Dec. 11, 1945. T. NAGEL 2,390,806

OIL BURNING SYSTEM

Filed Sept. 11, 1942 2 Sheets-Sheet 1

Fig. 1.

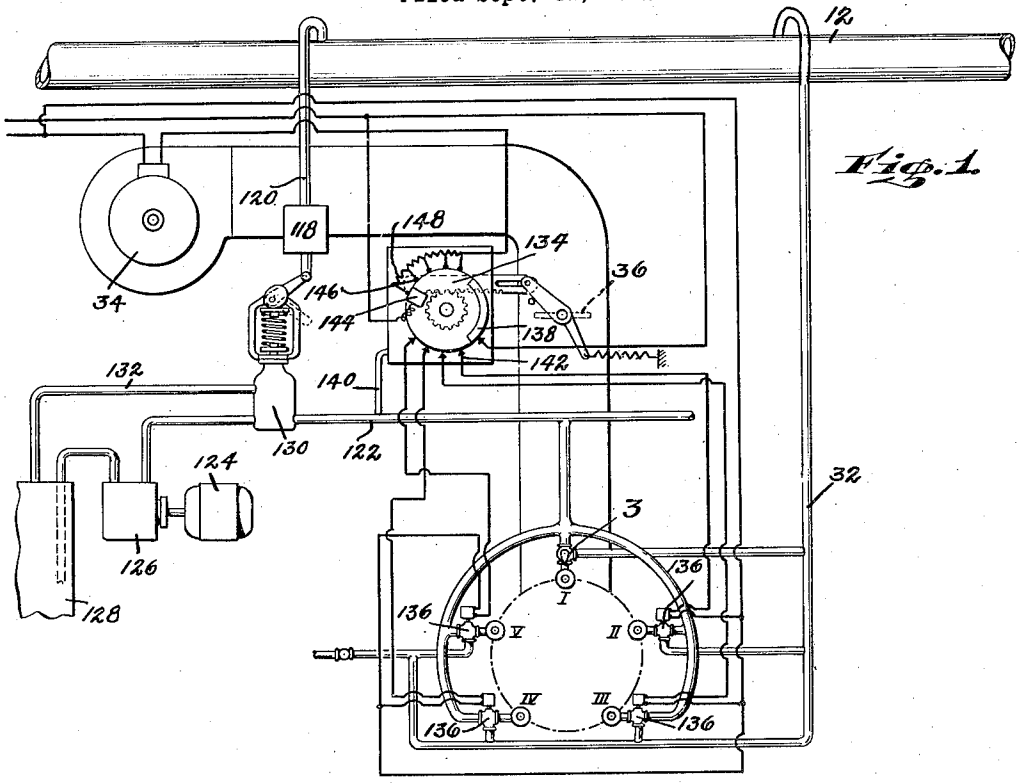
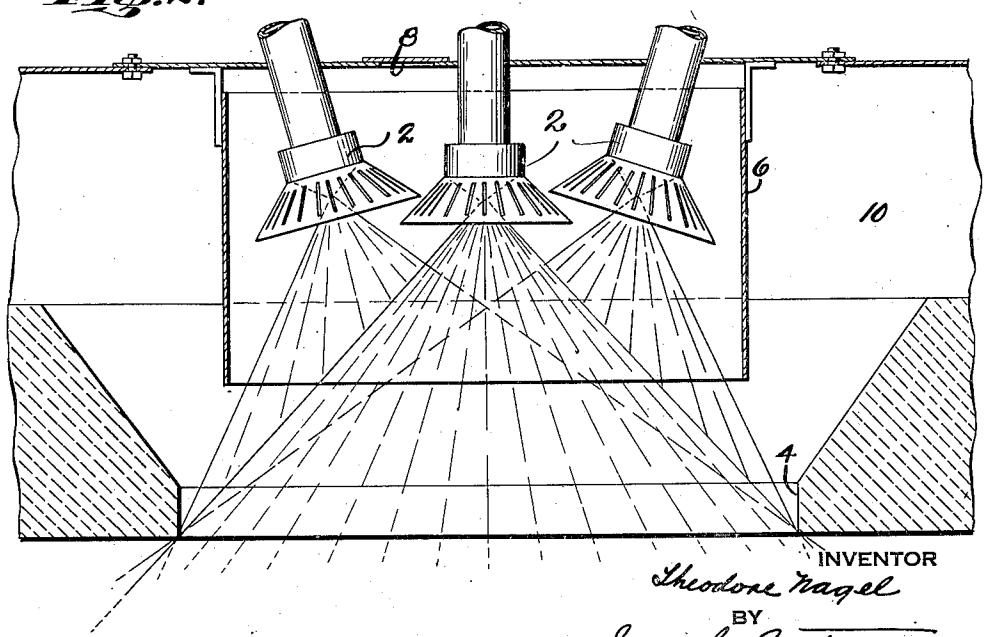


