Dec. 31, 1957 T. S. VOORHEIS 2,818,109

VARIABLE LOAD BURNER CONSTRUCTION

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Fig. 1.

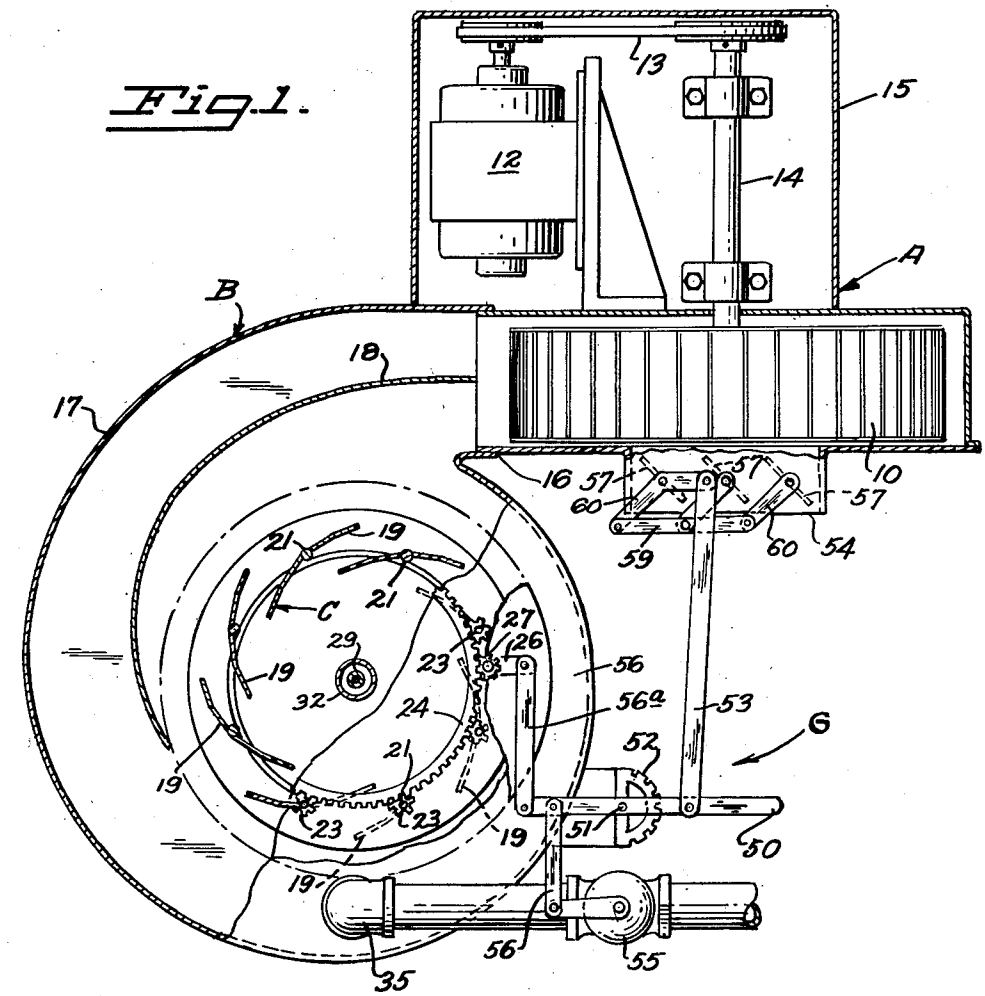
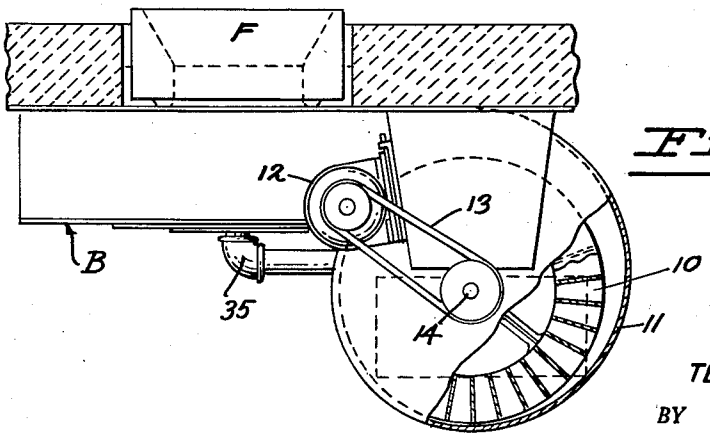


