Oct. 22, 1940. H. E. HENRIKSEN 2,218,643

FAN FOR LIQUID FUEL BURNERS

Filed Dec. 13, 1937 4 Sheets-Sheet 1

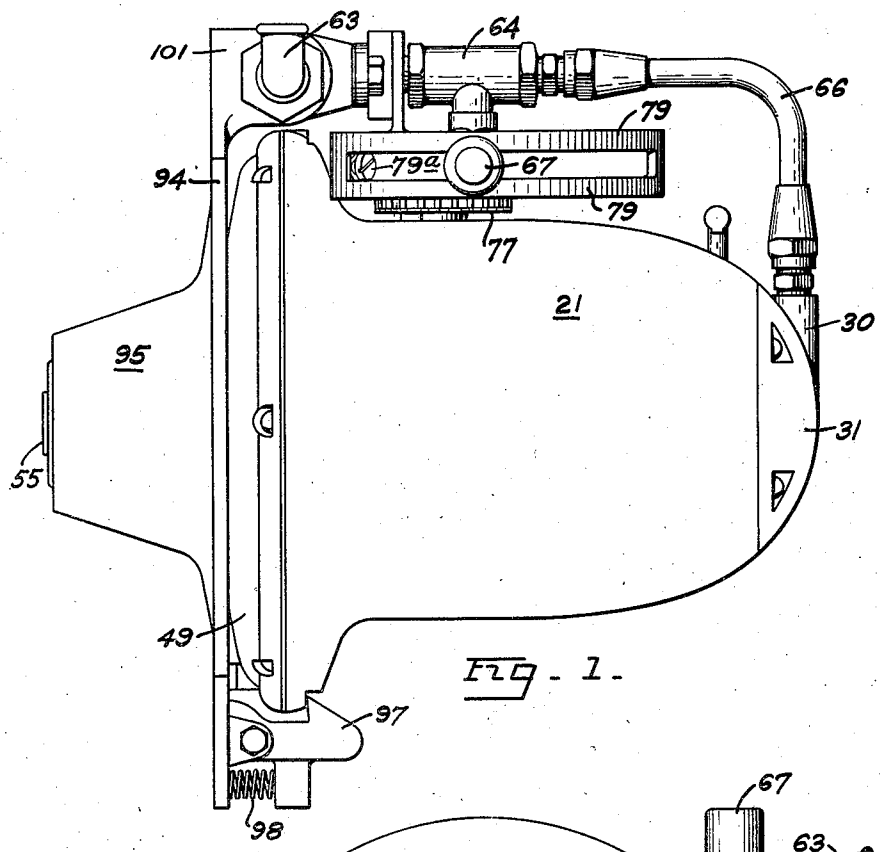


Fig. 1.

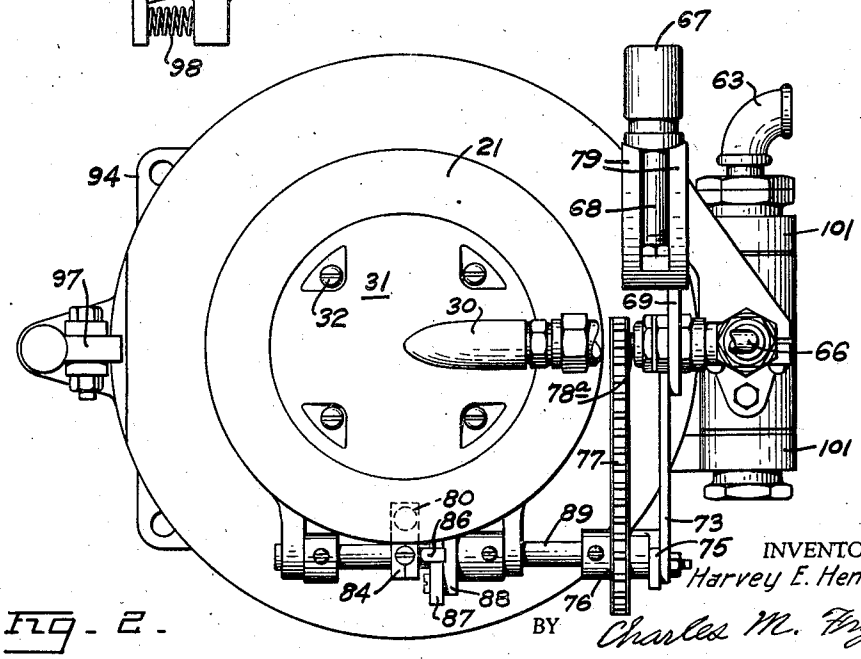


Fig. 2.

