March 2, 1965 A G. BAUER 3,171,472

SWEEPER MECHANISM FOR HEAT EXCHANGER

Filed March 26, 1962 2 Sheets-Sheet 1

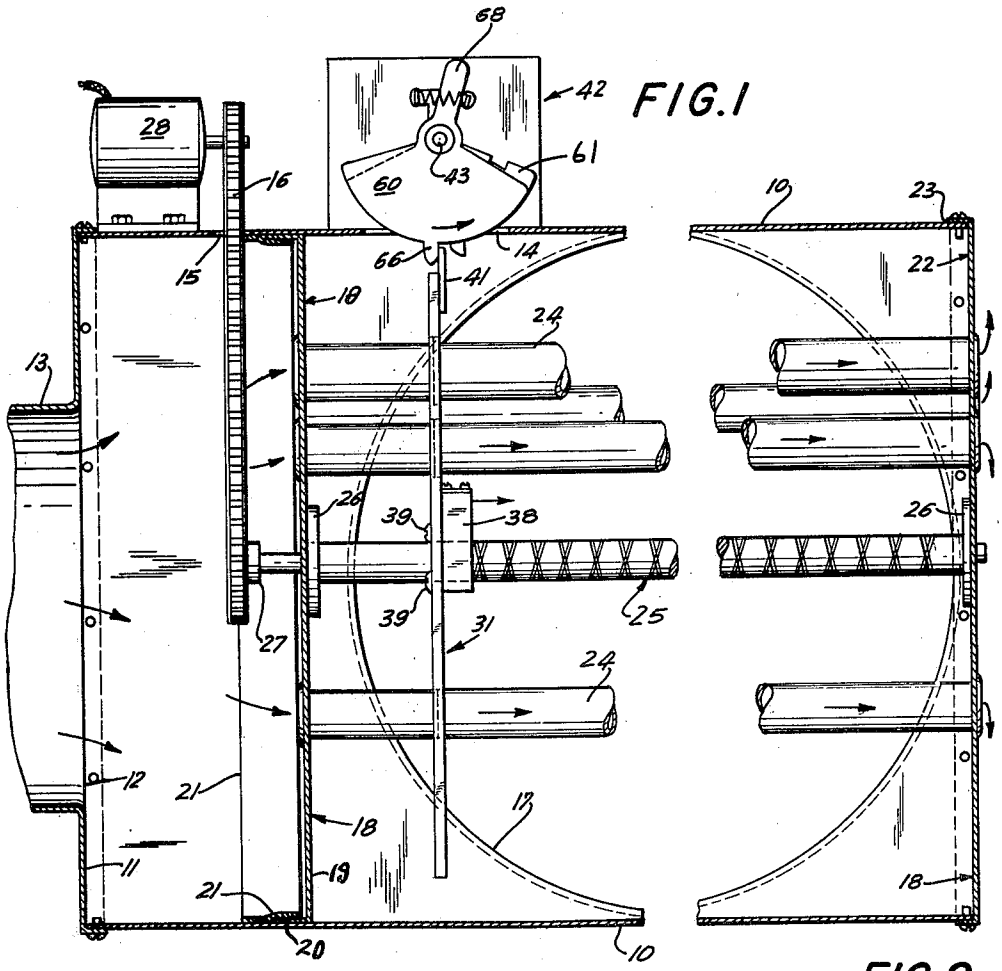


FIG. 1

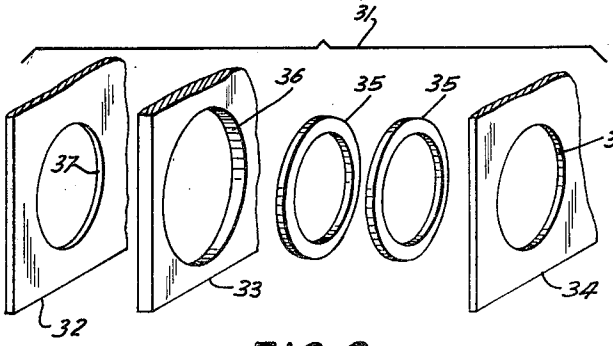


FIG. 8

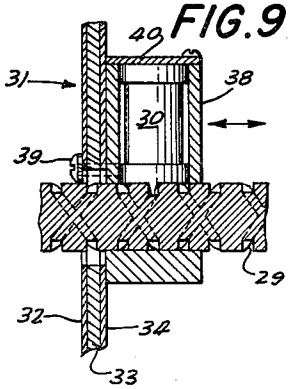


FIG. 9

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SWEEPER MECHANISM FOR HEAT EXCHANGER