Fig. 2.



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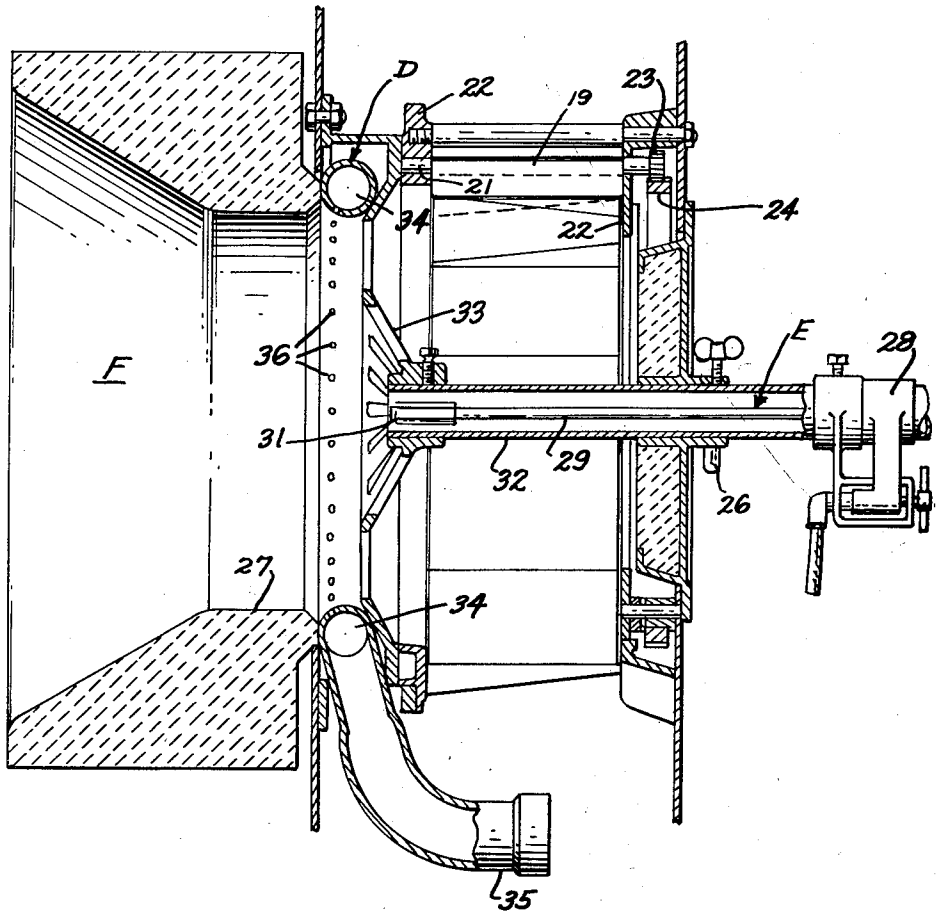
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Fig. 3.



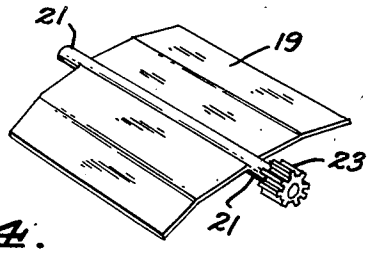


Fig. 4.