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FAN FOR LIQUID FUEL BURNERS

Filed Dec. 13, 1937 4 Sheets-Sheet 2

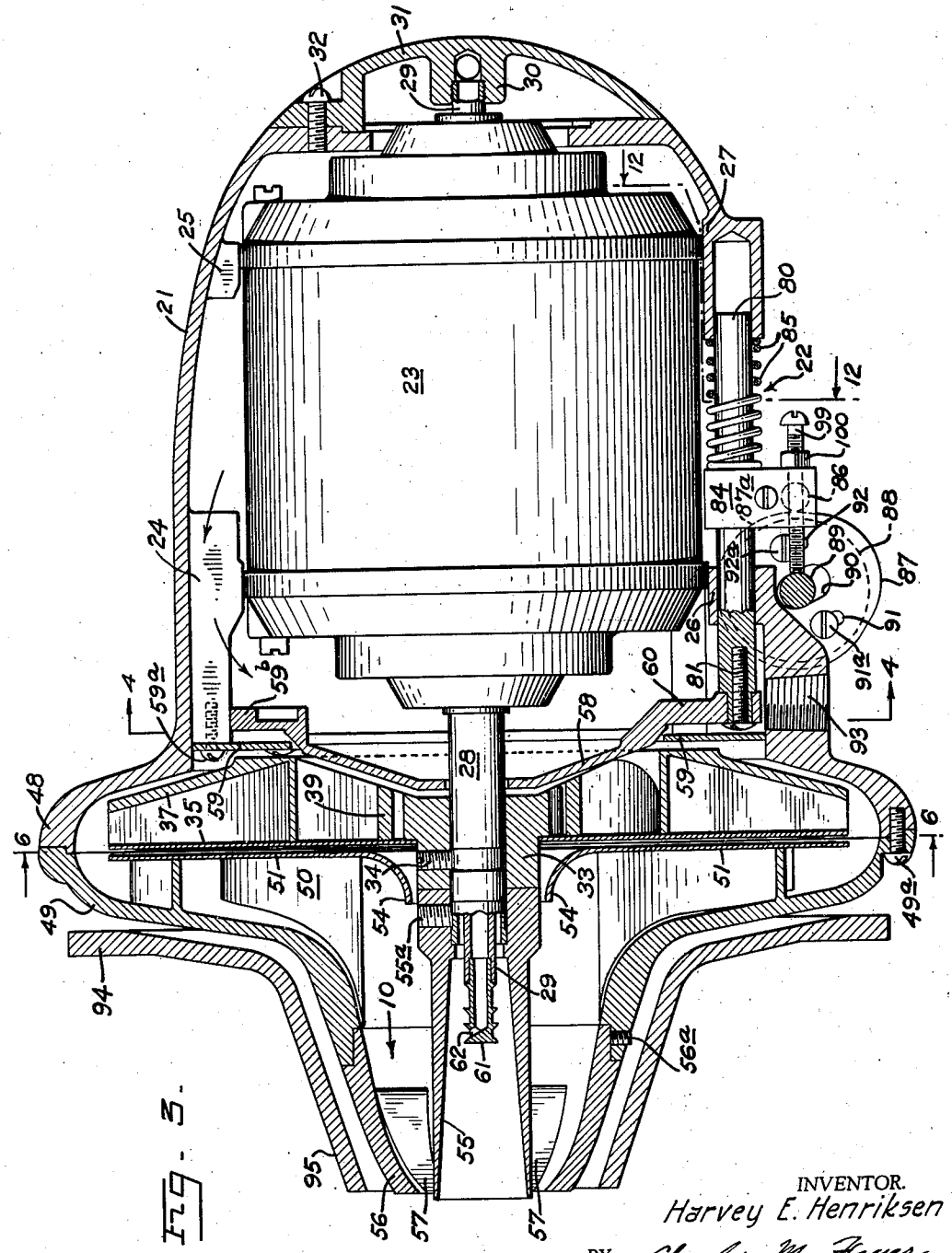


Fig. 3.

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FAN FOR LIQUID FUEL BURNERS

Filed Dec. 13, 1937 4 Sheets-Sheet 3

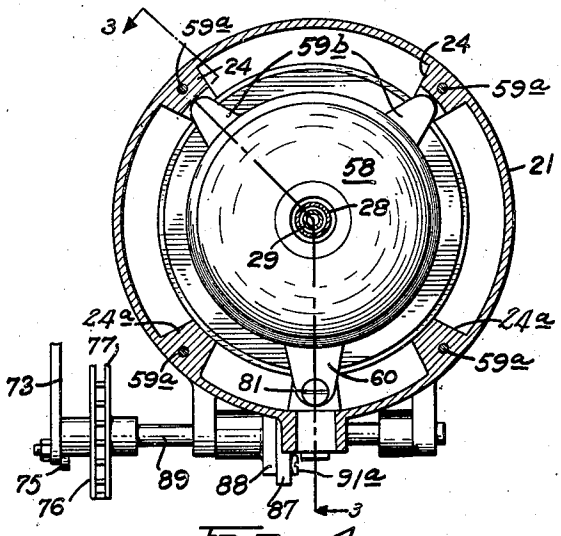


Fig. 4.

Fig. 10.

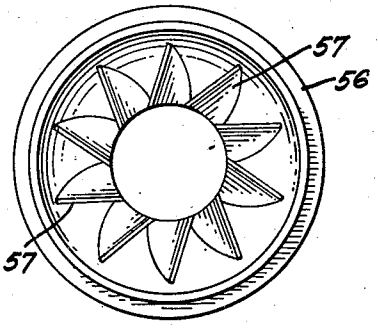
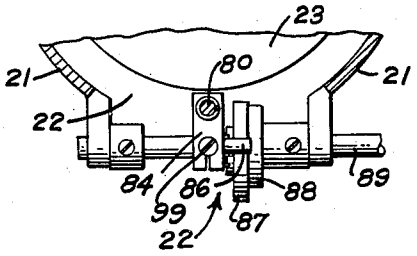


Fig. 12.



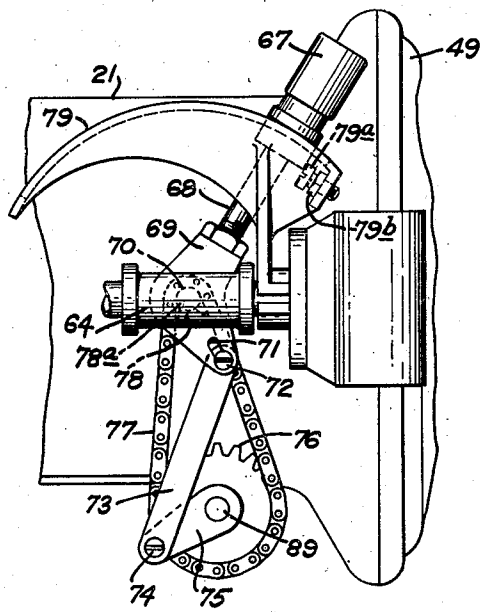


Fig. 5.

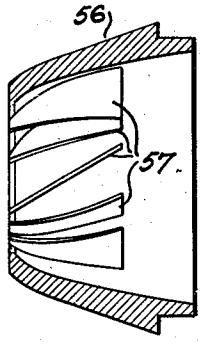


Fig. 11.

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FAN FOR LIQUID FUEL BURNERS

Filed Dec. 13, 1937 4 Sheets-Sheet 4

Fig. 6.

