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ADJUSTABLE HEAD FOR OIL BURNERS

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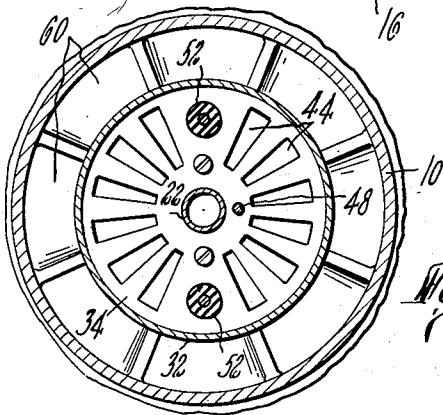
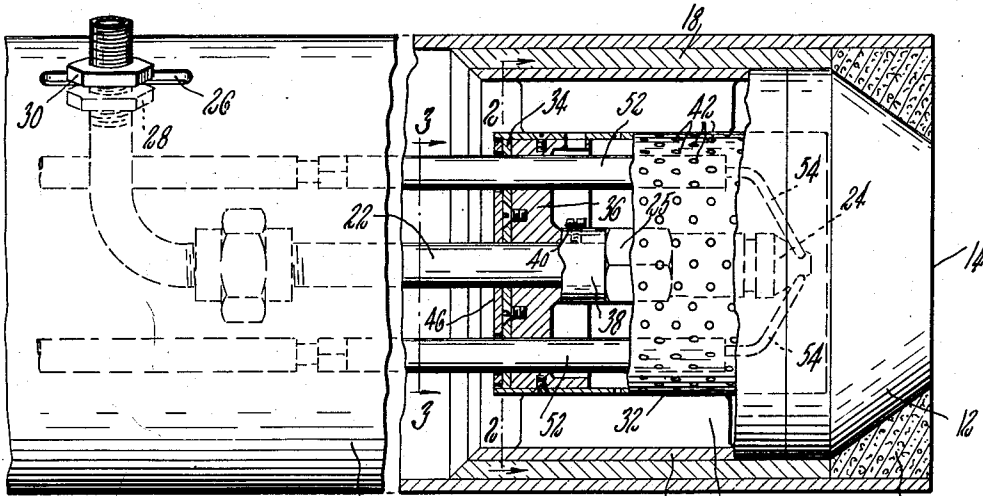


Fig. 1.

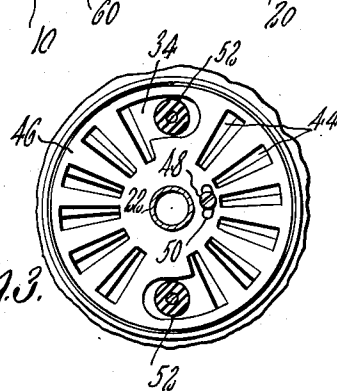


Fig. 3.

Fig. 2.

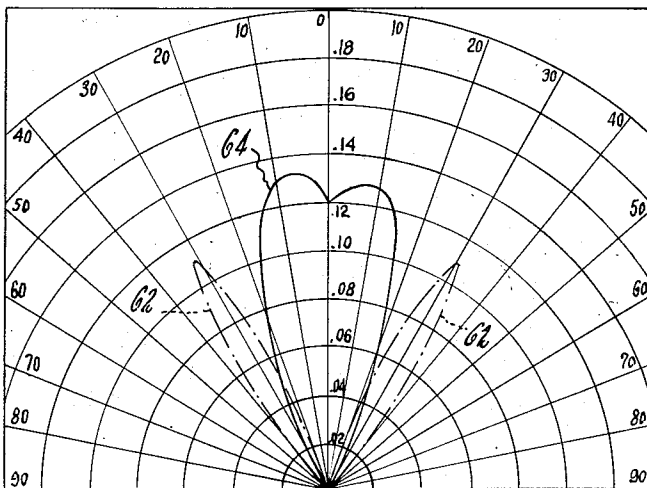


Fig. 4.