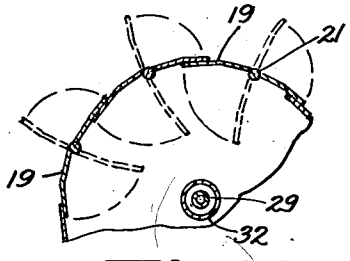


Fig. 5.

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VARIABLE LOAD BURNER CONSTRUCTION

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Application June 22, 1953, Serial No. 363,211

2 Claims. (Cl. 158—1.5)

This invention relates to a new and improved variable load burner constructions.

In commercial forced air draft oil and gas burners used to generate heat for boilers or the like, it is frequently desirable that such burners be capable of efficiently operating over a relatively broad firing range to meet greatly varied load conditions.

More particularly, in many industrial heating applications in connection with which burners are used, maximum efficiency in over-all operation is attainable only if the burner is capable of successfully operating with substantially equal efficiency at both a relatively high and relatively low firing rate. Thus, for example, it has been found that in many instances, the burner should be capable of operating substantially equally satisfactorily anywhere within a ten-to-one load range, or, in other words, that the burner should be capable of operating efficiently at as low as one-tenth of its maximum capacity or firing rate.

Although several of the more conventional forced air draft oil or gas burners in commercial use today of which I have knowledge are capable of operating reasonably efficiently and satisfactorily over a one-to-four or one-to-five firing range, if one attempts to operate such conventional burners at much below one-fourth or one-fifth of their maximum firing rate serious practical difficulties to the point of actual failure in combustion may result.

Perhaps the principal reason why prior art burners cannot be operated successfully at much below one-fourth or one-fifth of their maximum capacity is that no sufficiently satisfactory means has heretofore been developed for insuring an adequate or proper intermixture between air and fuel within the combustion chamber under conditions where both the volume of air and fuel introduced into the combustion chamber is less than one-fourth or one-fifth of the amounts introduced into the chamber when the burner is operated at maximum capacity.

It is a principal object of the present invention, therefore, to provide a burner construction which is capable of operating satisfactorily and efficiently over a relatively broad firing range, as, for example, over a ten-to-one firing range.

In the drawings:

Fig. 1 is a side elevational view of a burner construction embodying the invention with portions thereof shown broken away in section.

Fig. 2 is a plan view of the burner with the fan motor cover removed.

Fig. 3 is an enlarged longitudinal sectional view of the burner proper.

Fig. 4 is an enlarged perspective view of one of the air register vanes.

Fig. 5 is an enlarged fragmentary view in side elevation showing the air register vanes, in closed position.

Referring now more particularly to the drawings, the burner construction therein shown comprises, generally a blower or fan assembly A, a plenum or windbox unit B, an air register assembly C, a gas burner assembly D, an oil injection assembly E, and a combustion chamber, the entrance to which is designated generally at F.

The fan or blower assemoly, heretofore indicated generally at A, preferably comprises a motor-driven fan blower 10 mounted for rotation within a scroll type or volute fan housing 11. The motor 12 connected by belt drive 13 to drive shaft 14 may be conveniently located within enclosed cover 15 removably secured to fan housing 11. The blower discharge end of the fan housing is connected as at 16 to the inlet side of the plenum or windbox heretofore indicated generally at B.

As above indicated, windbox B consists of a scroll type or volute casing 17 which may be provided with one or more internal baffles such as indicated at 18 for insuring uniform air distribution to the burner via circular air register C.

Circular air register C comprises, more specifically, a plurality of arcuate vanes 19, each of which are pivotally mounted on an associated axle 21 for adjustable opening and closing movements. More particularly, each of the vane supporting axles 21 are rotatably journaled to opposite sides of a circular frame 22 whereby the vanes may be adjustably opened or closed in unison concurrently with variation in firing rate, by control means to be hereinafter described.

