES PATENT OFFICE

2,609,834

AIR VOLUME REGULATOR FOR STOKERS

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Application June 26, 1946, Serial No. 679,520

9 Claims. (Cl. 137—499)

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This invention relates generally to fuel stokers and more specifically to means for automatically controlling the supply of combustion air to the fuel bed in such stokers.

In stokers of conventional construction the fuel is fed from the hopper to the retort at a constant rate and combustion air is supplied to the retort through a separate duct coupled to the outlet of a constant speed blower. Experience has shown that changing conditions at the fuel bed, such as the thickness and firmness of the bed, the presence of blow holes or thin spots, alteration in the character of the coal, etc., all contribute to uncontrollable variation of the delivered combustion air pressure and hence permit such variations in the volume of combustion air supplied to the retort per unit time as to render burning cumulatively inefficient. It has therefore been found necessary to control the rate of combustion air delivery to the retort to maintain that rate as near constant as possible to the rate which will provide most efficient fuel combustion for the burner.

Air volume regulators with dampers which are initially manually adjustable to a fixed position and capable of modifying the output of the blower fan have been proposed but these will deliver the required volume of air only at a given static pressure, so that as the static pressure at the fuel bed varies due to the above mentioned changing conditions, the volume of air delivered will also vary uncontrollably. Hence automatic air volume controls have been found necessary and some have been proposed and used.

Automatic air volume regulators now available have succeeded somewhat in controlling the volume of air delivered to compensate for the varying static pressure at the fuel bed. These earlier regulators generally actuate a damper in the air duct either in response to a pressure drop measuring device or a velocity responsive element in the path of the combustion air. Although many of these known regulators have been considered efficient, in general their complicated structure renders them undesirable from a cost standpoint.

In the present invention we have devised an automatic air volume regulator which is of simplified construction and more efficient in operation than said earlier more complicated regulators.

Our present invention in its preferred embodiment differs from all other automatic air volume regulators known to us inasmuch as it embodies

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a novel rotary damper or shutter in the combustion air duct adjustable to a normally open position which determines the maximum rate of air flow through the duct. A stabilizer is provided for the damper to restrain its rotation in response to sudden variations in velocity of air flow due to sudden pressure changes, thus dampening the damper against undesirable fluctuation.

The major object of the invention is therefore to provide a novel automatic air volume regulator of simple construction which will insure a uniform and constant volume of air flowing through an air duct to the fuel bed of a burner, regardless of the resistance to air flow offered by the fuel bed.

A further object of this invention is to provide a novel rotary air volume regulator for the control of air flow in a stroker or the like.

Another object of the invention is to provide a novel air volume regulator valve having a statically balanced rotor equipped with an inertia member which is adjustable for varying the normal open position of the rotor and which is arranged for counteracting the effect of the air flow tending to close said valve.

A further object of this invention is to provide a novel stabilizing arrangement for a rotor damper in a stoker or the like.

It is a further object of the invention to provide a novel air volume regulator rotor adapted to be disposed in a combustion air stream and which is not of itself affected by the air velocity regardless of its adjusted position.

A further object of the invention is to provide a novel balanced quadrant type rotor valve for an air volume regulator.

A further object of the invention is to provide a novel air volume regulator having a rotary valve element which is statically balanced and adapted to rotate in response to velocity changes in combustion air flow therethrough, and adjustable means for opposing said tendency to rotate due to air flow and for determining the maximum opening of said valve.

Still another object of this invention is to provide an air volume regulator having a rotor equipped with a novel blade or said arrangement for insuring that the rotor is responsive to air flow during its entire range of movement.

A still further object of the invention is to provide a rotary air volume regulator valve having a novel inertia member mounting arm fixed on the rotor shaft.

Other objects of the invention will become

apparent as the description proceeds in connection with the appended claims and the annexed drawings wherein:

Figure 1 is a top plan view of a coal stoker assembly partly broken away to illustrate an air volume control according to a preferred embodiment of the invention;

Figure 2 is a side elevation of the stoker of Figure 1 also broken away to illustrate the air volume control in the assembly;

Figure 3 is an enlarged side elevation of the air volume regulator apart from the rest of the stoker;

Figure 4 is a transverse section through the air flow regulator substantially along line 4—4 of Figure 3;

Figure 5 is a partial longitudinal section through the air flow regulator substantially along line 5—5 of Figure 4;

Figure 6 is an end elevation of the rotor element of the air volume regulator illustrating the blade or sail arrangements; and

Figure 7 is a section along a diameter of rotor damper stabilizer.

