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OIL BURNING EQUIPMENT AND CONTROLLING MECHANISM THEREFOR

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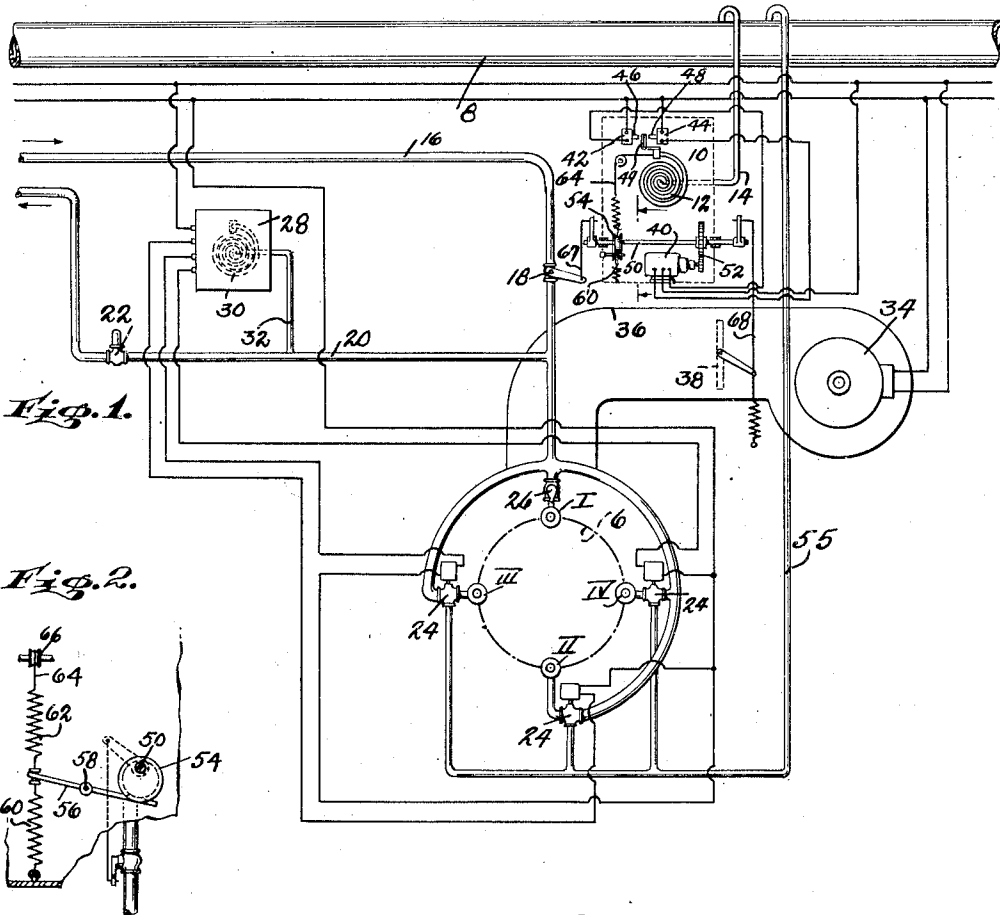
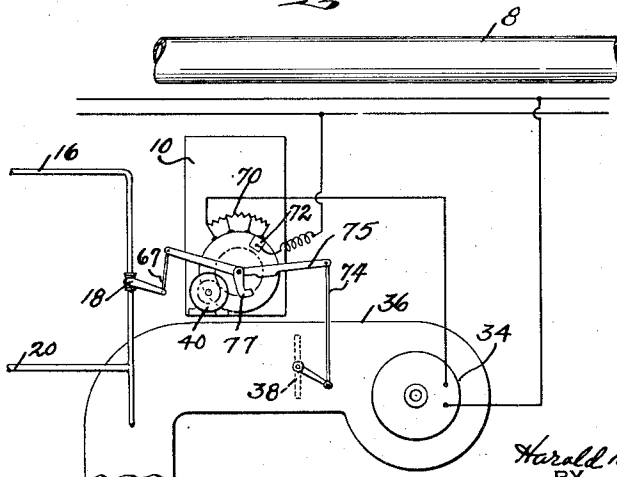


Fig. 3.



