July 24, 1951 F. O. HESS ET AL 2,561,795

GAS AND OIL BURNER

Filed Feb. 3, 1949 2 Sheets-Sheet 1

FIG. 1

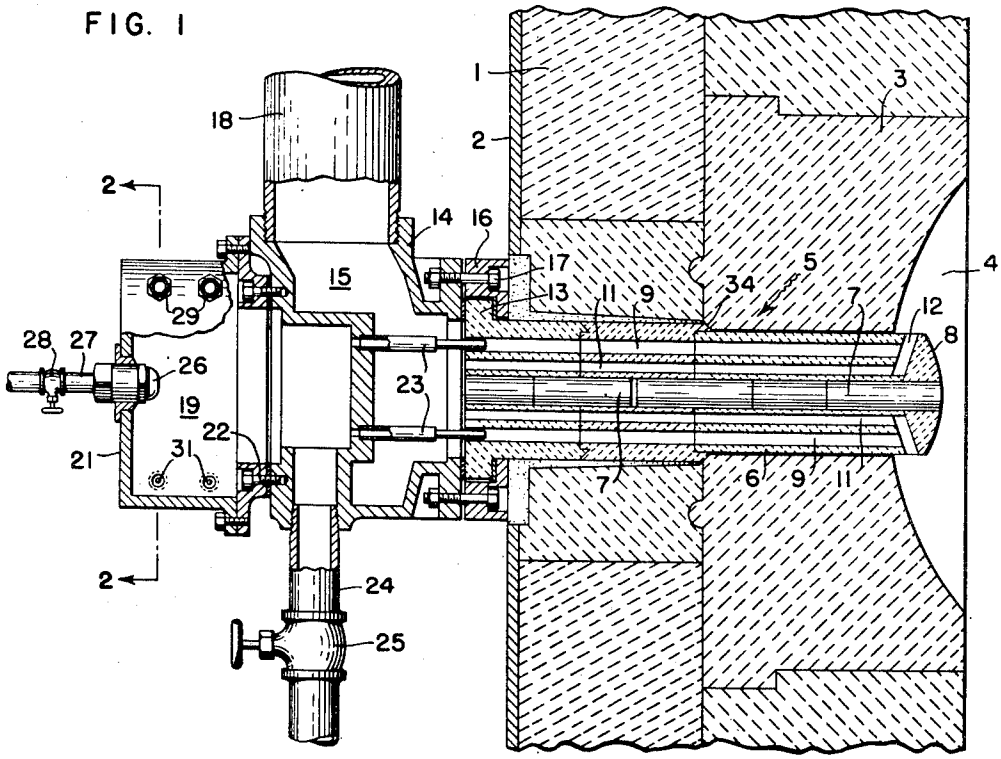
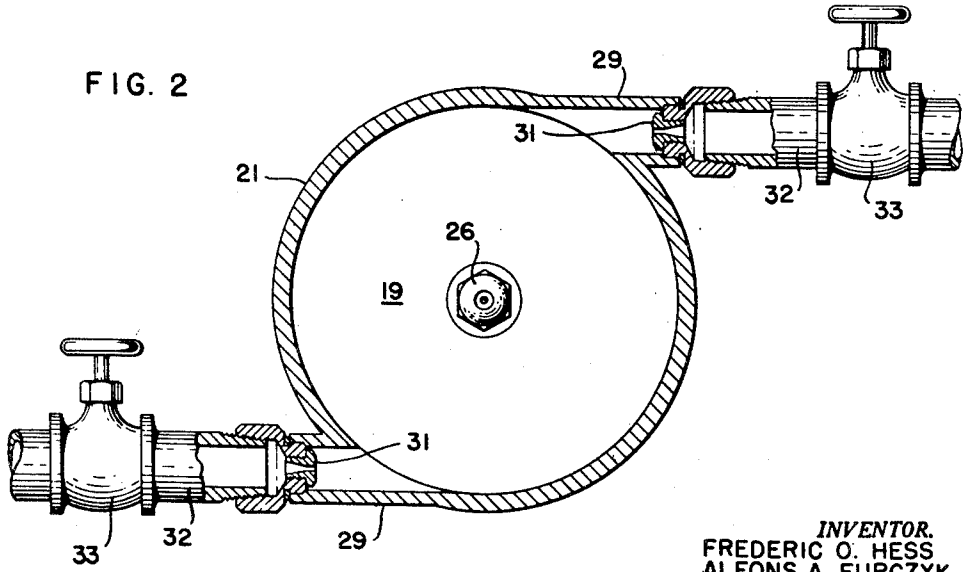