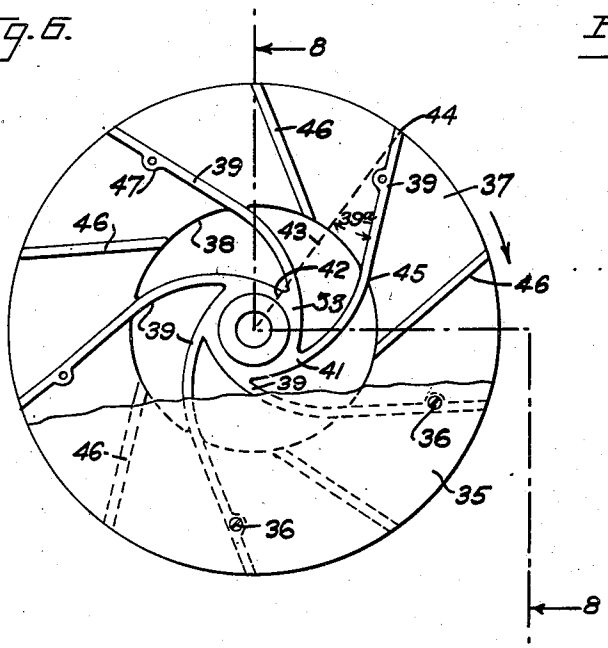


Fig. 8.

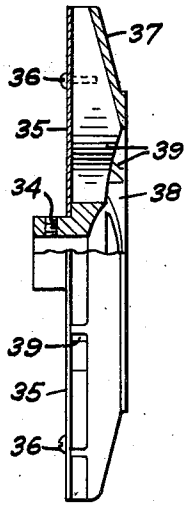


Fig. 7.

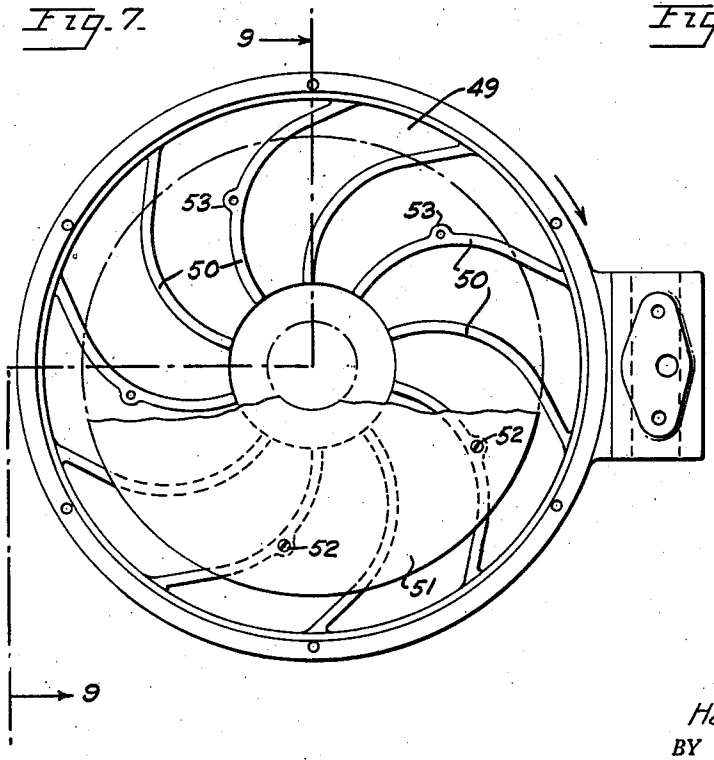
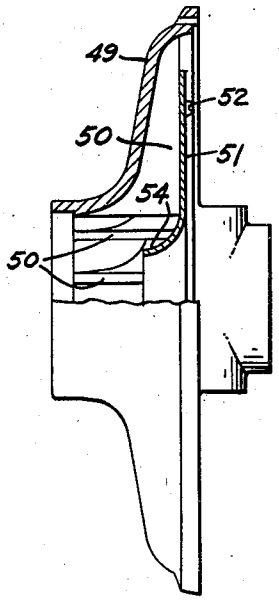


Fig. 9.



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Patented Oct. 22, 1940 2,218,643

UNITED STATES PATENT OFFICE

2,218,643

FAN FOR LIQUID FUEL BURNERS

Harvey E. Henriksen, San Francisco, Calif., assignor to Ray Oil Burner Co., San Francisco, Calif., a corporation of Delaware

Application December 13, 1937, Serial No. 179,502

13 Claims. (Cl. 230—114)

This invention relates to oil burners of the type in which oil in finely divided or atomized form is fed mixed with air, to the locus of combustion and more particularly to the fan thereof, its coordination therewith, and the control of the supply of fuel and air. My burner is preferably of the horizontal type, the oil being spun off of or out of a rotating cup mounted in the burner casing. A fan is usually in the burner casing for directing a blast of air into an annular space formed between the cup and a nozzle surrounding it, this blast of air aiding in the subdivision of the oil spun off by the cup and serving as the primary supply of air for combustion. An additional or secondary supply of air for combustion may flow through an annular space between the nozzle and a burner hinge plate which, as is the custom, may be attached to the furnace wall.

Oil burners of this type have heretofore been not all that could be desired insofar as efficiency is concerned because very little attention was given to the air flow through the burner, so as not to create turbulence causing loss in efficiency. Furthermore, the proper coordination of the flow of air and the flow of fuel oil is another factor that has to be considered in this connection. The amount of air required in actual practice is not actually, regardless of theory, proportional to the amount of oil being burned, and the changes in the rate of air flow as the rate of oil flow is changed have been made more or less empirically in actual practice, by guess of the operator.

Objects of my invention are to increase the efficiency of preparing and burning the fuel; to overcome the difficulties and disadvantages of prior devices; to provide an oil burner having increased output horsepower per unit of oil consumed and per unit of power consumed in the operation of the burner, and to increase generally the burner efficiency; to provide a smaller size burner which will have a power output equal to that of larger size burners heretofore used; to provide a burner which will have a greater power output than burners of the same size heretofore used; to make the air feed to the burner more efficient than heretofore; to avoid noisy operation; to simplify the control of air and of oil; to provide a simple, easily operable means for simultaneously controlling both the supply of oil and the supply of air; to provide an air-feed control dependent on the oil-feed control and which automatically varies the ratio of air to oil in the particular manner found best in actual practice; to provide an air-feed control of the nature referred to wherein the feed of air will not fall below a predetermined minimum even though but little oil be fed; to provide an air-feed control of the nature referred to wherein the feed of air will be constant when the feed of oil is lowered to and below a predetermined value; and other objects of the invention will become apparent on reading this specification.