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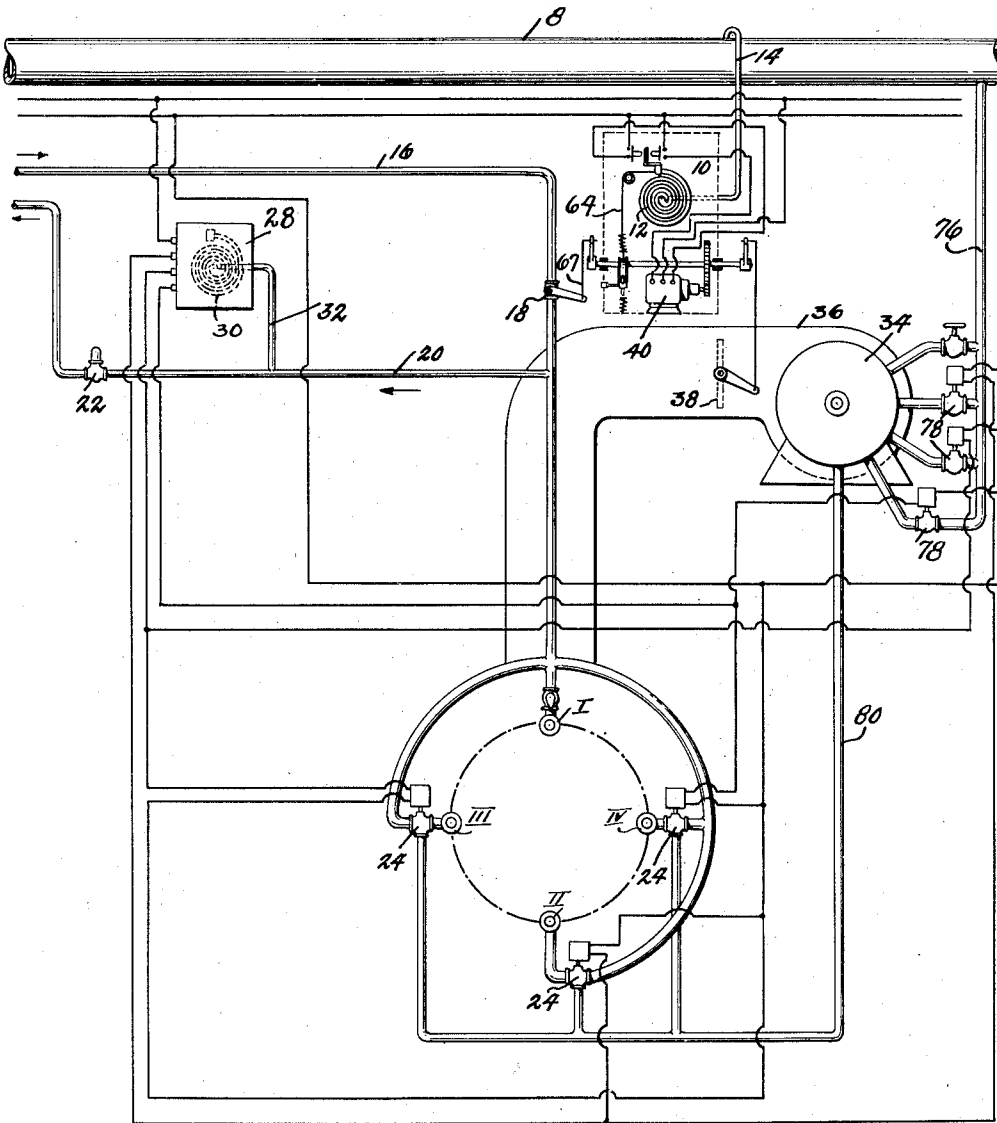
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*Fig. 4.*



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# UNITED STATES PATENT OFFICE

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## OIL BURNING EQUIPMENT AND CONTROLLING MECHANISM THEREFOR

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6 Claims. (Cl. 236—8)

This invention relates to an improvement in oil burning equipment and combustion controlling mechanism therefor, and has for one of its objects the provision of such equipment wherein combustion control is entirely automatic, and the practical maximum fuel range is very materially increased as compared with existing systems.