Fig. 2.



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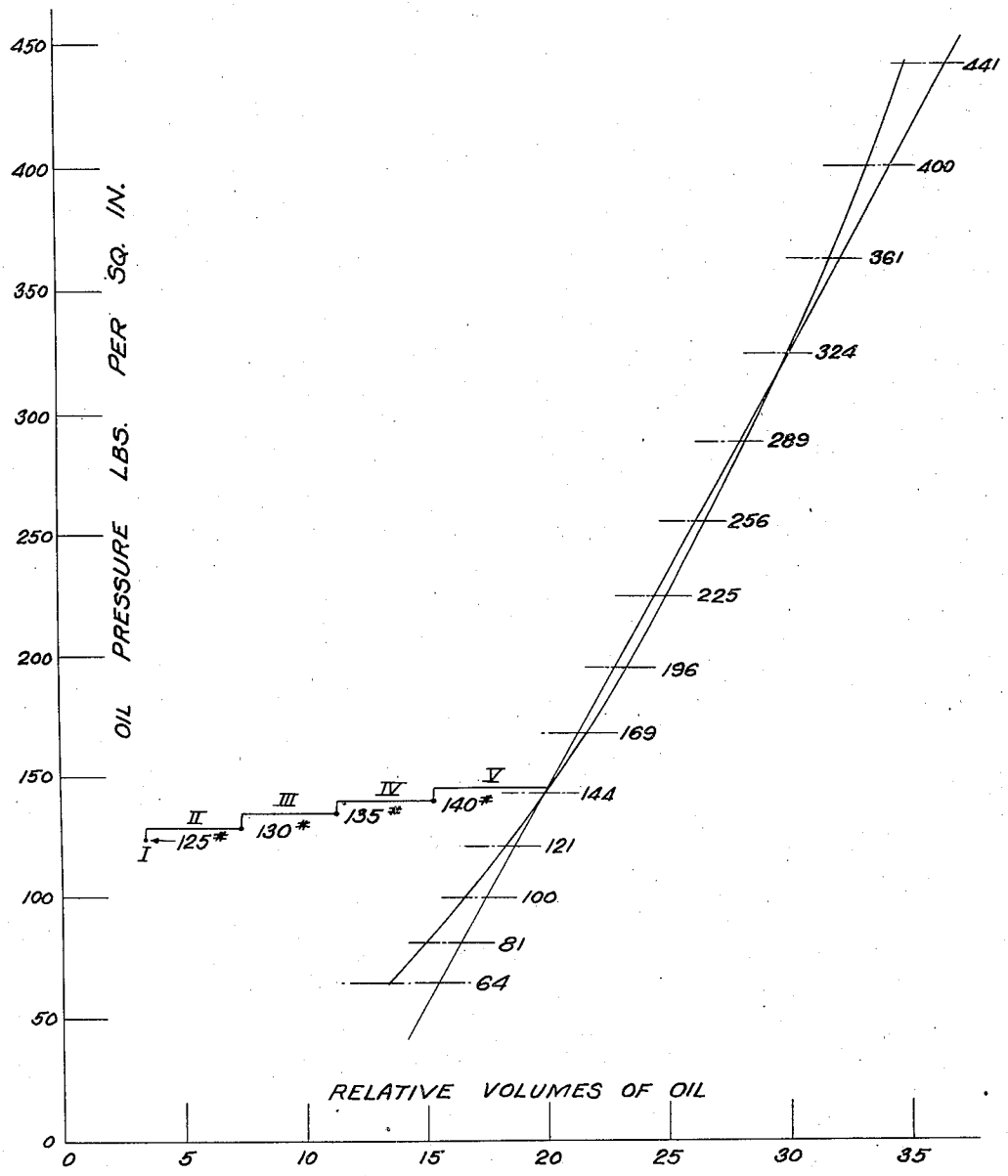