FIG. 2



INVENTOR.
FREDERIC O. HESS
ALFONS A. FURCZYK
BY JAMES B. HENWOOD

E. Wellford Moon

ATTORNEY.

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FIG. 3

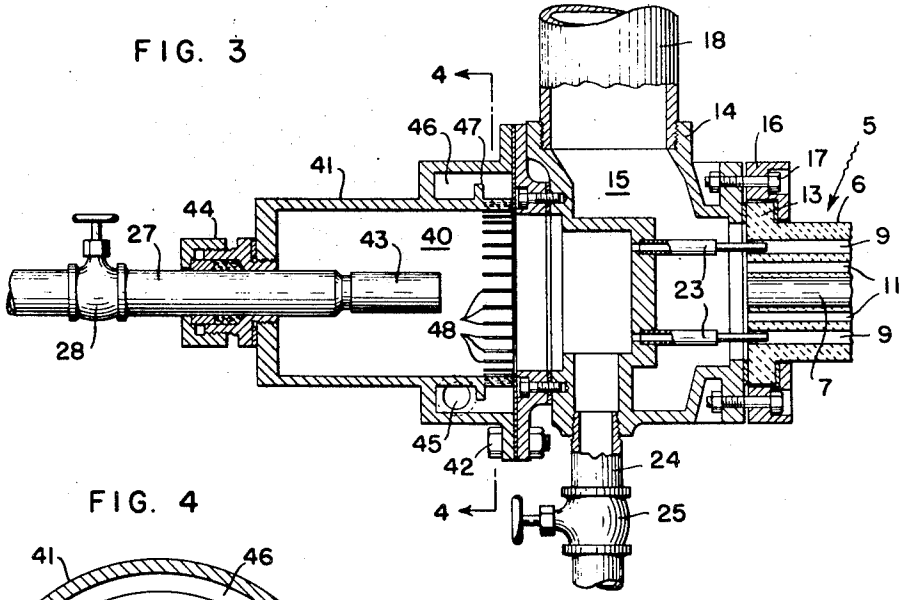


FIG. 4

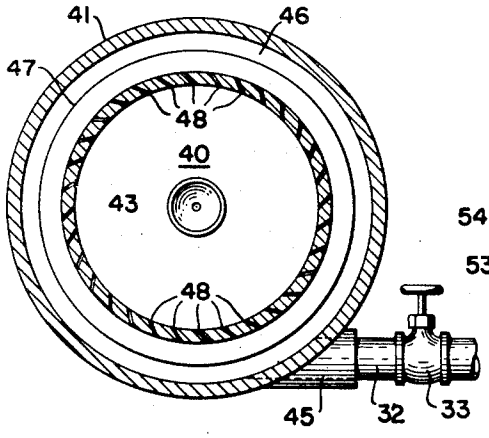


FIG. 5

INVENTOR.
FREDERIC O. HESS
ALFONS A. FURCZYK
JAMES B. HENWOOD

BY

ATTORNEY.

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UNITED STATES PATENT OFFICE

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GAS AND OIL BURNER

Frederic O. Hess and Alfons A. Furczyk, Philadelphia, and James B. Henwood, Bala-Cynwyd, Pa., assignors to Selas Corporation of America, Philadelphia, Pa., a corporation of Pennsylvania

Application February 3, 1949, Serial No. 74,372

14 Claims. (Cl. 158—11)

1

The present invention relates to burners and more particularly to a burner of the radiant cup type in which either gas or oil may be burned with equal efficiency.