Although my invention is useful in many fields, it is particularly useful in marine service where the fuel range requirements for ships at sea approximate 8 to 1. Up to now the practical maximum fuel range of oil burning systems for marine service at sea is about  $2\frac{1}{2}$  to 1 where oil pressure and flow are varied under automatic combustion control. In the same type of service employing constant oil pressure, variable capacity oil burners, having oil recirculation systems with automatic combustion control, the practical maximum fuel range approximates 5 to 1.

The present invention provides oil burning equipment in which combustion control is entirely automatic and covers a fuel demand of any practical wide range, as 8 to 1, for example, or a wider range, for ships at sea, with fire in all furnaces, my equipment operating without the necessity of changing nozzle sizes without the necessity of manually relighting nozzles previously turned off, and without the necessity of removing nozzles when they are turned off.

Commercially my equipment may embody a plurality or nest of atomizing nozzles at each furnace firing opening. One of the nozzles of each nest will continuously deliver oil and remain lighted so long as the furnace is in operation, this nozzle functioning as a torch for lighting each of the other atomizing nozzles when turned on oil.

Several embodiments of my invention have been illustrated in the accompanying drawings.

Fig. 1 is a diagrammatic showing of one embodiment of my invention wherein the automatic combustion control system embodies a constant speed blower for supplying combustion air and an automatically regulated or controlled damper;

Fig. 2 is a detail of the master control;

Fig. 3 is a fragmentary view of part of a system similar to the showing in Fig. 1, but wherein the blower speed is variable and the damper is fixed in position until all nozzles are placed in service; and

Fig. 4 is a view similar to Fig. 1 wherein the blower is steam turbine driven.

Referring to the drawings in detail and first of all to the embodiment of my invention illustrated in Figs. 1 and 2: It will be seen from these views

that I have provided a nest of four pressure atomizing oil nozzles I, II, III and IV at the firing opening 6 of a furnace.

The number of nozzles composing a nest as well as the number of furnace firing openings may be varied as will be understood, only four nozzles and one firing opening having been illustrated, however, for the sake of simplicity and clarity of description.

Nozzle I of the burner nest is always lighted so long as the furnace is in operation, and the relative disposition of the several nozzles composing the nest is such that this nozzle functions as a torch to light the nozzles II, III and IV when steam demands require that they be placed in service.

8 designates a steam main from the steam generating system, and 10 a master control comprising pressure coil 12 closed at its free outer end. The inner end of this pressure coil is connected to the steam main 8 by pipe 14. This master control in its low capacity position supplies sufficient oil feed and combustion air for the minimum requirements of nozzle I, and in its maximum capacity position supplies sufficient oil feed and combustion air for maximum requirements of all four nozzles. The line for supplying oil to the four nozzles I, II, III and IV is designated 16. This line is equipped with an oil regulating valve 18 which is controlled by the master control 10, as will be explained later. The oil return line is designated 20 and is equipped with oil relief valve 22.

Each of the nozzles II, III and IV is equipped with an oil valve 24 which is solenoid operated. Nozzle I is equipped with manually operated oil valve 26. Nozzle I is the first nozzle to be operated and remains on fire so long as the furnace is in operation.

28 designates a switch comparable in construction to the master control 10 in that it comprises a pressure tube 30, the inner end of which is connected to oil return line 20 by pipe 32.

Blower 34, shown in Fig. 1, supplies combustion air for the four nozzles, and is driven at constant speed by an electric motor and when in operation delivers air to the nozzles through a windbox 36.

38 designates an air damper the setting of which varies as will be brought out presently to vary the quantity of air flowing to the nozzles in accordance with the number of nozzles in operation at any instant to maintain a constant oil-air ratio.

Reverting to the master control 10: This con-

trol comprises a reversible electric motor 40. The contacts 42 and 44 for the two circuits of this motor are adapted to be closed by plungers 46 and 48, respectively, actuated by striker 49 which is attached to the free end of the pressure coil 12.