The stoker assembly comprises an open topped cabinet 11 containing a hopper 12 open at its bottom to a channel 13 in which is disposed a feed screw 14. Feed screw 14 is driven through transmission 15 by an electric motor 16 within the cabinet and extends through a tube 17 to a suitable retort 18 located at the furnace. Coal delivered into hopper 12 will thus be continuously fed to retort 18 when motor 16 is operating. Cabinet 11 is closed at the top by a suitable operable cover 19.

Motor shaft 21 is drive connected to the fan of a suitable constant speed and constant output blower 22, and the outlet of blower 22 is connected to a conduit 23 which extends generally parallel to tube 17 and delivers combustion air from the blower to retort 18. This general assembly is conventional in coal burner stokers.

An air volume regulator 24 is interposed in the combustion air passage between blower 22 and conduit 23, and preferably comprises a sheet metal duct 25, generally rectangular in cross-section and provided substantially at its center with a part cylindrical portion 26 having its axis horizontal and normal to the longitudinal axis of the duct. Duct 25 comprises a top panel 27 and a bottom panel 28 both secured as by welding along adjacent edges to a rear panel 29, and a front panel 30 is detachably secured along its edges to the top and bottom panels by suitable fastener assemblies 31.

As illustrated in Figure 4, panels 29 and 30 are formed with cylindrical pockets 32 and 33 at cylindrical portion 26 of the duct, for housing the ends of a damper rotor to be described. As illustrated in Figure 5, top panel 27 is formed at cylindrical portion 26 of the duct with an outwardly projecting cylindrical wall 34, and lower panel 28 is similarly formed with an outwardly projecting cylindrical wall 35. Walls 34 and 35 are equal in size and extend for quadrants of the cylinder, the other two quadrants of the cylinder being open to duct 25.

A suitable damper member 36 is mounted for rotation within cylindrical portion 26 of the duct and it preferably comprises a cylindrical rotor mounted for free rotation on a horizontal axis.

Rotor 36 comprises two parallel flanged side discs 37 and 38 secured along their edges as by welding to a lower part-cylindrical plate 39 and an upper part-cylindrical plate 40. The cylindrical surface of the rotor 36 is thus divided into two closure portions, an inlet aperture 41 and an outlet aperture 42. The width of apertures 41 and 42 is equal to the width of duct 25 opening thereinto.

Lower plate 39 is preferably a quadrant in extent and upper plate 40 is also substantially a quadrant in extent so that, when the rotor is disposed as illustrated in Figure 5, duct 25 will be substantially unobstructed by the rotor in that closure plates 39 and 40 are disposed entirely out of the air flow path. As illustrated in Figure 4, the sides 37 and 38 of rotor 36 are substantially coplanar with panels 30 and 29 so that apertures 41 and 42 are of substantially the same size as duct 25.

Rotor 36 is secured non-rotatably upon a horizontal shaft 43. Preferably shaft 43 is square and extends through square apertures in discs 37 and 38, which are retained from lateral movement on the shaft, as by being staked to the shaft at 44 and 45. Shaft 43 extends through a clearance aperture 46 in front panel 30 and is journalled at one end on a conical pointed screw 47 which is adjustably mounted in a suitably threaded aperture of an outstanding U-shaped bracket 48 secured as by welding to front panel 30. Screw 47 when adjusted is locked by jam nut 49. The rear end of shaft 43 is journalled on a similar conical pointed screw 51 adjustably mounted in a suitable threaded aperture in a lug 52 secured as by welding to rear panel 29. Screw 51 is locked in adjusted position by jam nut 53. This mounting of shaft 43 provides for lateral adjustment of rotor 36 with respect to the path of air flow so that apertures 41 and 42 may be accurately centered and aligned with the duct.

Shaft 43 and rotor 36 are therefore mounted for rotation in substantially frictionless bearing supports which provide for instant response of the rotor to forces tending to rotate it.

