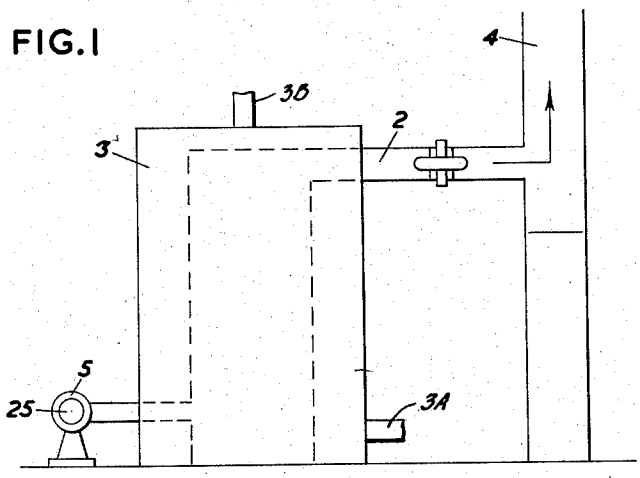
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FURNACE DRAFT CONTROLS

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FIG. 1



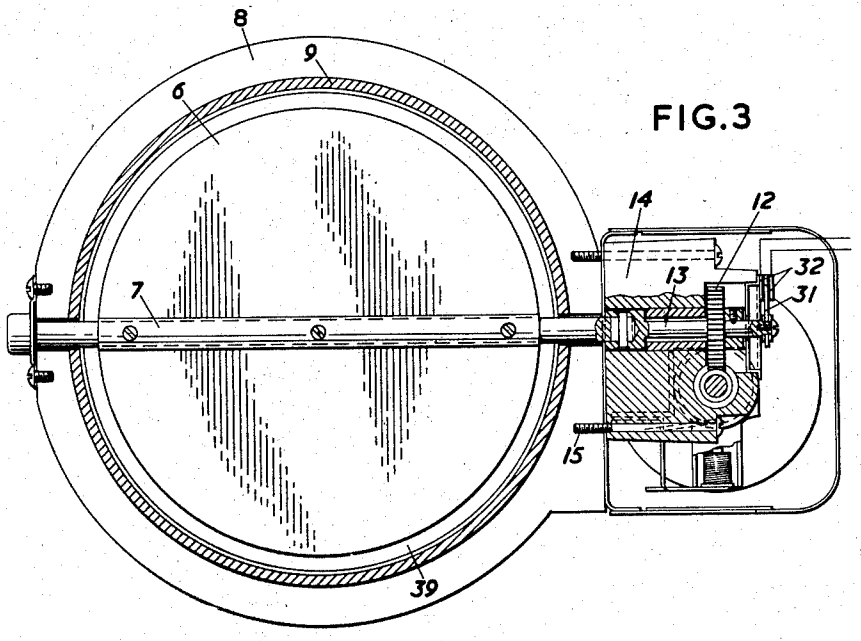




FIG. 3

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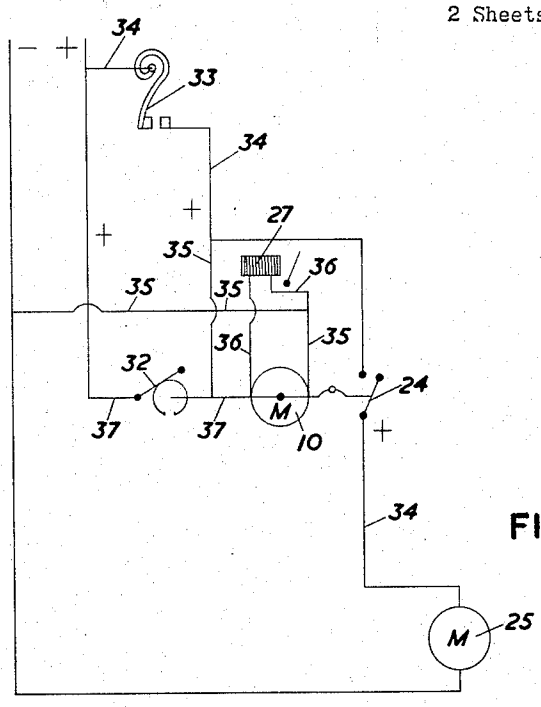