Radiant cup burners are widely used in industry because of the high concentration of radiant heat that may be obtained. The advantages of this type of burner are well known, but heretofore their use has been limited to applications where a gaseous fuel such as manufactured gas or natural gas has been available. While such fuel is generally available there are some locations, particularly where large installations are concerned, where the use of gas fuel must be curtailed during the winter months. This is highly undesirable for a number of reasons. Among them are the loss of production encountered and the economic loss of having a large amount of equipment standing idle.

The burner comprising the present invention is provided with a plurality of passages through which fuel and air are supplied in a rich mixture, and with additional passages through which secondary air is supplied. These ingredients are mixed at a burner tip and discharged in a radial direction to a cup where they are burned. The burning takes place within the cup to heat it to incandescence whereby radiant heat is projected from the cup to the space to be heated. Heating is also accomplished by the hot products of combustion as they circulate through the heating space. The fuel which is used may be gas, or it may be oil. In the latter case the oil is finely atomized and passed into the burner substantially in the form of a vapor through the same passages that the gas is passed when that is used as a fuel. The burner is so arranged that the piping of the fuel and air thereto is simple. Change from one type of fuel to the other is accomplished merely by manipulating valves in the two fuel lines.

It is an object of the invention to provide a radiant cup type burner in which oil may be used as a fuel. It is a further object of the invention to provide an oil fired burner in which all of the air required for combustion is mixed with the oil prior to the time it reaches the space to be heated. Thus complete combustion can take place in a relatively small space without the production of a long luminous flame. This latter feature is of particular importance since it is customary in burning oil to require a large combustion space for complete combustion to take place.

It is a further object of the invention to provide a means for finely atomizing or vaporizing oil so that it may be mixed with air to form a combustible mixture before it reaches the space in which combustion takes place.

It is a further object of the invention to provide a burner in which either gas or oil can be used as a fuel without any changes or adjustments of the burner. Thus the heating application in which the burner is used can be switched from gas to oil depending upon which fuel is most readily available at the time. And the change-over from one fuel to the other can be made without any alteration or adjustment to the burners or furnaces in which they are used.

2

The various features of novelty which characterize our invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which we have illustrated and described preferred embodiments of the invention.

In the drawings:

Figure 1 is a sectional view through one form of burner;

Figure 2 is a view taken on line 2—2 of Figure 1;

Figure 3 is a sectional view showing another form of the burner;

Figure 4 is a view taken on line 4—4 of Figure 3; and

Figure 5 is a sectional view of another form the burner may take with a separate oil atomizing chamber.

Referring to the drawings and in particular to Figure 1 there is shown at 1 a section of a furnace wall that is made up of any suitable refractory material. This wall is backed up in the usual manner by a sheet of metal 2. Located in the wall is a burner block 3 that is formed of a refractory material capable of withstanding extremely high temperatures. This block has a cup 4 formed in its surface and is provided with an opening extending from the base of the cup through the block which opening is continued through the refractory of the furnace wall. Extending through the opening and into the base of the cup is a distributor member 5 formed of a suitable refractory or alloy material. This member may be formed either as a single piece or in sections as is shown in the drawing, the choice being determined by the type of material of which it is made and whether or not that particular material can be formed in the necessary shape in one piece. The distributor here is shown as being formed of three ceramic pieces 6 which are held together by suitable plugs 7, the right hand one of which also holds a tip 8 in position against the end of the distributor. The distributor is provided with a plurality of pairs of radially displaced passages 9 and 11. These passages extend in pairs around the distributor and each pair

terminates at the end in the cup 4 in channels 12 that extend substantially radially of the distributor.

The outer or left end of the distributor in Figure 1 is formed with a flange 13 that has attached to it a casting 14 forming a chamber 15. The casting and flange are held together by means of a ring 16 which surrounds the flange and which is bolted to a suitable flange on the casting by means of bolts 17. Suitable gaskets are used between the parts in order to obtain a pressure tight connection. Air is supplied to the chamber 15 through a pipe 18.