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FIG. 2

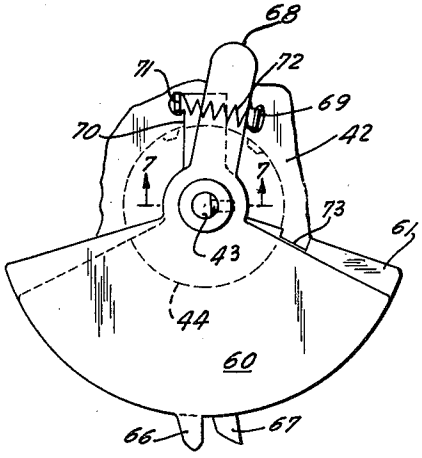


FIG. 3

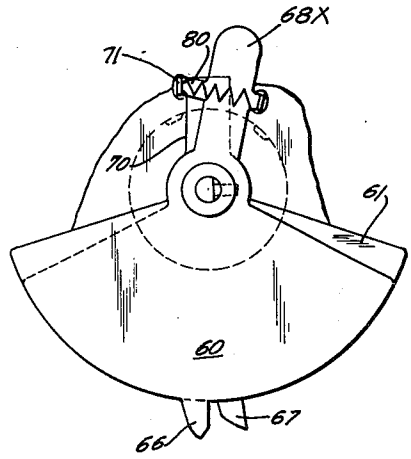


FIG. 4

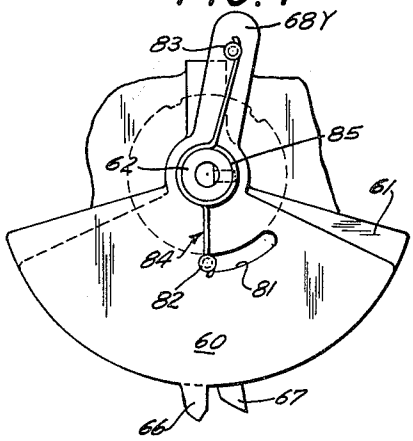
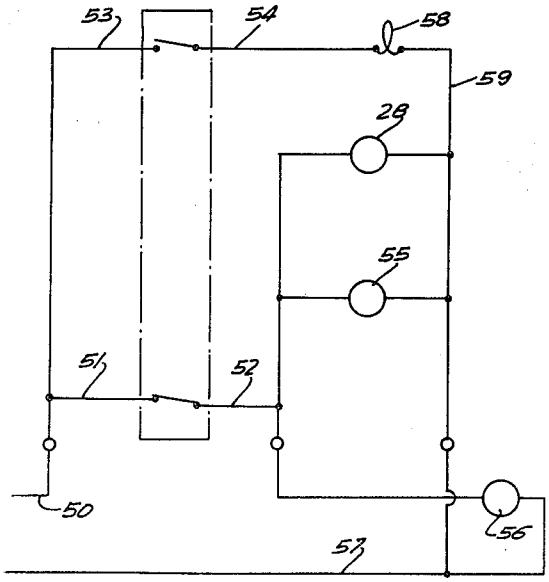


FIG. 6



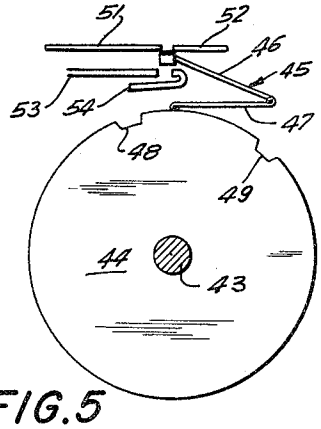


FIG. 5

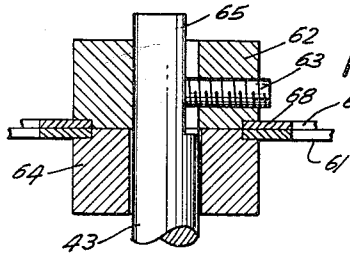


FIG. 7

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3,171,472

SWEEPER MECHANISM FOR HEAT EXCHANGER

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Filed Mar. 26, 1962, Ser. No. 182,406
5 Claims. (Cl. 165—12)

This invention relates to a device and method for cleaning heat exchanger tubes free from soot and more particularly to such heat exchanger attached to the exit flue of oil burners used in the heating of homes.