Circular air register assembly C is located within the scroll plenum 17 in such manner that the clearance between the circular register and the walls of the plenum diminishes in the direction of the air flow through the plenum so as to insure uniform distribution of air through the register vanes and into the burner.

The circular register is also located coaxially with respect to the throat opening of the combustion chamber, as well as with respect to the gas injection ring and oil spray nozzle of the burner, as will more fully hereinafter appear.

The construction of the air register is preferably such that when the vanes are fully closed or shut each vane lies generally within the plane of circumference of the circular register frame. It is further noted that the vanes are constructed and arranged so that when they are closed contiguous edges of adjacent vanes partially overlap one another in shingle-like arrangement, as shown in Fig. 5, for example. This arrangement is important because when the vanes are closed to near shut position during operation of the burner within its lowermost firing range, a highly desirable spiral motion will be imparted to the air flow through the register vanes as it passes into the combustion chamber. The importance and significance of inducing a spiral action to the air draft during low load operating conditions will be described more fully hereinafter.

Each of the vane axles **21** may be provided with a pinion or spur gear, such as indicated at **23**, adjacent its rearwardly projecting end. To control opening and closing movements of the vanes **19** in unison a ring gear **24** may be provided in mesh engagement with all of the vane axle pinions **23**. Selective movement of ring gear **24** in clockwise or counter-clockwise direction may be controlled through manipulation of control lever **26** provided with a spur gear or pinion **27** in mesh engagement with ring gear **24**. Referring specifically to Fig. 1, it is seen that upward movement of lever **26** will through its spur gear connection with the ring gear, cause the latter to move in a clockwise direction for causing opening of the air register vanes **19**. Similarly, movement of control lever **26** downwardly will cause counter-clockwise rotation of ring gear **24**, and consequent closing of vanes **19**.

In order to provide a means for regulating and synchronizing the opening and closing movements of the circular air register vanes concurrently with variations

in the air and fuel supply to the burner, a manual control station, indicated generally at G, may be provided. More specifically, control station G comprises a manual control lever **50**, pivoted as at **51** to quadrant **52** and pivotally connected by link arm **53** to multi-louver air damper **54**, which said damper is in communication with fan housing **10** for regulating the volume of air flow into the blower unit. Control arm **50** is also pivotally connected to gas valve **55** by a link arm **56**. Control arm **50** is further connected to control lever **26** by link *56a*.

From the foregoing arrangement, it is seen that when master control lever **50** is moved upwards, the damper blades **57** of multi-louver damper **54** will move toward closed position through conventional linkage comprising a control bar **59** and blade levers **60**, thereby restricting the volume of air into blower unit **10**. Upward movement of master control lever **50** will also cause corresponding closing of gas valve **55** and circular air register C by virtue of link connections **56** and *56a* with these latter components.

It is evident, of course, that downward movement of manual control lever **50** will, through the linkage above mentioned, cause corresponding simultaneous opening of the multi-louver damper **54**, air register assembly C, and gas valve **55**.

It will be readily understood, of course, that when oil instead of gas is burned, other linkage corresponding to that described above for opening and closing the gas valve may be provided for similarly controlling the oil supply to the burner upon movement of manual control lever **50** and in proper relation to the air supply.

In addition to providing a manual control station for adjustably regulating the supply of fuel and air depending on existing load conditions concurrently with adjustment of vane opening of an adjustable vane register as above described, it is desirable in many commercial installations embodying the invention to provide a suitable system for automatically controlling both the air and fuel supply to the burner according to varying load conditions. It will suffice to remark that various types of automatic or semi-automatic control systems have been developed and used in the past for controlling air and fuel supply to a burner according to heat requirement of the boiler or other unit in connection with which the burner is employed for generating heat. Such automatic or semi-automatic control systems are, accordingly, well known in the art, and further elaboration in regard to such systems is therefore considered unnecessary, beyond recognizing that by this invention such automatic means of varying rate of fuel and air supply to a burner, will concurrently vary the vanes of an adjustable vane air register as above described from a closed or nearly closed position at minimum firing rate to a largely open position at maximum firing rate.