FIG. 4

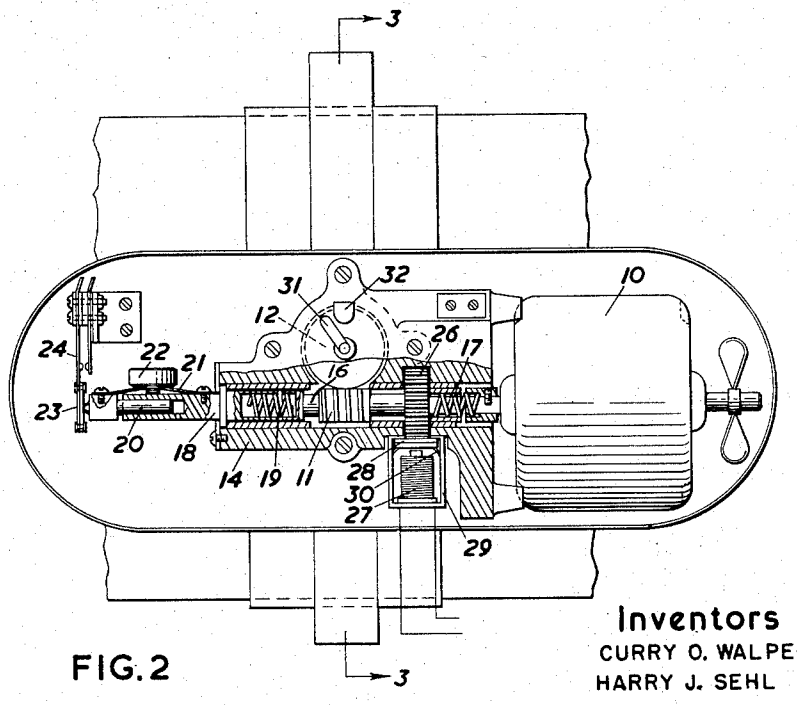



FIG. 2

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2,869,624

# FURNACE DRAFT CONTROLS

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Application March 30, 1956, Serial No. 575,049

8 Claims. (Cl. 158—1)

This is a continuation-in-part of application Serial No. 441,886, filed July 7, 1954, now abandoned.

This invention relates to improvements in combustion heat controls and is more particularly designed for use in automatic oil fired furnaces of the type wherein a combustible gaseous mixture of oil vapor and air is injected into a furnace combustion chamber which is substantially sealed against entrance of induced air under suction of the furnace draft, and the object of the invention is to provide a damper device controlling passage of the products of combustion from the combustion chamber through the smoke stack, and which is actuatably arranged to periodically and momentarily block the egress of the combustion products at a multiplicity of times per minute and whereby such products are periodically and momentarily confined within the combustion chamber during periods when the furnace is alight; the successive momentary periods of confinement of the products of combustion against flow into the furnace smoke stack causing the flame of the burning gases in each period of confinement to expand into close proximity to the walls of the combustion chamber and whereby a large portion of the heat from the burning gases which would otherwise pass into the smoke stack is transferred through the walls of the combustion chamber into its surrounding air or water jacket, the periods of confinement being of insufficient duration to interrupt the continuous flow of combustible gaseous mixture into the combustion chamber.

With the foregoing and other objects in view as shall appear, the invention consists of a furnace heat control constructed and arranged all as hereinafter more particularly described and illustrated in the accompanying drawings in which:

Figure 1 is a diagrammatic view of a furnace wherein the draft control is positioned within the venting tube extending from the furnance to the smoke stack.

Figure 2 is an illustration, partly in section, of the electric motor and gear reduction drive for actuating the damper.

Figure 3 is a cross-sectional view through the assembly shown in Figure 2, being taken through the line 3—3, Figure 2, and

Figure 4 illustrates a wiring circuit for synchronizing the operation of the furnace burner and draft control assembly.

Like characters of reference indicate corresponding parts in the several views of the drawings.

The draft control is designed to be readily installed in any standard hot water or hot air domestic type furnace, although, of course, the invention is not restricted to this particular use or to type of fuel, and to this end the actuating device is designed to be inserted within the standard venting tube 2 extending from the combustion chamber of a furnace 3 to the smoke stack 4. The illustration shows an oil burning hot water furnace having the usual oil injection assembly 5 positioned exteriorly



thereof, the furnace being fitted with the usual water circulating inlet and outlet pipes 3A and 3B.