A second chamber 19 is located back of and concentric with the chamber 15. This chamber is formed of wall members that are either fabricated from individual pieces or made as a casting, as desired, and which is attached to the casting 14 by bolts 22. Suitable gaskets are placed between these parts in order to obtain a pressure tight joint between them. The second chamber communicates with the outer row of openings 9 in the distributor member 5 by means of tubes 23 that are fitted into openings in the partition between the two chambers 15 and 19. It is noted that these tubes extend a short distance into the opening 9 and are slightly smaller in diameter than the openings so that air can be aspirated around the tubes and into the openings.

Fuel is supplied to the second chamber 19 and passes through the tubes 23 into the openings 9 where it is discharged into the cup 4 to be burned. If gas is the fuel that is being used, it is supplied through a pipe 24 extending into the chamber 19 which pipe is controlled by a valve 25. If oil is to be burned it is supplied to chamber 19 through a suitable atomizer 26 that is connected to an oil supply pipe 27 having a valve 28 in it. The oil that is supplied by the atomizer is further broken up into smaller particles so that it can be more easily carried through the tubes 23 and passes 9 by means of air under pressure that is introduced into the chamber 19. To this end the member 21 forming the walls of the chamber is provided with a plurality of tangentially located ports 29, each of which has a nozzle 31 of the proper shape and diameter to give a high velocity jet of air. The ports 29 are connected with a supply of air under pressure by means of pipes 32 having valves 33 located therein.

The distributor 5 and the castings 14 and 21 that are attached thereto are assembled as a unitary structure, and are moved into place in the opening provided in the furnace wall and burner block 3 as a unit. The assembly is located in the burner block by means of a shoulder 34 formed on the outer surface of the distributor which abuts a corresponding shoulder on the burner block so that the tip 8 and channels 12 project into cup 4. Preferably the space between the refractory furnace wall and the assembly is filled with a suitable cement so that no air can leak into the cup of the burner around the edges of the distributor. The assembly is properly centered and fastened in position by means of suitable bolts extending from it to the shielding 2 or a brace that forms part of the outer wall of the furnace.

In the operation of the burner, assuming that gas is the fuel, valves 28 and 33 will be closed and valve 25 will be opened. Raw gas will therefore be introduced into chamber 19 and pass from this chamber through tubes 23 into the passages 9 formed in the distributor. This gas will be diluted slightly by air coming in through chamber 15, which air passes around the outside of tubes 23

and into the passages 9. The dimensions of the tubes 23 and the passages 9 are such, however, that the gas mixture in these passages is too rich to burn by itself. When the mixture reaches the channels 12 it is turbulently mixed with air passing through the inner passages 11 from chamber 15 to form a combustible mixture. The combustible mixture is blown from the channels and is ignited and burned within the cup 4 in a plurality of radially directed flames. The angle of the channels 12 with respect to the surface of the cup is such that these flames will sweep along the surface of the cup and rapidly heat the latter to incandescence. Therefore an incandescent surface of the cup is created which will serve to speed up the combustion of the gas and air mixture to such an extent that combustion will be completed prior to the time that the mixture leaves the cup 4. Thereafter the highest temperature heating effect that is obtained is primarily from the heat radiated from the incandescent surface of the cup 4. This heat, however, is augmented to a large extent by the hot products of combustion that leave the cup and pass into the furnace chamber.

If the burner is to be operated with oil as a fuel, valve 25 will be closed and the valves 28 and 33 will be open. Oil passing through the pipe 27 and the atomizer 26 is broken down into small particles in chamber 19. It has been found that these particles can be further broken up by the use of a number of high velocity, high pressure jets of air that sweep into the chamber. These swirling air streams hitting against the particles of oil from the atomizer further reduce these particles in size until they are, in effect, a vapor and will burn with the same characteristics as a gas. The high pressure in chamber 19 produces a high velocity flow of the oil vapor through tubes 23 and passages 9 to the channels 12 where they pass into the cup 4 of the burner block. The amount of air that is supplied in the chamber 19 is sufficient to produce a rich mixture that aspirates additional air to help carry the small particles of oil through the passages 9. Even with the added air the mixture in passages 9 is too rich to burn so there is no danger of a backfire. The remaining air that is necessary for combustion passes from the chamber 15 through the passages 11 and is mixed with the rich oil vapor in the channels 12. This vapor is discharged into the cup 4 as a combustible mixture and is completely burned in the cup. It has been found that by the action of the jets of air in the chamber 19, commonly called a "swirl chamber," the oil is broken up into small enough particles so that when it is discharged from the channels 12 it in effect is a vapor and will burn with a blue flame similar to gas. The velocity of the air in chamber 19 is such that the droplets of oil will be carried rapidly through passage 9 with a minimum of coalescing.