The actual burner unit shown in the drawings comprising gas burner assembly D, oil injection assembly E, and combustion chamber, above mentioned, may also be of more or less conventional design. More specifically, the entrance to combustion chamber F is truncated conical shape in cross-section defining a restricted throat **27**, and is formed of suitable plastic refractory material.

The oil burner assembly E is shown as comprising a mechanical atomizer (or steam atomizer) **28** adapted for connection to a source of oil (and steam) under pressure (not shown), an oil supply tube **29** and a spray nozzle tip **31**. The supply tube **29** and spray tip **31** are housed within a guide tube **32** which, in turn, is provided with an oil burner shield **33** adjacent its forward end.

The gas burner assembly D is shown as comprising a gas ring **34** adapted for connection via supply conduit **35** to a source of gas under pressure (not shown), and formed with a plurality of gas jets or openings **36** through which gas is supplied to the combustion chamber.

Generally speaking, when a burner of the general type

above described is operated within a firing range at or approaching its maximum firing rate, no particular difficulty is encountered in causing adequate intermixing between air and fuel (whether it be gas or oil supply) for proper combustion. In short, when the burner is operating within its higher firing range, the relatively large volume of air necessary to sustain combustion entering the combustion chamber under a relatively high velocity head will, as a consequence, result in adequate turbulent intermixing between the fuel and air for efficient and proper combustion. However, it is also generally true that the lower the firing range at which the burner is operated, the lesser will be the amount of inherent turbulent intermixing between the fuel and air by virtue of the decreased volume of air and fuel being introduced into the combustion chamber at the lower firing ranges.

As hereinabove pointed out, the more conventional oil or gas burners employing a scroll plenum or a circular or rectangular plenum in conjunction with a fixed vane type register, are incapable of being operated within a firing range much below one-fourth to one-fifth of maximum capacity—i. e., when an attempt is made to operate the burner at a firing rate between one-fifth to one-tenth of maximum capacity, improper combustion, or failure of combustion, will result, due principally to lack of sufficient rotational air velocity to provide adequate turbulent intermixing of the fuel and the air.

However, in burners constructed according to the present invention when such a burner is operated in its lower firing range, the air register vanes are preferably closed to practically fully shut position whereat the contiguous edges of adjacent arcuate vanes partially overlie or overlap one another in shingle-like arrangement. Indeed, excellent results are obtained in operating the burner within its lower-most firing range by closing the register vanes to a point where substantially only air "leakage" through the vanes is permitted. By closing the vanes to this extent, sufficient resistance is built up to overcome the natural directional flow of air around the outer surfaces of the scroll plenum to insure uniform distribution and flow of air through the register vanes. In this connection, it is pointed out that if a fixed or "set" open vane register is employed with a scroll plenum the fixed vanes will not provide sufficient resistance at low loads or firing rates to the directional flow of the air around the plenum to prevent substantially all of the air flow from entering the burner through a localized area of the register such as the one vane opening located at the point of minimum clearance between the register and the volute walls of the plenum. However, and as above stated, by closing the adjustable vane register to a point where only minimum air "leakage" is permitted through the vanes, sufficient resistance is built up to overcome the directional flow of the air and cause it to uniformly enter through all, instead of simply one or several, of the vanes.

A further advantageous and important factor in closing the air register vanes to a point where only air leakage is permitted during operation of the burner within its lower-most range is that the overlapped arrangement of the vanes imparts a highly desirable swirling motion to the air flowing into the combustion chamber.

More particularly, it has been determined from experience that a pronounced swirling motion imparted to the air will produce and maintain optimum efficiency between gas and air mix, and it is particularly desirable, of course, to be able to maintain optimum efficiency between fuel and air mix when the burner is operating in its lowermost firing range, as well as through its upper firing range.

