July 27, 1943. R. C. VROOM ET AL 2,325,444

AIR REGISTER

Filed May 2, 1942 3 Sheets-Sheet 1

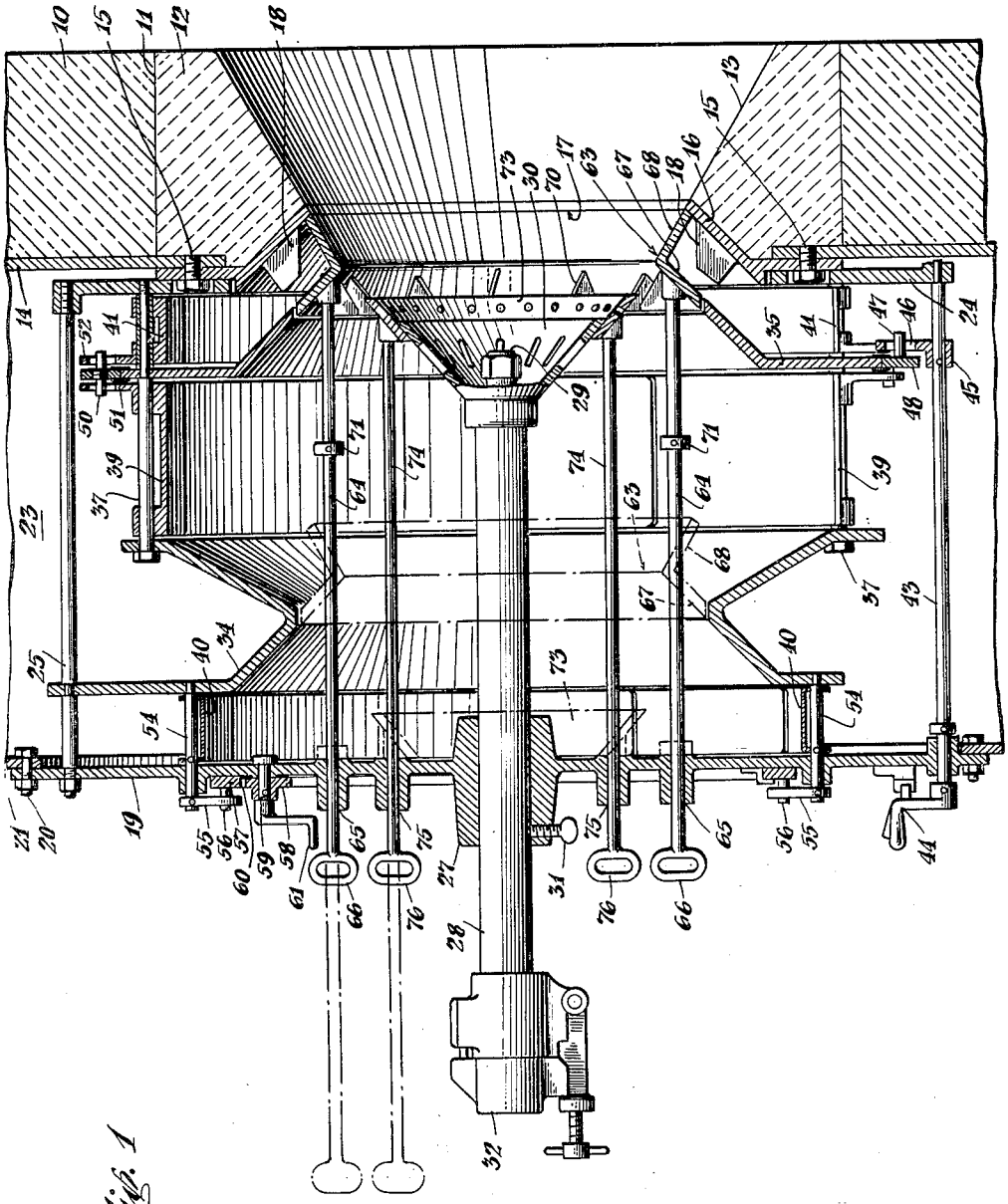


Fig. 1