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ADJUSTABLE HEAD FOR OIL BURNERS

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7 Claims. (Cl. 158—76)

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This invention relates to a burner head of the type primarily consisting of a fuel nozzle from which a conical spray of oil is adapted to be projected together with a conical stream of air into the combustion chamber of a furnace. Burners of this type have been in wide use for many years and many individual features of construction have been devised and tried for the purpose of obtaining improved results in the combustion of the fuel. In seeking to improve burners of this type, several objectives have usually been in view, such as economy of operation by complete combustion of the fuel without however, introducing into the combustion chamber excess air which would tend to reduce the temperature therein with a resultant loss in operating efficiency. Another important objective, especially in domestic installations is a quiet flame which is free from pulsations or vibrations. Pulsating flames are not only objectionable on account of the resultant noise but can often set up vibrations in domestic furnaces which may have damaging or destructive effects on the firebrick combustion chamber or the furnace itself.

Heretofore, innovations in the structure or adjustment of burners has been more or less hit-or-miss, the results being judged by such criteria as the appearance of the flame, the presence or absence of pulsations, the density of the smoke produced, and the CO₂ content of the combustion gases, the percentage of CO₂ being an indication of the extent to which the oxygen in the air supplied to the burner is combining with the fuel in the combustion process. As far as we are aware, there has been no attempt made, until recently, to make a measured exploration of the patterns of air streams projected from burners. By means of a simple apparatus consisting of a small tube arranged to be mounted with an open end in front of a burner and its orifice toward the burner, and a manometer connected to the other end of the tube, quantitative measurements have been made and charted, showing significant patterns of air flow in the streams emitted by various burners and by a single burner with various adjustments. Photographs of flames in the fire-box show that the pattern of a flame closely resembles that of the air stream which is explored when no fuel is being supplied. In making experiments to determine the character of an air stream, the tube in the testing apparatus is mounted so that its orifice can be swung around in a semicircle from one side of the burner orifice to the other, read-

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ings of the manometer being taken for successive angular positions of the tube orifice with respect to the axis of the burner. Experiments show that there are two distinct types of air patterns which are hereinafter described in more detail and are referred to as the sunflower type and the candle flame type. The type of pattern desirable for any particular installation will depend largely on the characteristics of the furnace in which the burner is installed and the kind of oil to be burned. An object of the present invention is to provide a burner which can easily be adjusted to give either type of air pattern so that it can be satisfactorily installed in any kind of furnace, and can be adjusted to burn distilled fuel oil or the more recent "catalytic" fuel oils, or mixtures of the two in any proportion. In the burner hereinafter described as an embodiment of the invention the main air stream within the burner flows between two coaxial cylinders, the outer cylinder terminating in a frusto-conical lip. Helical vanes mounted in the space between the cylinders give the column of air a whirling motion so that it emerges from the orifice in the form of a hollow cone. The fuel nozzle is coaxial with the cylinders and is designed to emit a hollow conical spray of fuel. If no provision is made for an inner air stream the velocity of the main air stream and of the fuel spray sets up an area of lowered pressure behind the fuel nozzle which results in objectionable sporadic flare-backs. According to the present invention, the inner cylinder is provided with a considerable number of perforations which admit sufficient air from the main stream to the space around and behind the fuel nozzle to relieve the low pressure there. This air enters the inner cylinder with no forward velocity and its subsequent flow in the axial direction is merely sufficient to prevent the development of low pressure behind the fuel nozzle. This is not sufficient to modify the pattern of the main stream as it emerges from the orifice of the burner. As hereinafter explained, the burner thus far described is designed to produce the "sunflower" type of air stream pattern or flame in the firebox. This type of flame is necessary for the successful use of oil fuel which is wholly or predominantly of the "catalytic" type produced by the use of cracking processes well known in the art. It is also necessary for proper combustion of catalytic oil that the emerging air stream have maximum symmetry so that all portions of the fuel spray will be uniformly supplied with air at the base of the flame. It has been

found that even a slight irregularity in the air pattern results in a corresponding local inadequacy of air supply in contact with the fuel sprayed from the nozzle. If at any such point the droplets of fuel are heated above 650° F. without being ignited, owing to insufficient access of air, the oil in such droplets will coke instead of burning and will escape as soot. Exploration of the air pattern of a burner reveals such irregularities and indicates corrective measures necessary for achieving a symmetrical pattern.