The rotor has been described in a high degree of particularity because it is considered to be an important feature of this invention, it having been discovered that this element may be rotated to any given angular position within an air duct and maintain that position functioning as a valve to govern the volume of air and maintaining its position without beng materially affected by the velocity of the air stream.

Outside the duct, an inertia member arm 55 is secured non-rotatably to shaft 43 between panel 30 and bracket 48 as by square apertures in its U-shaped extremity fitting over square sides of shaft 43 and is retained from lateral movement by set screw 56. Inertia member arm 55 consists of a metal strap provided with an elonagted offset slot 57 in which an inertia member or weight 58 is slidably mounted and locked by adjusting screw assembly 59. When inertia member 58 is locked at the extremity of arm 55 farthest from the axis of rotor 36, the center of gravity of the entire rotor and inertia member assembly mounted on bearings 47 and 51 is so located as to dispose the rotor in the position illustrated in Figure 5 whereby the duct is completely unobstructed by closure plates 39 and 40.

Slot 57 runs at such angle and is offset such a distance that when inertia member 58 is adjusted toward the axis of rotor 36 the center of gravity of the entire assembly is shifted to tend to rotate rotor 36 clockwise from the position of Figure 5 and thereby restrict the flow of combustion air through duct 25. The position of weight 58 therefore determines the maximum

normal idle opening of the duct, as will further appear.

A rotor stabilizer 61 is provided on shaft 43 outside front panel 30. Stabilizer 61 preferably comprises an annular casing 62 made of two identical cups secured together as by bolt assemblies 63. Casing 62 is journalled on the cylindrical hub 64 of a stabilizer disc 65 which is non-rotatably secured upon shaft 43 so as to rotate therewith. Casing 62 is anchored against rotation, as by a pin 66 on panel 30 projecting through an aperture in peripheral flange 67 of the case.

Stabilizer disc 65 operates in a chamber 68 which is preferably filled with a viscous grease that has the same consistency from forty degrees below to two hundred degrees above zero centigrade. The grease adheres to the relatively rotatable surfaces of stationary case 62 and stabilizer disc 65, thereby tending to retard and dampen any sudden changes of position between the case and disc. Rotor 36 is thus restrained from oscillating in a fluctuating air current due to suddenly varying resistances of the fuel bed and the pull of the chimney draft.

A plurality of transverse sails or vanes 69, 70 and 71 are provided extending across aperture 41 in the path of the incoming combustion air. These vanes are each arcuate sheet metal plates, preferably welded at their ends to rotor discs 37 and 38. As illustrated in Figure 5, the several vanes are so disposed that air entering as indicated by the arrow will tend to rotate rotor 36 clockwise. The purpose of this arrangement is to insure that substantially the same effective area of the vanes is presented normal to the incoming air stream during the entire range of rotation of rotor 36 so that the air stream through the duct at all times retains control of the rotor.

In operation, the combustion air supplied by blower 22 is automatically metered by regulator 24. With no air passing through duct 25, as when blower 22 is inactive, the duct opening afforded by rotor 36 depends upon the adjusted position of weight 58 on arm 55, since when the rotor is idle and not under the influence of air velocity within the duct, the rotor assembly always tends to assume a position where weight 58 is in the vertical plane containing the axis of rotation of the assembly. Thus, starting with the maximum opening when weight 58 is in its outer-most position as in Figure 5, the idle open position of the rotor may be adjusted clockwise by adjustment of weight 58 upwardly along arm 55. This adjusted idle position of course determines the maximum effective duct opening for that adjustment.

When blower 22 is furnishing combustion air, the force exerted by the air stream against the rotor vanes tends to rotate rotor 36 clockwise toward closed position and thus move closure plate 39 to restrict the effective opening in duct 25. Rotation of rotor 36 is opposed by the counter-effect of the inertia member which tends by gravity to return to its idle position.

The vertical distance that weight 58 is lifted per degree of rotation of the rotor is increased in harmonic proportion as arm 55 swings from the normally idle hanging position toward a horizontal position when rotor 36 is rotated by the air stream. Therefore, for a certain velocity of air in the duct, weight 58 will be lifted only through a certain number of degrees before the harmonic increasing opposition to such lift equals the lifting force due to velocity of the air stream, and the tendency of the air velocity to close rotor 36 and the tendency of weight 58 to open the rotor reach a point of equipoise and rotor 36 is therefore maintained balanced in an intermediate partly open position where a certain air volume is delivered to the retort.