Generally stated, my invention comprises making substantially uniform the cross sectional area of the path of the air through my device, and particularly at the inlet of and after entering the fan, so that there is no squeezing or expansion of the air in its path and all flow is translated into straight velocity with minimum turbulence or eddy currents; by having such air flow to the fan inlet without hindrance thereto to avoid turbulence or eddy currents; by having the fan blades begin at a point set forward on the hub as compared to straight radial blades so as to provide for increased length of the blades and thereby enable the fan to handle a greater volume of air with greater pressure; by having the fan blades curved at the inlet opening of the fan to provide streamline flow at the inlet and thereby avoid turbulence, and then straight from the inlet opening to the outer periphery of the fan so as to prevent change of direction of the air while being guided between the vanes; by arranging the angle of discharge of the fan blades so as to decrease the tangential component of movement of the air after it leaves the fan blades and thereby reduce turbulence; by providing a means to receive the air thrown out by the fan blades which is so co-related to the fan that change of direction of movement of the air is decreased; and by having vanes in the nozzle to impart a rotary movement to the air. I also provide a means operable by an adjusting lever or other simple control for changing the rate of feed of the fuel oil and simultaneously the rate of feed of the primary supply of air. The optimum rate of feed of such air is predetermined for each rate of feed of such oil, and there is a means to co-ordinate the rate of air flow to whatever rate of fuel oil flow is chosen while the burner is in operation, so that the proper co-ordinated flow occurs in any position of the lever or other simple control means.

I have illustrated the preferred embodiment of my invention on the accompanying drawings which form a part of this specification and on which

Fig. 1 is a plan view of my burner;

Fig. 2 is a rear elevation thereof;

Fig. 3 is a cross-section taken on the line 3—3 of Fig. 4 looking in the direction of the arrows, with parts in elevation;

Fig. 4 is a cross-section on the line 4—4 of Fig. 3, looking in the direction of the arrows;

Fig. 5 is a side elevation from the right of Fig. 2, showing the control handle and appurtenant parts;

Fig. 6 is an elevational view of the fan, taken in a plane indicated by line 6—6 of Fig. 3, and looking in the direction of the arrows, with parts broken away to illustrate more clearly the construction;

Fig. 7 is an elevation viewed along the line 6—6 of Fig. 3, but looking to the left thereof, with parts broken away;

Fig. 8 is a sectional elevation of Fig. 6 on the line 8—8 thereof, looking in the direction of the arrows;

Fig. 9 is a sectional elevation of Fig. 7 on the line 9—9 thereof, looking in the direction of the arrows;

Fig. 10 is an elevation of the outlet nozzle looking in the direction of arrow 10 in Fig. 3;

Fig. 11 is a cross section thereof; and

Fig. 12 is a cross section on the line 12—12 of Fig. 3, but on a reduced scale.

The various views of the drawings illustrate the correct contour and proportions of the various parts and their relationship with respect to each other, as actually employed on my burner.

The greater part of my device is enclosed within a casing 21 which has an opening 22, preferably at the bottom thereof. An electric motor 23 is supported within the casing by contact with lugs 24, 25, 26, and 27. The motor shaft 28 is hollow, and within it is a stationary pipe 29 screwed into a hollow lug 30 on a casing cap 31 which is suitably fastened to the casing 21 by screws 32. A fan hub 33 is attached to the hollow motor shaft 28 by means of one or more screws 34 passing through the fan hub and bearing against the shaft. The fan comprises a plate 35 attached by screws 36 to an impeller plate 37 having a central opening 38 and impeller vanes or blades 39 extending from the center thereof to the periphery. The impeller blades are not truly radial, but each blade leaves the hub 33 almost tangentially thereto at a point 41 preferably at a lead of about eighty-six and one-half degrees (86½°) ahead, in the direction of rotation, of the point 42 at the intersection of the hub with a theoretical radius 43 which extends outwardly to the point 44 where the blade ends at the periphery of the plate. Each impeller blade 39 is curved between the point 41 and the point 45 at which it meets the edge of the fan inlet, in such a manner that it is streamlined and thereby avoids turbulence and eddy currents. From the point 45 on out to the point 44 at the periphery of the fan it is straight and makes an angle 39a of about twenty-two degrees (22°) with its theoretical radius 43. A substantially greater angle results in slippage and loss of efficiency. Each blade 39 has the same characteristics. Between each two adjacent blades 39 are blades 46 which have the same characteristics as the blades 39 except that they extend only from the inner periphery to the outer periphery of the annular plate 37, that is, from the periphery of the fan inlet to the periphery of the fan. The total number of blades is preferably 10, spaced thirty-six degrees (36°) apart; and preferably all the blades and the impeller plate 37 are formed as a unitary casting. The blades 46 could be the same as the blades 39 and have a similar curved part extending to the hub. It is desirable, however, in a device of the dimensions indicated by the accompanying drawings to omit this curved part in order to provide a greater space for the entry of air into the fan. For example, in a device which is sufficiently large or in one which has a sufficiently large hub, the blades 46 may be complete and substantially the same as the blades 39. Any of the blades, for example the blades 39, may be provided with lugs 47 having threaded holes to accommodate the screws 36, and these lugs are best arranged on the sides of the blades which do not impel the air, in order to avoid obstacles to the flow thereof.

The angles which have been specified above are those found most satisfactory for the particular size of burner illustrated, which burner is shown substantially four-fifths (⅘) full scale on Fig. 3. These angles may of course vary. It is desirable that the lead angle as determined between points 41 and 42 be as great as possible to provide for increased length of the blade which is desirable for obtaining increased air capacity and pressure. The lead angle is more or less determined by the size of the fan hub; and in larger size burner fans wherein larger hubs are feasible, it may be much greater than that of eighty-six and one-half degrees (86½°). The angle 39a of twenty-two degrees (22°) is also variable within reasonable limits for different size burner fans, it being important that such angle be not so great as to permit air slippage but yet large enough to reduce as much as possible the tangential discharge component of the air which results in eddy currents and consequent loss of power.