For many domestic installations the sunflower type of flame is objectionable as it is apt to be noisy and vibratory. Hence, provision is made for an adjustment of the burner to produce the quieter candle form of flame. According to the invention this is done by the use of symmetrically arranged apertures in the rear end wall of the inner cylinder with shutters to close them if desired. The shutters when opened permit a substantial axial inner flow of air which meets and modifies the main air stream and results in a longer flame which is nearer to the axis than the sunflower type. This is due to the fact that air passing through apertures in the rear wall of the inner cylinder is impelled by the static pressure of the air against the rear face of this wall and issues within the inner cylinder as jets having a strong velocity in the axial direction with a resultant modification of the pattern of the main air stream. Here again it is important that the inner air stream be as regular and symmetrical as possible so that the fuel spray will be uniformly supplied with air. The shutter can be adjusted, if desired, to produce intermediate shapes of flame between the extreme forms described as may be found best suited to some particular furnaces.

For a more complete understanding of the invention reference may be had to the following description thereof and to the drawing, of which—

Figure 1 is a fragmentary side elevation of the burner head embodying the invention, a part being broken away to show in section;

Figure 2 is a section on the line 2—2 of Figure 1;

Figure 3 is a section on the line 3—3 of Figure 1, showing the air control shutter partly closed; and

Figure 4 is a diagram indicating air patterns resulting from different settings of the shutter.

The burner head includes a cylindrical casing member 10 having a frusto-conical lip 12 terminating in the discharge orifice 14. In the burner illustrated in Figure 1 the casing 10 is shown as installed within a larger cylindrical casing 16, thus indicating that the burner head can be mounted within the housing of a previously installed unit. In such cases, if the casing 10 is smaller than the interior diameter of the original casing 16, an adapter sleeve 18 may be fitted within the outer casing 16 to fill the clearance between the outer casing 16 and the burner casing 10. Furthermore, the space between the forward end portion of the outer casing 10 and the lip 12 may be filled with cement 20, if desired. It is to be understood that the nested casings 10 and 16 are virtually a single casing with a frusto-conical terminal lip and are hereinafter referred to collectively as the outer casing or outer cylinder.

A fuel supply pipe 22 is mounted within the casing 10 and is coaxial therewith, a fuel nozzle

24 with the customary nozzle adapter 25 being mounted on the discharge end of this pipe. As indicated, this pipe may be bent so as to extend out through a slot 26 in the wall of the casing 16. Suitable nuts 28 and 30 may be threaded on the portion of the pipe projecting through the slot 26, these nuts being tightened to secure the supply pipe and its nozzle in any position of coaxial adjustment.

An inner cylinder 32 is supported within the casing 10 coaxially therewith. This cylinder is entirely open at its forward end with no lip or constriction, but is provided with a wall or plate 34 at its rear end. The wall is supported by a transverse frame member 36 having a collar 38 integral therewith, the fuel pipe 22 fitting in a bore through the frame 36 and collar 38. The inner cylinder 32 is thus conveniently supported on the fuel pipe 22 and is adjustable axially thereon. A set screw 40 serves to secure the inner cylinder in any adjusted position on the fuel pipe 22. The length of the sleeve 38 is carefully determined so that when its forward end face is engaged by the rear end of the nozzle adapter 25, then the nozzle 24 will be properly located with respect to the forward end of the inner cylinder 32. Thus the forward face of the collar 38 acts as a gauge or stop for the nozzle adapter whenever the nozzle with its adapter is removed and replaced.