The oil burners conventionally used to heat homes are generally very wasteful and inefficient in that a vast amount of hot air is blown up the chimney and into the atmosphere by the burner fan used to supply air to the combustion chamber.

In this invention a heat exchanger is disposed in the exit flue, having a plurality of heat exchanger tubes disposed at a right angle to the exit flue and the flow of the combustion gases therein.

Thus, for example, the temperature of the gases coming into the heat exchanger located in the exit flue adjacent to the furnace may have a temperature of about 650° F. whereas the combustion gases leaving the heat exchanger may have a temperature of only about 250° F. Thus there is a large drop in temperature of the flue gases in passing over the plurality of tubes in the heat exchanger, the heat being directed into the cellar of the home or conducted by conventional air ducts where desired.

A disadvantage of using heat exchanger in the exit flue is that soot condenses on the heat exchanger tubes and builds up with time so as to seriously interfere with the flow of the combustion gases from the furnace into the chimney, and said soot being a heat insulator seriously affects the efficiency of the heat exchanger.

According to this invention, means are provided for cleaning the heat exchanger tubes whenever the furnace is in operation. The heat exchanger while described in conjunction with a home oil burner is not limited to oil fired furnaces nor to home use, since clearly it is operable for larger installations as well.

Also according to this invention means are provided for turning off the furnace oil burner should the sweeper mechanism or its co-acting electric clock fail. This is important, for as stated above, if the furnace operates without operation of the cleaning means in the heat exchanger, the soot will build up and interfere with the flow of the gases of combustion and furthermore, the soot greatly interferes with the transfer of heat since it functions as an insulator. In extreme cases, a heavy soot buildup is equivalent to a total insulation of the heat exchanger tubes.

This invention provides means and method for continuously keeping the heat exchanger tubes clean and it also provides a means and method for shutting off the furnace should the actuating means for the sweeper or electric clock used in conjunction with the sweeper fail.

This invention is described by a plurality of embodiments shown in the accompanying drawing but is not limited thereto.

FIG. 1 is a longitudinal view through a rectangular heat exchanger disposed transversely in the round flue pipe from the furnace and showing a few of a large plurality of heat exchanger tubes and the sweeper means and the actuating means for operating said sweeper means,

FIG. 2 is a front elevation view of one embodiment of safety switch means used in conjunction with the operation of the sweeper plate,

FIG. 3 is a front elevation of a modified safety switch,

FIG. 4 is a front elevation of another modified safety switch,

FIG. 5 is a schematic elevation view of a clock wheel and wheel riding switch means, said wheel being provided with a first rim notch for turning off the furnace main switch in the event of failure of the sweeper means and provided with a second rim notch for turning off the furnace main switch in the event of clock failure,

FIG. 6 is a schematic wiring diagram of this invention,

FIG. 7 is a view taken substantially on line 7—7 of FIG. 1 showing a fixed cam and a free wheeling cam disposed on the clock shaft,

FIG. 8 is an exploded view of the sweeper plate showing its laminate structure and the means of captively retaining a pair of floating cleaner rings, and

FIG. 9 is a section view of the pawl means used to advance and to return the sweeper plate.

Turning to the drawing, a rectangular shell **10**, preferably of rust resistant or stainless steel, is provided with a conventionally secured end plate **11** having an aperture **12** therein to which a blower pipe **13** is attached. The blower pipe **13** leads to a conventional electric motor operated blower (not shown). The top wall of the shell **10** is provided with a longitudinal slot **14** for a pair of cams, to be described hereinafter, and also with a substantially square slot **15** through which a sprocket chain **16** is passed.