The broad concept of the invention is to insert a suitable valve or damper element in the venting tube and to actuate the damper whereby it periodically moves into a substantially closed position to momentarily confine the products of combustion to the combustion chamber, and while the damper arrangement may be produced in a variety of designs, we have found the swingable butterfly type of damper plate to be the most simple and positive in operation, and for this reason have shown this arrangement in the drawings.

A swingable damper plate is mounted upon a journalled spindle 7 extending horizontally across a collar 8 upon the side of which the mechanism for rotating the spindle and damper plate is mounted. The collar 8 is formed with a pair of side sleeves 9 which receive the ends of two sections of the venting tube 2.

The damper plate 6 is rotated by an electric motor 10 connected to the spindle 7 by a reduction gear. The reduction gear consists of a worm 11 rotated by the motor shaft and meshing with a worm wheel 12 carried upon a spindle 13 in alignment with the damper spindle 7 and coupled thereto. The worm and worm wheel assembly is contained within a suitable housing 14 secured to the collar 8 by studs 15.

The worm 11 is carried upon a spindle 16, the spindle at one end being connected to the shaft of the motor by a spiral spring coupling 17 and at the other end to a spindle 18 by a second spiral spring coupling 19. The spindle 18 projects from the housing 14 for the purpose of supporting a governor actuated by the rotative speed of the spindle. The governor comprises a plunger 20 slidably contained within a bore in the outer end of the spindle 18 and a governor weight carrying flat spring 21 secured at one end to the spindle 18 and at the other end to the outer end of the plunger, whereby the arc of swing of the governor weight 22 in response to the rotative speed of the spindle 18 moves the plunger 20 to and fro. The outer end of the plunger is designed to press against and move a spring switch actuating arm 23 of a switch 24 which controls the circuit from the power main to the motor and ignition 25 of the furnace burner.

To assure that the damper plate 6 will always come to rest in a closed position transversely of the venting tube when the motor 10 stops, a solenoid brake for the worm 11 is provided. The brake consists of a toothed wheel 26 mounted upon the worm carrying spindle 16 and a solenoid coil 27 arranged in alignment therewith. A plunger piece 28 is positioned within the casing 29 of the coil, being movable into engagement with the teeth of the wheel 26 under the urging of a suitably arranged spring 30. When the solenoid is energized it attracts the plunger from out of engagement with the toothed wheel and when the circuit to the coil is broken the spring urges the plunger into engagement with the teeth to immediately stop rotation of the wheel and the worm 11. The spring couplings 17 and 19 are provided to take up stopping and starting strains between the motor and the spindle 16, and the spindle 16 and the governor carrying spindle 18.

In order to provide a control whereby the circuit to the motor 10 is broken at the moment when the damper plate 6 is in the closed position transversely of the venting tube, a rotating make-and-break switch arrangement is incorporated in the assembly and consists of an arm 31 of insulating material carried upon the outer end of the worm wheel spindle 13 to rotate therewith. A pair of switch contact pieces 32 are mounted upon the face of the housing 14 in the path of rotation of the arm and are arranged to be momentarily pressed apart by the arm to open the switch each time the arm passes therebetween as

it rotates, whereby one of two secondary circuits to the motor is momentarily broken once during every revolution of the damper plate; the break occurring when the damper plate is in the transverse closed position, as illustrated in Figure 3.

The operation of the electrical controls will be more clearly comprehended upon reference to the wiring diagram shown in Figure 4. The diagram shows the actuation of a furnace controlled by a thermostat switch 33, it being appreciated that the use of this control is incidental to the invention, for example in the case of a hot water furnace an aquastat control would probably be used in conjunction with the thermostat.

The lead 34 from the power main to the burner motor 25 passes through the thermostat switch 33 and the governor switch 24, under which arrangement the motor 25 will not start until the thermostat switch 33 and governor switch are closed. The damper motor 10 is actuated by a primary circuit and a shunt circuit. The primary circuit 35 extends from the lead 34 through the motor and back to the main, and the shunt circuit 36 extends across the motor and through the solenoid brake 27.