Fig. 3.

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Patented Dec. 11, 1945 2,390,806

UNITED STATES PATENT OFFICE

2,390,806

OIL BURNING SYSTEM

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Application September 11, 1942, Serial No. 457,933

6 Claims. (Cl. 158—45.5)

This invention is directed to oil burning systems and has for one of its objects the provision of an oil burning system which, while it may be controlled manually or semi-automatically, is preferably controlled entirely automatically, wherein the practical maximum fuel range is very materially increased as compared with existing automatically controlled systems.

In marine service, for example, the fuel range requirements for ships at sea approximate 8 to 1. Prior to my invention the practical maximum fuel range of oil burning systems for marine service at sea, where oil pressure and flow are varied under automatic combustion control, is about 2½ to 1. In oil burning systems with constant pressure, variable capacity oil burners, having oil recirculation systems with automatic combustion control, the practical maximum fuel range approximates 5 to 1. For the wider fuel range demand in marine service at sea, the two systems above referred to require the manual turning off and relighting of burners.

At a meeting of naval architects, ship builders and equipment manufacturers on the subject of "Combustion controls in marine service" sponsored by the American Society of Mechanical Engineers, and held in the society's building at 29 West 39th Street, New York city, on March 20, 1942, the chief engineer of the Federal Shipbuilding and Drydock Corporation pointed out that the practical operating range of conventional oil burning systems equipped with automatic combustion control fell short of marine requirements, as above pointed out, and stressed the need for increasing the range of complete automatic combustion control of oil burning systems to meet the wide range demand for steam in marine service at sea.

The present invention provides an oil burning system which meets the demands above referred to, in that I provide for a fully automatically controlled system covering a fuel demand of any practical wide range, as 8 to 1, for example, for ships at sea, with fire in all furnaces, and without changing nozzle sizes, without manually relighting burners previously turned off and without removing burners when they are turned off.

It is to be understood, of course, that my system may be manually controlled or it may be controlled semi-automatically, or as presently to be described and as preferred in marine service, it may be entirely automatically controlled.

I wish to emphasize also that my improved system is adapted for other than marine work, the marine service having been mentioned purely by way of illustration as a certificate of need.

Broadly speaking, my invention provides an oil burning system wherein I place a multiple number of oil burner nozzles, constituting a nest, at each furnace firing entrance, through which fuel and air are injected. These nozzles are so arranged and controlled that one nozzle will continuously deliver oil and remain lighted so long as the furnace is in service, and function as a torch for lighting the other nozzles as they are placed in service, the number of nozzles in service depending upon the steam demand on the boiler being fired by the furnace.

In the accompanying drawings:

Fig. 1 is a diagrammatic view of one embodiment of my invention;

Fig. 2 is a part sectional plan view of the burner nozzle nest; and

Fig. 3 is an oil capacity curve for a nest of burner nozzles.