INVENTORS
Robert C. Vroom
BY David P. Graham
ATTORNEY

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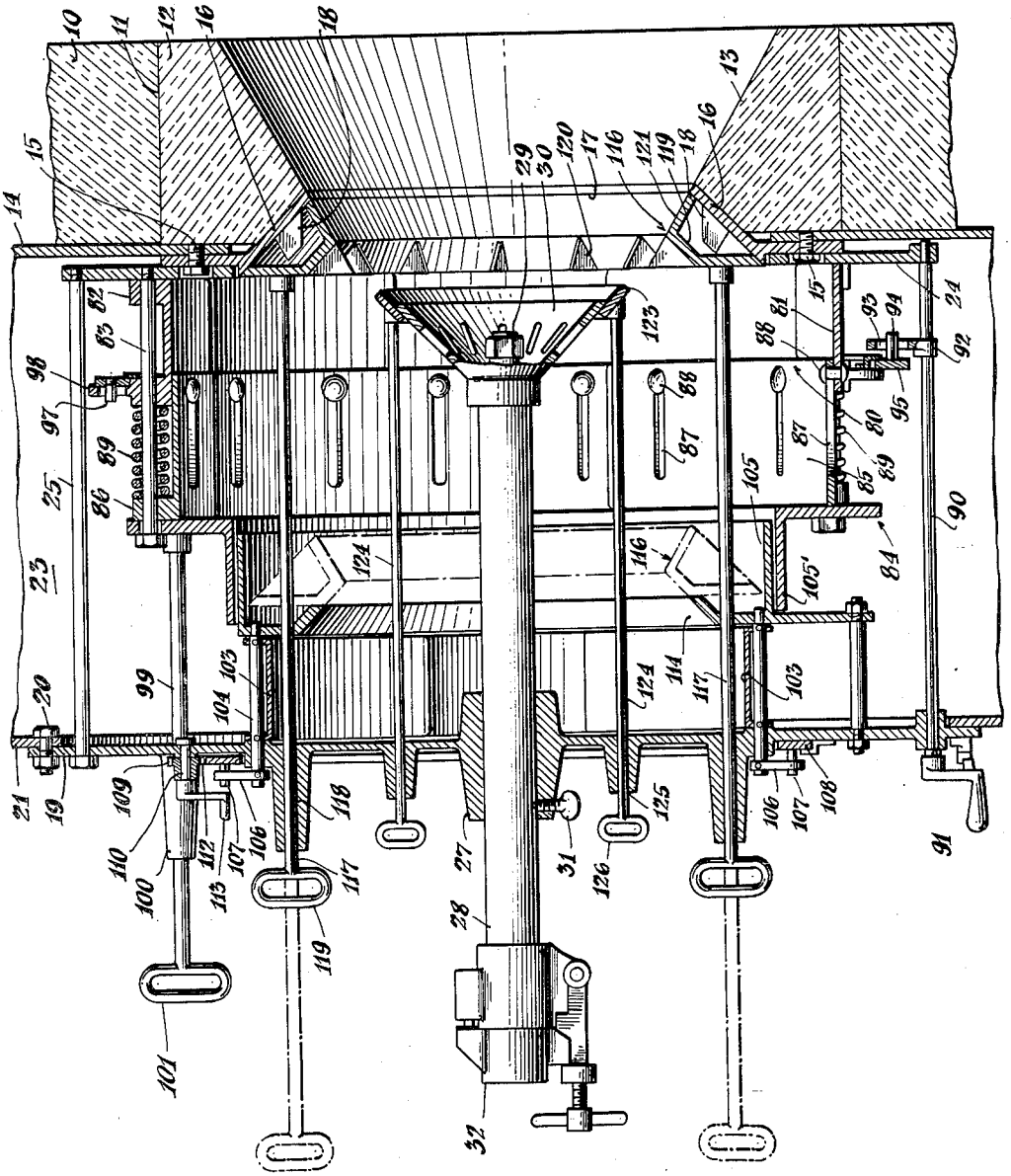