Although, it might perhaps be expected that reasonably satisfactory admixture of gas and air would be obtained under these latter operating conditions, it has been found, very surprisingly, that substantially equally good results are obtained in operating the unit as an oil burner. More particularly, it has been found that the flow of air

entering through throat 27 and into the combustion chamber proper will actually cause the comparatively small conical shaped atomized oil spray injected from nozzle tip 31 to be "mushroomed" or sucked outwardly toward the truncated conical shaped walls of the burner resulting in intimate intermixing of the oil spray particles with the air stream to insure complete combustion with a minimum of excess air. This mushrooming outwardly of the oil spray and consequent admixture with the swirling air flow will occur even when the amounts of oil and air being introduced into the chamber have been reduced to such an extent that the burner is operating at or approaching one-tenth of its maximum firing capacity.

Although the present invention has been described in some detail by way of illustration and example for purposes of clarity and understanding, it is understood that certain changes and modification may be practiced within the spirit of the invention as limited only by the scope of the claims appended hereto.

I claim:

1. In a forced air draft oil or gas burner of the type in which air under pressure is supplied to the combustion chamber for intermixing with the fuel to be burned, the combination comprising: a blower assembly for inducing a forced draft of air; adjustable damper means associated with said blower assembly for regulating volume of air flow through said blower assembly; a scroll plenum in communication with said blower assembly; a circular air register for imparting a swirling motion to air discharged therefrom disposed interiorly of said scroll plenum comprising a circular frame; a plurality of vanes pivotally mounted to said frame for movement from a closed position, whereat said vanes lie generally within the line of circumference of said circular frame and with contiguous edges of adjacent vanes overlapped in shingle-like arrangement, to an open position, whereat said vanes are disposed generally radially with respect to said circular frame; said circular air register disposed within said scroll plenum with the clearance between the circular register and the volute walls of the scroll plenum diminishing in the direction of air flow from said blower assembly through said plenum; an entrance to a combustion chamber; said circular air register disposed in coaxial alignment with respect to said entrance; fuel supply means; adjustable regulating means for regulating the fuel supply to said entrance; and manual control means associated with said damper means, said vanes of said circular air register, and said adjustable fuel supply means, for simultaneously regulating proportionate fuel and air supply to said entrance in relation to varying load requirements of the burner concurrently with air register vane control.

2. In a forced air draft oil or gas burner of the type in which air under pressure is supplied to the combustion chamber for intermixing with the fuel to be burned, the combination comprising: a blower assembly for supplying substantially 100% of all combustion air; adjustable damper means operably associated with said blower assembly for regulating volume of air flow through said blower assembly; a windbox in communication with said blower assembly; a circular air register to impart a swirl to air discharged therefrom disposed interiorly of said windbox comprising a circular frame; a plurality of vanes pivotally mounted to said frame for movement from a closed position to an open position to impart varying degrees of swirl to air passing through said register; an entrance to a combustion chamber; said circular air register disposed in coaxial alignment with respect to said entrance; fuel supply means located adjacent said entrance; adjustable fuel regulating means for regulating the fuel supply to said entrance; and manual control means operably associated with said damper means, said vanes of said circular air register, and said adjustable fuel regulating means, operable to substantially simultaneously relatively open and close said damper means, said vanes, and said fuel regulating means proportionate to the increase and decrease respectively of the load requirements of the burner.

References Cited in the file of this patent

UNITED STATES PATENTS

1,684,079	White	Sept. 11, 1928
1,738,176	Dyer	Dec. 3, 1929
2,203,553	Thoresen	June 4, 1940
2,211,684	Baker	Aug. 13, 1940
2,382,913	Robinson	Aug. 14, 1945
2,387,280	McIlvaine	Oct. 13, 1945
2,473,347	Sanborn	June 14, 1949