

Sept. 29, 1931.

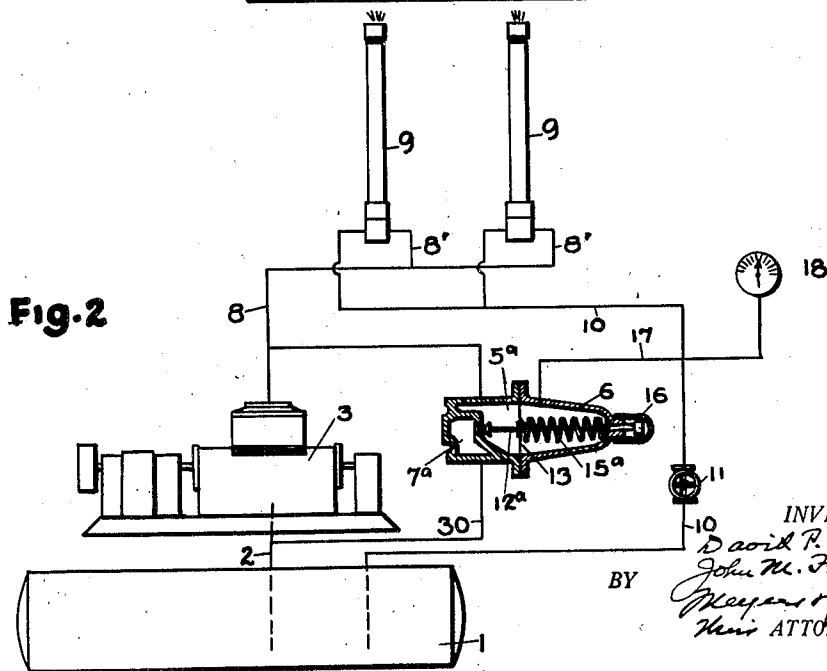
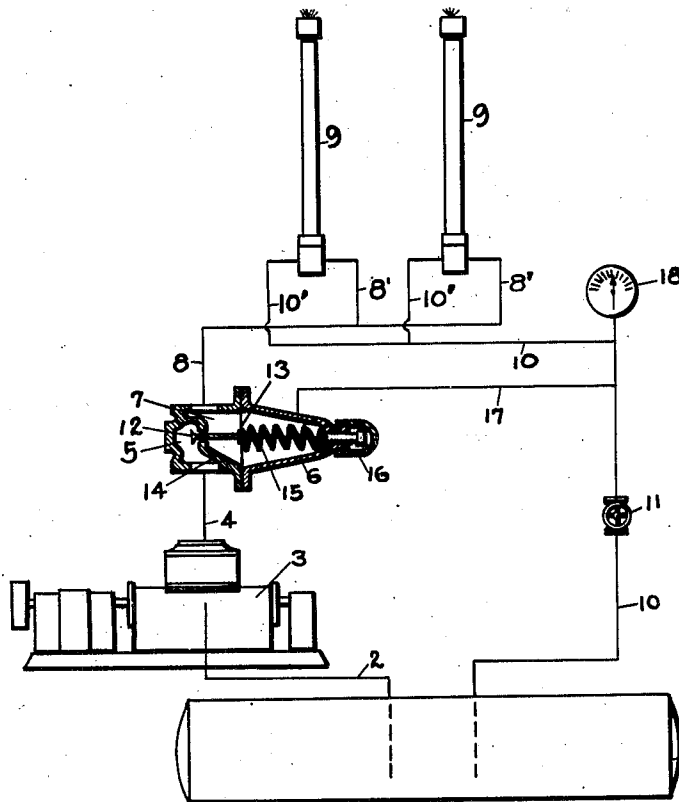
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1,824,952