As previously related, the blade is curved between points 41 and 45, such curvature being preferably no greater than that necessary to produce substantially true streamline flow at the inlet, so as to reduce turbulence. The portions of the blades between points 45 and 44 is made straight to prevent change in direction of the air while flowing between the vanes, to thereby also reduce turbulence.

Air enters the fan from the right, as seen on Figs. 3 and 8, through the central opening of the annular plate 37. The blades 39 increase in width from the hub outwardly to the inner periphery of the annular plate 37, and they decrease, as do the blades 46, in width from there outwardly to the outer periphery of the annular plate 37 which is inclined to the axis of rotation and has the shape of a truncated cone, as seen on Fig. 8. This presents to the incoming air a dish-like set of blades forming a concave conically shaped air intake within the fan, and which pick up the air as soon as it enters the fan and impel it along their convex sides outwardly at right angles to the direction of entry into the fan. The outer periphery of the annular plate 37, the outer ends of the vanes 39 and 46, and the outer periphery of the plate 35 terminate on the same circular cylindrical surface.

The casing 21 is flared outwardly as at 48 to confine and direct the air thrown outwardly by the fan. There is very little, if any, turbulence (eddy currents) in such air. Its motion is principally toward the left as seen on Fig. 3, and any motion tangentially to the periphery of the

fan and in the direction of rotation of the fan, which occurs in centrifugal fans, is substantially decreased. This air is picked up and brought in toward the axis of the device to be discharged forwardly over the end of the oil feed which will be hereinafter described. For the purpose of so directing and discharging the air thrown outwardly by the fan, I provide annular plates with vanes between them to form air paths leading toward the center. A member 49 forming an extension of the casing and attached to the casing part 48 by screws 49a, extends from this casing part inwardly and forwardly, and is provided with stationary vanes 50 which gather up the air flowing against them and deflect it in centrally inwardly. A plate 51 is attached thereto, as by means of screws 52 accommodated in lugs 53 on the convex sides of the blades. A central forward extension 54 of the plate 51 directs the air flowing between the stationary vanes 50 forwardly about the oil discharge cup 55 through which the oil is discharged to the left as seen on Fig. 3. A nozzle member 56, providing an air discharge opening, is attached to the casing plate 49, as by screws 56a, to receive the forwarded air, and interiorly thereof are deflecting vanes 57 shaped and arranged to give the air a rotative movement counter to that of the oil. Turbulence and eddy currents have thus been minimized in the air passing from the place of entrance into the fan up to the place where it is used.

Oil flows through the stationary pipe 29 and through the conventional nozzle 61 at the end thereof. This nozzle may be of any suitable construction and preferably has an opening 62 at the upper side thereof to discharge the oil in a stream against the interior of the rotating oil discharge cup 55 which is mounted on and attached to the motor shaft, as by screws 55a. Due to its speed of rotation and its conical interior tapering outwardly toward the discharge end, the oil discharge cup spins the oil out from the end thereof imparting a rotative movement to the oil as it is spun out. The air discharged past the end of the oil discharge 55 rotates in a direction counter to that of the oil for the purpose of providing finer comminution and a better fuel mixture.

A hollow fitting 63 is connected to the supply of oil which is under at least sufficient pressure to make it flow to the burner at the maximum desired rate. From the fitting 63 the oil flows through a valve 64 which may be of any suitable conventional construction, and then through the pipe 66 into the hollow lug 30 from whence it flows through pipe 29 and out through the nozzle 61.

Such oil valve is opened and closed by an actuating stem rotatable through a range of over one hundred and eighty degrees (180°) between the wide open and shut positions. The actuating stem of the valve which controls the feed of oil to the burner is, in turn, controlled by an actuating or control lever which preferably is limited to a swing of about ninety degrees (90°) for convenience of operation, but which is so connected with the valve that such a ninety degree (90°) movement causes rotation of the actuating stem of the valve throughout its range of movement. This permits of a short stroke of the lever adjusted by the operator to set the valve anywhere between the range of wide open to closed, and makes the control of the device more convenient and the device itself more compact. As an exemplification of this feature I provide an operating handle 67 at the end of a rod 68 which is secured into one arm 69 of a bell crank lever pivoted at 70, the other arm of which has a slot 71 to accommodate the pin 72. This pin is at the end of link 73 pivotally connected at 74 to the crank 75 attached to the sprocket 76. A sprocket chain 77 extends about this sprocket and about a smaller sprocket 78 fixed on the valve control stem 78a, the rotative movement of which opens or shuts the oil valve. The operating handle 67 rides over parallel guides 79 between which the rod 68 extends, and either one or both of these may be marked to indicate the comparative amount of oil being fed when the operating handle is in any particular position. The guides are connected to each other at both ends to limit the movement of the handle 67. The limit of movement may be pre-adjusted, for example by means of an adjustable screw 79a threaded into the connection between the guides 79 at an end thereof, and a lock nut 79b to hold it fast in adjusted position. The end of the movement of the handle 67 may thus be adjusted. The mechanical movement so far described has the function of making the member which opens and closes the oil valve rotate through a greater angle than the movement of the operating handle.

I provide a connection between the operating handle 67 and a reciprocative air valve shutter plate 58 which controls the flow of air to the fan to that required for any particular quantity of oil fed to the burner. This plate 58 is mounted directly at the fan intake for sliding movement toward and away from a baffle plate or valve seat 59 located closely adjacent to the fan intake between the fan and the motor. This baffle plate is fastened by means such as screws 59a to the lugs 24, and additional lugs 24a may be provided for a similar purpose. The valve plate 58 is convexly conical or dish-shaped complementary to the fan intake and together with the baffle plate or seat 59 directs all air into the fan intake, to thereby provide a substantially uniform cone-like flow of air converging into the fan inlet well within the fan. Thus atmospheric air can enter the burner through the wide opening 22 to a position closely adjacent the inlet to the fan and be consequently admitted into the fan under substantially atmospheric conditions, with no throttling effect which would cause turbulence with consequent loss of efficiency

