Dec. 23, 1930. H. ADAMS 1,785,804

PROCESS FOR OIL BURNING

Filed June 17, 1924

Fig. 1.

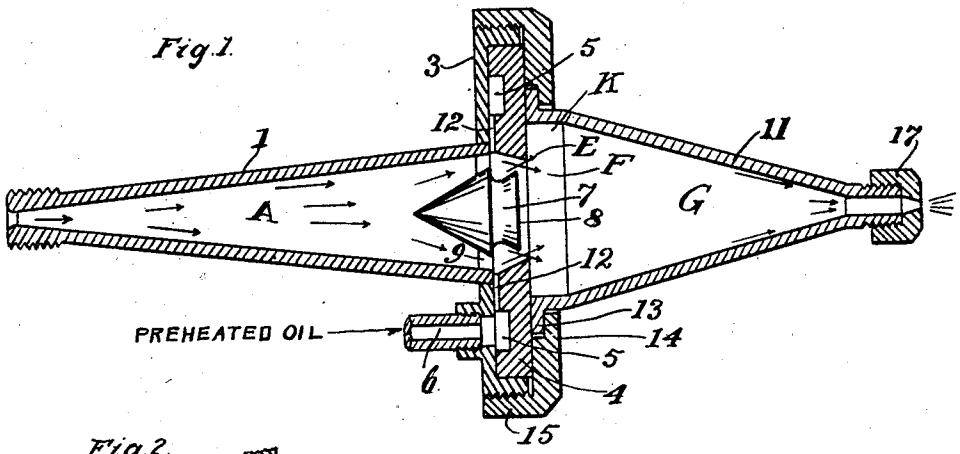


Fig. 2.

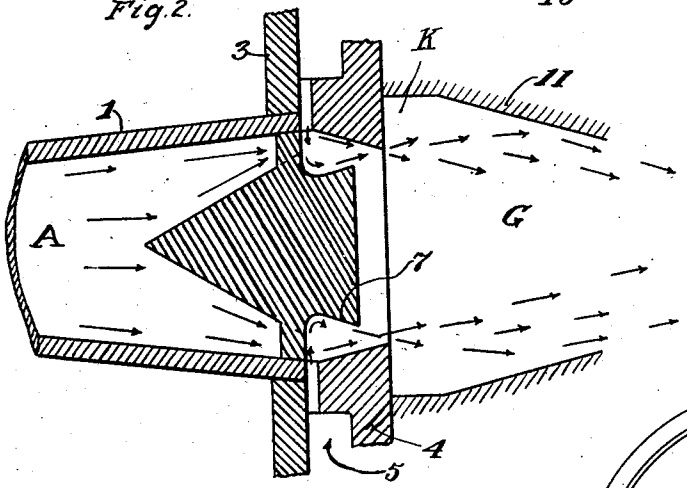


Fig. 3.

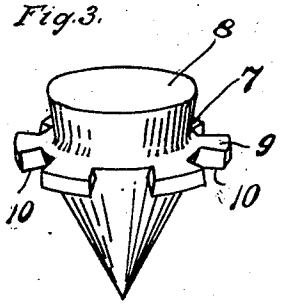
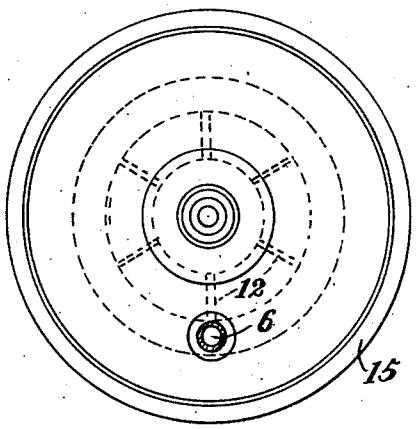


Fig. 4.