When the thermostat switch 33 closes in calling for heat, current flows through the circuit 35 to start the motor 10 and at the same time flows through the circuit 36 to energize the solenoid 27 whereby the brake lock is removed thus permitting the damper plate 6 to rotate under the drive of the motor. During the initial rotation of the damper plate 6 the governor switch 24 remains open until the driven spindle 18 has acquired sufficient momentum to operate the governor weight 22 to close the switch 24 and thus close the circuit 34 to the furnace motor, whereby the furnace burner lights only after the damper plate 6 has commenced to rotate. A conductor 37 extends from the main through the rotating switch 32 to the positive side of the motor 10, and as previously explained is opened once upon every rotation of the damper plate 6, which opening of the switch has no effect upon the actuation of the motor 10 as long as the circuit through the thermostat switch 33 remains closed.

When the heat requirements have been satisfied the thermostat switch 33 opens to break the circuit 35 to the motor 10 and the lead to the burner motor 25. The breaking of the circuit 35 does not stop the motor 10 as it is still fed through the conductor 37 until such time as the switch 32 is opened through the movement of the rotating arm 31, the current during this time also flowing through the solenoid coil 27.

When the switch 32 is opened at the moment when the damper plate 6 is in the closed position transversely of the venting tube the de-energization of the coil 27 allows the plunger 28 to engage the brake wheel 26 and stop the rotation of the damper plate, and at the same instant the governor wheel 22 will cease to rotate with the resultant outward movement of the plunger 20 whereby the switch 24 is opened.

The foregoing described particular electrical switch and circuit arrangement is not an essential part of the spirit of the invention but is provided to insure that the damper plate commences its rotation before the furnace burner is ignited so as to obviate back pressures in the combustion chamber and to provide the necessary draft; and also when the furnace is extinguished to position the damper plate transversely of the venting pipe whereby the passage between the combustion chamber and the chimney is substantially closed during the periods that the burner is extinguished.

As will be seen upon reference to Figure 3, the damper plate 6 is of somewhat less diameter than the inside diameter of the venting tube whereby a by-pass opening 39 is formed between the periphery of the damper and the inside face of the tube when the damper is in the passage interrupting or closed position, by which arrangement the draft through the vent pipe is never completely cut off. It should be understood that it is within the scope of the invention to utilize a damper plate which has a diameter susbtantially the same as the inside diameter of the venting tube and to provide another arrangement for avoiding the cutting off of the draft through the vent pipe. One such arrangement could be to shift the position of switch contact piece 32 so that when the damper plate stops rotating at the end of a firing cycle, it will maintain a position at an acute angle to the transverse position set forth above.

From the results of numerous and careful tests on our standard six-section hot water boiler furnace with an eight inch stack we have found that a rotative speed of the damper of approximately forty-five R. P. M. or ninety closures per minute gives the highest heat imparting efficienty to a furnace of this type. It should be understood that the rotative speed may be increased or decreased with resulting efficiencies which are an improvement over the efficiency of a comparable furnace not having the benefit of our invention. However, it will be appreciated that it is difficult to foresee the number of closures per minute that will give best results in everyone of the very numerous furnace combustion chambers and smoke stack proportions and designs. Our observations show that it is necessary to so regulate the closures that the flames and hot gases have sufficient time during each closure to fan out or expand toward the walls of the combustion chamber and that the closure must also be of insufficient duration to interrupt the continuous flow of combustible air and fluid mixture from the burner into the combustion chamber.

With our furnace the speed could be adjusted from 5 to 100 revolutions per minute and provide increased efficiency over comparable furnaces not having an intermittently closed flue. At speeds either above or below the optimum of 45 R. P. M. the $CO_2$ efficiency drops. At high speeds above the maximum for improved results, the effect is to decrease the area of the stack so that soot accumulates in the combustion chamber, decreasing the efficiency of burning. At low speeds below the minimum for improved results, the damper remains substantially closed for too long an interval with the same poor results.

In a general manner, while there has been disclosed in the above description, what is deemed to be the most practical and efficient embodiment of the invention, it should be well understood that the invention is not limited to such embodiment as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the present invention as comprehended within the scope of the accompanying claims.

We claim:

1. A furnace comprising, a combustion chamber, means for continuously supplying a forced air combustion mixture to said combustion chamber for continuous burning therein, means for passing a medium to be heated in heat transfer relation to the flame in said combustion chamber during the firing cycle, means forming an egress passageway from said combustion chamber, and power operated means in said passageway for periodically, at a predetermined frequency of a multiplicity of cycles per minute, blocking and unblocking almost the entire flow of combusted products through said passageway, the frequency being of sufficient duration to retard the flow of combustion gases through the vent egress and to coincidentally expand the flame of the burner into close proximity to the heat transfer means and of insufficient duration to interrupt the continuous flow of the combustion mixture into the combustion chamber.