The cylindrical wall of the cylinder 32 is preferably perforated as indicated at 42, a large number of relatively small perforations being indicated in Figure 1. These permit the infiltration of air without initial axial velocity into the inner cylinder to prevent the building up of low pressure within this cylinder.

The rear wall 34 is provided with a series of relatively large apertures 44, these apertures preferably being in the form of narrow sectors symmetrically arranged around the axis of the cylinder as indicated in Figure 2. A shutter 46 in the form of a disk is fitted against the rear face of the wall 34 and is rotatable through a sufficient angle to open or tightly close the apertures 44, the shutter disk 46 having similar apertures arranged to register simultaneously with all the apertures 44 when the shutter is moved to the opened position. The shutter is movable to a closed position in which it closes all of the apertures 44 and thus completely shuts off any flow of air through the rear wall 34. A set screw 48 extends through an arcuate slot 50 in the shutter disk 46 and is threaded into the wall 34. When this screw is set up, it secures the shutter in any position of adjustment.

Ignition means for the burner includes electrodes in the form of a pair of insulated rods or heavy wires 52 which have bare end portions 54 the tips of which are suitably spaced to provide a spark gap near the orifice of the fuel nozzle 24. For minimum interference with the uniform distribution of the air stream within the inner cylinder when the apertures 44 are open, the electrodes 52 are arranged symmetrically with respect to the axis of the inner cylinder 32 and fuel pipe 22, that is, they pass through the rear wall 34 and frame 36 at points equally and oppositely spaced from the axis of the fuel pipe, as indicated in Figures 2 and 3. The electrodes are also preferably as small as is consistent with the functions they must perform.

The casing 10 carries on its inner surface a series of helical vanes 60 which cause the main air stream flowing in the space between the cas-

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ing and the inner cylinder 32 to form a conical pattern as it emerges from the orifice 14. The diameter of the inner cylinder 32 is preferably equal to or greater than the orifice 14. By axially adjusting the position of the inner cylinder 32, the clearance between its forward end and the inner surface of the lip 12 can be varied so as to choke the main stream of air if desired.

When a conical stream of air flows from the orifice 14 the shutter 46 being closed, the forward and outward velocity of the air tends to lower the air pressure within the cone, this area of lowered pressure being near the orifice 14 and being distinct from the low pressure area which is formed back of the fuel nozzle unless relieved by some means such as the perforations 42.

The small amount of air which enters the inner cylinder through the perforations 42 to prevent back flash of the flame within the inner cylinder is insufficient in amount to affect the pattern of the main air stream. The resulting flame is of a frusto-conical shape and is herein referred to as the "sunflower" type of flame. A flame of this type, especially when symmetrical in shape and free from irregularities, indicates a relatively high efficiency of combustion and in general is necessary for the proper combustion of fuel oils which are largely or wholly of the catalytic type. The "sunflower" type of flame is usually somewhat noisy and therefore objectionable in some domestic installations where a quiet flame is highly desirable. By adjusting the shutter disk 46 to open the apertures 44 partly or fully, the nature of the flame can be radically changed, the resultant flame being longer and narrower so as to resemble more nearly a candle flame. Such a flame is relatively quiet and may be nearly as efficient as the "sunflower" type but usually cannot be employed for fuel oils containing a high percentage of catalytic oil. The elongated flame results from the fact that the main air stream is modified by the inner air stream which enters the rear end of the inner cylinder 32 with considerable axial velocity and emerges from the open forward end of the inner cylinder to mix with the main air stream, there being no transverse obstructions in the inner cylinder forward of the frame 36. If the apertures 44 are fully opened the inner air stream is of considerable volume as well as velocity and materially alters the shape of the flame. In extreme cases when an extra large flow is desired in the inner stream, the shutter 46 and plate 34 can be removed, leaving the rear end of the inner cylinder fully open.