OIL BURNING SYSTEM

Filed Oct. 1, 1929

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

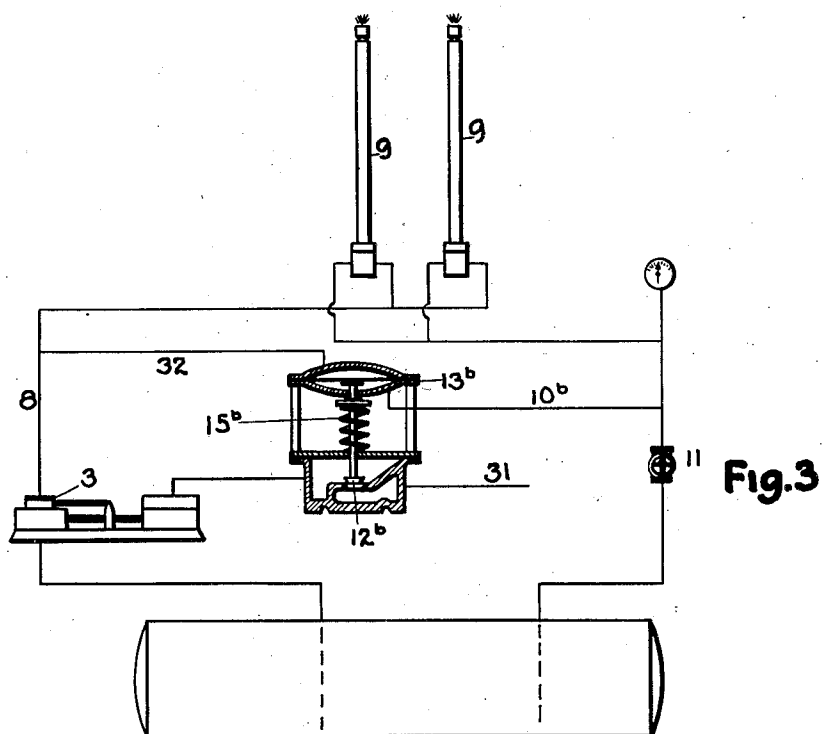


Fig. 3

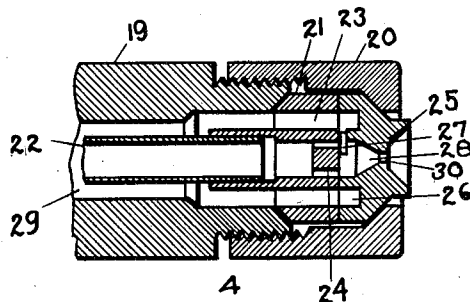


Fig. 4

Fig. 6

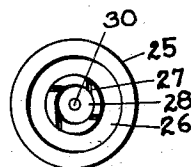
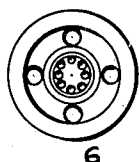


Fig. 5

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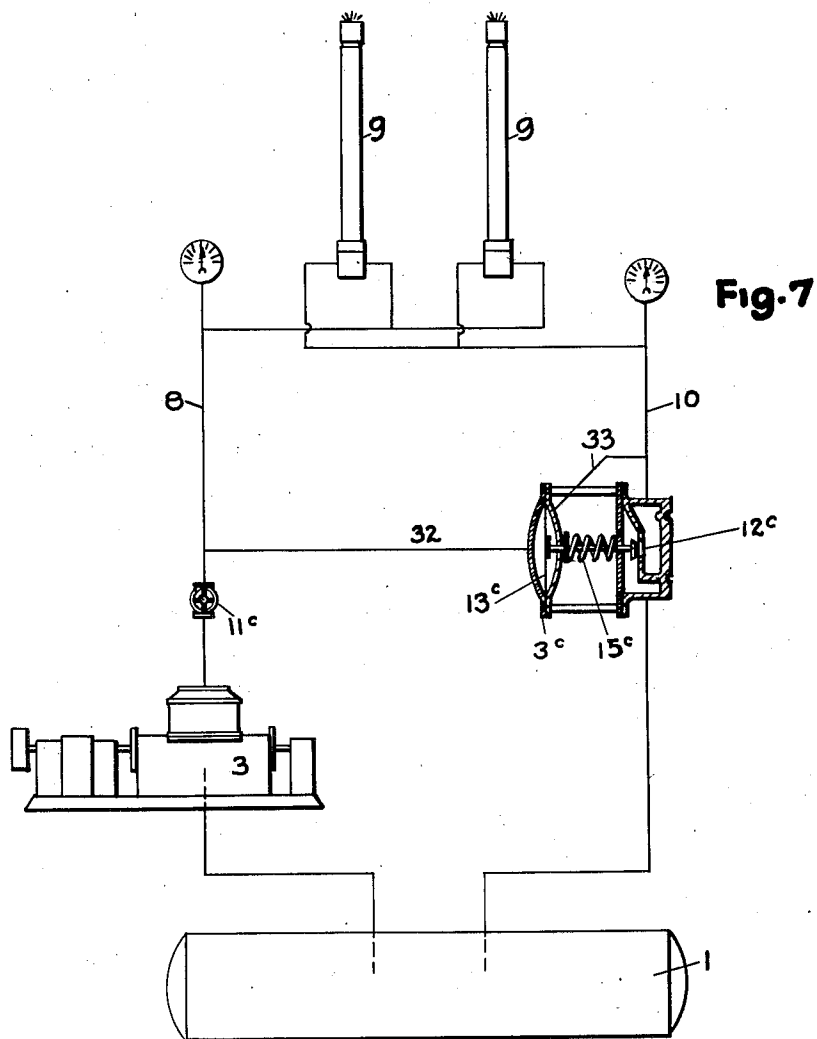
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OIL BURNING SYSTEM

