May 4, 1948. J. A. LOGAN 2,441,025

SMOKE RESPONSIVE CONTROL FOR OIL BURNERS

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Fig. 1.

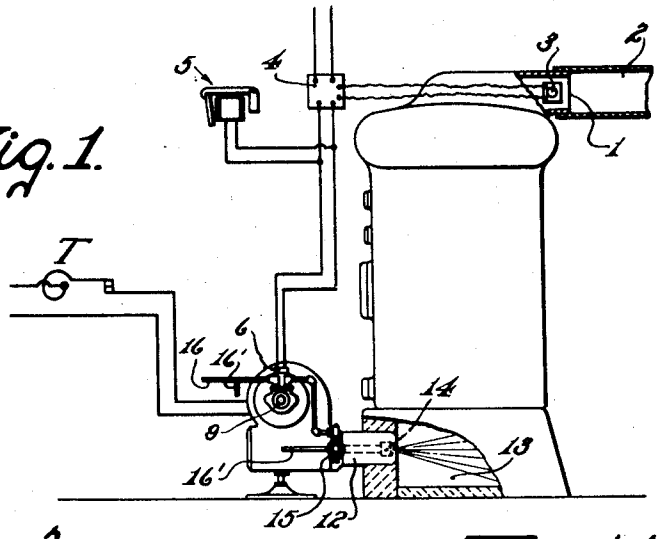



Fig. 3.

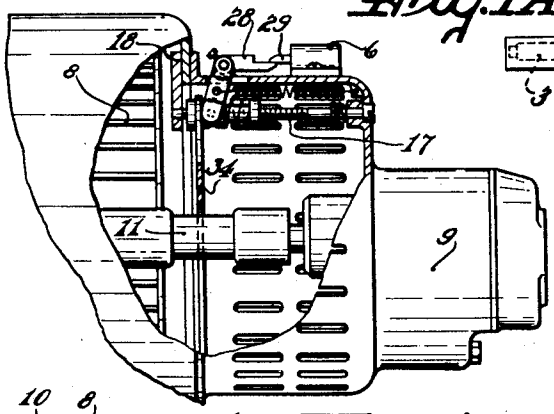



Fig. 1A.

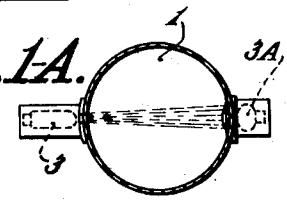



Fig. 2.

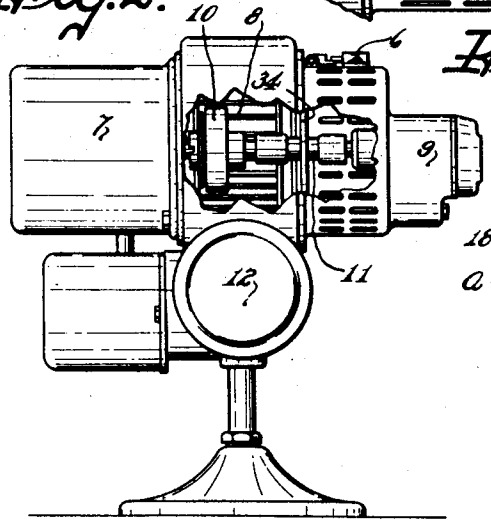
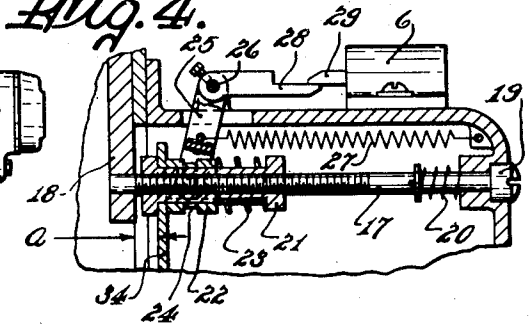



Fig. 4.




INVENTOR
JOSEPH A. LOGAN

BY Chapin & Neal
ATTORNEYS

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## SMOKE RESPONSIVE CONTROL FOR OIL BURNERS

Joseph A. Logan, Hadley, Mass., assignor to Gilbert & Barker Manufacturing Company, West Springfield, Mass., a corporation of Massachusetts

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6 Claims. (Cl. 158—28)

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This invention relates to improvements in automatic oil burner controls. Its purpose is to provide a new control system particularly useful in automatic oil pressure atomizing burners of the domestic and analogous types.