In the operation of the burner either gas or oil can be used as a fuel and to switch from one fuel to the other it is only necessary to manipulate the valves in the fuel supply lines. It has been found that with a burner of this type operation on either gas or oil is substantially the same. Practically no difference is noted in the radiance of the cup whether oil or gas is being burned. It is found, however, that the size of the particles of oil is dependent to a large extent upon the agitation and the velocity of the gas entering into the chamber 19. The higher the velocity of the gas and the more agitation that is obtained, the smaller the

particles of oil that are produced. It has also been found that these particles of oil retain their small size and do not coalesce to any appreciable extent if the vapor flowing from the chamber 19 to the burner cup is maintained at a reasonably high velocity. Therefore, the burner operation is enhanced if the turbulence in the chamber 19 is increased. As an example, satisfactory operation is obtained if air is supplied to pipe 18 under approximately 30" to 40" water column. If the burner is being operated on gas the gas can be supplied at 30" to 38" water column, depending upon its B. t. u. content, with the lower pressure used with gas of high B. t. u. content. When operating the burner as an oil burner, oil is atomized at the pressure necessary for the type of atomizer being used. The air is admitted through the nozzles 31 at approximately 3 to 6 p. s. i. This creates sufficient turbulence and atomizing effect so that the oil is in effect broken down to a vapor so that the same characteristics are obtained as with gas. While it is not necessary, better operation will usually be obtained if the air supplied to the chamber 19 is heated, and under some conditions it is desirable to heat this air to 400–450° F. Normally if the air is heated the velocity of the air need not be as great as if the air is not heated.

Gas and oil can, of course, be supplied simultaneously to the chamber 19, and burned at the same time if it is so desired.

In the embodiment of Figures 3 and 4 of the invention the same distributor member 5 and casting 14, forming air chamber 15, are used that were used with the embodiment of Figure 1. There is disclosed in this embodiment, however, a different construction for the swirl chamber in which the oil is vaporized.

Referring to the drawing, the swirl chamber therein is shown at 40 and is formed by a casting 41 that is fastened by bolts 42 to the back of the casting 14. Suitable gaskets, of course, are used between the various parts in order to obtain a pressure tight construction. In this case the atomizer 43 is moved substantially in the chamber 40, and is maintained in its adjusted position by means of a suitable packing and gland construction 44.

Air to additionally reduce the size of the atomized oil particles is admitted through a tangentially located port 45 to an annular passage 46 that extends around the outer part of the swirl chamber. The air admitted through the port 45 from pipe 32 is directed in an annular path by a flange 47 in the chamber so that it may flow evenly and at high velocity through all of the substantially tangential or chordal slots 48 which are formed in the inner wall of the annular passage.

The burning of the gas or oil in this embodiment of the invention is the same as that which has been described above in connection with Figures 1 and 2. It is noted, however, that the atomizer has been moved forward so that the atomized oil will be sprayed into a position directly in front of a large number of substantially tangential slots 48 through which the vaporizing air is received. It has been found that for some purposes a finer vaporization of oil is obtained in a small chamber to which air is admitted from a large number of openings. In any event, vaporization of the oil into extremely fine droplets is accomplished by the air flowing into the chamber 40 through the slots 48. Due to the pressure in this chamber the vaporized oil is carried forwardly through tubes 23 into passages 9 of the distributor where it is mixed with the secondary air in channels 12 so that it may be burned in cup 4 of the burner. In operating this embodiment of the burner with gas, valve 28 in the oil supply line and valve 33 in the vaporizing air supply line are closed and valve 25 in the gas line is open. Gas can then flow in the manner described above through tubes 23 to the distributor member. The pressures of the various fluids are substantially the same as those given above in connection with the description of Figures 1 and 2.