The opposed side walls of the shell **10** are each provided with suitably large aperture **17** to which the flue pipe is attached.

A heat exchanger unit **18** preferably of stainless steel is provided with a multi-apertured rectangular inner wall **19** having a peripheral exteriorly disposed continuous edge **20** at a right angle thereto. The interior walls of the chamber of shell **10** is provided with a substantially continuous holding strap **21** secured at one end as by welding to the shell. As shown in FIG. 1, the continuous edge **20** lockingly and substantially hermetically engages the strap.

The exterior heat exchanger wall **22** is of slightly larger height and width and is provided with a continuous lip **23** to overlap the adjacent edge of the shell **10**, said lip being removably secured to the shell by conventional means such as screws.

The exterior plate **22** has a like manner of apertures disposed in corresponding relationship to inner plate **19**. A plurality of heat exchanger tubes **24** are disposed between the end plates **22** and **19** and are crimped thereto by hydraulic pressure to effect an air tight seal.

A central shaft aperture is provided in each plate **19** and **22** and a conventional re-entrant spiral shaft **25** is disposed in these apertures. Preferably a suitable apertured bearing plate **26** is secured as by welding, bolting or riveting about each central aperture in each end plate to provide a suitably large bearing surface.

As shown in FIG. 1, the shell **10** is provided with an end chamber between shell end plate **11** and the inner heat exchanger end plate **19**. The end of shaft **25** protrudes into this chamber and it is provided with a conventional sprocket wheel **27**. The chain **16** engages wheel **27** and is connected to the shaft of a suitable motor **28**, which latter is secured by metal bolts to the top wall of the shell or housing **10**, or by slotted adjustable angle fitting (not shown).

The shaft **25** is provided with a continuous re-entrant spiral groove **29** so that a pawl follower **30** having a tongue disposed in the groove will travel continually back and forth along the shaft **25** upon turning of said shaft.

An important feature of this invention is the provision of a unique sweeper plate **31**. The plate **31**, as shown in FIG. 8 is of a laminate construction consisting of a thin inner perforated sheet **32**, a middle relatively thick perforated sheet **33** and a thin outer perforated sheet **34**.

The number and location of the perforations correspond to the number and location of the heat exchanger tubes **24**. The perforations of sheets **32** and **34** are round and slightly larger than the diameter of the tubes **24**, whereas the round perforations of the middle sheet **33** are considerably larger than the diameter of the tubes **24**.

A pair of like diameter thin flat rings **35** is disposed within each of the apertures **36**. The rings **35** having an outer diameter suitably less than the diameter of aperture **36**, and said rings have an outer diameter suitably greater than the outside diameter of the apertures **37** of sheets **32** and **34**, and an inner diameter having a free sliding fit over tubes **24**.

Accordingly rings **35** are captively and floatingly held in between sheets **32** and **34** within aperture **36** of the middle sheet **33**. Clearly as the rings **35** gravitationally are movingly pushed over the tubes **24** they have a scrubbing action on the tubes, thereby removing any soot clinging thereto, which removed soot is then blown away up the chimney.

As shown in FIG. 1, a container **38** having a chamber to receive the pawl follower **30**, is secured to the laminate sweeper plate **31** by a pair of screws **39** so that it can not be rotated and therefore is in effect integral with said laminate plate **31**. The plate **31** can not rotate since it is capitively held by the tubes **24** passing therethrough, the number of tubes **24** being for example, about thirty two.

A cover plate **40** is secured to the top of the container **38** to keep the pawl follower in place and for removing said follower, if necessary. A tab **41** is secured, as by spot welding, to the top of the laminate plate **31**.

A safety feature of this invention is the provision of means, turning off the entire unit including the oil burner if the operating or sweeper mechanism should fail. To accomplish this result a conventional electric clock mechanism **42** is employed. The shaft **43** of the clock is provided with a conventional slip clutch (not shown). As shown in FIG. 5, a switch operating wheel **44** preferably of suitable plastic construction is secured to the shaft **43**. A conventional micro-switch element **45**, shown schematically in FIG. 5, is provided with a switch contact leg **46** and a friction contact leg **47**. The contact leg rides on the rim surface of the wheel **44**, normally between two depressions or cut-outs **48** and **49** located suitably in said rim surface.