The air patterns for the open and closed positions of the shutter 46 are indicated on the chart shown in Figure 4. This chart was prepared by actual experiment, the dot and dash lines 62 representing the air pressures registered at the orifice of the testing apparatus when the burner was operated without fuel and with the apertures 44 fully closed. The solid line curve 64 represents the air pressures at various angles in the stream emerging from the orifice 14 when the apertures were fully open. Readings were taken on a manometer connected to a small tube which was mounted on a bracket in such a way that its orifice would face the discharge 14, the orifice of the tube being spaced a short distance away from the orifice 14, the bracket supporting the tube permitting the adjustment of the tube to positions of any angularity from directly in line with the axis to positions 90° away on either side. The resulting curves illustrated by the dot and dash lines 62 in Figure 4 indicate that when the

apertures 44 are fully closed, the main stream of air emerges in a sharply defined hollow cone. The graph shown is not complete since the pressures indicated at and near the axis were actually negative, that is, below atmospheric pressure. Hence, such points on the graph would be off the chart.

When the apertures 44 are wide open, the resultant air stream emerging from the orifice 14 has maximum pressure near the axis and quickly falls off to a negligible pressure from 10° to 25° from the axis.

The shutter disk thus permits adjustment of the flame to the "sunflower" type or the "candle flame" type or to any intermediate shape between these two extremes as may be required for any particular installation. The relative volumes of flow of the main and inner air streams can further be regulated by coaxial adjustment of the inner cylinder 32 toward or from the lip 12. Since the diameter of the inner cylinder is preferably at least equal to or somewhat greater than the diameter of the orifice 14, it is evident that adjustment of the inner cylinder forward to a position in which its forward end is close to the lip 14 could result in choking the main air stream to such an extent that its flow may be negligible in comparison with that of the inner air stream. Thus a wide variation of air streams can be had by adjusting the inner cylinder and the shutter disk.

It is highly important that, whatever positions of adjustment the inner cylinder and shutter disc may have, turbulence within the burner head be kept at a minimum so as to avoid as far as possible irregularity and noise in the air stream and flame within the firebox. For this reason the apertures 44 are evenly and symmetrically distributed over the rear wall of the inner cylinder and the perforations 42 are evenly distributed over the cylindrical wall of the inner cylinder. Furthermore, the electrodes 52 are for the same purpose symmetrically arranged as hereinbefore described.

We claim:

1. A burner head for liquid fuel comprising: a cylindrical casing; an inner cylinder coaxial within said casing and defining therewith an annular air passage; a frusto-conical lip at the discharge end of said casing; axially and circumferentially overlapping helical vanes in said passage contacting the inner surface of said casing and the outer surface of said cylinder; transverse means across the rear end of said cylinder and having a plurality of aperture means therein extending substantially across the same for axial flow of air therethrough; laterally adjustable shutter means controlling said aperture means and operable to completely shut off the axial flow of air into said cylinder through said transverse means; a fuel supply pipe extending through said transverse means and coaxial with said casing; and an atomizing fuel nozzle mounted on said pipe coaxially within said cylinder adjacent the forward end thereof.

2. The structure defined in claim 1 in which the inner cylinder has a plurality of small perforations therein for passage of air therethrough into said cylinder to avoid low pressure therein rearwardly of the nozzle orifice when the aperture means are closed by the shutter means.

3. The structure defined in claim 2 in which the aperture means are arranged symmetrically about the axis of the inner cylinder.

4. The structure defined in claim 2 in which

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the diameter of the inner cylinder is at least as large as that of the minor diameter of the lip.

5. The structure defined in claim 2 in which the lip is smooth-walled.

6. The structure defined in claim 2 in which the vanes are disposed entirely rearward of the lip.

7. The structure defined in claim 2 in which the inner cylinder is of uniform diameter throughout its entire length.

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