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3 Sheets-Sheet 3



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OIL BURNING SYSTEM

Application filed October 1, 1929. Serial No. 396,581.

Our invention relates to oil burning systems in which mechanical atomizers or pressure burners are employed. In this type of burner the oil is delivered under pressure through passages substantially tangential to the wall of a central chamber in the tip and in such way as to impart to the oil a rapid whirling motion before it is discharged from the tip in the form of a cone shaped spray.

10 The straight or ordinary mechanical atomizer in which all of the oil delivered to the atomizer is sprayed into the combustion chamber is, however, subject to a marked limitation in capacity range, that is, in the

15 number of pounds of oil atomized per burner per hour.

Prior to our invention what is known as the Peabody-Fisher wide range system had gone into extensive commercial use. By that system a wide range in capacity, without loss in atomizing power, is secured by causing a portion of the oil, after its entry into the tip chamber, to be returned to the pump or storage tank. The system is described in U. S.

25 Patents No. 1,326,488 granted December 30th, 1919 and No. 1,628,424 granted May 10, 1927. By opening the valve in the return pipe, as described in said patents, the quantity of oil actually sprayed into the furnace will be reduced but the quantity flowing through the tangential passages into the tip chamber will increase somewhat. In the operation of the system, depending upon the amount of opening of the return valve, there will be a variable

35 pressure in the tip chamber and in the return pipe, and a variable spray angle.

Our invention relates to this general type of wide range system and is directed to a method and apparatus by which a substantially constant, instead of a variable, pressure differential will be maintained across the tangential passages, resulting in an essentially constant quantity of fuel entering the tip

45 chamber at a corresponding uniform velocity, thus giving a more nearly constant spray angle for all capacities, and a reduction in the quantity of oil returned to the storage tank when operating at low capacities.

50 The invention will be understood by refer-

ence to the accompanying drawings in which—

Figs. 1, 2 and 3 are diagrammatic layouts of systems by which the method may be practiced.

Fig. 4 is a longitudinal section through the end of the atomizer.

Figs. 5 and 6 are end views of the tip and plug, respectively of Fig. 4.

Fig. 7 is diagrammatic layout of a modified system.

Referring to Fig. 1, the numeral 1 designates an oil storage tank connected by a pipe 2 to the suction side of a pump 3. The latter may be of any suitable type adapted to maintain a substantially constant pressure through line 4 which leads to chamber 5 in a valve casing 6. From the outlet chamber 7 of said casing a pipe 8 leads, through branch connections 8', to atomizers 9. The latter may be of the construction described in Patent No. 1,628,424. In the present system, and as described in said patent, each atomizer has an oil return line 10' leading from the tip chamber. These are connected to a common line 10 which discharges into the storage tank 1, when the valve 11 is open. The return oil may be run to another tank or otherwise disposed of.