Some domestic burners operate to automatically change the air-oil ratio between starting and running periods and again between running and stopping periods of each cycle. The practice avoids smoking while the burner is starting and stopping by providing plenty of air. As these burners enter into their full speed running periods, the air-oil ratio is changed and is maintained at the changed ratio so as to burn the oil at high efficiency during the full speed periods, by using less air in the ratio. Such practice is carried out for example by the domestic burner disclosed in my prior Patent No. 1,985,934, issued January 1, 1935.

The new control system adds to the advantages of the prior art disclosure a way of automatically increasing the air in the air-oil ratio in the event of the burners smoking during the running period. This way of operating with an air increase is for an emergency. The air-oil ratio in efficient running periods, is normally quite close to the smoking point. For example, in adjusting the ratio for efficient burning periods, one may adjust until smoke is evident in the flame, then readjust for just enough more air to stop smoking. Then the full burning periods will be approximately efficient and without any substantial smoking. If refinements are wanted, gas analysis instruments are used to help make finer adjustments. The emergency is more likely to happen and cause smoke, the more one "tunes" the burner for the efficient running periods.

Assume that during the operation of a domestic burner, it starts to malfunction and smoke for any one or more of various reasons. For example, suppose a dirt speck gets clogged in the atomizing orifice, causes poor atomizing without decreasing the oil supply, the result is a smoky flame. Or suppose that the air supply is decreased by malfunction of the burner parts, the result in many instances will be a smoky flame. The normal automatic burner will generally continue to run with a smoky flame, with an accumulating soot deposit in the heater, resulting in building up bad conditions on account of such deposit and for other reasons. In any such emergency the use of my invention results in setting up operations to meet the emergency and until a service man is called to remove the cause of trouble.

The way to practice the invention will be disclosed by way of example shown in the accompanying drawings,

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Fig. 1 shows a heater with an oil burner and a diagrammatic layout of the control system of this invention;

Fig. 1A is a detail view or diagram of a photo-cell arrangement;

Fig. 2 shows a rear view of the burner with part of the casing cut away to indicate the transmission between motor, fan, and oil pump;

Fig. 3 is a detail view indicating the means for adjusting the air inlet to the fan; and

Fig. 4 is another detail on an enlarged scale of parts indicated in Fig. 3.

In the example the heater has a draft outlet 1 to connect to the smoke pipe 2 going to the chimney. Adjacent the outlet or in some other place in the heater where any smoke will appear, there is mounted a smoke detector 3. This may be a photo-cell or other device for a similar function. When smoke appears at the position of the photo-cell 3, it operates to cause a change in current to operate relay 4. When relay 4 operates, a drop annunciator 5 operates to signal and the relay operates to energize a solenoid 6. The solenoid operation then trips mechanism to make the desired adjustment for the burner in the emergency of its flame smoking. It is desirable to attach the photo-cell, its relay, and the circuits as parts built into the heater at the factory before installation in the home. It is desirable to build the solenoid 6 and mechanism to be described for operation under the solenoid control at the factory, as parts of the burner. This is indicated in the example of Fig. 1, except that the circuit and relay are laid out as a separate diagram. In Fig. 1A, I have indicated a photo-cell arrangement in which a light beam from lamp 3A is sent across the draft passage 1 to the sensitive cell 3. If not interrupted the beam holds the parts in normal position as a result of its passage. The smoke will interrupt the beam and result in the relay operation.

The parts in the burner assembly including the solenoid 6 will be best seen in Figs. 2, 3, and 4. The transmission between motor 7, fan 8, and pump 9 of the burner is seen in Fig. 2. It is a known form in which the motor shaft is fast to the rotor of fan 8 and to the driving element of a centrifugal clutch 10. The driven part of this clutch is connected through a flexible coupling 11 for driving the shaft of the oil pump 9. For a full discussion of this arrangement and its purpose reference is made to my aforesaid patent. It will be referred to again, but the purpose is

to have the fan 8 operate to feed air through tube 12 to combustion chamber 13, Fig. 1, whenever the motor is turning and regardless of its speed; to operate the oil pump 9 only when the fan is feeding air at substantially full fan speed and to avoid feeding and atomizing oil at nozzle 14 by not running the oil pump unless the fan feed of air is substantially at high speed.