Fig. 2

INVENTORS
Robert C. Vroom
BY David P. Graham
ATTORNEY

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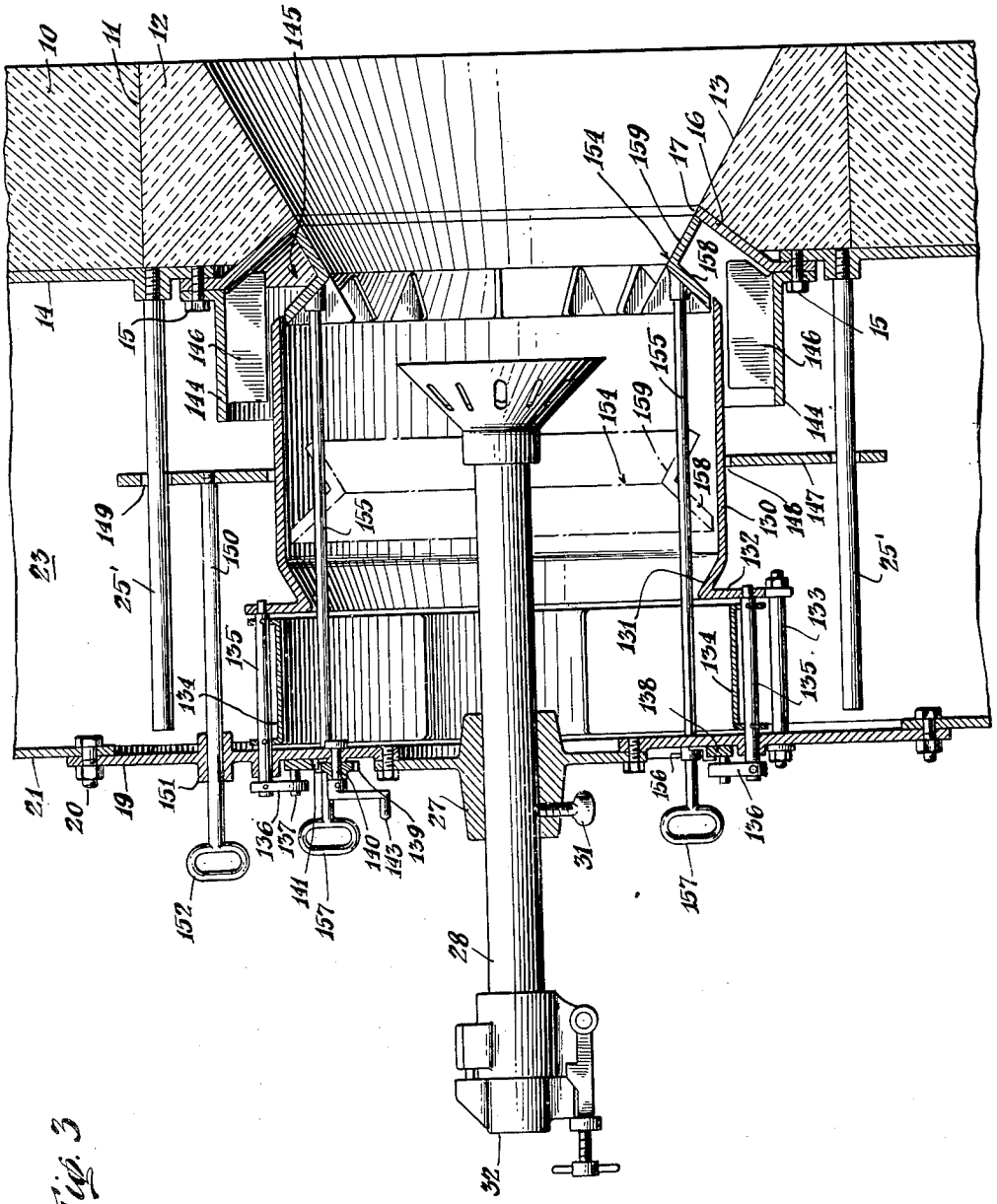


Fig. 3

INVENTORS
Robert C. Vroom
BY David P. Graham
ATTORNEY

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UNITED STATES PATENT OFFICE

2,325,444

AIR REGISTER

Robert C. Vroom, Montclair, N. J., and David P. Graham, Flushing, N. Y., assignors to Peabody Engineering Corporation, New York, N. Y., a corporation of New York

Application May 2, 1942, Serial No. 441,452

10 Claims. (Cl. 158—1.5)

This invention relates to air registers or the like and more particularly to an air register for use in a burner of the general type disclosed in Vroom Patent No. 2,210,476, dated August 6, 1940.

In a burner of this type, an air register is provided which may take the form of a casing having peripheral doors through which air for combustion is admitted. The doors control the direction and velocity of the air and cause the same to form a rotating mass of air within the air register having a degree of turbulence and a velocity of rotation best adapted to promote the mixture of air and fuel for combustion.

It is an object of the present invention to provide a new and improved means for controlling the velocity of air supplied to a burner of the above type.

Another object of the invention is to provide, in a burner of the above type, improved means for controlling the velocity of air at the burner throat.

Another object is to provide a register of the type above specified in which air for combustion is admitted at different radial and axial zones for purposes of stabilization and control.

Various other objects and advantages will be apparent as the nature of the invention is more fully disclosed.

Although the novel features which are believed to be characteristic of this invention are pointed out more particularly in the claims appended hereto, the invention itself may be better understood by referring to the following description, taken in connection with the accompanying drawings forming a part thereof in which a specific embodiment of the invention has been set forth for purposes of illustration.

In the drawings,

Fig. 1 is a longitudinal sectional view of a burner embodying the present invention; and

Figs. 2 and 3 are longitudinal sectional views illustrating two other embodiments of the invention.

In the following description and in the claims certain specific terms have been used for convenience in referring to various details of the invention. These terms, however, are to be given as broad an interpretation as the state of the art will permit.

Referring to the drawings more in detail, the invention is shown in Fig. 1 as applied to a burner for a furnace having a front wall 10 of the usual refractory material and an opening 11 in which is positioned a ring of refractory blocks 12 having flared inner surfaces 13 forming the burner throat. A plate 14 is positioned over the front wall 10, and to this plate there is secured, as by bolts 15, an annular flanged member 16 having an annular opening 17 registering with the burner throat. Suitable vanes 18 are disposed about the sloping annulus of member 16 for controlling the direction of air flow at the burner throat.