To apply the present invention to the system described in said patents, there is introduced into the main line between the pump and the atomizers a valve 12 having a stem connected to a flexible diaphragm 13 secured at its periphery to the casing 6. This valve controls an opening in the partition 14 between the inlet and outlet chambers 5 and 7. A spring 15 bears against the side of the diaphragm opposite to that of the valve and is normally adjusted to hold the valve open. By means of the screw 16, to which one end of the spring is connected, the pressure exerted by the spring upon the diaphragm may be regulated.

Between the atomizer and valve 11 is a branch pipe 17 connecting the return line to the chamber in casing 6 in which spring 15 is located, so that the same oil pressure will be present in pipe 17 and on one side of diaphragm 13, as in the return line 10. Thus

any variation in pressure in the return line may be utilized to actuate valve 12 to permit more or less oil to flow to the atomizers. A gauge 18 indicates the pressure in the return line.

For convenience of description, we have shown in Figs. 4, 5 and 6, certain parts of a well known type of atomizer. In these figures the numeral 19 designates a portion of the burner barrel to which is secured a cap 20. Seated on the beveled end of the burner barrel is a plug 21 fitted over the end of an inner tube 22. The plug is formed with a set of outer passages 23 and a set of inner passages 24. Seated on the face of the plug is a tip 25 formed with a channel 26 and ducts 27 leading from said channel substantially tangential to the wall of the tip chamber 28 having an outlet orifice 30. The tip and plug are held in assembled position by cap 20.

The atomizer shown, when used in the system illustrated in Figs. 1, 2 or 3, is so connected that the branch supply line 8' of a given atomizer delivers the oil to the passage 29 between the burner barrel and the inner tube and from which it flows through passages 23 and tangential ducts 27 to chamber 28, where it is in rapid rotation due to entry through tangential ducts 27 and some or all of the oil is discharged through the tip orifice 30. The inner tube 22 is connected to the return line 10, so that when valve 11 is opened, a portion of the oil delivered to the tip chamber will be returned to a storage tank.

The function of valve 12 is to control the amount of oil flowing from line 4 to line 8 in accordance with variations in the pressure of the return oil through line 10, it being understood that when valve 11 is opened more or less, the capacity of the atomizer will vary. By varying the pressure of oil delivered to the atomizer inlet to correspond to a decrease or increase of the pressure in the return line, a substantially constant differential between the inlet pressure and the pressure in the tip chamber will be maintained.

The operation of the system illustrated in Fig. 1 will be understood by assuming first that it is being operated as a straight mechanical atomizer system with the return valve 11 fully closed, and that the inlet pressure, that is, the pressure existing at the inlet to the tangential passages 27 leading to the tip chamber is 200 lbs. per sq. in., and that there is a pressure drop through said tangential passages of 50 lbs. thus giving a pressure of 150 lbs. per sq. in. in the tip chamber 30. This will set up a pressure in the branch line 17 and on the spring side of the diaphragm 13, of approximately 150 lbs. This pressure, together with that exerted by spring 15, will hold the valve 12 open to permit the full quantity of oil under the line pressure of 200 lbs., to be delivered to the atomizer inlet.

Under these conditions the pressure in

line 4 will be maintained substantially constant at 200 lbs., and the pressure within the tip chamber will be maintained substantially constant at 150 lbs.

If now the valve 11 in return pipe 10 is opened to permit the return of a portion of the oil from the tip chamber to the storage tank there will be a drop in pressure in the tip chamber. Assuming this drop in pressure to be 50 lbs., then the pressure in pipe 17 and on the spring side of diaphragm 13 will be reduced a like amount. This will effect a partial closing of valve 12 until the oil pressure in chamber 7 and line 8 approaches 150 lbs. per sq. in. instead of the original 200 lbs. per sq. in. Under that condition diaphragm 13 will be in balance and valve 12 will remain in its new position until the pressure in line 10 is again changed by moving valve 11. The pressure at the burner inlet will therefore become 150 lbs. per sq. in. There is thus the same differential between the inlet pressure and that in the tip chamber, namely, 50 lbs. per sq. in. Similarly, if the pressure of the return oil is reduced to 50 lbs. there will be a further closing of valve 12 to reduce the supply pressure to say, 100 lbs. per sq. in., thus maintaining the same pressure differential across the slots of the tip chamber.

