This invention relates to a variable air supply control for gun type burners commonly used in residential heating plants. The invention may also be adapted to convert burners presently in use. In either event the structure of this invention when incorporated into the gun type burner will permit a more efficient regulation of the burner for all periods of operation, that is, during acceleration of the burner parts at the starting stage of operation, during the normal full running period, and during deceleration of the burner parts as the latter are coasting to a stop. By a more efficient regulation of the burner in connection with the gun type oil burner apparatus with the structure of this invention incorporated therein is meant a more efficient regulation of the ratio of air and oil supplied respectively by the burner fan and pump for firing in the combustion zone.

The ordinary gun type burner, having an air fan and oil pump driven by an electric motor and moving synchronously therewith at all times, is handicapped by the fact that in starting and stopping periods of the operating cycle the fan, if adjusted for efficient operation at the full running periods, being non-positive in action, will not make available a rate of air supply sufficient to burn all the oil supplied at these periods by the pump, which is positive in action. The deficient air supply at the start and stop results in a puff of smoke at such periods. This will occur at any time the ordinary burner is adjusted for an efficient ratio of air to oil for the full running period of operation. Consequently, the burner is generally regulated by over-balancing the ratio of air to oil in order to avoid smoke and a costly soot-forming deposit in the heater during the start and stop, and when so regulated it will operate to supply air to mix with the atomized oil at a high rate and velocity which will during the full running period produce a lean mixture. However, unless this is done, carbon deposit from "smoking" will insulate the heat transfer surfaces. It is common knowledge in this art that although the starting and stopping periods are of short duration the accumulation of many such periods in the heating season presents a serious problem if the burner is permitted to smoke at those periods. So it is a common practice to avoid smoke at all times by providing a lean mixture for the full running period as outlined above.

This objectionable feature has partially been overcome by providing a centrifugal clutch mechanism placed in the motor drive shaft connection between the fan and the pump. The latter is then driven to supply oil only when the motor and the fan have attained substantially high speed operation. Thus the air supply precedes and follows the delivery of oil and acts to prevent smoking at the start and stop. This type of clutch device is disclosed in United States Logan Patent No. 1,985,934 issued January 1, 1935. The device enables a closer adjustment to an efficient ratio of air to oil.

The present invention has for an object to provide an improved structure to automatically control the air supply for the gun type burner, to give an added assurance that no puff of smoke will occur at the start and stop, and to permit a still closer adjustment to an efficient ratio of air to oil supply for the full running period. This object is obtained by providing an auxiliary air inlet to the fan which inlet is adapted to admit additional air only during the starting and stopping periods of the burner operation. Provision is further made to render said auxiliary inlet ineffective during the full running period. By thus providing for an increased difference between the rate of air flow at the start and stop and the rate during the running period the overall performance of the burner is favorably affected.

It is an object of this invention also to provide auxiliary fan structure on the clutch mechanism of the unit and to position said mechanism with the added fan structure so as to provide the auxiliary inlet with means to introduce additional air at the start and stop and to substantially block off air during the full running period.

How the structure of this invention is adapted for operation in the gun type burner and how its features operate to permit closer regulation of the air-oil ratio for the full running period of operation without the objection of smoke formation at the start and stop will best be disclosed in connection with the accompanying drawings, in which:

Fig. 1 is an exterior elevational view of the new structure adapted as a unit for attachment in a gun type burner;

Fig. 2 is a view on line 2—2 of Fig. 3;

Fig. 3 is a view on line 3—3 of Fig. 1;

Fig. 4 is a sectional view taken through the hub of the fan of the burner showing the manner of coupling the structure of Fig. 1 thereto;

Fig. 5 is a sectional view of an oil burner combination indicating the new structure incorporated therein;
Figs. 6 and 7 are end and sectional elevations of a burner fan inlet shutter construction having an integral sleeve for encasing the auxiliary fan structure; and

Figs. 8 and 9 are end and sectional elevations of a sleeve for attachment to the air shutter of a burner.