The burner is shown as comprising an air register having a front plate 19 secured, as by bolts 20, to a plate 21 which is spaced from the plate 14 to form a plenum chamber 23 in which air is supplied under pressure to the register. A back plate 24 is secured to the front plate 19 by suitable means, such as stay bolts 25. The back plate 24 bears against the surface of member 16 for effecting an air seal. In certain embodiments, such as, for example, an air register for use at atmospheric pressure, the register may be supported by securing the back plate 24 to the plate 14 in which event the plate 21 may be omitted.

The register front plate 19 is provided with a hub 27, and an atomizer barrel 28 having an atomizer tip 29, and a diffuser 30 is mounted in the hub 27 and secured in position by a set screw 31. The tip 29 and diffuser 30 are arranged to direct a stream of finely divided fuel into the burner throat. The atomizer barrel 28 may also carry a coupling member 32 containing the fuel connections, not shown.

The atomizer barrel may be of the type disclosed more in detail in the Peabody Patent No. 1,628,424, dated May 10, 1927, and may comprise, for example, means for supplying fuel under pressure to the atomizer tip and for discharging the same in a finely divided spray. The operating capacity may be varied by varying the supply pressure or by returning a portion of the fuel from the atomizer tip to the fuel pump and controlling the pressure in the return line, as more fully described in the said patent. Other fuel supply means may be used for burning various types of gaseous, liquid or pulverized fuel as shown, for example, in Warner Patents Nos. 1,790,395, dated January 27, 1931, and 1,865,983, dated July 5, 1932.

For controlling the velocity of air to the burner, the register is provided with stationary annular walls 34 and 35 which are secured to the back plate 24 by stay bolts 37, and with three sets of peripherally spaced air doors which are curved to form the peripheral wall of the air register chamber. The three sets of air doors comprise the main air doors 39, auxiliary air doors 40, and tertiary air doors 41. The main

air doors 39 form a peripheral wall between the interior annular walls 34 and 35 of the register, the auxiliary air doors 40 form a peripheral wall between the front plate 19 and interior wall 34, and the tertiary air doors 41 form a peripheral wall between interior wall 35 and back plate 24 of the register.

The main air doors 39 and the tertiary air doors 41 are pivotally mounted on the bolts 37 and are adapted to be swung angularly about said bolts so as to adjust the air inlet openings between said doors. The doors 39 and 41 are actuated by a rotatable shaft 43 which is journaled in front plate 19 and back plate 24 and is provided with an operating handle 44 at the front of the register. The shaft 43 carries a lug 45 having a slot 46 engaged by a pin 47 on a ring 48 which is rotatably mounted on the outer periphery of annular wall 35 of the register. The ring 48 also carries a plurality of spaced pins 50 engaging in slots formed in lugs 51 and 52 carried by each of the main air doors 39 and each of the tertiary air doors 41, respectively. The arrangement is such that rotation of the shaft 43 by handle 44 causes rotation of the ring 48 which, through pins 50 and lugs 51 and 52, swings the doors 39 and 41 angularly about the bolts 37 so as to adjust the air inlet openings between said doors. In some instances individual adjustment of each door or separate controls for doors 39 and for doors 41 may be desired. The auxiliary air doors 40 are shown as simultaneously actuated by means of shafts 54 each of which is secured individually to each of said doors and is journaled in the interior wall 34 of the register. Each shaft 54 extends through the front plate 19 and carries a lug 55 having a slot engaged by a pin 56. The pins 56 cooperating with the various lugs 55 are carried upon a ring 57 which is rotatably mounted upon the front plate 19. Suitable means may be provided for operating the ring 57, such, for example, as a pinion 58 carried on a shaft 59 and engaging a rack 60 on said ring. The shaft 59 may be operated by suitable means such as a handle 61. Actuation of the ring 57 causes pivotal movement of the lugs 55 and swings the auxiliary air doors 40 about the rods 54 so as to adjust the openings between said doors. As in the case of air doors 39 and 41 mentioned above, it may sometimes be desirable to provide individual adjusting means to permit individual adjustment of each of the auxiliary air doors 40.

An auxiliary burner throat 63 is supported within the air register by a pair of rods 64 which extend through openings 65 in the front plate 19 and are provided with suitable handles 66 by means of which the auxiliary throat 63 may be moved axially within the register. The auxiliary throat 63 is of V-shaped cross section, having an inwardly sloping annular wall 67 and an outwardly sloping annular wall 68. The outwardly sloping annular wall 68 is adapted to register with the flared surface 13 of the burner throat, thus reducing the effective area of the burner throat when the auxiliary throat 63 occupies the position shown in full lines in Fig. 1, and at such time the inwardly sloping annular wall 67 of auxiliary throat 63 fits within the inwardly sloping annulus of the stationary wall 35 and forms a continuation thereof. Suitable vanes 70 are disposed about the sloping surface 67 of the auxiliary throat 63 for controlling the direction of air flow.