Since it is usually known what volume of air per unit time affords most efficient combustion for a particular burner, it is apparent that the parts can readily be so proportioned and adjusted that rotor 36 assumes the proper angular position to pass this air volume when blower 22 is operating and the fuel bed conditions are normal.

The amount that the rotor 36 will close due to a given velocity of air through the duct is dependent upon the adjusted position of inertia member 58 on arm 55. When the inertia member is adjusted to a position at the outer extremity of the arm as in Figure 5, the tendency of inertia member 58 to hold the rotor open is rendered the most effective possible, since the leverage afforded by arm 55 is the greatest possible and inertia member 58 must also be moved through ninety degrees of rotation to completely close the rotor. As inertia member 58 is adjusted toward the axis of rotation of arm 55, the rotor 36 is partially closed and thus neither it nor the inertia member will have to be lifted through 90 degrees to close the rotor. Also inertia member 58 is rendered less effective due to the decrease in leverage afforded by arm 55. In the preferred embodiment of the invention upper plate 40 is of slightly less peripheral length than the lower plate 39 in order that it may deflect the air stream towards the vanes 69, 70 and 71 thereby insuring a substantial amount of air against the vanes even when the duct 25 may be substantially closed by plate 39.

In practice we prefer to provide the rotor, vane and arm assembly, apart from weight 58, as a statically balanced assembly which will maintain any given angular position of rotation in which it may be placed, when blower 22 is not operating. Addition of the weight causes the assembly to assume its normally open idle position from which it is, during operation, displaced to a balanced open position by velocity of the air stream through the duct. It will be appreciated that rotor 36 in practice will probably never completely shut off passage of air through the duct.

The effect that the momentum of inertia member 58 would have in hindering the establishment of a point of balance for rotor 36 is cancelled out by stabilizer 84. The grease adhering to the surfaces of disc 92 and of case 86 retards the effect any force might have in tending to change the position of the said disc within the said housing.

The offset construction of arm 55 is for the purpose of increasing or decreasing the degree of maximum opening and obtaining a large effective leverage for weight 58 through the use of a relatively short arm. If desired, arm 55 and weight 58 may be replaced by a spring assembly or any other suitable device to accomplish these same ends.

During normal operation when there are no unusual changes in the fuel bed or effective draft in the burner, the normal balanced open position of rotor 36 will be maintained. However, suppose that the fuel bed becomes thicker and more resistive to traverse of combustion air, as when the coal feed is too high for efficient combustion of all the coal. Blower 22 keeps delivering a con-

stant volume of combusion air per unit time into the duct, but the thickened fuel bed resists its passage and develops an increasing back pressure in the duct and an accompanying reduction in velocity of the air passing through the duct. However, since the degree of closure effected by rotor **36** varies inversely with respect to the air stream velocity, this reduction in air velocity will result in a reduction of the closing force acting on the rotor and weight **58** will be permitted to rotate the rotor counterclockwise to increase the effective opening through the duct. This permits more combustion air to be supplied to the fuel bed with the result that the fuel is burned faster and the tendency of the fuel bed to resist passage of air is now reduced. As the resistance of the fuel bed decreases, velocity of the air stream in the duct increases and the rotor starts to rotate toward closed position. This continues until a normal fuel bed condition is attained, at which time the rotor has regained its balanced open position. The stabilizer **61** prevents sudden and merely temporary changes in air stream velocity from affecting the rotor, but may not be necessary for many installations.

Suppose that the fuel bed becomes thin and contains holes. The combustion air, since the back pressure in the duct is low, passes through the fuel bed at a relatively high velocity and tends to blow out the fire and scatter and deposit fly ash over the heating surfaces of the furnace. In the regulator of the invention, the high air stream velocity causes clockwise movement of rotor **36** toward closed position, thereby reducing the volume of air supplied to the fuel bed, reducing combustion and enabling the coal feed to thicken up the fuel bed and reduce the air stream velocity. As the air stream velocity reduces, rotor **36** moves toward open position and a point of balance is gradually attained where the desired volume of air is being supplied to a normal fuel bed.