By thus varying the supply pressure to the burners 9 while maintaining substantially the same differential between the supply and return pressures, the spray angle will be maintained substantially constant since the velocity of rotation of the oil in tip chamber 30, which is governed only by the pressure drop across tangential passages 27, remains unchanged. Therefore, the quality of the spray will be the same at all capacities.

For a given pressure in chamber 30 (assume this to be 25 lbs. per sq. in.) less oil will enter said chamber if the supply pressure were 75 lbs. than if the supply pressure were 200 lbs., as in this latter case the pressure drop across tangential passages 27 will be 175 lbs. as against a pressure of 50 lbs. in the former case.

The total oil circulated through the burner will be approximately in proportion to the square root of the pressure drops across the tangential passages. Consequently at reduced burner capacities the total oil pumped, for any given amount sprayed and as a result the amount of oil returned to the storage tank, will be considerably less if the system is connected as herein described than would be the case if conventional methods were followed.

In explaining the theory of action of the mechanical atomizer with reference to the form and fineness of spray which issues from the tip, two forces must be considered:

First, pressure within the tip which causes the oil to issue through the orifice, and

Second, the centrifugal force created by giving the oil within the tip chamber before its exit through the orifice, a rapid whirling motion about the axis through the center of the orifice.

If the first force is considered alone, namely, pressure within the tip, its effect is to determine the quantity of oil which will issue through the orifice in a given time. In other words, as the pressure is increased within the tip chamber, the amount of oil delivered through the orifice will be increased. This force acts substantially parallel with the axis and has no effect on the form of the issuing stream of oil except as this form may be slightly modified by friction produced by moving the oil across the wall of the orifice. If the orifice is very small and the pressure very high, the effect will be to produce a spray of a rather coarse quality. This spray is caused by the friction on the wall of the orifice and is inconsiderable as affecting the angle of the spray even under extreme conditions of a very high pressure and a very small orifice.

In the case of the ordinary mechanical atomizer the pressure within the tip chamber is comparatively low, and the orifice is of material size. Under these conditions the spraying effect from the above cause is almost negligible. In other words, the stream of oil issues from the tip in practically a straight line. Attempts to use a plain orifice for spraying oil in commercial atomizers for boiler purposes by merely delivering the oil through an orifice under pressure have not been successful. Some other factor is required.

The other factor is the centrifugal force above referred to. Upon the amount of this force created within the tip chamber, practically the entire spraying effect depends. A body when whirled rapidly around a center will fly off radially from the center when allowed to do so. In the case of oil rotating rapidly about an axis, the effect will be for particles of the oil to fly off radially from the center in all directions. This results in the breaking up of the body of the oil into very small particles, it being obvious that the amount of centrifugal force created will affect the fineness of the spray, that is, the number and size of the particles, and also the angle at which they fly off from the point of liberation. The tendency is for the particles to fly off radially in a plane at right angles to the axis of rotation. In the case of an atomizer of the type here considered, this tendency is retarded by the resistance offered by the oil to its separation into small particles, and by the pressure in the tip chamber which tends to drive the oil through the orifice in a path parallel to the axis.

According to the amount of centrifugal force created within the tip chamber it will

be obvious, therefore, that the angle of the spray will vary between the axial direction and a plane at right angles to this axis. Some intermediate position is taken by the particles flying away from the periphery of the orifice and this intermediate position is called the angle of spray.