Operation

In the normal operation of the burner, the auxiliary throat 63 is retracted within the air register to the dotted line position shown in Fig. 1, and the actuating rods 64 may be provided with limiting stops 71 which are engageable with the front plate 19 to insure the proper positioning of the auxiliary throat 63 at the restricted central annulus of the stationary wall 34 to control the flow of air from the auxiliary doors 40. However, when the auxiliary throat 63 is moved axially through the air chamber into registery with the flared surface 13 of the burner throat, not only does the inwardly sloping annular wall 67 of the auxiliary throat reduce the effective throat area of the burner, but, furthermore, the outwardly sloping annular wall 68 of said auxiliary throat 53 in registering with the flared surface 13 of the burner throat bears against the flanged member 16 and blocks the flow of air from the tertiary doors 41 to the burner.

A flared diffuser extension 73 is supported within the air register by a pair of rods 74 which extend through openings 75 in the front plate 19 and are provided with suitable handles 76 by means of which said extension 73 may be moved axially within the register. In the normal operation of the burner, the diffuser extension 73 is retracted against the front plate 19 of the register as shown in dotted lines, in which position said extension has no effect upon the passage of the air through the register. However, when the burner is operated at reduced capacities, at which time the auxiliary throat 63 is moved into registry with the flared surface 13 of the burner throat to reduce the effective throat area and to block off the flow of air from the tertiary air doors 41, the diffuser extension 73 may be moved inwardly to its limiting position in contact with the diffuser 30, as shown in full lines to further reduce the effective area of the burner throat. Of course, either the auxiliary throat 63 or the diffuser extension may be used separately if desired.

When the burner is to be operated at maximum capacities, the auxiliary throat 63 and the diffuser extension 73 are retracted within the air chamber, as shown in dotted lines. Under such conditions the main air doors 39, the auxiliary air doors 40 and the tertiary air doors 41 may all be adjusted, by proper manipulation of the operating handles 44 and 61, as previously described, to permit the desired flow of air to the burner throat. At such times it will be noted that the tertiary air doors 41 admit air directly at the burner throat under the directional guidance of the stationary vanes 18 on plate 16, while the air entering through the main doors 39 is directed to the burner throat by the sloping annulus of stationary wall 35, and the flow of air from the auxiliary doors 40 is controlled by the restricted annulus of stationary wall 34 and the retracted throat 63. When it is desired to operate the burner at extremely low capacities, however, the auxiliary throat 63 and the diffuser extension 73 are moved axially within the air chamber to the positions shown in full lines in Fig. 1. Under such conditions, as previously described, the auxiliary throat 63 reduces the effective area of the burner throat and furthermore blocks the flow of air from the tertiary air doors 41; hence even though said tertiary doors 41 may be opened simultaneously with the main air doors 39 by actuation of handle 44, no air will flow to the burner throat from the tertiary doors. Further-

more, under such conditions, the diffuser extension 73 further reduces the effective throat area as previously described. The flow of air to the burner from the main doors 39 and the auxiliary doors 40 may, of course, be regulated by proper manipulation of the operating handles 44 and 61. Three sets of doors have been shown for purposes of illustration. Any desired number of sets may be used as required.

Fig. 2

Fig. 2 shows a modification of the invention which employs only two sets of peripherally spaced air doors, and in which one of said sets of doors comprises telescoping sections which are adjustable axially of the air chamber to regulate the flow of air therethrough as disclosed in Vroom Patent No. 2,210,476, above mentioned. The general construction of this air register, however, is similar to that previously described, and similar reference numerals have therefore been applied to the same elements, including the framework encompassing the plenum chamber 23 and the atomizer barrel 26 and associated parts. For controlling the supply of air to the burner, the register of Fig. 2 is provided with a plurality of peripherally spaced main air doors 80 which are curved to form the peripheral wall of the air register chamber. Each door 80 comprises a section 81 provided with ears 82 which rotate on a pin 83, and a section 85 having an ear 86 which is slidably held on the pin 83. The pins 83 are secured in the back plate 24 and extend through a slidable flanged plate 84. Each section 85 may be provided with a slot 87 engaged by a pin 88 carried by a section 81. The sections 85 are similar in shape to the sections 81 and are adapted to slide thereover in a direction axially of the register. A spring 89 may be carried on the pin 83 to normally hold the sections 85 in their forward position. It is to be understood, of course, that the pins 88 may be positioned in the sections 85 and the slots 87 may be formed in the sections 81 if desired, or other securing means may be used.