Our air volume regulator is efficient in operation and inexpensive to construct and service, and is reliable.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

We claim:

1. In an automatic air volume regulator adapted to be interposed in a passage between a blower for supplying combustion air and a fuel burner, a statically balanced rotary valve member mounted for free rotation in said passage on an axis transverse to the path of combustion air, said member having opposed peripheral apertures adapted to be aligned with said passage and a passage closure portion adapted to move transversely of the passage with rotation of said valve member, a transverse air impingement vane on said member extending across one of said apertures, and means for opposing rotation of said member by said air stream.

2. A statically balanced shutter for an automatic air volume regulator comprising a rotary cylindrical member closed at its ends and provided with diametrically opposite combustion air inlet and outlet apertures on its periphery, and transverse vane means secured to the periphery of said member in one of said apertures.

3. In an automatic air volume regulator for a fuel burner having a combustion air passage connected to a source of air pressure, an enlarged region in said passage of substantially cylindrical shape, a cylindrical shutter member rotatably mounted upon a transverse axis within said region, said member being provided with diametrically opposite inlet and outlet apertures on its periphery and said apertures each having a width and circumferential extent at least equal to the adjacent dimension of said passage so that member may be disposed with said apertures in substantially unobstructing alignment with said passage and with the peripheral wall of said member disposed in said enlarged region out of the combustion air path, vane means on said member in one of said apertures for rotating said member by the air stream through said passage, and means operatively connected to said member for opposing rotation thereof by the air stream.

4. In the automatic air volume regulator defined in claim 3, the periphery of said member serving as a closure for said passage as said member is rotated.

5. In the automatic air volume regulator defined in claim 3, one of the two spaced peripheral wall portions of said member being of greater circumferential extent than the other.

6. In an automatic air volume regulator having a passage adapted to conduct a stream of air under pressure, means for automatically controlling the amount of air delivered through said passage comprising a valve rotor assembly and control means operably connected to said valve rotor assembly for opposing rotation of said valve rotor assembly by the air stream, said rotor assembly including a valve rotor mounted for free rotation in said passage about an axis that extends transversely of said passage and disposed in the path of the air stream, and said valve rotor assembly having such balanced structure and weight distribution that it is capable of maintaining any given position of rotation of said rotor in said passage when no air is being forced through said passage, and means on said rotor in the path of the air stream for providing rotation of said rotor assembly in response to the velocity of the air stream, the opposing forces of said air stream velocity and said control means being balanced when said valve rotor assembly is disposed to permit passage of a substantially constant predetermined volume of air through said passage.

7. In an automatic air volume regulator having a passage through which air is adapted to be forced under pressure, a rotor assembly freely rotatably mounted upon an axis transversely of said passage, a closure member on said rotor assembly adapted to be progressively interposed in the path of the air stream as said rotor assembly is rotated in response to changing velocities of said air stream, vane means on said rotor assembly disposed in the air stream for rendering said rotor assembly responsive to velocity of the air stream, said vane means comprising a plurality of blades so relatively disposed as to present substantially the same total projected area to said air stream during the normal range of movement of said rotor assem-

bly, and means for opposing rotation of said rotor assembly by the air stream.

8. In an air volume regulator, a rotor assembly including a rotor having aligned peripheral apertures each substantially a quadrant in extent, air passage defining means in which said rotor is pivoted about a substantially centroidal axis transverse to said passage and means responsive to the velocity of air flow through said passage tending to rotate said rotor about its pivot so as to increase or decrease the passage opening upon decrease or increase in said air velocity, respectively, and means operably connected to said rotor assembly adjustable for determining the angular position of said rotor and the maximum opening of said passage through said rotor when air is passing therethrough, said means also tending to maintain said rotor in its said adjusted angular position.

9. In an air volume regulator, means defining a passage through which air is adapted to be forced under pressure, a rotor assembly including a valve rotor, a transverse shaft in said passage for mounting said rotor for angular movement about a substantially centroidal axis, said rotor having opposed peripheral apertures each substantially a quadrant in extent, a vane on said rotor rendering the rotor responsive to air velocity through said passage, an arm secured to said shaft having a portion offset with respect to a radius of said shaft, and means on said arm adjustable for determining the angular position of said rotor and the maximum opening of said valve when air is passing therethrough.

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