That which sets up or creates the centrifugal force in the tip chamber is the velocity at which the oil flows through the tangential ducts which lead from a source of supply outside the tip into the tip chamber. This in turn depends upon the differential existing between the pressure at the entrance to the tangential ducts outside the chamber and the pressure in the chamber itself. If the differential in pressure is increased the angle of spray will be increased and will more nearly approach the limit provided by the plane at right angles to the axis. If the differential in pressure is lessened the angle of spray will be lessened, and if no centrifugal force whatever is set up, the oil will issue axially and will have no angle at all.

By the present invention the drop in pressure between the inlet to the tangential ducts and atomizer tip chamber is maintained substantially constant, notwithstanding a constant pump pressure on the oil supply to the system.

In the system illustrated in Fig. 2 the valve 12^a is located in a bypass 30 leading from line 8 on the pressure or discharge side of pump 3 to the suction line 2.

As pump 3 is a constant-speed pump, the pressure in the delivery line 8 will vary, depending upon the quantity of oil by-passed through line 30. This quantity is determined by the extent of opening of valve 12^a controlled by the pressure in the return-line 10. The delivery pressure in this arrangement is impressed on the valve side, and the return pressure on the spring side of diaphragm 13, so that by adjusting the spring-load 15^a any desired differential may be maintained between the supply pressure and the return pressure, with the same advantageous results as described with reference to the system of Fig. 1 plus the added advantage of a reduced power consumption of pump 3 at burner capacities below the maximum since a substantially constant quantity of oil will be pumped at a continually lesser head as the burner capacity is reduced by opening valve 11.

In the system illustrated in Fig. 3, the valve 12^b controls the steam-supply line 31 of pump 3. The spring 15^b is adjusted to normally hold the valve 12^b wide open so that the pump will deliver the quantity of oil necessary when operating at maximum capacity. A branch-pipe 32 leads from the supply line 8 to the valve-casing on the upper side of diaphragm 13^b, to which diaphragm the valve stem is attached. A branch

line 10^b leads from the return line 10 to the underside of said diaphragm.

The arrangement is such that the movements of valve 12^b will be controlled by the supply and return oil pressure plus the additional spring load 15^b. When the valve 11 is opened or closed, and the oil return pressure falls or rises, the oil supply pressure will fall or rise correspondingly. A constant differential between the oil supply and return pressures, therefore, will be maintained according to the setting of the spring load 15^b.

The power consumption of pump 3 will be reduced as the pump discharge head is reduced as just described.

In the system illustrated in Fig. 7 the valve 12^c controls the amount of oil returned and valve 11^c controls the supply pressure to the burners 9. A branch pipe 32 leads from the supply line 8 to the valve casing on the side of the diaphragm 13^c away from the spring 15^c. A branch pipe 33 leads from the return line 10 to the spring side of diaphragm 13^c. This arrangement is such that the return oil pressure will be controlled by the movements of valve 12^c which in turn is controlled by the supply and return oil pressures and spring load, the supply pressure being varied by opening or closing valve 11^c. When the valve 11^c is opened or closed, and the oil supply pressure rises or falls the oil return pressure will rise or fall correspondingly. A constant differential between the oil supply and return pressures, therefore, will be maintained according to the setting of the spring load 15^c.

What we claim is:

1. The method consisting in delivering oil under pressure to an atomizer, returning a portion of the oil from said atomizer, and automatically varying the pressure of oil delivered to the atomizer by variations in the pressure of the return oil.

2. The method consisting in delivering oil under pressure to an atomizer, permitting the return of a portion of the supply oil from the atomizer, and varying the pressure of oil delivered to the atomizer by the pressure of the return oil to thereby maintain a substantially constant differential between the inlet pressure and the pressure in the atomizer.

3. The method consisting in delivering oil under pressure to an atomizer, varying the capacity of the atomizer by returning a portion of the oil therefrom, and utilizing variations in pressure of the return oil to vary the pressure of oil supplied to the atomizer.

4. An oil burning system comprising an atomizer, means for supplying oil thereto under pressure, means for returning a portion of the oil from the atomizer, and means for varying the pressure of supply oil by variations in the pressure of the return oil.

5. An oil burning system comprising a source of fuel supply, an atomizer having a tip formed with a chamber to which the oil is

delivered, and means for automatically maintaining a substantially constant differential between the inlet pressure and the pressure in the tip chamber.