Angular adjustment of the main air doors 80 about the pins 83 is controlled by a rotatable shaft 90 which is journalled in front plate 19 and back plate 24 and is provided with an operating handle 91 at the front of the register. The shaft 90 carries a lug 92 having a slot 93 engaged by a pin 94 on a ring 95 which is rotatably mounted on the outer periphery of the main air doors 80. The ring 95 also carries a plurality of spaced pins 97 engaging in slots formed in lugs 98 carried by each of the air doors 80. Rotation of the shaft 90 by handle 91 causes rotation of the ring 95 which, through pins 97 and lugs 98, swings the doors 80 about the pins 83 so as to adjust the openings between said doors. It will be noted that this angular adjustment of the doors 80 by means of handle 91 in Fig. 2 is similar to the adjusting operation performed by handle 44 in Fig. 1.

For controlling the axial position of the sections 85 of the air doors 80, it is necessary to move the flanged plate 84 axially within the air chamber. This may be accomplished by means of a rod 99 which is secured to the plate 84 and extends outwardly through a hub 100 on the front plate 19 and is provided with an actuating handle 101. It will be observed that, by forcing the rod 99 toward the right or left as viewed in Fig. 2, the axial position of the sections 85 of the air doors may be adjusted as desired.

The air register of Fig. 2 is also provided with a set of auxiliary air doors 103 which are generally similar in construction and operation to the auxiliary air doors 40 of Fig. 1. The auxiliary air doors 103 are actuated by means of pins 104 each of which is secured individually to one of said doors and is journaled in the vertical flange of a cylindrical member 105 which telescopes within the annular flange 105' of the movable plate 84. Each pin 104 extends through the front plate 19 of the register and carries a lug 106 having a slot engaged by a pin 107. The pins 107 cooperating with the various lugs 106 are carried upon a ring 108 which is rotatably mounted upon the front plate 19. In the embodiment illustrated, the ring 108 is operated by a pinion 109 carried on a shaft 110 and engaging a rack 112 on said ring. The shaft 110 may be operated by a handle 113. Rotation of the ring 108 causes pivotal movement of the lugs 106 and swings the auxiliary air doors 103 about the pins 104 so as to adjust the openings between said doors. It will be noted that this operation of the auxiliary air doors 103 is similar to the operation of the auxiliary air doors 40 in Fig. 1. In the embodiment illustrated, the cylindrical member 105 is provided with an inwardly sloping annular throat 114 whereby the air admitted through the auxiliary doors 103 is directed through the air chamber to the burner throat.

An auxiliary burner throat 116 is supported within the air register of Fig. 2 by a pair of elongated rods 117 which extend through openings 118 in the front plate 19 and are provided with suitable handles 119 by means of which the auxiliary throat 116 may be moved axially within the register. The auxiliary throat 116 has an inwardly sloping wall 119 carrying vanes 120 for controlling the direction of air flow, and an outwardly sloping annular wall 121 which is adapted to register with the flared surface 13 of the burner throat for reducing the effective throat area when the auxiliary throat 116 is in the operative position illustrated in full lines. A diffuser extension 123 is supported within the air register by a pair of rods 124 which extend through openings 125 in the front plate 19 and are provided with suitable handles 126 by means of which said extension 123 may be moved axially within the register.

Operation of Fig. 2

In the normal operation of the burner at maximum capacities, the auxiliary throat 116 and the diffuser extension 123 are retracted within the air chamber, and under such conditions the inwardly sloping wall 119 of auxiliary throat 116 registers with a sloping annulus 114 of the cylindrical member 105, to control the air flow from the auxiliary doors 103. The atomizer being set by suitable means for the required load, the air doors 80 and 103 are adjusted by means of the handles 91 and 113 to cause the air to enter the register with the desired direction and velocity to set up a whirling motion within the register adapted to produce an efficient mixture of air and fuel at the burner throat. When the load is reduced by suitable adjustment of the atomizer, the air flow through the register may also be reduced by sliding the plate 84 axially of the register. When operating the register at low capacities, the auxiliary throat 116 and the diffuser extension 123 are moved axially within the air chamber to the positions shown in full lines. Under such conditions, as previously described, the

auxiliary throat 116 reduces the effective area of the burner throat, which effective throat area may be further reduced by the diffuser extension 123.

Fig. 3

Fig. 3 shows another modification of the invention, in which the furnace structure including the burner throat 13, and the atomizer barrel 26 and associated parts are similar to those previously described, as is also the framework forming the plenum chamber. In this embodiment of the invention, however, a cylindrical member 130 is mounted axially within the plenum chamber 23 with its peripheral edges spaced from the front and back plates 19 and 14, as illustrated. The cylinder 130 is tapered inwardly adjacent its forward (fireroom) end to provide a throat 131 and the forward edge is provided with a flange 132 by means of which the cylinder is secured to the front plate 19 as by bolts 133.