With reference to the drawings the structure shown in Figs. 1, 2 and 3 includes an auxiliary intake fan adapted to be driven directly by the air supply fan of the burner, a speed-responsive clutch and a neutralizing fan 1', the rotation of which is controlled by the clutch. The clutch includes a driving member 2 in the shape of a drum, on which the blades of fan 1 are integrally formed in the operation of casting the drum, and a driven member 3 similarly formed with the blades of fan 1'. As will later appear, suitable means are carried by the drum 2 and actuated by centrifugal force for the purpose of driving the member 3 and preferably controlling the oil pump of the burner.

Conventionally, the driving member 2 has a ferrule 4 formed therewith, to which is suitably fixed one end of a short length of rubber hose 5, the other end of which is suitably fixed to another ferrule 6. The latter has its free end open, forming a socket 7, adapted to fit over the hub of the fan of the burner. The cylindrical wall of the socket 7 is pressed inwardly to form a plurality (four as shown in Fig. 4) of splines 8, adapted to engage grooves in the hub of the burner fan for an operable driving engagement. The ferrule 6 has fixed thereto a collar 9 and threaded into the collar is a set screw 10, adapted to be turned inwardly to clamp the ferrule to the hub of the fan and hold it against axial movement. The arrangement affords a convenient means for coupling the driving member 2 to the fan of the burner. The rubber tube affords a flexible coupling, enabling the member 2 to be driven efficiently by the burner fan even if its axis is not exactly aligned with that of the burner fan.

The driving member 3 has coaxially-disposed outer and inner hubs 11 and 12 (Fig. 2) bored to receive an end of the drive shaft of the oil pump of the burner. The hub 11 is at a set screw 13 threaded therein and adapted to engage a flat on the oil pump shaft for an operable driving engagement. Pressed into a counterclockwise in the inner end of the inner hub 12 is a bushing 14, affording a bearing to receive one end of a stub shaft 15, the other end of which shaft is fixed in the driving member 2 and located coaxially therewith. The shaft 15 and the bushing 14 affords a means for holding the driving and driven members 2 and 3 of the coupling in close alignment.

For clutching the elements 2 and 3, any suitable speed-responsive means may be provided. An example of one means suitable for the purpose is shown in Figs. 2 and 3. The driving member 2 has fixed to it at diametrically opposite points two fulcrum pins 16 which project into the interior of drum 3 and which pivotally support, one on each, weights 17. A spring 18 connects a stud 19 on each weight 17 to the nearest pin 16, the weights being appropriately recessed as at 20 and 21 to receive these springs. Each weight 17 forms a lining 22, adapted to engage the inner periphery of drum 3, when the weight is thrown outwardly by centrifugal force. Each weight also has a curved inner surface coaxial with its outer curved surface and these inner curved surfaces are adapted to be drawn inwardly by the springs 18 against a rubber bumper 33 in the shape of a torus ring, engaged in a groove in a hub 24 formed on member 2. Each weight 17 has a hook 25, somewhat narrower than the rest of the weight (Fig. 3), which hook is adapted to engage in a notch 26 in the other weight to limit the extent to which the weights can be thrown outwardly by centrifugal force. The clutching means described is arranged to engage and disengage responsive to opening the drum 1, the burner fan has attained a predetermined high speed as closely as feasible to full speed.

The fans 1 and 1' are arranged to control an auxiliary air inlet to the burner fan. This air inlet may be provided by a sleeve 27 (Figs. 8 and 9) which is adapted to extend through a central hole made in the air shutter of the burner and which is adapted to be secured to the shutter by suitable screws or bolts, passing through holes 28 provided in an outturned flange 29 on the sleeve. In some cases, it may be more convenient to provide a sleeve integral with the shutter, such as is shown at 30 in Figs. 6 and 7. This shutter has a central hole 31 of the proper size to receive the auxiliary fan and the sleeve is formed by a short marginal T-shaped flange 32 embossing hole 31.