Referring to the drawings in detail and first of all to the embodiment of my invention illustrated in Figs. 1 and 2: This embodiment of my invention comprises a nest of burner nozzles designated 2 in Fig. 2 disposed at the one firing opening 4 of a furnace. In Fig. 1 these nozzles, for clarity of description, are designated I, II, III, IV and V. These nozzles are so disposed relatively to each other and to the furnace firing opening that the spread of the diverging stream of ignited atomized oil from each nozzle approximates the diameter of the firing opening so that one of the nozzles, which is always burning so long as the furnace is in service, will function as a torch in lighting the other nozzles when steam demand requires that they be set in operation.

The nozzle nest is surrounded by a windshield 6, air for ignition passing to the nozzles through the wind-shielded zone thus provided, damper controlled torch-hole opening 8 being provided for initially lighting up. Combustion air is supplied at 10 about the exterior of the windshield 6. The method involved in the operation of the nozzles 2 is covered by my prior Patent No. 2,206,553, dated July 2, 1940.

This oil burning system is purely illustrative and other types may be used instead of the one illustrated.

12 designates a steam main from the steam generating system and 118 a master control connected to the steam main 12 by line 120. The pipe for supplying oil to the nozzles is designated 122. This line may feed any number of nozzle nests, as will be understood, although shown as feeding but the one nest.

124 designates the oil pump motor and 126 the oil pump for delivering oil under controlled variable pressure to the line 122 from any suitable supply source 128, the usual oil strainers and oil heaters not being shown.

The master control 118 controls an oil pressure regulating valve 130 by which the oil pressure in the line 122 is varied. The oil return line from the pressure regulating valve 130 to the supply tank is designated 132.

134 designates switch mechanism which is controlled by the pressure of the oil in the oil line 122. Nozzle I of the nozzle nest is manually controlled in that it is equipped with a manually controlled oil valve 3. The reason for this is that this nozzle is always on oil so long as the equipment is in service. Nozzles II, III, IV and V, however, are equipped with solenoid operated valves 136 which are controlled by the switch 134 as will be brought out hereinafter. Purge line 32 connected to the steam main 12 is provided for purging each nozzle of the nest as the nozzles are shut off.

34 designates a blower for supplying combustion air to the nozzles. This blower is driven at variable speed depending upon the number of nozzles in operation at any instant. The switch for controlling the blower speed is the switch 134 above referred to. This switch also controls the setting of damper 36.

To produce efficient combustion, approximately 125 pounds minimum oil pressure is required to effect good atomization of fuel oil, which must be preheated to increase its fluidity to approximately 150 seconds Saybolt Universal. Oil pressures substantially less than 125 pounds produce inefficient combustion primarily due to inefficient atomization.

The relative capacity of the orifice of a pressure-atomizing nozzle varies directly as a function of the square root of the oil pressure, so that as the oil pressure range increases, the oil capacity curve increases its divergence from a straight line. Functioning over a limited oil pressure range with automatic combustion control, wherein the combustion air volumes approximate a straight-line-increase in air volume with respect to a straight-line-increase in oil volume, is important for producing efficient combustion. The deviation of an oil nozzle capacity curve from a straight line is illustrated in Fig. 3, which also shows a limited oil pressure range wherein the curve of the nozzle-oil-capacity range approximates a straight line. This pressure range, as shown in Fig. 3, extends from 125 pounds to 350 pounds and for best results I operate within this oil pressure range.

In Fig. 1 I have shown all parts in the positions occupied when the equipment is simply running on nozzle I which means, of course, that the solenoid operated valves 136 for nozzles II, III, IV and V are closed. The damper 36 too is in closed position, this position of the damper, however, allowing air to flow past the damper in volume required for the operation of nozzle I with the blower 34 running at its slowest speed.

The pressure of the oil in the oil line 122 may be 125 pounds and the steam pressure in the main 12 255 pounds, for example. Upon the demand for more steam than is being generated by nozzle I there will be a drop in the pressure in the steam line 12 and the master control 118, which is connected directly to the steam line, functions to operate the pressure control valve 130 to increase the oil pressure in the line 122.