Turning to the wiring diagram FIG. 6, the energized or hot electrical wire **50** from the stack control enters the micro-switch unit, shown in dotted outline, where contact between wires **51** and **52** is made during normal continuous operation. When however the sweeper unit or the clock unit fails the wheel **44** is rotated so that leg **47** falls into a depression **48** or **49** as the case may be, thereby moving leg **46** so as to effect a contact between wires **53** and **54** which are open in normal operation.

As shown in the wiring diagram FIG. 6 and FIG. 5, the wire **52** of the normally closed contact energizes the sweeper motor **28** and the clock motor **55** in the clock unit **42** as well as the oil burner motor **56**, the return line or ground wire being indicated by the number **57**.

Whenever the leg **47** falls into a depression **48** or **49**, the normally open switch is closed and the normally closed switch is opened so that the sweeper motor **28**, the clock motor **55** and the oil burner motor **56** are turned off since now the current flows through wires **50**, **53**, **54** and the pilot light **58** and thence through wire **59** to the ground wire **57** (FIG. 6).

Various means may be provided for actuating the clock wheel, a plurality of three embodiments being shown in FIGS. 2, 3 and 4.

Turning to FIGS. 2 and 7, a pair of segment cams are provided, namely an outer or fixed cam **60** and an inner or free wheeling cam **61**. Cam **60** is provided with a bushing **62** press fitted integrally thereto, said bushing **62** being provided with a central aperture to receive shaft **43** and a threaded radial aperture in which a set screw **63** is disposed. The free inner or wheeling cam **61** is provided with a bushing **64**, which is not secured to shaft **43**. Shaft **43** is preferably provided with a flat area **65**, against which set screw **63** is rigidly secured.

The outer cam **60** is provided with a suitable rim tab **66** and the inner cam with a suitably configurated rim tab **67**. Cam **60** is provided with an integral handle portion **68** having an integral tongue **69** at right angle thereto. The inner cam **61** is also provided with an integral handle portion **70** having a suitable integral tongue **71** at a right angle thereto. A tension spring **72** is secured to the tongues **69** and **71** tending to pull them together. As shown in FIG. 2, a suitable arresting flap **73** is turned over at a right angle to the plane of cam **61**.

In the operation of the cams **60** and **61**, FIG. 1, the sweeper plate **18** is moved by motor **28**, during the oil burning operation only, slowly back and forth on, for example, a twenty four minute cycle.

The clock mechanism **42** rotates the fixed cam **60** and the arrested free wheeling cam counterclockwise at a suitable number of degrees per minute.

Thus the free wheeling cam **61** is arrested in its clockwise rotation but is free wheeling in a counterclockwise rotation manner.

To begin the operation of the device the tab **41** of the sweeper plate which latter is in its extreme leftward position (FIG. 1) engages tab **66** of the outer cam **60**. In this condition, the location of the depending leg **47** of the microswitch is shown in FIG. 5 and is between the notches or depression **48** and **49**. In normal operation, leg **47** always rides on the wheel rim between these two notches. It is only when something goes wrong that the terminus of the leg **47** falls into a notch to actuate or close the normally open switch and thereby cause the pilot light to light up indicating trouble in the operation.

The sweeper plate **31** is moved to the right by rotation of the shaft **25** and the cam follower **30**. In so doing the tab **41** contacts and moves tab **67** and thus suitably counterclockwise rotates inner cam **61**. However cam **61** is spring loaded to fixed cam **60** and it is moved counterclockwise faster than the fixed outer cam **60** moves counterclockwise due to clock rotation, until tab **67** snaps back over the pushing tab **41** on the sweeper plate, to be to the left of the tab **41**. The sweeper plate **18** and its tab **41** then continues to the extreme right (FIG. 1) and then returns leftwardly. Meanwhile the clock has rotated both cam **60** and the arrested cam **61** so that on the return of the sweeper plate, tab **41** clears tab **67** of the inner cam **61** and engages cam **66** of the outer cam and pushes it leftwardly against the slip clutch of the clock unit **42** to return both cams to their leftward-most position as shown in FIG. 1, whereupon the cycle is repeated.