The new structure is shown incorporated in the gun type oil burner in Fig. 5. The fan housing of the burner is shown at 33, the fan at 34 with its hub 35 suitably secured to the projecting end of the shaft 37 of the electric motor 38, which is bolted to one end face of the housing 33. The opposite end face is the main air inlet 39 to the burner fan. The outlet for air to pass to the nozzle of the burner is shown at 40. From the last named end face of housing 33 extends a bracket 41 in which the oil pump 42 is supported with its drive shaft 43 extending inwardly toward the fan. A flexible coupling ordinarily connects shaft 43 to the fan hub 35. Such coupling ordinarily passes through a small central hole in the air shutter 44. This shutter has fixed thereon a nut 45, threaded on a screw 46, which is rotatably mounted at its end on the oil pump shaft. The hub 47 of the nut 45 is an end face of the housing 33. This screw has a head 41 by which it may be turned. A spring 48 on the screw acts between the inner face of bracket 41 and a washer 49, held in place on the screw by a pin 50, to hold head 47 against the outer face of bracket 41. Rotation of the shutter is prevented by a stud 51, fixed at one end in bracket 41 and having its other end loosely engaged in an opening in the shutter. By turning screw 46, the shutter 44 may be moved toward or away from the air inlet opening 30.

In applying the new structure as a conversion unit for attachment to an existing burner, the pump 42 may be removed and also the flexible coupling by which its drive shaft 43 is connected to the hub 35 of fan 34. The air shutter 44 is removed for the driving purpose. Then turning the screw 46 until it is disengaged from nut 45, then pulling the screw axially outward until its inner end is disengaged from its bearing and pulled outwardly beyond nut 46. The stud 51 is also moved axially outward to free it from the shutter outer surface. As a conversion unit the new structure is now applied by sliding the splined socket 7 over the corresponding splined hub 35 of the burner fan and then turning the set screw 10 to hold the hub and socket against axial displacement. The shut-
ter 44, which was removed, may have its small central hole enlarged to receive the auxiliary air inlet sleeve 27, which can be secured thereto by bolts 52 passed through the holes 28 in flange 29 and through suitable holes drilled in the shutter. Alternatively, a shutter with an integral sleeve, such as is shown at 56 in Figs. 6 and 7, may be substituted for the old shutter. The shutter 44 or 30, as the case may be, is then put in place by sliding it over the clutch drums 2 and 3 and fans 1 and 1', then replacing the screw 46 by threading it into nut 45, inserting its inner unlubricated end in its bearing in the fan housing 33, and finally applying pin 50 to hold spring 48 in place and cause it to draw head 47 against bracket 41. The stud 51 is also put back in place (it may be held to the bracket 41 by a set screw 53). The oil pump 42 is next put in place in the bracket 41 and its driving shaft 43 is inserted in the bore in the hubs of the driven clutch drum 3. The set screw 13 is then turned to engage the flattened part of the pump shaft for an operable driving engagement. This shaft 43 may be telescoped to various extents in the bore of the hubs 11 and 12 on drums 3 in order to compensate for variations which may exist in different burners in the distance between the fan hub and pump shaft. The driving element 2 may also be furnished with flexible couplings like 5 of different length for the same reason. Having completed the installation as a conversion unit, the usual sheet metal enclosures 54 for the shutter and pump are applied as indicated.