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1,785,804

UNITED STATES PATENT OFFICE

HENRY ADAMS, OF PLAINFIELD, NEW JERSEY

PROCESS FOR OIL BURNING

Application filed June 17, 1924. Serial No. 720,612.

This invention relates to a new apparatus and process for oil burning using first, mechanical atomization of heated oil, second, a second mechanical atomization, third, steam (preferably superheated) or air atomizations, and fourth, mixing; the result being that the oil is turned into a mixture of highly heated atomized oil and oil gas or vapor.

The principal object of the invention is to obtain a more thorough and economical combustion of oil than has been heretofore possible.

Another object of the invention is to deliver to the tip of the nozzle of the burner oil gas mixed with the finest possible atomized heated oil.

It is a well known fact in present modern practice that oil should have its viscosity reduced to about 8° Engler, as determined by a viscosimeter, in order to enable the burner to atomize the oil properly. This is done by heating the oil until a viscosimeter test gives the required viscosity and to calculate the approximate temperature required; but it is better to experiment in the furnace in order to get the desired temperature that the oil should be heated to in order to do efficient work.

It is also a well known fact, that in many of the oil burning methods now used the degree of heat to which the oil of different specific gravities can be heated is stated. For example, it is recognized that an oil of 24° Baumé gravity should not be heated to over approximately 160° F. before it is put in the burner. If an oil of this gravity is heated to say as high as 200° F. it still may be used in some of the present burners, but if heated to over 200° F. or to a point that approximates the fire point of the oil, the present modern burners will not handle it but will sputter, puff intermittently and also carbonize badly and, in many cases, will go out entirely. For this reason it is recognized in oil burning that the oil should be kept below at least the flash point, which at 24° Baumé would be approximately 200° F., in order for the burner to operate efficiently. These figures are only approximations but show that the present process in modern practice of burning oil is limited as to the temperature to which the oil can be heated.

At present oil is heated for the sole purpose of reducing the viscosity or increasing the fluidity, in order to aid in atomizing; and the degree of this heat required is determined by the viscosity of the oil and the ability of present burners to handle it. In present practice, using the most modern burners, oils having a gravity of 16° Baumé or above show very little change in viscosity by heating to over 180° F.

It is recognized that oil is not completely distilled under a temperature of 800° F. For practical purposes the fact is that the various constituents of fuel oil give off combustible vapors or gases at temperatures which vary from 100° F. and upwards. On approaching the boiling point of the oil, unless special precautions are taken, a residue of solid carbon is formed which would choke up narrow passages or pipes through which the fuel may have to pass.

It is obvious that the heat required to burn oil into gas will vary with the analysis of the oil and that some portion of the oil will be turned into gas while the rest will remain liquid with some suspended solids. Therefore, in order properly to carry out my process the mixture of gas and heated oil at the tip of the burner must be constantly well mixed under constant heat and pressure, in order to insure a steady flame at the tip of the burner, and also to avoid the possible depositing of the solids, caused by decomposition of the oil, which would form coke and clog the burner.

My process comprises the following steps:

First: Using oil heated between the flash point and the fire point the heat for preheating the oil being independent of the heat of the atomizing fluid or steam. By doing this, important beneficial objects are obtained as follows—the viscosity is reduced, which allows finer atomization, which in turn means more rapid and efficient combustion, permitting a greater rate of combustion per cubic foot of furnace volume per hour; also, the moment the oil is heated to the flash point, inflammable gas is given off, the quantity of

this gas depending entirely upon the degree of heat given to the oil.

Second: In confining this mixture of heated oil and oil vapor in a reservoir plate, and again heating the oil by means of radiated heat from the furnace, while the oil is in the reservoir plate and wire-drawing the heated oil for the first atomization of the same, the atomized oil after it is wire-drawn being caused to twirl, when it strikes the curved impact plug (Fig. 3).