Mounted above the motor 40 is jack shaft 50 geared to the motor by reduction gear train 52. Mounted on the jack shaft 50 is cam 54 which cooperates with a follower bar or rod 56 pivoted intermediate its ends as shown at 58. To the free end of the follower bar or rod 56 I connect two springs 60 and 62, the lower end of the spring 60 being anchored, while the upper end of the spring 62 is connected by cable 64, which moves over idler roller 66, to the free end of the pressure tube 12. The function of this master control is to start the motor in one direction or the other, depending upon a few ounces rise or fall of steam pressure in the pressure tube 12, upon increase or decrease in steam demand, thereby, through various instrumentalities which will be later referred to, automatically increasing or decreasing the number of nozzles in operation, and to open the motor circuit when the steam being generated meets the steam demand. It will be apparent from an inspection of the drawings that upon an increase or decrease of steam pressure in the system the position of the end of the pressure tube 12 is altered to close contacts 42 or 44, as the case may be. As the jack shaft 50 is rotated due to this operation of the motor to create a new positioning of the various controls of the system, there is a change in the relative tension of the springs 60 and 62 through pivoting of the follower rod 56, and when the forces of steam pressure and spring tension have become balanced the motor circuit automatically opens and jack shaft movement stops. Thus it will be seen the master control operates in a series of steps for a given pressure increment above or below the normal steam pressure and each step produces progressively a substantially uniform increase or decrease of oil and air flow to the burner nozzles until steam pressure reaches normalcy. The advantage of readjusting oil and air conditions in small increments rather than in larger ones tending to "balance out" the steam pressure resides in the fact that steam pressure will not increase or decrease too rapidly so that "hunting" will not occur, and danger of overrunning of the motor 40 with wide pressure variations is avoided.

The oil regulating valve 18 is actuated by linkage system 67 actuated by jack shaft 50, while the damper 38 is actuated from the same shaft through linkage system 68.

As above pointed out, my equipment is so constructed and arranged as to control the operation of the nozzles II, III and IV in accordance with the steam demand on the system, and in this connection the setting of the oil regulating valve 18 is varied automatically dependent upon the number of nozzles in operation, while the damper 38 is automatically varied in its setting dependent upon the number of nozzles in operation.

The steam pressure in the header 8 is maintained constant throughout the range of the equipment. Constant pressure within my meaning is within five pounds either way from a given pressure. The controlling apparatus is motivated by as little as a four ounce change in steam pressure, but it is understood, of course, that it is the ability of the boiler to respond to load demands which determines the degree of con-

stancy of steam pressure. For this reason I have defined constant steam pressure as meaning, for example, five pounds variation.

Coming now to the operation of my equipment: As above pointed out, nozzle I is always on when the equipment is in operation, and in the drawings I have shown the parts in such position. Under these conditions the master control is in its minimum or lowest capacity position, so that sufficient oil feed and combustion air are supplied for the minimum requirements of nozzle I.

Assuming now that there is an increased demand for steam. This means that there will be a drop in pressure of a few ounces in the pressure tube 12 of the master control, so that the same will actuate the plunger 48 to cause a bridging of the contacts 44 thereby to close the circuit of the motor 40. The starting up of the motor 40 will, through reduction gearing 52 and jack shaft 50, actuate the linkage 67 to increase the opening of the oil valve 18, so that the oil pressure in the oil feed line to the burners and in the oil return line 20 will increase, which increase will actuate the switch 28 to close the circuit to the solenoid for the oil valve 24 of nozzle II to open this valve to oil and close the purge line 55 to this nozzle. At the same time, through the linkage 68 which is also connected to jack shaft 50 the damper 38 will be shifted to permit the passage of an increased amount of combustion air passing through the windbox. Nozzle II will now be lighted by nozzle I and both nozzles will then be in operation. Similar operations occur for placing nozzles III and IV in operation. All four nozzles are now on and burning oil at or near their minimum oil pressure. On continuing demand for steam the master control 18 increases the oil feed through wider opening of valve 18 and increases the volume of combustion air correspondingly through further opening of the damper 38 until the nozzles are operating at full capacity.