In operation of the burner it is necessary to adjust the air shutter 44 to get the proper rate of flow of oil to the burner. This is done by turning the screw 46 to move the shutter towards or away from the air inlet 43 to vary the effective area of the inlet. It will be of advantage now to move the shutter closer to the inlet than it was before in the use of prior art structure which is herein described as improved, because the invention involves the change in the air-shutter with the new fan blade construction on the clutch parts, provides for the admission of additional air during the starting and stopping intervals of operation of the burner and enables the rate of air supply during normal running intervals of operation of the burner to be adjusted closely to the rate theoretically necessary for perfect combustion. The adjustment of the air shutter is made while the burner is in operation with the auxiliary fans 1 and 1' revolving in the central opening of the air shutter. The fans 1 and 1' when revolving operate in a general way to neutralize each other. Fan 1 tends to draw air into the space on the inlet side of the burner fan. Fan 1' tends to draw air out of this space. The effect of both fans operating against each other is to generally block off passage of air in either direction. Although some air may be passed such movement of air as may be present will be inconsequential. Thus, the auxiliary air passage is effectively closed against movement of any substantial amount of air through it during the period of full running operation. The air shutter is adjusted until the rate of air flow is brought as closely as possible to the rate theoretically necessary. This may be determined by analysis of the flue gases or by inspection of the flame or both in the usual and well-known manner. The shutter may be set so that a very high percentage of CO results to indicate excellent combustion and high efficiency in the burning of the oil. This may be safely done because the difficulties due to smoky operation during the starting and stopping intervals are overcome by the use of the structure of this invention as will be explained below.

In operation when the burner motor 38 is started, the main fan 34 and the auxiliary intake fan 1 are set in operation, but the oil pump 42 and fan 1' do not immediately revolve. With the fan 1' stationary, the burner fan 34 will draw in air not only through its usual inlet 30, but also will be aided by the introduction of air through the additional inlets comprising the spaces between the blades of fan 1', and the annular space representing the clearance between the tips of those blades and the inner periphery of air sleeve 27 in which the fans are enclosed. Not only will the area of the inlet to the main fan be increased by that area just mentioned but the passage of air will be increased due to the operation of the auxiliary intake fan 1. The rate of air intake added by operation of fan 1 increases the head start afforded to the burner fan before the oil pump delivers oil and the fan 1' neutralizes the effect of fan 1. The air thus gets in motion at the nozzle with a sufficient velocity for good mixing and at a rate which is substantially greater than is used during normal running intervals of operation of the burner. Consequently when oil is emitted from the nozzle, there is an excess air supply to produce a comparatively lean mixture and combustion occurs without the puff of smoke usually incident to starting up of the burner. Once the fan 34 has acquired sufficient speed to produce the desired air flow at the nozzle, the pump will be operated to force oil to the nozzle and the auxiliary fan inlets, as described, is rendered ineffective so that the rate of air-supply to the burner is reduced to that necessary to produce efficient combustion in the burning of the oil. The auxiliary air inlet is rendered ineffective by rotation of the auxiliary fans which now generally block off passage of air through the central opening. The conditions that now exist are the same as they were, when the adjustment of the air shutter was made, and the air-oil ratio is that necessary to give a high percentage of CO, and thus efficient combustion in the burning of the oil. When the burner is stopped, the oil pump and auxiliary fan 1 quickly come to rest. As soon as the speed of the motor slackens a little following the opening of its supply circuit, the speed-responsive clutch opens and this is followed by a sudden stopping of the oil pump and fan 1' because of the load on the oil pump. The motor 38, fan 34, and fan 1, however, continue to turn for several seconds due to the momentum of the heavy rotor of the motor and the comparatively light load on the fan of the character shown.

The auxiliary air inlet is again effective to pass additional air into the inlet side of the main fan. Hence, air flow at substantial velocity and at a rate large enough to maintain a lean mixture is maintained after the pump stops and at the main fan coasts under the momentum as stated. Thus, the puff of smoke that usually occurs during the stopping interval of operation of the ordinary burner is eliminated and the burner stops quietly and without any smoke to cause objectionable soot deposits in the hasting frame.