However should the sweeper plate fail to operate for any reason as for example, a broken chain **16**, the sweeper actuator tab **41** will not recycle the clock timer. Thus the cams **60** and **61** rotate counterclockwise until the leg **47** falls into notch **49** of the wheel **44** fixed to the clock shaft **43** thereby shuting off the oil burner, sweeper motor, and clock motor and lighting up the warning light **58**.

In case the clock should fail, the sweeper plate makes one normal cycle and since the cams **60** and **61** have not rotated due to the clock failure, the actuator tab **41** on the sweeper plate on its return leftward trip engages the outer surface of tab **67** of cam **61** and pushes cam **60** by way of the arrester flap **73** until leg **47** drops into suitably located notch **48**, thus again turning off the sweeper motor, and burner motor and lighting up the warning light **58**.

A pair of modified cams are shown in FIG. 3. In this modification cam **60** has a modified integral handle **68X** having a projection **80** tab in the plane of the cam. The projection **80** engages the upright tongue **71** of the handle **70** of cam **61**. In the modification of FIG. 3, the flap **73** on cam **61** is deleted and the projection **80** on the cam **60** handle **68X** is substituted in lieu thereof.

Another modification is shown in FIG. 4. In this modi-

fication, the arresting flap 73 on inner cam 61 is deleted. The cam 60 is provided with a suitable curved slot 81 and a fixed pin 82 is secured to cam 61 and protrudes through the slot and is adapted to move in said slot 81. A pin 83 is fixedly secured to the handle 68Y of the cam 60 and a suitable two prong spring 84 is disposed so as to be biased against pin 83 with one prong and against pin 82 with the other prong, said spring having a central loop 85 disposed about the bushing 62. The spring 84 and its coacting pins 82 and 83 with slot 81 substitute functionally for the spring 72 and flap 73 of the modification of FIG. 2.

This invention has been described by a plurality of embodiments but it is not limited thereto as it is of broad or generic scope.

I claim:

1. In a heat exchanger having a burner motor and a housing having a slot aperture in its top wall and disposed in a flue pipe and having a plurality of parallel heat exchanger tubes disposed in the flue gases, a movable apertured sweeper plate engaging said tubes in the apertures thereof and disposed transversely to said tubes, a rotatable re-entrant spiral shaft engaging said plate and electrical motor means for rotating said shaft, the safety improvement for turning off burner motor power in the event of mechanical failure comprising tab means secured to said sweeper plate and slip clutch electrical clock means secured to the outside top wall of said housing adjacent said slot aperture therein and disposed over said tab means, said clock means having an electrically operated rotatable shaft, a first disc means fixedly secured to said shaft and having a rim tab disposed in said housing slot aperture, a second disc means freely mounted on said shaft and having a rim tab disposed in said slot aperture, arresting means disposed on said second disc for engaging said first disc, spring means engaging said first and said second disc means urging continuous engagement of said arresting means, a rim dual notched wheel mounted on said shaft and electrical contact means engaging selectively said notches to cut off power supply in the event of sweeper plate failure or electrical clock failure.

2. The device of claim 1 wherein the first disc means comprises a substantially semi-circular flat portion having an opposed integral handle, said handle having an integral tongue element at about a right angle thereto, the rim tab thereof being substantially in the center of the semi-circular rim; the second disc means comprises a substantially semi-circular flat portion also having an opposed integral handle, said handle having a suitable integral tongue element at about a right angle thereto, the rim tab of said second disc means being substantially in the center of the rim thereof, said arresting means of the free second disc engaging the first disc to effect a spaced-apart relationship of said rim tabs, said spring means being a coil spring engaging the respective tongues of the respective handles of said disc means.

3. The device of claim 2 wherein the arresting means of said first disc is a turned over edge flange adapted to engage an edge of said semi-circular portion of said second disc means.

4. The device of claim 2 wherein the arresting means is a planar projecting element of said handle of said first disc means adapted to engage said tongue of said second disc means.

5. The device of claim 1 wherein the spring means is a loop spring the loop of which is disposed about said shaft, said first disc being provided with an angular slot, said arresting means being a pin secured to said second disc and protruding through said slot, said loop spring being secured at one end to said first disc means and at the other end to said pin protruding through said slot.

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