The plate 58 has projecting lugs 59b and 60, the lugs 59b sliding along depressed portions of the lugs 24 to guide the plate in straight axial movement. The plate is attached to a rod 80 by means of a screw 81 passing through the lug 60. This rod is capable of longitudinal sliding movement in perforations through the lugs 26 and 27. An ear or lug 84 is fastened to the rod in adjustable position thereon and is forced to the left as seen on Fig. 3 by means of a compression spring 85. A pin 86 projects from the lug 84 and rides against a cam 87 attached to a cam-carrying plate 88 mounted on the shaft 89 upon which the sprocket 76 is mounted, so that this plate 88 will rotate with this sprocket. Cam 87 has a slot 90 passing through the center thereof so that the shaft 89 may pass therethrough, and is also provided with two additional slots 91 and 92 for permitting screws 91a and 92a to pass therethrough to enter threaded openings in the cam-carrying plate 88. The three slots permit of radial and circumferential adjustment of the cam

with respect to the cam-carrying plate and the pin 86. Such cam 87 is so shaped and so positioned that upon movement of the control lever 67 to vary the oil feed, the air shutter plate 58 will be moved differentially with respect to the oil feed control valve to thereby insure the proper air-oil ratios for varying fire conditions. In this connection, it is apparent that the contour of the cam may be predetermined to suit any burner operating conditions. Upon movement of lever 67 to supply more oil, the cam will be rotated so that it will push the pin 86 and thereby effect movement of rod 80; the spring 85 always maintaining the pin 86 in contact with the cam, so that when handle 67 is moved to close the oil valve, the shutter 58 will also be moved toward minimum air feed position.

The degree of firing may be controlled merely by movement of the operating handle 67 which as is now apparent controls the rate of flow of oil to the burner and adjusts the rate of feed of air for the maximum efficiency of the burner at the particular rate of feed of the oil. The cam has a dwell portion 87*a* in which rotation of the cam does not change the position of the pin 86 nor of the valve plate 58, because at the lower firing ranges when the burner is operating at substantially or close to minimum capacity it is best to be able to vary the flow of oil without changing the rate of flow of air.

A set screw 99 fitting in a threaded perforation in the lug 84 may be fixed in adjusted relation to the said lug by a lock nut 100. The end of this screw abuts against the shaft 89 and thereby holds the lug 84 at not less than a predetermined distance to the right and so prevents the feed of air being less than a predetermined minimum. This permts of varying the minimum amount of primary air independently of the cam, and insures that when the burner is shut off and then subsequently started, there will always be a supply of air immediately available.

I usually attach my burner to a hinge plate 94 which is attached to the furnace wall, and which is shaped to form the outer nozzle 95 between which and the nozzle 56 is an annular path through which the secondary air supply of combustion may flow by natural draft. The burner is attached to the hinge plate by means of the hinge 101 so that it can be swung away from the opening or maintained in operative position by the usual latch 97 maintained in position by the spring 98. In case it is desired to mount the burner on a pedestal, a screw threaded opening 93 is provided to receive the pedestal, such opening being plugged when the burner is mounted on the hinge plate.

Air enters the casing through the opening 22, passes around the motor and thereby cools it, and is then drawn off to the left as seen in Fig. 3, passing between the lugs 24 and between the valve plate 58 and the baffle plate 59, the quantity of flow of air being controlled by the position of the valve plate relatively to the baffle plate. The entire volume of air is admitted at the central fan intake without interference, and the fan blades 39 and 46 and the walls 35 and 37 of the fan casing are so arranged that the path of air flow has substantially the same total cross sectional area throughout its flow through the fan, so that all the forces applied to the air will be translated only into velocity with no squeezing or expansion of the air as it progresses through the fan, with the result that turbulence or eddy currents will be avoided. In other words, the total area of inlet 38 is substantially equal to the total discharge area at the periphery of the fan, and each of these total areas is substantially equal to the total area of any intermediate cross section. This is accomplished primarily due to inward taper of the fan from the inlet to the periphery, and by having the air flow through all of the space between the vanes or blades. The cross sectional area of the air path continues to remain unchanged after the air leaves the fan. The discharge of air from the fan is uniform all around the periphery of the fan, which results in a constantly even flow, the direction of which is changed on passing from the casing part 48 to the part 49, where the cross sectional area of the air path is substantially the same as that in the fan. The cross sectional area of the air path remains substantially unchanged until the air has entered the nozzle or air discharge opening 56 which is close to the locus of use of the blast of air. With this in view, the casing part 49 is bent forwardly as it approaches the center so that the spaces between the blades 50 become deeper as they become narrower toward the center, thus maintaining constant the cross sectional area of the air path. Not only is the path of the air through the fan maintained constant in cross sectional area, but it remains the same almost up to the point of exit of the air from the nozzle, and in fact throughout my burner it is preferably substantially unvarying in cross section except where variation is necessary as at the air control valve. The air control valve is directly at the intake of air into the fan, which, as previously related, is important because it allows the air to enter the fan under atmospheric conditions. The path of the air is the least tortuous possible, and there is no throttling of the air before it reaches the fan.

Turbulence and eddy currents in the forwarded air are thus not only minimized after the air enters the fan, but also from the place of entrance into the burner at the opening 22 almost up to the locus of use. Friction in the flow of the air in the fan, and in fact throughout the burner, is avoided to the maximum possible degree. Noise is thereby avoided, and the waste of power and loss of efficiency in prior burners as a result of turbulence, is minimized in my device. With the fan blades having the spiral like shape including the curved portion at the intake and the straight portion from there out to the periphery, the air is thrown out from the fan in a direction having more of a radial component and less of a tangential component than if the blades were merely straight. This also tends to minimize the amount of turbulence or eddy currents since by this arrangement there is less change of direction of the air than formerly.

Straight radial blades in the fan eject the air therefrom with a greater tangential component, thus causing more of a change in direction and greater turbulence. The curved part of the blades increases the blade length, as does the obliqueness of the straight part. Increased blade length and lack of slippage both contribute to increased velocity of the air. The gate type of valve for controlling the rate of flow of air offers a restriction in the path thereof, whereas the reciprocating type permits of an uninterrupted flow of air converging toward the fan intake.