The flange 132 of cylinder 130 is spaced from the front plate 19, as illustrated, and within this space are mounted the main air doors 134 in a manner similar to the air doors 103 of Fig. 2. The main air doors 134 are individually actuated by means of shafts 135 which are journalled in the flange 132 of cylinder 130. The shafts 135 extend through the front plate 19 of the register and each shaft carries a lug 136 having a slot engaged by a pin 137. As in the embodiment previously described, the pins 137 cooperating with the lugs 136 are carried on a ring 138 which is rotatably mounted upon the front plate 19. The ring 138 is operated by a pinion 139 carried on a shaft 140 and engaging a rack 141 on said ring. The shaft 140 is operated by a handle 143, rotation of which handle causes pivotal movement of the lugs 136 and swings the main air doors 134 about the shafts 135 so as to adjust the openings between said doors.

At the rear (furnace end) of the air register of Fig. 3 a cylindrical collar 144, of a diameter larger than the cylinder 130, is mounted concentrically about the cylinder 130 and is secured to the plate 14 by means of the bolts 15 which also secure the annular flanged plate 16. Since the cylindrical collar 144 is spaced from the cylinder 130, and since the rear end of cylinder 130 is spaced from the plate 16 which registers with the burner throat 13, an annular peripheral air passage 145 is formed between cylinder 130 and collar 144 permitting the flow of air from the plenum chamber 23 through the air passage 145 directly to the burner throat. Suitable vanes 146 are disposed about the inner wall of collar 144 for controlling the direction of air flow through the passage 145.

For controlling the supply of air to the burner throat through the auxiliary passage 145, a movable baffle plate 147 may be provided having a circular opening 148 which fits over the cylinder 130, and having holes 149 through which guide rods 25' extend, permitting the baffle plate 147 to be moved axially within the air chamber. Axial movement of the baffle plate 147 within the air chamber is effected by means of a rod 150 which is secured to said plate and extends outwardly through a hub 151 on the front plate 19, the rod 150 being provided with an actuating handle 152. By actuating the rod 150, the baffle plate 147 may be moved either to the right or the left in Fig. 3, thus varying the size of the entrance to the auxiliary air passage 145, or completely blocking said entrance when desired.

An auxiliary burner throat 154 is supported within the cylinder 130 by a pair of elongated rods 155 which extend through hubs 156 on the front plate 19 and are provided with suitable handles 157 by means of which the auxiliary throat 154 may be moved axially within the register. The auxiliary throat 154 is of V-shaped cross section having an inwardly sloping annular wall 158 which closely fits the inner wall of cylinder 130, and an outwardly sloping annular wall 159 which is adapted to register with the flared surface 13 of the burner throat, thus reducing the effective area of the burner throat when the auxiliary throat 154 occupies the position shown in full lines. Furthermore, when the annular wall 159 of auxiliary throat 154 registers with the flared surface 13 of the burner throat, it also abuts against the flanged plate 16 and blocks the auxiliary air passage 145, thus shutting off the flow of air through air passage 145 to the burner throat. It therefore permits closure with damper 147 omitted.

When the burner of Fig. 3 is to be operated at maximum capacities, the auxiliary throat 154 is retracted within the cylinder 130, as shown in dotted lines, and when in such retracted position the auxiliary throat 154 cooperates with the flared surface 131 of cylinder 130 to control the flow of air from the main air doors 134 to the burner throat 13. Under such conditions air flows through the auxiliary air passage 145 directly to the burner throat 13. When operating the burner in this manner, the main air doors 134 may be adjusted angularly to control the admission of air as in the embodiments previously described, and the baffle plate 147 may be moved axially within the air chamber to control the flow of air through the auxiliary passage 145.

The auxiliary throat 154 forms an adjustable constriction which may be adjusted axially within the cylinder 130 to regulate the zone at which the air admitted behind the fuel admission means is directed toward the axis. When it is desired to operate the burner at low capacities, the auxiliary throat 154 is moved axially within the cylinder 130 to the position shown in full lines, thus reducing the effective area of the burner throat and at the same time blocking the flow of air through the auxiliary passage 145.

Although several specific embodiments of the invention have been shown for purposes of illustration, it is to be understood that various changes and modifications may be made therein as will be readily apparent to a person skilled in the art.

What is claimed is:

1. A burner comprising a throat, and means including a fuel atomizer barrel, an atomizer tip and diffuser for introducing fuel for combustion, an air register for supplying air to said burner having air inlet passages, and having a discharge opening supplying air for combustion to said throat, and an adjustable diffuser extension positioned to cooperate with said burner throat to reduce the effective throat area so as to control the air velocity therethrough.

2. A burner comprising a throat, and means including a fuel atomizer barrel, an atomizer tip and diffuser for introducing fuel for combustion, an air register having adjustable air inlet openings and having a discharge opening supplying air for combustion to said throat, an auxiliary throat movable axially in said chamber and adapted to cooperate with said burner throat to reduce its effective throat area, and an adjustable diffuser extension cooperating with said dif-

fuser adjacent said burner throat to further reduce the effective area thereof so as to control the air velocity therethrough.