On a decrease in steam demand the cycle of operation is reversed. The pressure tube 12 operates to close contacts 42, to close the reverse circuit of the motor 40 so as to move the oil valve 18 and damper 38 and switch 28 toward initial position, so that the nozzles will go off in IV, III, II order. As each oil valve 24 is closed the purge line 55 to that particular nozzle is opened so as to purge oil from the nozzle.

It will be understood, of course, as above explained, that the operation of the motor 40 is in step with the steam demand, the motor rotating in one direction on increase in steam demand, and in the opposite direction on decrease in steam demand, and that when the proper amount of steam is being generated to meet the steam demand the motor circuit is automatically opened and the motor comes to rest, the parts actuated thereby remaining as they were when the motor circuit was opened. It will be understood, too, that at all times the number of nozzles in operation depends on the oil pressure in the line to the nozzles, which pressure will be the same as that in the return line 20, and that the quantity of oil and air supplied at a fixed oil-air ratio is dependent upon the demand for steam.

In the embodiment of my invention as illustrated in Fig. 3 I provide equipment similar to that above described, but in this instance the speed of the blower 34 is varied, while the air damper 38 remains in initial position until all four nozzles are on at minimum oil pressure, whereupon if the demand for increased steam

continues the damper 38 will be moved gradually to full open position as the oil pressure on all nozzles is gradually increased, thereby maintaining the oil-air ratio substantially constant. The master control 10 in this embodiment of my invention includes resistance units 70 and movable contact 72 in the circuit of the motor for the blower 34, the movable contact being driven by the motor 40 as will be understood. As the master control 10 functions as described in connection with Fig. 1 successively to start up and stop the motor 40 to actuate the various controls, contact 72 will be actuated to cut the resistance units 70 in or out to vary the speed of the motor for the blower 34.

The jack shaft of the master control, which is linked to the oil feed valve 18 by linkage 67 as above described, is also connected to the damper 38 by linkage 74. The link 75 from 74 to the jack shaft is loose on the latter so that the damper 38 remains in the dotted line position of Fig. 3 until all four burners are on, the link 75 thereafter being actuated by a dog 77 which rotates with jack shaft 50 to actuate the link 75 and move the damper to full open position.

In the embodiment of my invention as illustrated in Fig. 4 the blower 34 is driven by a steam turbine receiving its steam by way of line 76 connected to header 8, the steam lines to the turbine with one exception, namely the line corresponding to nozzle I, being provided with electric operated valves 78 which are opened and closed as each nozzle is turned on or off. It will be seen from the drawings that the circuits for the turbine valves are connected in parallel to the circuits for the electrically operated valves 24 of the nozzles. As a consequence of this construction the steam admitted to the blower turbine depends upon the nozzles in operation, with a variation in the blower speed dependent upon the number of nozzles in operation. Nozzles II, III and IV are steam purged as they are shut off, by steam from line 80 connected to the low pressure side of the turbine for the blower 34.

It will be seen from all of the foregoing that I have provided an oil burning system wherein I provide a plurality or nest of oil atomizing nozzles at each firing opening of a furnace, one of these nozzles functioning as a torch to light the others. It will be seen also that the nozzles are fully automatically controlled, the controlling mechanism being responsive to but a few ounces variation in steam pressure, so that the steam pressure on the line is maintained substantially constant within the steaming capacity of the installation regardless of the steam demand on the system.

It will be seen, furthermore, that in Fig. 1 I employ a constant speed blower and variable damper for supplying and controlling the combustion air; in Fig. 3 the blower is of the variable speed type, the damper remaining in fixed position until all nozzles are in operation; while in Fig. 4 I employ a steam turbine for driving the blower and vary the setting of the damper.

It is to be understood that changes may be made in the details of construction and arrangement of parts herein illustrated and described within the purview of my invention.

What I claim is:

1. An oil fired system for generating steam, said system comprising in combination a plurality of pressure atomizing nozzles at the firing opening of a furnace, an electrically operated

valve for each nozzle, a master control governed by the pressure of the steam being generated for controlling said valves to vary the number of nozzles in operation, a steam-turbine-driven variable speed blower for supplying combustion air to said nozzles, a plurality of electrically operated valves for controlling the admission of steam to the turbine thereby to vary its speed, said master control also governing said turbine valves, whereby the number of nozzles in operation and the speed of said turbine are varied in accordance with the steam demand on the system.