Third: This mixture of highly heated atomized twirling oil and vapor is caused to impact against an opposing curved surface, for the second atomizing of the oil; directly after impact the atomized oil is given a further twirling motion, and caused to travel in a different direction from that given when the oil was first caused to twirl; this mixture of highly heated atomized oil and oil gas or vapor always having been and still being free from interference from the steam or air that is used in the following step—

Fourth: As the mixture of highly heated twirling atomized oil and oil gas leaves the impacted surface, it is now struck for the first time by a stream of steam or air at the point where the steam or air has reached its highest velocity. This is done by projecting the steam or air through a nozzle designed for complete expansion, which increases the velocity of the steam, and is accomplished by gradually increasing the diameter of the nozzle beyond the throat or smaller section; in which case the velocity of the steam issuing from a nozzle of this description increases as the pressure drops until at the end of the nozzle a velocity of from 3000 to 4000 feet per second may be realized, if the back pressure be low; whereas, in an ordinary orifice steam from 100 to 150 lbs. pressure issuing into the air will have a velocity of only from 1300 to 1500 feet per second. So, by employing a nozzle designed for complete expansion, a minimum of steam is used for the atomizing of the oil, and this again brings out a beneficial result as there will be less dead gases to handle from the furnace.

Fifth: The final mixture of highly heated atomized oil, oil vapor or gas and steam now passes into an enlarged mixing chamber where it is thoroughly mixed and again highly heated by means of radiated heat from the furnace, as the mixing chamber extends slightly into the furnace; the final mixture is gradually compressed, and finally passes into the furnace where the proper amount of air is supplied for complete combustion.

The amount of oil gas or inflammable vapor that is in the final mixture depends on the temperature of oil delivered to the burner; then the temperature of the reservoir plate, and finally the temperature of the mixing chamber.

My process has been practically demonstrated in a reverberatory copper furnace and is now in daily use saving a large percentage of fuel and is carried out by using the burner as shown and described in my United States patent application Serial No. 678,977 filed Dec. 6, 1923, which need not here be described in detail.

Said burner is shown in the annexed drawing, in which Fig. 1 is a longitudinal section of the burner;

Fig. 2 is a similar view of a fragmental portion of the burner, drawn to a larger scale;

Fig. 3 is a perspective of a detail; and

Fig. 4 is a rear elevation of the burner.

Briefly stated, the burner comprises a forwardly tapering steam conducting casing 1 the forward end of which is provided with a disk 3 having a threaded flange in which is received a distributing ring or plate 4 provided with a groove forming with said disk a reservoir 5 receiving fuel through the inlet 6. Said plate 4 is also provided with inwardly pointed ducts 12 slightly offset, or tangential relative to the axis of the burner, adapted to discharge streams of fuel against the curved face 7 of the abutment plug 8 provided therearound with a series of bridges or lugs 9 fitting in the end of the casing and forming steam ports or passages 10 therebetween, the abutment plug 8 having a conical portion extending in direction counter to the steam flow for deflecting the streams of steam to the ports 10. The curved surface of the face 7 begins, Figs. 1, 2 and 3, at the peripheral edge of the cone portion of the abutment plug 8, and terminates at the peripheral edge of the flat face of the abutment plug, a narrow passage being formed between the peripheral edge of the flat face and the adjacent edge of the plate 4, which passage communicates with the mixing chamber G later mentioned. The curved abutment face 7 is disposed in the path of travel of the oil and oil vapor issuing from the ducts 12, and this path of travel is substantially transverse to the path of travel of the steam issuing from the ports 10. The ducts 12 are arranged relative to the curved surface of the face 7, so that the oil and vapor issuing from the ducts 12 first contact with the curved face 7 adjacent to the peripheral edge of the cone portion of the abutment plug 8, and are given a twirling motion and further atomized. The twirling oil and oil vapor after contact with the curved surface 7 pass into the above mentioned passage in the direction indicated by the arrows E, and the steam compressed after gradual expansion to a highest point in the tapering casing 1 issuing from the ports 10 and deflected by the end face of the plate 4 passes through said passage in the direction indicated by the arrows F, the steam due to the bridges 9 being free from interference or

shutting off action relative to the oil and oil vapor, the result being that the paths of the twirling oil and vapor and the steam intersect at a point in said passage slightly beyond the line of the plane of the flat face of the abutment plug 8, thereby causing further atomization of the oil of the twirling oil and vapor, followed by sudden expansion of the steam in zone K and mixture of the steam and oil and vapor in the mixing chamber G; this mixture then being gradually compressed until it is discharged from the nozzle 17.