In some cases it may be desirable to vaporize the oil at a location away from the burner. A construction which will permit this to be accomplished is shown in the embodiment of the invention disclosed in Figure 5 of the drawing. In this case a small chamber 52 is formed in the casting 14 by placing a closure 53 across the back of the casting and holding it in place by a retaining ring 54 as is best shown in the drawing. Fuel is supplied to chamber 52 through a pipe 55 that is connected by a T 56 to the gas supply line 24. The vaporized oil to be burned flows through the T 56 and pipe 55 from a valve 57. The other side of this valve is connected by a short length of pipe with the vaporizing chamber 58.

Vaporization of the oil in this case is accomplished by means of a high pressure stream of air supplied through a pipe 59 to a mixing venturi 61 that extends into the vaporizing chamber. This venturi is provided in its throat with a plurality of small holes 62 for a purpose that will be described. An atomizer 63 for the oil is attached to the end of the oil pipe 28 and projects substantially into the mouth of the venturi.

In the operation of this vaporizing system high velocity air is blown into the chamber 58 in opposition to atomized oil that is supplied to the chamber through the atomizer 63. The air meeting the atomized oil head-on will further reduce the size of the oil particles so that it is, in effect, a vapor. In addition to the above a circulation of the oil vapor is set up around the outside of the venturi through holes 62 and back into the venturi in opposition to additional oil coming from the atomizer. This action results in breaking the oil particles down to an extremely fine condition so that they can be carried by the air through pipe 55 to chamber 52 where they will travel through tubes 23 to passages 9 of the distributor. In view of the fact that pipe 55 may be of some length and therefore the vaporizing chamber is some distance from the casting 14, it is generally desirable to use hot air in the vaporization of the oil in this case since the heat of this air will additionally tend to vaporize the oil and present coalescing of the droplets prior to the time they are discharged into the burner cup.

From the above description it will be seen that we have provided a highly efficient radiant cup type burner that can be operated with equal economy and efficiency using either gas or oil as the fuel. Because of the construction of the burner a compact arrangement is obtained that can be fastened directly to the furnace in the various positions in which burners are necessary for the proper heating of the furnace. The arrangement also has the advantage of being extremely simple from a piping point of view in that a minimum number of pipes for the fuel and the combustion

supporting air is used. The burner also has the advantage of having entirely closed air ducts so that the amount of combustion air can be closely controlled to obtain the optimum amount thereof. Burners of this type have been operated satisfactorily to produce cup temperatures on either oil or gas in the neighborhood of 2700° to 2950° F.

The arrangement of the passages in the distributor member 5 contributes substantially to the operation of the burner. By having the fuel and combustion supporting air supplied to the cup 4 of the burner block in a plurality of streams a thorough mixing of the materials is obtained. Much better mixing is possible than if the fuel and air were supplied in annular layers with the mixing occurring just prior to entry into the cup. It is noted that the proper ratio of air and fuel can be supplied to the burners by any conventional ratio control means. The volumes of air and fuel, either gas or oil, will, of course, vary with the amount of heat that is to be produced.

While in accordance with the provisions of the statutes, we have illustrated and described the best form of embodiment of our invention now known to us it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit and scope of the invention, as set forth in the appended claims, and that in some cases certain features of our invention may be used to advantage without a corresponding use of other features.

What is claimed is:

1. In a burner, the combination of a ceramic cup having an opening in the bottom thereof, an elongated distributing member extending into said cup through said opening, said member having a plurality of passages formed therein and opening into the cup through which fuel and air may flow to said cup to be burned therein, means attached to said member forming a chamber in open communication with each of said passages and through which air is supplied to the passages, means forming a second chamber adjacent to said first chamber, smaller than said passages extending between said second chamber and some of said passages, means to supply a gaseous fuel to said second chamber, means to supply a finely dispersed oil to said second chamber, gas and oil passing from said second chamber through said conduits and passages to the cup and means to control individually the supplies of gaseous fuel and dispersed oil.