When this oil pressure has built up to 130 pounds, for example, during which time the steam pressure in the main 12 has dropped for example one pound, the movable contact 138 of the switch mechanism 134 will have been moved, due to the mentioned increase in oil pressure, this switch mechanism 134 being connected by the line 140 with the oil line 122, into position to engage fixed contact 142. This contact controls the circuit of the solenoid of the valve 136 of nozzle II to open this valve and this nozzle, which will be ignited by nozzle I, will be put in service at 130 pounds oil pressure.

At this same time the movable contact 144 of the switch 134 will have been moved clockwise to engage fixed contact 146 to short circuit resistance 148 in the circuit of the motor for the blower 34 so that the speed of the latter will be increased thereby to increase the pressure and volume of combustion air flowing past the damper 36 to satisfy combustion of oil from nozzles I and II.

As steam demand continues to increase the steam pressure drops and the same cycle of operation, as above described, is repeated successively with respect to nozzles III, IV and V at, for example, each one pound drop in steam pressure and each five pound increase in oil pressure until the oil pressure has been increased to 145 pounds and all five nozzles are in operation.

Up to 145 pounds of oil pressure the speed of the blower 34 increased on each five pounds rise in oil pressure in the line 122 thereby to supply sufficient combustion air to the nozzles without altering the setting of the damper 36. Should the demand for steam continue to increase so as to exceed the steam now being generated the resultant drop in pressure in the steam line will cause the control 118 to function further to increase the oil pressure in the line 122 until this pressure has been built up to 325 pounds. From the time the oil pressure begins to increase above 145 pounds the damper 36 gradually opens in step with the increased demand for combustion air until at 325 pounds the damper stands fully open.

Similar methods to that described of control of the combustion air can be used should the blower be driven by steam instead of electricity simply by regulating the steam valve on continued increase in steam demand.

All five nozzles are now in operation. The oil pressure in the line 122 is 325 pounds, the damper 36 is fully open, the blower 34 is running at maximum speed and the pressure from the steam line 12 has dropped to say 250 pounds. The system, therefore, is now operating at maximum capacity.

On a decrease in the steam demand the above described cycle is reversed, the nozzles being separately shut off in the order V, IV, III and II at 145, 140, 135 and 130 pounds oil pressure due to the successive opening of the circuits which close the oil valves 136. The air damper 36, it will be appreciated, gradually moves through to its initially closed position and the air blower 34 then gradually decreases in speed. The pressure in the steam line 12 gradually rises until with only nozzle I in operation and the oil pressure at 125 pounds the pressure in this line will have risen to its original pressure of 255 pounds.

As previously pointed out, the steam line 32 from the steam main 12 is connected to each nozzle valve 32 and as each valve operates to shut off its oil flow it at the same time opens the line 32 to admit steam to the nozzle to purge the same of residual oil. When the equipment is entirely closed down, that is, when the hand valve 3 for the nozzle I is closed, a connection is opened to the steam line 32 to purge this nozzle also.

It will be seen, therefore, from the foregoing that the system illustrated in Fig. 1 provides for automatically maintaining a steam pressure ranging from, for example, 255 pounds for low steam demand to 250 pounds for capacity steam demand upon the system.

I want it distinctly understood that the values specifically referred to with respect to steam and oil pressures are illustrative and not limitative. Obviously the system may be so designed as to depart from these values without, however, departing from the spirit and scope of my invention.

Fig. 3 as an example shows the relative capacities of each nozzle and nest of fuel nozzles at oil pressures varying over a range from 125 to 325 pounds per square inch as follows:

Relative capacities of single nozzle and nest of five nozzles

	Pounds oil pressure					
	325	145	140	135	130	125
Nozzle:						
V	6	4	Off	Off	Off	Off
IV	6	4	3.92	Off	Off	Off
III	6	4	3.92	3.86	Off	Off
II	6	4	3.92	3.86	3.80	Off
I (torch)	6	4	3.92	3.86	3.80	3.74
Relative capacity	30	20	15.68	11.58	7.60	3.74
Capacity ratio	8.0	5.35	4.2	3.1	2.0	1.0

It will be seen from the foregoing that my invention provides for a fuel range of 8 to 1 in this example.