My burner may thus be controlled very simply, easily, quickly and effectively by a simple movement of a single control lever. In addition to

this the burner operates very efficiently at all settings of the control lever because the supply of air is the optimum for that rate of flow of liquid fuel to which the burner may be adjusted by moving the operating handle 67. The oil follows the simplest path through the device and is prepared for burning only as it approaches the outlet. The air likewise follows the simplest path through the burner and the rate of flow thereof is controlled immediately at the entrance into the fan.

The structure of my device reduces the size of the burner per unit of output and also reduces the power required to operate it per unit of output.

Various details have been referred to for the purpose of describing but not limiting the invention and which may be varied without departing from the spirit thereof.

I claim:

1. A blower comprising a casing, a fan within said casing provided with a concavely dished air intake within and centrally thereof, a baffle mounted within said casing around said intake, and a valve plate within said casing having with reference to said intake a convex shape complementing that of said intake so as to fit substantially within said intake in the closed position thereof and mounted for reciprocating movement axially of said fan at said baffle and said intake.

2. A blower comprising a casing, a fan within said casing provided with vanes and an intake within and centrally thereof, said vanes forming an air path of substantially uniform cross section to avoid constriction of the air in its flow therethrough, a baffle mounted within said casing all around said intake, said intake being concavely dish-shaped, and a valve plate within said casing having with reference to said intake a convex shape complementing that of said intake so as to fit substantially within said intake in the closed position thereof and mounted for reciprocating movement axially of said fan at said baffle and intake to provide and control an unthrottled hollow cone-like path for the air into said intake shaped substantially like said intake.

3. A blower comprising a casing, a fan rotatable therein including spaced apart plate members having vanes positioned therebetween and having a concave shaped inlet within and about the axis of rotation thereof, the parts of the fan including the vanes being so arranged as to provide substantially the same cross sectional area for the passage of air from adjacent the inlet to the discharge of the fan, the casing being provided with an opening for ingress of air to the fan, and means for controlling the flow of air including a shutter valve within said casing having with reference to said concave inlet a convex shape complementing that of said inlet so as to fit substantially within said inlet in the closed position thereof and mounted for reciprocative movement axially of said fan at said inlet to provide and control an unthrottled hollow cone-like path of substantially uniform cross section for the air into said inlet and shaped substantially like said inlet.

4. A blower construction for an oil burner of the rotary oil-discharge cup type comprising a casing provided with an air discharge opening adjacent one end thereof and with a chamber, means segregating said chamber into a fan compartment and another compartment communicating with said air discharge opening, a rotatable fan in said fan compartment constructed to preclude substantial squeezing or expansion of air in its passage therethrough comprising spaced apart plate members and spaced apart impeller blades positioned between said plate members, the plate members converging toward each other in a direction toward the periphery thereof, one of said plate members having a centrally disposed aperture for inlet of air and said blades being constructed adjacent said aperture to provide an inwardly dish-shaped air inlet about and within the axis of rotation of the fan, all of the space between said impeller blades providing passages for flow of air therethrough, the cross sectional area of said passages being substantially uniform throughout, said casing being open adjacent said air inlet to provide for unthrottled ingress of air, and means for controlling the flow of air including a valve plate within said casing having with reference to said inwardly dish-shaped inlet a convex shape complementing that of said inlet so as to fit substantially in said inlet in the closed position thereof and mounted for reciprocative movement axially of said fan at said inlet to provide and control an unthrottled hollow cone-like path for the air into said inlet shaped substantially like said inlet.

5. A rotatable fan blower construction for an oil burner of the rotary oil-discharge cup type comprising a casing having an air discharge opening, a hub rotatable about the axis of said air discharge opening, spaced apart plate members secured to said hub, one of said plate members having an air inlet opening centrally thereof about said axis, spaced apart impeller blades between said plate members, said impeller blades having straight portions lying between said opening and the periphery of said plate members and extending outwardly in a direction obliquely backwardly with respect to the direction of rotation of said fan, at least some of said impeller blades also having portions which are spiral-like and extend inwardly from said opening toward the center of rotation in a curve and meeting said hub at positions spaced forwardly in the direction of rotation from the points where radial lines from the outer ends of said blades meet said hub, the straight portions of said blades decreasing and the spiral-like portions of said blades increasing in width away from the center of rotation.

6. A blower construction for an oil burner of the rotary oil-discharge cup type comprising a casing having an air discharge opening adjacent one end thereof, a motor adjacent the opposite end of said casing and enclosed thereby, a rotary fan driven by said motor to rotate about the axis of said discharge opening and having a concavely dished air intake about the axis of rotation of and within said fan and connecting with the interior of said casing, a reciprocative shutter valve within said casing at said intake to control the flow of air into said intake and having with reference to said intake a convex shape complementing that of said intake so as to fit substantially within said intake in the closed position thereof, said casing having an air inlet between said ends and adjacent said fan intake to cause air to pass through said casing and to enter said fan under substantially atmospheric conditions.

7. A blower construction for an oil burner of the rotary oil-discharge cup type comprising a casing having an air discharge opening adjacent one end thereof, a motor adjacent the opposite

end of said casing and enclosed thereby, a rotary fan driven by said motor to rotate about the axis of said discharge opening and having a concavely dished air intake about the axis of rotation of and within said fan and connecting with the interior of said casing, a reciprocative shutter valve within said casing at said intake and having with reference to said intake a convex shape complementing that of said intake so as to fit substantially within said intake in the closed position thereof, and an annular baffle within said casing between said valve and said fan to control the flow of air into said intake, said casing having an air inlet between said ends and adjacent said fan intake to cause air to pass through said casing and to enter said fan under substantially atmospheric conditions.

8. A blower construction comprising a substantially tubular-like casing which is imperforate at one end and has an air discharge opening at the other end, a motor positioned within said casing between said ends and having a shaft rotatable about the axis of said discharge opening, a rotatable fan positioned between said motor and said discharge opening and drivable by said shaft about the axis of said discharge opening, said fan having a centrally disposed concavely dished air intake, and a valve plate within said casing adjacent said intake having with reference to said intake a convex shape complementing that of said intake so as to fit substantially within said intake in the closed position thereof and mounted for reciprocative movement along said axis in directions toward and away from said intake to provide and control a substantially unthrottled hollow cone-like path for the flow of air into said intake shaped substantially like said intake, a peripheral portion of said casing located between said ends being provided with an air inlet adjacent said valve plate to provide a substantially unthrottled path for the flow of air from the casing inlet to the fan intake, whereby efficiency is enhanced.