2. In a burner, the combination of an elongated member having a plurality of axially extending passages therein, said passages terminating in radially disposed portions adjacent to one end of said member, means forming a chamber in open communication with the other end of said member and through which air is supplied to each of said passages to be discharged through the radial portions thereof, means to supply gas to some of said passages, means to supply finely dispersed oil to some of said passages, the air and gas or oil becoming intimately mixed as they travel through said passages and radially disposed portions to form a combustible mixture upon issuing therefrom, and means to control separately the supply of gas and oil.

3. In a burner, the combination of a distributing member having a plurality of pairs of radially displaced passages extending axially thereof, each of said pairs of passages terminating at one end in a substantially radially extending channel that extends to the outside surface of said member, a structure forming a chamber communicating with one of each of said pairs of passages, an atomizer for oil extending into said chamber, means to supply oil to said atomizer, means to supply a plurality of jets of air under pressure to said chamber, the air under pressure serving to agitate the atomized oil in said chamber, means to supply a combustible gas to one of each of said pairs of passages, means to control individually the supplies of oil, air under pressure and gas, and means to supply combustion supporting air to the passages through which the gas flows.

4. In a burner, the combination of a ceramic cup having an opening in the bottom thereof, a ceramic member extending into said cup through said opening, said member having a plurality of pairs of radially displaced passages extending axially thereof, each pair of passages terminating in a common channel extending substantially radially into said cup near the bottom thereof, means to supply air through said passages, and means to supply finely dispersed oil through at least one of each of said radially displaced pairs of passages, the air and oil comingling to form a combustible mixture as they leave said channels and enter into said cup.

5. In a burner, the combination of a member having a plurality of radially displaced pairs of axially extending passages therein, said pairs of passages terminating adjacent to one end of said member in channels that extend substantially radially to the periphery of said member, means forming a chamber communicating with some of the passages at the other end of said member, an atomizer extending into said chamber, means to supply oil to said atomizer, means to supply a plurality of jets of air to said chamber to further break up the atomized oil into a fine mist, the mist passing through said passages, and means to supply additional air through the remainder of said passages whereby a combustible mixture is formed at said channels.

6. In a burner, the combination of a member provided with a plurality of axial passages extending from one end to a point adjacent to the other end, and with substantially radial channels connecting the said other ends of said passages with the periphery of said member, means forming a chamber in communication with the passages at said one end, an atomizer for oil extending into said chamber, means forming a plurality of substantially tangentially extending openings in said chamber through which air under pressure may be admitted in a plurality of streams to disperse the oil supplied by said atomizer and carry the same through said passages.

7. In a burner, the combination of a cylindrical distributing member having an end thereof adapted to extend into the space to be heated, said member having a plurality of passages extending from one end toward the end in said space, said passages terminating in substantially radially extending portions that open into said space, an atomizer for oil fuel, means to receive the atomized oil from said atomizer and through which oil is supplied to some of said passages, means to supply a plurality of substantially tangentially directed jets of air into said receiving means with the oil from said atomizer whereby an oil and air vapor is formed, said vapor passing through said some of said passages, means to supply air through the remainder of said passages, the air and vapor combining to form a combustible mixture in the radially extending portions of said passages.

8. In a burner, the combination of a refractory block having a cup formed in one face thereof and an opening through the block from the base of said cup to the opposite face thereof, a cylindrical distributing member extending through said opening into said cup, said member being formed with a plurality of pairs of radially displaced passages, each pair of passages being connected by a substantially radially extending channel with the periphery of said member and near the base of said cup, an atomizer for fuel oil, means to direct oil from said atomizer through one of each of said pairs of passages, means to supply air through each of said passages, said means including a portion thereof to direct air in a plurality of substantially tangential jets against oil being discharged from said atomizer whereby an air and oil mixture will flow through said ones of said pairs of passages and air alone will flow through the remaining passages into said cup where they will be burned.