The relative nozzle capacities in the above table can be used for determining exact oil capacities of the nozzles. For example, a ship with two boilers burns 360 barrels per 24 hours (full speed) at sea. With one nest of five nozzles for each boiler, the nozzle capacity per hour at 325 pounds oil pressure will be

$$\frac{360}{2\times 24\times 5}=1.5$$

barrels/hr. and at 336 pounds of oil per barrel is approximately 500 pounds of oil per hour per nozzle.

As above pointed out, it is to be understood that in practice the furnace may have several firing openings in which event I would provide a nest of nozzles at each opening. I have elected to show but a single furnace firing opening for simplicity of illustration. It is to be understood, also, that an installation may include several furnaces. However, whether an installation includes one or several furnaces and one or several furnace firing openings, it is to be understood that there is a nest of nozzles at each furnace firing opening and that the nozzles are so disposed relatively that one nozzle of each nest will function as a torch for lighting the others.

It is to be understood also that while so far as an 8 to 1 fuel range is concerned, this or any other desired range can be obtained whether the nozzles are controlled manually, semi-automatically, or automatically. For my purpose full automatic control is preferred.

It is to be understood also that the various controlling devices herein described may be substituted by other types within the purview of my invention and that various other changes may be made in the details of construction and arrangement of parts herein illustrated and described without departing from the spirit and scope of my invention.

What I claim is:

1. An oil burning system comprising a plurality or nest of oil burner nozzles at a firing opening of a furnace, an electrically operated oil valve for each of said nozzles, with one exception, oil pressure operated switch mechanism for controlling said valves, and an oil pressure valve controlled by the steam pressure generated by the furnace for controlling said switch mechanism.

2. An oil burning system comprising in combination a plurality or nest of oil burner nozzles at a firing opening of a furnace, a blower for supplying combustion air to the nozzles, switch mechanism for varying the speed of said blower, thereby to vary the combustion air delivered by said blower, and a damper in the air stream connected to said switch mechanism, said damper opening after the switch mechanism for the blower has been actuated to maximum blower speed.

3. An oil burning system comprising a plurality or nest of pressure atomizing nozzles at a firing opening of a furnace, an oil line common to all of said nozzles for supplying oil under pressure to the nozzles, a pressure regulating valve in the said oil line controlled by the steam pressure generated by the furnace for varying the oil pressure in the line, an electrically operated valve for each of said nozzles, and a switch controlled by said pressure regulating valve for controlling said electrically operated valves to effect the successive turning on and turning off of some of said nozzles with variations in the steam pressure generated by the furnace.

4. An oil burning system comprising in combination a plurality or nest of pressure atomizing nozzles at a firing opening of a furnace, means for supplying oil under variable pressure to said nozzles, an electrically operated oil valve for each of said nozzles, and a switch controlled by the said varying oil pressure for controlling said valves for effecting their successive opening and closing.

5. An oil burning system comprising a plurality or nest of oil burner nozzles at one or more firing openings of a furnace, an electrically operated oil valve for each of said nozzles, with one exception, means for supplying oil under pressure to said nozzles, an oil pressure valve controlled by the steam pressure generated by the furnace, for controlling the pressure of said oil, oil pressure operated switch mechanism for controlling said electrically operated valves, said switch mechanism being controlled by said oil pressure valve.

6. An oil burning system comprising in combination a plurality or nest of pressure atomizing oil burner nozzles at a firing opening of a furnace, means for supplying oil under pressure to said nozzles, an electrically operated oil valve for each of said nozzles, oil-pressure operated variable setting switch mechanism for said valves, an oil pressure valve for varying the pressure of the oil to vary the setting of said switch mechanism, and a connection from the steam line of the furnace to said oil pressure valve to vary the setting of the same and the setting of said switch mechanism to vary the operation of said electrically operated valves in accordance with variations in the steam pressure.

THEODORE NAGEL.