A second casing 11 provided at its outer end with a nozzle 17 and at its inner end with a flange 13 resting against the plate 4 is held in place by a retainer disk 14 having an internally threaded flange 15 received on the flange of the disk 3 and engaging said disk 5 and the flange 13. This casing 11 receives heat from the furnace and forms a mixing and heating chamber G having the expansion zone K at its mouth and the nozzle 17 at its discharge end.

Oil at 24° Baumé which is the gravity of the oil that said plant is now operating with is taken as an example for the description of the operation. This oil has a flash point of approximately 200° F. and a fire point of 229° F. The oil is heated to approximately the fire point and in many tests and runs conducted by myself this temperature was raised to as high as 280° F. The oil is introduced into the burner through inlet 6 shown in Fig. 1 and goes into the small reservoir 5 in the plate 4, under an average working pressure of 50 pounds. This reservoir plate is heated by the action of the steam passing through the burner, also from the radiated heat from the furnace. The oil passing through this heated reservoir plate 4 is now in a partial gaseous state, the more readily distilled portions of the oil being in a gaseous state and the remainder of the oil being still in a liquid state. This reservoir acts as a mixing chamber, and the undistilled liquid portion of the oil is thoroughly mixed with the gaseous portion, and both are forced and carried out through oil ducts 12, where the liquid portions of the oil are wire-drawn and atomized by this action.

On leaving the ducts 12 the mixed gas and oil now pass over the small bridges or lugs 9 of the abutment plug 8 and strike the curved face 7 of the plug 8. Steam under pressure enters through the casing 1 as shown by the arrows A. The fuel mixture on leaving the outer edge of the abutment plug is struck by streams of steam which are free from twirling motion and, due to passage of the mixture over the lugs or bridges 9, during its twirling motion the mixture is kept free from interference or shutting off action arising from the velocity of the streams of steam. Thus it will be seen the liquid portion of the oil is completely atomized in the finest possible condition, and passes into the mixing chamber G. Here it is again mixed, and further heated by the heat of the steam and radiated heat from the furnace, it being borne in mind that the burner extends somewhat into the furnace and is heated thereby. The small remaining portion of ungasified oil, thoroughly mixed with the oil gas, will pass out through the tip of the nozzle 17 under a constant pressure, whereupon the gas and the extremely fine atomized oil are burnt.

In carrying out my process, using the aforesaid apparatus, the gas and oil leaving the tip of the burner will burn with a sharp, quick, steady flame without puffing or sputtering of any kind. The puffing or sputtering is entirely eliminated on account of the action of the reservoir plate, the curved abutment plug and the mixing chamber G, as they keep the oil and the ungasified portion of the oil thoroughly and completely mixed with the gas at all times and under constant pressure.

In using steam as the last atomizing agent, the quantity of steam is reduced to a minimum, as low as from three tenths to five tenths pounds of steam to a gallon of oil. This obviously reduced the amount of dead gases that must be handled from the furnace, and also the amount of the steam to be superheated, and thus reduces the amount of delayed combustion, all of which means a saving of fuel.

It is obvious that air can be used instead of steam, either high or low pressure, also that heavier oils can be used. In the latter case, the temperature to which the oil must be heated would be different from the example cited. It is also obvious that the other structures can be used for carrying out my process and that there may be modifications of and variations in the before described process and apparatus without departing from the spirit of the invention or exceeding the scope of the appended claims.