9. In a burner, the combination of structure forming a chamber, an atomizer to supply finely divided oil particles to said chamber, said structure being formed with a plurality of openings leading into said chamber, means to supply air under pressure through said openings to agitate violently the oil particles in said chamber, a member having a first group of passages communicating with said chamber and adapted to extend into a space in which the oil is to be burned, and a second group of passages connecting with the first group of passages at a point adjacent to the point where the latter passages enter said space, means to direct the oil and air from said chamber into said first group of passages, and means to supply air for combustion through said second group of passages.

10. In a burner, the combination of a member having a plurality of axially extending passages therein, said passages terminating in radially disposed portions adjacent to one end of said member that is adapted to extend into a space to be heated, means to supply gas to some of said passages, means to supply finely dispersed oil to some of said passages, means to supply air to said passages, the air passing into the passages to which the gas or oil is supplied being sufficient in quantity and velocity to make a rich mixture therewith that is non-explosive in nature and which will carry the gas or oil through said passages, the remaining air and the gas or oil mixtures becoming intimately mixed into a combustible mixture in said radially disposed portions as they issue into said space, and means to control separately the supplies of gas and oil.

11. In a burner, the combination of a member having a plurality of axially extending passages therein, one end of each of said passages adapted to terminate in a space to be heated, means forming a chamber communicating with the other ends of said passages, an atomizer extending into said chamber to supply atomized oil to said chamber, said means forming said chamber being provided with a plurality of openings through which air under pressure may be introduced in said chamber with said atomized oil in quantities sufficient to make a rich, non-explosive mixture, and with sufficient velocity to carry the oil through said passages with a minimum of coalescing of the droplets thereof, said member being provided with additional axially extending passages communicating with said first-mentioned passages just prior to the point

at which they reach said space, and means to supply through said additional passages enough air to produce a combustible mixture with said non-explosive mixture as the latter reaches said space.

12. In a burner, the combination of a member adapted to extend into a space to be heated, said member having a plurality of radially displaced pairs of axially extending passages therein, said pairs of passages each terminating at one end in channels extending substantially radially to the surface of said member and in said space, means forming a chamber communicating with one of each of said pairs of passages, an atomizer extending into said chamber, means to supply oil to said atomizer whereby oil will be sprayed into said chamber in fine droplets, means through which air can be supplied to said chamber in quantities to form a non-explosive mixture and at a velocity sufficient to carry said droplets through the passages communicating with said chamber, said air also acting to break said droplets of oil into smaller droplets, means to supply air to the other passages of said pairs, said last-mentioned air combining with the oil-air mixture in said channels with turbulence to form an explosive mixture that flows into said space to be burned therein in a plurality of flames.

13. In a burner, the combination of an elongated distributing member having an end thereof adapted to extend into a space to be heated, said member being formed with a plurality of axially extending passages which terminate at the surface of said end adapted to extend into said space, means forming a chamber attached to the other end of said member with said chamber in open communication with said passages, means to supply air to said chamber whereby the air can pass through said passages to said space, means forming a second chamber adjacent to said first chamber, conduits extending from said second chamber into said passages, said conduits being smaller than said passages, oil atomizing means extending into said second chamber, means to supply air under pressure to said second chamber to carry atomized oil through said conduits and passages to said space, the oil and air from said second chamber mixing with the air from said first chamber in said passages to form a combustible mixture.

14. The combination of claim 13, including means to supply a fuel gas to said second chamber, the gas passing through said conduits and passages into said space, and means to control individually the supply of oil, air under pressure, and gas whereby gas or oil and air under pressure may be supplied to said second chamber.

FREDERIC O. HESS.
ALFONS A. FURCZYK.
JAMES B. HENWOOD.

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Certificate of Correction

Patent No. 2,561,795 July 24, 1951

FREDERIC O. HESS ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 3, line 41, for "passes" read *passages*; column 7, line 45, before "smaller" insert *conduits*;

and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 2nd day of October, A. D. 1951.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.