2. A furnace comprising, a combustion chamber, means for continuously supplying a forced air combustion mixture to said combustion chamber for continuous burning therein and means for passing a medium to be heated in heat transfer relation to the flame in said combustion chamber, during the firing cycle, means forming an egress

passageway from said combustion chamber, a butterfly damper plate rotatably contained within said passageway, an electric motor for rotating said damper plate at a predetermined frequency of a multiplicity of times per minute for periodically blocking and unblocking the flow of combusted products through said passageway, the frequency being of sufficient duration to retard the flow of combustion gases through the vent egress and to coincidentally expand the flame of the burner into close proximity to the heat transfer means and of insufficient duration to interrupt the continuous flow of the combustion mixture into the combustion chamber, a primary circuit actuating the motor, a solenoid operated brake connected in shunt across said motor circuit for stopping the rotation of said motor when said solenoid is deenergized, and switch means for deenergizing said solenoid operated brake at the end of a firing cycle only when said damper plate is in closed position.

3. A furnace according to claim 2 further comprising a burner motor connected across said primary circuit, burner motor switch means for energizing said burner motor only when said damper motor is operating at the proper speed.

4. A furnace according to claim 3, in which said burner motor switch means comprises a governor driven by said damper motor, and a switch actuated by said governor when proper speed is attained.

5. A furnace comprising, a combustion chamber, means for continuously supplying a constant even flow of air combustion mixture to said combustion chamber for naintaining a continuous flame therein during the entire firing cycle, means for passing a medium to be heated in heat transfer relation to the flame in the combustion chamber, means forming an egress passageway from said combustion chamber, a damper plate mounted in said passageway for rotation about an axis transverse to said passageway, and an electric motor connected to rotate said damper at a predetermined fixed frequency of a multiplicity of times per minute for periodically blocking and unblocking almost the entire flow of combusted products through said passageway, the frequency being of sufficient duration to retard the flow of combustion gases through said egress passageway and to coincidentally expand the flame of the burner into closer proximity to the heat transfer means and of insufficient duration to interrupt the continuous flow of combustion mixture from the burner into the combustion chamber.

6. A furnace comprising, a combustion chamber, means for continuously supplying a constant even flow of air combustion mixture to said combustion chamber for maintaining a continuous flame therein during the entire firing cycle, means for passing a medium to be heated in heat transfer relation to the flame in the combustion chamber, means forming an egress passageway from said combustion chamber, a damper plate mounted in said passageway for rotation about an axis transverse to said passageway, an electric motor connected to rotate said damper at a predetermined fixed frequency of a multiplicity of times per minute for periodically blocking and unblocking almost the entire flow of combusted products through said passageway, the frequency being of sufficient duration to retard the flow of combustion gases through said egress passageway and to coincidentally expand the flame of the burner into closer proximity to the heat transfer means and of insufficient duration to interrupt the continuous flow of combustion mixture from the burner into the combustion chamber and stop means, operative at the end of a firing cycle for stopping said rotation and maintaining said damper in a position transverse to said passageway.



7. A furnace according to claim 6 in which the dimensions of said damper are smaller than the inside transverse dimensions of said passageway to provide a small slot between said damper and passageway through which fumes may pass at the end of the firing cycle.

8. In the operation of a furnace having a combustion chamber opening into a venting egress, a burner delivering a constant and even flow of air and combustible fluid mixture to the combustion chamber to maintain a continuous combustion flame therein during the periods when the furnace is alight together with heat transfer means for passing a medium to be heated in heat transfer relation to the flame in the combustion chamber; a method of increasing the heat transference from the combustion chamber to a medium to be heated through intermittent retardation of the flow of the combustion gases and comprising the step of intermittently blocking almost the entire flow of the combustion gases to the venting egress of the combustion chamber at a predetermined frequency of a multiplicity of times per minute, the frequency being of sufficient duration to retard the flow of combustion gases through the venting egress and to coincidently expand the flame of the burner into closer proximity to the heat transfer means and of insufficient duration to interrupt the continuous flow of combustible air and fluid mixture from the burner into the combustion chamber.

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