2. An oil fired system for generating steam, said system comprising in combination a plurality of pressure atomizing nozzles at the firing opening of a furnace, an oil valve for each of said nozzles, all but one of said valves being electrically operated, a steam turbine driven blower for supplying combustion air to said nozzles, a plurality of electrically operated valves for controlling the admission of steam to the turbine thereby to vary the speed thereof, switch mechanism for the simultaneous control of the nozzle valves and turbine valves, whereby as each nozzle valve is operated a corresponding turbine valve will be operated, and a master control governed by the pressure of the steam being generated for controlling said switch mechanism, whereby the nozzles and turbine driven air blower will be driven in accordance with the demand for steam on the system and the steam pressure will be maintained substantially constant.

3. An oil fired system for generating steam, comprising in combination a plurality of pressure atomizing nozzles at the firing opening of a furnace, a manually operable oil valve for one of said nozzles, an electrically operated oil valve for each of the remaining nozzles, an air blower and a damper common to all of said nozzles, an oil supply line for supplying oil to the nozzles, an oil flow regulating valve in said oil supply line, an electrically operating master control linked to said oil flow regulating valve and to said damper, electrical contact mechanism for the master control operated by the pressure of the steam being generated to vary the setting of said oil flow regulating valve and said damper, switch mechanism for said electrically operated nozzle valves for varying the number of nozzles in operation, an oil return line connected to the said oil supply line at the discharge side of said oil flow regulating valve, said switch mechanism being connected to said oil return line so as to operate in accordance with the setting of said oil flow regulating valve, whereby variations in the demand for steam will effect variations in the setting of said oil flow regulating valve and damper, thereby to vary the number of nozzles in operation.

4. An oil fired system for generating steam, comprising in combination a plurality of pressure atomizing nozzles at the firing opening of a furnace, an oil valve for each of said nozzles, switch mechanism for some of said valves, an oil supply line for supplying oil to the nozzles, an oil flow regulating valve in said oil supply line, a master control comprising an electric motor connected to said oil flow regulating valve, contact mechanism for said motor actuated by the pressure of the steam being generated, thereby to vary the setting of the said oil flow regulating valve in accordance with steam demand on the system, an oil return line connected to the oil supply line at the discharge side of the said oil

flow regulating valve, the said switch mechanism for the nozzles being connected to said oil return line to be varied in its setting by variations in the setting of the oil flow regulating valve, thereby to vary the number of nozzles in operation with variations in the steam demand on the system to maintain substantially constant steam pressure.

5. An oil fired system for generating steam, comprising in combination a plurality of pressure atomizing nozzles at the firing opening of a furnace, an electrically operated oil valve for each of said nozzles, an oil supply line for said nozzles, an oil flow regulating valve in said line, a reversible electric motor connected to said oil flow regulating valve, switch mechanism for said motor under the direct control of the pressure of the steam generated to vary the setting of the oil flow regulating valve, an oil return line connected to the oil supply line at the discharge side of the said oil flow regulating valve, and switch mechanism for said electrically operated nozzle valves connected to said oil return line, whereby variations in the setting of said oil flow regulating valve due to operation of said electric motor will vary the number of nozzles in operation.

6. An oil fired system for generating steam comprising in combination a plurality of pressure atomizing nozzles at the firing opening of a furnace, a blower for supplying air to support combustion at said nozzles, a variable setting damper for varying the quantity of air flowing to the nozzles, an oil supply line for supplying oil to said nozzles, an oil regulating valve controlling the pressure of the oil flowing to said nozzles through said line, an electrically operated oil valve for each nozzle, an oil return line connected to said oil supply line, oil pressure operated switch mechanism for said oil valves connected to said oil return line and under control of the oil pressure in the return line, as determined by the setting of the oil regulating valve for opening the oil valve of one or more nozzles, and a master control including an electric motor connected to said oil regulating valve and to said air damper and under the direct control of the pressure of the steam being generated, whereby under varying steam demands on the system said nozzles will be regulated and said air damper will be shifted to maintain the steam pressure substantially constant.

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