The use of a sleeve, such as 27, or a flange, such as 32, on the air shutter has the advantage that it enables considerable latitude in the relative axial positions of the auxiliary fans and shutter. For example, the shutter might be located in a plane, transverse to the axis of the fans 1 and 1' and to the left of a similar plane passing
through the left hand ends of the blades of fan 1', provided there is a sleeve to extend to the right sufficiently to cover a part of fan 1'. And the shutter can be adjusted over a wider range when a sleeve is used.

The invention provides structure which may be incorporated in various oil burners of the gun type to eliminate smoky operation during the starting and stopping intervals and to enable the burner to operate with greater efficiency during normal running intervals of operation of the burner. It also provides a type of structure which may be applied to various burners as a conversion unit to accomplish the same purpose in burners already installed and in use.

I claim:

1. In combination an oil burner fan housing having an inlet and outlet, a fan within the housing, a drive shaft fixed to said fan, a centrifugal clutch with a driving member having fan blades directed to introduce air to the interior of the housing and a driven member having fan blades directed to draw air from the interior of the housing, said driving member being operatively connected to said driven member, and a shutter at said housing inlet having an opening and means on said shutter for encasing said clutch members, and oil delivery means with a driven shaft connected to said driven member and adapted for actuation of said means when said clutch is centrifugally operated.

2. The combination in an oil burner of the gun type adapted for residential heating units of a main fan and housing therefor, an inlet and outlet in the housing, a shutter adjustable mounted in said inlet, said shutter being provided with an opening therein for admitting air to the interior of the housing, a cylindrical sleeve on the shutter to define said shutter opening, a transmission shaft and mounting thereon for said fan, said shaft extending through said sleeve, a clutch connection on said shaft and encased in said sleeve separating the shaft into driving and driven portions, the driving portion within the sleeve being provided with a series of intake fins, the driven portion having adjacent oppositely directed fins to neutralize the effect of said intake fins when the clutch connection is operative to drive both said portions.

3. In an oil burner of the high pressure atomizing gun type for household use a fan, a fan housing with an inlet and outlet for air to be moved by said fan, a pump for delivery of oil, means for driving said fan, and apparatus connecting said fan and pump for driving the latter simultaneously with said fan only at a predetermined high speed and for increasing the inlet area of the housing when the driving means is actuating the fan alone, said apparatus comprising a speed responsive device with adjacent driving and driven members connected respectively to said fan and to said pump, an air inlet shutter adjustably mounted in the housing inlet to define the area for passage of air to the housing, said shutter being provided with an auxiliary opening embordering the adjacent driving and driven members, and oppositely directed fan blades on said members, the blades on said driving member formed to draw air to the interior of the housing and the blades on said driven member formed to direct air away from said housing interior.

4. A conversion unit for application to an oil burner of the high pressure atomizing gun type for residential use, said burner including a fan for delivery of air, a fan housing provided with an inlet and outlet for movement of air by said fan, a pump for delivery of oil, and means for driving said fan and pump simultaneously; said unit comprising a speed responsive clutch for positioning in said housing inlet and having a driving member and an adjacent driven member, a coupling at the free end of the driving member adapted for attachment to said fan driving means and a coupling at the free end of the driven member adapted for attachment to the pump driving means, and an adjustable shutter for defining the area of said housing inlet, said shutter having an opening and means on said shutter for encasing said driving and driven members of the clutch, fan blades on said driving member of the clutch formed to draw air into the interior of said housing and fan blades on the driven member formed to direct air outwardly away from said housing interior.

5. A conversion unit for gun type oil burners comprising a driving shaft and a driven shaft each having couplings at their opposite free ends, a centrifugally operated clutch means on the driving shaft at its other end and a driven member on the driven shaft operatively connected to said clutch means, oppositely directed fan blades on said clutch means and the driven member, the blades of said clutch means directed to draw air toward said drive shaft and an open ended cylindrical sleeve adapted to encase said blades and having a flanged portion adapted for the mounting of said sleeve in a burner.

JOSEPH A. LOGAN.

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