While in claims herein, steam is mentioned as forming streams, it is understood that these claims are broad enough to cover air as an equivalent of steam.

I claim as my invention:

1. The oil burning process which consists in gradually expanding steam under pressure, compressing the expanding steam, wire-drawing the oil, atomizing the wire-drawn oil, causing the atomized wire-drawn oil to travel in a path which intersects the path of the steam discharged after said compression, compressing the oil and steam at the intersection of their paths for further atomizing the oil, mixing the oil and steam, expanding said mixture for thoroughly mixing the oil and steam, gradually compressing the thoroughly mixed oil and steam, and discharging and burning the mixture.

2. The oil burning process which consists in gradually expanding steam under pressure, deflecting and compressing the expanding steam, wire-drawing the oil, atomizing the wire-drawn oil, causing the atomized wire-drawn oil to travel in a path which intersects the path of the steam discharged after said compression, compressing the oil and steam at the intersection of their paths for further atomizing the oil and mixing the oil and steam, compressing the mixture of oil and steam, expanding said mixture for thoroughly mixing the oil and steam gradually compressing the thoroughly mixed oil and steam, and discharging and burning the mixture.

3. The oil burning process, which consists in gradually expanding steam under pressure, compressing the expanding steam, wire-drawing the oil, atomizing the wire-drawn oil, giving a twirling motion to the oil, causing the twirling oil to travel in a path which intersects the path of the steam discharged after said compression, compressing the oil and steam at the intersection of their paths for further atomizing the oil and mixing the oil and steam, expanding said mixture for thoroughly mixing the oil and steam, gradually compressing the thoroughly mixed oil and steam, and discharging and burning the mixture.

4. The oil burning process which consists in gradually expanding steam, compressing the expanding steam, preheating the oil by heat independent of said steam, wire-drawing the pre-heated oil, atomizing the wire-drawn oil, giving a twirling motion to the oil causing the twirling oil to travel in a path which intersects the path of the steam discharged after said compression, compressing the oil and steam at the intersection of their paths for further atomizing the oil and mixing the oil and steam, compressing the mixture of oil and steam, expanding the mixture of oil and steam for thoroughly mixing the oil and steam, gradually compressing the thoroughly mixed oil and steam, and discharging and burning the mixture.

5. A method of burning liquid fuel comprising gradually expanding a stream of steam under pressure; contracting the stream of steam to a narrow annular cross section thereby increasing its speed to a maximum velocity and reducing the pressure; and injecting atomized fuel into said stream substantially at the point of maximum velocity.

6. A method of burning liquid fuel comprising gradually expanding a stream of steam; contracting and dividing said stream to form a plurality of streams of narrow cross section and high velocity; directing atomized fuel into said high velocity streams thereby to be further atomized and mixed with the steam and thereafter suddenly expanding the mixture.

7. A method of burning liquid fuel comprising gradually expanding a stream of steam; contracting the steam to a narrow annular cross section, dividing the stream around the cross section into high velocity streams with spaces of low pressure between the streams; directing fine jets of fuel radially into said low pressure spaces to be expanded and atomized therein, then further disrupting the fuel jets; and directing the fuel obliquely into said high velocity streams to be further atomized and mixed with the steam.

8. A method of burning liquid fuel comprising gradually expanding a stream of steam; contracting the steam to a narrow annular cross section, dividing the stream around the cross section into high velocity streams with spaces of low pressure between the streams; directing fine jets of fuel radially into said low pressure spaces to be expanded and atomized therein, then further disrupting the fuel jets; directing the fuel obliquely into said high velocity streams to be further atomized and mixed with the steam, and suddenly expanding the mixture thereby to further disrupt and atomize the fuel; converging and increasing the velocity of the mixture and then discharging the mixture in the form of a fine mist.

Signed at New York in the county of New York and State of New York this 16th day of June, A. D. 1924.

HENRY ADAMS.