The oil when feeding enters pump 9 from feed line 16, feeds out under pressure to automatic pressure regulating valve 15, and is atomized at nozzle 14 under constant pressure, in the usual oil burner fashion merely indicated herein. The valve 15 bypasses enough oil around the pump by conduit 16' to maintain the atomizing pressure normally constant. The atomizing nozzle has a small orifice of predetermined size which will feed a constant oil quantity to the flame within a given time when the oil is fed under constant pressure. To vary the air-oil ratio it is desirable to adjust for the quantity of air fed into the combustion chamber 13 meeting the oil at the flame. When a substantial difference is wanted in the oil feed it is usually arranged for by changing the nozzle size. The adjustment of the air factor is made with relation to one nozzle size intended to keep the oil quantity constant.

The air enters the casing, Fig. 3, through casing openings indicated at the right of an adjustable shutter or disk valve 34. This is a disk, making with the fan casing an annular air inlet *a*, Fig. 4, to the fan blades 8. The air inlet *a* is made larger or smaller when disk 34 is adjusted to the right or left respectively. Such air inlet structure for hand adjustments is old per se. This is only one of many types of air adjustments for the fan. In my structure, however, I provide for both hand and automatic adjustments as will be explained.

The threaded rod 17 at its left end, has a free bearing in flange 18 and a slotted head 19 at the outer end. Spring 20 acts as indicated to hold rod 17 in the position shown for hand rotation from head 19 without axial movement of the rod. A long spool 21 is threaded on rod 17. When the latter is turned in one and then the other direction spool 21 is moved in one or the other direction and axially. Another spool 22 is mounted to slide between the heads of spool 21. The disk 34 is carried as indicated by this second spool 22. Spring 23 holds spool 22 and disk 34 against the left hand head of spool 21. A groove 24 is engaged by opposite pins in a fork at the end of arm 25, which has fast to it a pivot pin 26 mounted in a bracket bearing. The arrangement provides part of the means to slide spool 22 to the right on spool 21 against spring 23. Another and stronger spring 27 attached to the casing at one end and to arm 25 at the other, will slide spool 22 to the right as stated, when permitted to do so. This sliding to the right is normally prevented by a finger 28 held down in the normal position shown, Fig. 4, by the axially movable plunger 29 of solenoid 6. Finger 28 is angularly adjustable, being pivoted on pin 26. After adjustment it is made fast to that pin by the set screw indicated, Fig. 4. The arm 25 and finger 28 then form a bell crank lever structure. Spring 27 is tensioned to pull this lever structure counterclockwise when solenoid 6 operates to move its plunger 29 to the right to remove the latch hold on finger 28. When that movement of arm 25 occurs, spool 22, carrying air adjusting disk 34, slides to the right on spool 21, the relatively weak spring 23 permitting spring 27 to dominate. The heads of



spool 21 provide limiting stops for the movements of spool 22 between two adjusting positions. The arm 25 should have a loose enough fit with groove 24 to prevent binding.

The function of the structure just described is first to provide means to position disk 34 at a selected one of a range of adjustments. This is done by turning rod 17. In addition to this function is the second function of automatically repositioning disk 34, from any one of its hand adjusted positions, to another position, one which will admit substantially more air to the fan to pass to the combustion chamber for changing the air-oil ratio when the solenoid 6 is operated. It operates when the burner flame makes smoke, an event detected by photo-cell 3, Fig. 1.

After the automatic control works in the event of the emergency, air is fed into the combustion chamber to avoid smoking. The adjustment for continued running with such excess air to avoid smoking is made for the purpose of continuing the heating operation until a service man can remove the cause of the burner's smoking when it runs without such excess air. When the burner is running with the emergency air supply, it has much less than its customary efficiency. The drop annunciator 5, in signalling condition, indicates this relatively inefficient running. If the burner is not serviced to correct this relatively inefficient condition a substantial quantity of oil will be wasted. The feeding of excess air is intended for the period of the emergency only. If, for example, the atomizing nozzle becomes partially plugged; the flame starts to smoke; the excess air is immediately and automatically admitted to stop the smoke; annunciator 5 is operated; the service man is called; stops the burner; clears the nozzle; starts the burner again; latches arm 28 under solenoid plunger 29; resets annunciator 5; and the efficient burner air-oil ratio is reestablished for the normal and efficient burner operation. This gives an example of a complete cycle in the use of this invention in burner management.