6. An oil burning system comprising a source of fuel supply, an atomizer having a tip formed with a chamber to which the oil is delivered, means for returning a portion of the oil from said chamber, and means controlled by the pressure of the return oil to maintain a substantially constant differential between the inlet pressure and the pressure in the tip chamber.

7. An oil burning system comprising a source of fuel supply, an atomizer having a tip formed with a chamber to which the oil is delivered, means for varying the pressure in said chamber by returning a portion of the oil admitted thereto, and means controlled by the pressure of the return oil to reduce the pressure of supply oil to the tip chamber.

8. An oil burning system comprising a fuel supply line, an atomizer having a tip formed with a chamber, the wall of which is provided with ducts leading from the supply line, means to permit return of a portion of the oil from said chamber, and means controlled by the pressure of the return oil to maintain substantially the same pressure differential across the ducts of said chamber.

9. An oil burning system comprising a source of fuel supply, an atomizer having a tip formed with a chamber to which the oil is delivered, said chamber having an oil return pipe leading therefrom and also a discharge orifice, and means controlled by the pressure of the oil in said return pipe to maintain a substantially constant pressure drop between said chamber and atomizer inlet.

10. An oil burning system comprising a source of fuel supply, an atomizer having a tip formed with a chamber to which the oil is delivered, said chamber having an oil return pipe leading therefrom and also a discharge orifice, a valve in the supply line, and means controlled by the pressure of the oil in said return pipe to control the movements of said valve.

11. An oil burning system comprising a fuel supply pipe, an atomizer having a tip formed with a chamber to which the oil is delivered, said chamber having an oil return pipe leading therefrom and also a discharge orifice, and means controlled by the pressure of the oil in said return pipe to vary the pressure of oil delivered through the supply pipe.

12. An oil burning system comprising a fuel supply line, an atomizer having a tip formed with a chamber to which the oil is delivered, said chamber having a pipe leading therefrom to permit the return of a portion of the oil from said chamber, means for varying the quantity of oil returned, and means controlled by the pressure of the oil

in the return pipe to maintain a substantially constant differential between the inlet pressure and the pressure in the tip chamber.

13. An oil burning system comprising a source of fuel supply, an atomizer having a tip formed with a chamber to which the oil is delivered, means for returning a portion of the oil from said chamber, and means for varying the capacity of the atomizer while maintaining a substantially constant differential between the inlet pressure and the pressure in the tip chamber controlled by the pressure of the return oil.

14. An oil burning system comprising a source of fuel supply, an atomizer having a tip formed with a chamber to which the oil is delivered, means for varying the capacity of the atomizer, and means for automatically maintaining a substantially constant differential between the inlet pressure and the pressure in the tip chamber at all capacities.

15. An oil burning system comprising a source of fuel supply, an atomizer having a tip formed with a chamber to which the oil is delivered, an oil return pipe leading from said chamber, means in said pipe to vary the capacity of the atomizer, and means controlled by the pressure in the return pipe to control the pressure of oil admitted to the tip chamber.

16. An oil burning system comprising a source of fuel supply, an atomizer having a tip formed with a chamber to which the oil is delivered, said chamber having an oil return pipe leading therefrom and also a discharge orifice, and means controlled by the pressure of the oil in the supply pipe to maintain a substantially constant pressure drop between said chamber and atomizer inlet.

17. An oil burning system comprising a fuel supply line, an atomizer having a tip formed with a chamber to which the oil is delivered, said chamber having a pipe leading therefrom to permit the return of a portion of the oil from said chamber, means for varying the oil supply pressure and means controlled by the pressure of the oil in the supply line to vary the pressure of the oil in the return pipe to maintain a substantially constant differential between the inlet pressure and the pressure in the tip chamber.

Signed at New York, in the county of New York and State of New York, this 24th day of September, 1929.

DAVID P. GRAHAM.

Signed at New York, in the county of New York and State of New York, this 27th day of September, 1929.

JOHN M. FERRY, JR.