3. A burner comprising a throat, and means including a fuel atomizer barrel, an atomizer tip and diffuser for introducing fuel for combustion, an air register for supplying air to said burner comprising front and back walls and a peripheral wall having a plurality of axially spaced peripheral inlet passages, one of said inlet passages being disposed adjacent said burner throat to admit air directly thereto, means for regulating the flow of air through said inlet passages, an auxiliary throat movable axially in said chamber and adapted to cooperate with said burner throat to reduce its effective throat area, means on said auxiliary throat for blocking the flow of air through the inlet passage adjacent said burner throat, and an adjustable diffuser extension cooperating with said diffuser adjacent said burner throat to further reduce the effective area thereof so as to control the air velocity therethrough.

4. A burner comprising a throat, and means including a fuel atomizer barrel, an atomizer tip and diffuser for introducing fuel for combustion, an air register for supplying air to said burner comprising front and back walls and a plurality of axially spaced sets of peripheral air doors cooperating therewith, the doors of each set overlapping when closed to form the peripheral wall of an air register chamber and being adjustable angularly to control the air flow therethrough, one of said sets of doors being disposed adjacent said burner throat to admit air directly thereto, an auxiliary throat movable axially in said chamber and adapted to cooperate with said burner throat to reduce its effective throat area, means on said auxiliary throat for blocking the flow of air through the set of doors adjacent said burner throat, and an adjustable diffuser extension movable axially in said register and adapted to cooperate with said diffuser and said throat to further reduce the effective area of said burner throat so as to control the air velocity therethrough.

5. A burner comprising a throat, and means including a fuel atomizer barrel, an atomizer tip and diffuser for introducing fuel for combustion, an air register for supplying air to said burner comprising front and back walls and a set of peripheral air doors cooperating therewith, said doors overlapping when closed to form the peripheral wall of an air register chamber and being adjustable angularly to control the air flow therethrough, an auxiliary air passage opening into said air register chamber adjacent said burner throat to admit air directly thereto and having an annular inlet opening directed forwardly around the outside of said register, and means including a transverse baffle plate movable axially of said register to variably close said annular inlet opening for controlling the flow of air through said auxiliary passage.

6. A burner comprising a throat, and means including a fuel atomizer barrel, an atomizer tip and diffuser for introducing fuel for combustion, an air register for supplying air to said burner comprising front and back walls and a set of peripheral air doors cooperating therewith, said doors overlapping when closed to form the peripheral wall of an air register chamber and being adjustable angularly to control the air flow therethrough, an auxiliary air passage opening into said air register chamber adjacent said burner throat to admit air directly thereto, means for controlling the flow of air through said auxiliary passage, an auxiliary throat movable axially in said chamber and adapted to cooperate with said burner throat to reduce its effective throat area, and means on said auxiliary throat for blocking the flow of air through said auxiliary air passage.

7. In a burner having a throat and fuel supply means adapted to introduce fuel for combustion, an air register having adjustable air inlet openings and having a discharge opening for supplying air for combustion to said throat, and an auxiliary throat movable axially in said register and adapted to cooperate with said first mentioned throat to control its effective throat area so as to control the air velocity therethrough, air directing vanes carried by both of said throats, said auxiliary throat having means rendering the vanes on said first throat ineffective when said auxiliary throat is in operative position.

8. In a burner having a throat and fuel supply means adapted to introduce fuel for combustion, an air register comprising a peripheral wall having a plurality of axially spaced peripheral inlet passages therein for admitting air to different portions of said register and having a discharge opening for supplying air for combustion to said throat, at least some of said inlet passages being disposed in front of the zone of fuel admission, and an annular throat restriction having means to direct the air toward the axis of the burner, and means to adjust said restriction axially to vary the location of the axial zone at which the air from said last-mentioned passages is directed by said restriction toward the axis of the burner.

9. In a burner having a throat and fuel supply means adapted to introduce fuel for combustion, an air register comprising a peripheral wall having a plurality of axially spaced peripheral inlet passages therein for admitting air to different portions of said register and having a discharge opening for supplying air for combustion to said throat, said inlet passages being disposed both in front and in back of the zone of fuel admission, and an annular throat restriction having means to direct the air toward the axis of the burner, and means to adjust said restriction axially to vary the location of the axial zone at which the air from said last-mentioned passages is directed by said restriction toward the axis of the burner, said restriction being arranged to close the back inlet passages when adjusted to its rearmost position.

10. In a burner having a throat and fuel supply means adapted to introduce fuel for combustion, an air register having adjustable air inlet openings and having a discharge opening for supplying air for combustion to said throat, an auxiliary air passage opening into said air register chamber adjacent said burner throat to admit air directly thereto, means for controlling the flow of air through said auxiliary passage, an auxiliary throat movable axially in said chamber and adapted to cooperate with said burner throat to reduce its effective throat area, and means on said auxiliary throat for blocking the flow of air through said auxiliary air passage.

DAVID P. GRAHAM.
ROBERT C. VROOM.