The invention is particularly important in the use of domestic oil burners. Improvements such as explained in my prior patent, enable a service man to adjust the air-oil ratio for high efficiency in burning the oil and do that without causing smoking in the starting and stopping periods. When such efficiency is attained in practice, the air-oil ratio adjustment is close to the smoking point for the running periods. The custom is increasing to use scientific instruments to analyze the draft gases and keep on making refined adjustments of the air-oil ratio to get the highest attainable efficiency in a given domestic burner operation. These make a substantial difference in the householders oil bill for the year in addition to giving better heating results generally. All such prior work to benefit the householder has been done largely on the assumption that once the air-oil ratio is efficiently adjusted, the burner will continue to give the efficiency expected. But that prior art work "tunes" the burner up to a point where it is particularly sensitive to adverse conditions and to malfunction when the burner is not kept "tuned up" in every respect for its expected performance. For example, consider the practice under the invention of my prior patent. The air-oil ratio is controlled to feed excess air to avoid smoking in the starting and stopping periods, to eliminate excess air to get higher efficiency in the running between starting and stopping periods. It will be clear

that if the centrifugal clutch, indicated here as element 10, should stick and not keep the oil pump out of operation in the starting and stopping periods, and not thus control the ratio automatically for the starting and stopping periods, then the close adjustment for efficient running periods would cause much more smoke in the starting and stopping periods than in the case of common practice prior to said invention. Such common earlier practice is to provide for enough excess air in the running periods to avoid smoking in the starting and stopping periods, an expensive compromise. Such excess air in the running periods is, however, available upon the burners getting slightly out of good condition. It gives a margin of air for the householder's burner to keep it going without smoking trouble to the extent excess air is available from such compromise arrangement, but this was all at the householder's oil expense in all running periods when the excess air was not needed.

One useful idea in the present invention is to retain all the advantages of efficiency in any such practice as that of my prior invention, and while retaining these provide a margin of excess air only in the emergency of the burner getting out of order enough to make the burner smoke except for the supply of this excess air. Household burners go through their cycle of starting, running, and stopping periods many times in one day and several thousands of times in one heating season. The conditions and circumstances of using household burners with only intermittent attention of service men are quite different than those of power plant oil burners. The present invention is particularly adapted to benefit the householder and other users of his type of burner.

Having disclosed my invention, I claim:

1. An oil pressure atomizing burner of the automatic type having a motor driven fan and oil pump with means to adjust the air-oil ratio for normal burning with a constant rate of oil consumption, an adjusting shutter for the fan air supply and means tending to move it automatically between a normal hand set position determining the air supply at a constant rate for the efficient air-oil ratio of full burner speed and for the circumstances of normal burner operations, to an emergency position for feeding excess air to the burner for emergency operation, a latch to normally prevent movement to such emergency position, electrical control means to release said latch, and a smoke detector device operatively connected in circuit with said control means to release the latch when smoke is detected whereby the burner can not return automatically to the condition of adjustment under which it started to smoke and personal attention is invited to remove the cause for smoking in that condition of adjustment which is normally most efficient for oil burning operations.

2. In a domestic type oil pressure atomizing burner, a room thermostat to start and stop the burner for intermittent operations in accordance with the change in the need for heat, said burner including a fan and oil pump atomizing means, a motor and transmission including a centrifugal clutch operable to automatically increase the air of the air-oil ratio of the starting and stopping periods as compared with the full speed running periods of the burner, and an emergency control means for the burner to supply it with excess air in the full speed running periods but only in the event the burner flame starts to smoke for any reason, said emergency means comprising a photo-cell responsive to smoke in the products of combustion from said burner flame, circuit means and appliances therein under the control of the photo-cell including a magnet adapted for operation when the photo-cell detects smoke in the products of combustion, shutter mechanism controlling the fan air supply and operatively connected to said magnet to be automatically opened up for the excess air supply when the magnet is operated by the photo-cell in response to smoke and arranged for the shutter mechanism to remain opened up until reset to normal position by personal attention.