9. A blower construction comprising a substantially tubular-like casing which is imperforate at one end and has an air discharge opening at the other end, a motor positioned within said casing between said ends and having a shaft rotatable about the axis of said discharge opening, a rotatable fan positioned between said motor and said discharge opening and drivable by said shaft about the axis of said discharge opening, said fan being provided with vanes forming an air path of substantially uniform cross section to avoid constriction or expansion of the air in its flow therethrough and having a centrally disposed concavely dished air intake, a valve plate within said casing adjacent said intake having with reference to said intake a convex shape complementing that of said intake so as to fit substantially in said intake in the closed position thereof and mounted for reciprocative movement along said axis in directions toward and away from said intake to provide and control a substantially unthrottled hollow cone-like path for the flow of air into said intake shaped substantially like said intake, a peripheral portion of said casing located between said ends being provided with an air inlet adjacent said valve plate to provide a substantially unthrottled path for the flow of air through said fan from said casing inlet to said fan intake, whereby the path for the flow of air from said casing inlet to and through said fan is substantially unthrottled and efficiency enhanced.

10. A blower construction comprising a substantially tubular-like casing which is imperforate at one end and has an air discharge opening at the other end, a motor positioned within said casing between said ends and having a shaft rotatable about the axis of said discharge opening, a rotatable fan positioned between said motor and said discharge opening and drivable by said shaft about the axis of said discharge opening, said fan being provided with vanes forming an air path of substantially uniform cross section to avoid constriction or expansion of the air in its flow therethrough and having a centrally disposed concavely dished air intake, a valve plate within said casing adjacent said intake having with reference to said intake a convex shape complementing that of said intake so as to fit substantially in said intake in the closed position thereof and mounted for reciprocative movement along said axis in directions toward and away from said intake to provide and control a substantially unthrottled hollow cone-like path for the flow of air into said intake shaped substantially like said intake, a peripheral portion of said casing located between said ends being provided with an air inlet adjacent said valve plate to provide a substantially unthrottled path for the flow of air from the casing inlet to the fan inlet, the path of air through said fan and to said discharge opening being substantially unthrottled, whereby efficiency is enhanced.

11. A blower construction comprising a substantially tubular-like casing extending along an axis and which is imperforate at one end and has an air discharge opening about said axis at the opposite end, said casing being provided with an enlarged chamber between said ends extending transversely across said axis, means segregating said chamber into a fan compartment positioned to communicate with the portion of said casing adjacent said imperforate end and into another compartment communicating with said air discharge opening, a motor within said casing between said imperforate end thereof and said fan compartment and having a shaft extending along and rotatable about said axis, a fan in said fan compartment mounted on said shaft for rotation about said axis and having a centrally disposed air intake about said axis, and a valve plate within said casing between said motor and said fan mounted for reciprocative movement along said axis in directions toward and away from said intake to control the flow of air into said intake, the periphery of said casing between said fan compartment and said imperforate end having an air inlet opening adjacent said valve plate.

12. A blower construction comprising a substantially tubular-like casing extending along an axis and which is imperforate at one end and has an air discharge opening about said axis at the opposite end, said casing being provided with an enlarged chamber between said ends extending transversely across said axis, means segregating said chamber into a fan compartment positioned to communicate with the portion of said casing adjacent said imperforate end and into another compartment communicating with said air discharge opening, a motor within said casing between said imperforate end thereof and said fan compartment and having a shaft extending along and rotatable about said axis, a fan in said fan compartment mounted on said shaft for rotation about said axis and having a centrally dis-

posed air intake about said axis, said intake being dished concavely from a face of said fan at a locus spaced from said axis to a locus adjacent said axis between the faces of said fan to form said intake well within the fan, and a valve plate within said casing between said motor and said fan mounted for reciprocative movement along said axis in directions toward and away from said intake, said valve plate having with reference to said intake a convex shape complementing that of said intake so as to fit substantially within said intake in the closed position thereof and provide a substantially hollow cone-like path for the flow of air into said intake shaped substantially like said intake, the periphery of said casing between said fan compartment and said imperforate end having an air inlet opening adjacent said valve plate

13. A blower construction comprising a substantially tubular-like casing extending along an axis and which is imperforate at one end and has an air discharge opening about said axis at the opposite end, said casing being provided with an enlarged chamber between said ends extending transversely across said axis, means segregating said chamber into a fan compartment positioned to communicate with the portion of said casing adjacent said imperforate end and into another compartment communicating with said air discharge opening, a motor within said casing between said imperforate end thereof and said fan compartment and having a shaft extending along and rotatable about said axis, a fan in said fan compartment mounted on said shaft for rotation about said axis constructed to preclude substantial squeezing or expansion of air in its passage therethrough comprising spaced apart plate members converging toward each other toward the periphery thereof and spaced apart impeller blades positioned between said plate members, one of said plate members having a central aperture about said axis for inlet of air and said impeller blades being of decreasing width from adjacent the edge of said aperture to a locus adjacent said axis to form in cooperation with said aperture a concavely dished air intake within the fan, and a valve plate within said casing between said motor and said fan mounted for reciprocative movement along said axis in directions toward and away from said intake, said valve plate having with reference to said intake a convex shape complementing that of said intake so as to fit substantially within said intake in the closed position thereof and provide a substantially hollow cone-like path for the flow of air into said intake shaped substantially like said intake, the periphery of said casing between said fan compartment and said imperforate end having an air inlet opening adjacent said valve plate.

HARVEY E. HENRIKSEN.

CERTIFICATE OF CORRECTION.

Patent No. 2,218,643. October 22, 1940.

HARVEY E. HENRIKSEN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 31-32, for "variour" read --various--; page 5, second column, lines 11 and 12, for the words "and within the axis of rotation of" read --the axis of rotation of and within--; page 6, second column, line 2, claim 9, before "enhanced" insert --is--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 3rd day of December, A. D. 1940.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)