3. In a domestic type oil atomizing burner, the prior art combination of a motor to be switched on and off automatically under thermostat control to start and stop the burner, a motor transmission, a centrifugal clutch therein, fan mechanism operable on the driving side and oil pump atomizing mechanism operable on the driven side of the centrifugal clutch providing automatic means to increase the air in the air-oil ratio of the starting and stopping periods as compared to that of the full running periods of operation, and emergency air control means added to said combination and operable automatically to increase the air in the air-oil ratio during full speed running operations of the burner, in the event that the burner flame starts to smoke for any reason, said emergency means comprising an electric circuit means and appliances therein including a photo-cell responsive to smoke in the products of combustion from said burner flame, a magnet under the control of the photo-cell and adapted to be operated thereby when smoke is detected in said flame, said fan mechanism having a movable shutter mechanism to vary its air supply to the burner flame and movable to increase the air supply when the magnet is operated in response to the smoke detecting action of said photo-cell, said movable shutter means including a device to hold it in position for the increased air supply until returned by hand to its normal position whereby further smoking in the burner operations may be avoided until the cause of its smoking has been corrected by a service man.

4. Oil burner apparatus of the house heating type comprising the elements of motor, encased air fan with inlet and outlet ports, oil pump, means to atomize oil at a constant rate, spark gap ignition means, hand adjustable air control shutter mechanism to precisely determine the air rate to determine the air-oil ratio for the burner flame when the burner is running at full speed with said motor driving the fan and oil pump, such elements being adapted for intermittent "on and off" burner operation under the control of a room thermostat, the combination with such elements of a photo-cell responsive to smoke in the products of combustion from said burner flame, circuit means containing the photo-cell, adapted for emergency control operation when the photo-cell detects smoke in the products of combustion, a magnet in the circuit means to be energized when smoke is detected, a latch operable by the magnet when the latter is energized, air shutter mechanism including a stored power means, tending to increase the air passage opening through the fan casing, but normally held from action by said latch, whereby in the emergency of such malfunctioning of the usual burner operation as produces smoke in the burning of the oil, a substantial supply of excess air is furnished to make a thin air-oil

ratio mixture and quickly avoid the smoke for further operation of the burner until such elements are serviced to put them in efficient running condition.

5. An oil burner apparatus of the type including a fan and casing to feed air at a predetermined rate, an oil pump and regulating means to feed oil at a predetermined rate, means to atomize the oil fed by the pump into the air fed from the fan for mixing and burning in the combustion chamber of a furnace, an electric motor, a transmission to drive the fan and pump, means connecting the fan to the transmission to always turn with the motor, a centrifugal clutch in the transmission, means connecting the pump to the driven side of the clutch to turn only when the motor and fan operate together at high speed; whereby the oil will not feed as the motor is getting up speed and coasting to a stop, hand set adjusting means to regulate the air rate through said fan casing, in combination with an automatic means to reset said adjusting means for a larger air rate in the emergency that the burner begins to smoke, said automatic means comprising a magnet, a latch operable by the magnet, a spring tending to open up said adjusting means but held by said latch to normally prevent the spring action, an electric circuit for said magnet, a photo-cell adapted to be positioned at the furnace to detect smoke from the burner operation and to control said relay and cause the latter to close the circuit containing said latch magnet for releasing of the latch and opening of the adjusting means when the burner smokes for any reason during its high running operation.



6. An oil burner of the gun type including automatic apparatus adapted to be started and stopped under thermostat control and such type as contains oil atomizing means operable for a constant rate of oil delivery while the burner is running at full speed and an air fan and casing to deliver air to mix with oil for the burner flame, means for controlling the rate of such air delivery, said means comprising a shutter adapted to regulate an air port opening for the air going through said casing to the flame, mechanism which is hand operable at any time to position and set said shutter for an air-oil ratio to burn the oil efficiently, resilient means tending to hold the shutter in its hand set position, spring mechanism tending and strong enough to move the shutter out of said hand set position into a more open position for a larger air supply in the event the flame smokes, a latch to normally prevent the action of said spring mechanism, a magnet operable to release said latch for said spring mechanism to act, a circuit means adapted to operate said magnet, and means including a photo-cell in the circuit means adapted to detect smoke from the burner flame and control the circuit means to operate the magnet and release said latch when the burner flame smokes.

JOSEPH A. LOGAN.


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