United States Patent [19]

Hapgood

[11] **3,830,221**

[45] **Aug. 20, 1974**

[54] **OIL HEATER PROTECTION SYSTEM**

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[73] Assignee: **Raytheon Company,** Lexington, Mass.

[22] Filed: **May 31, 1972**

[21] Appl. No.: **258,148**

[52] **U.S. Cl.** **126/374,** 165/39

[51] **Int. Cl.** **A47j 27/00,** F28f 27/02

[58] **Field of Search** ..... 165/165, 39; 126/374, 351, 126/350 R; 236/20, 78 A

[56] **References Cited**

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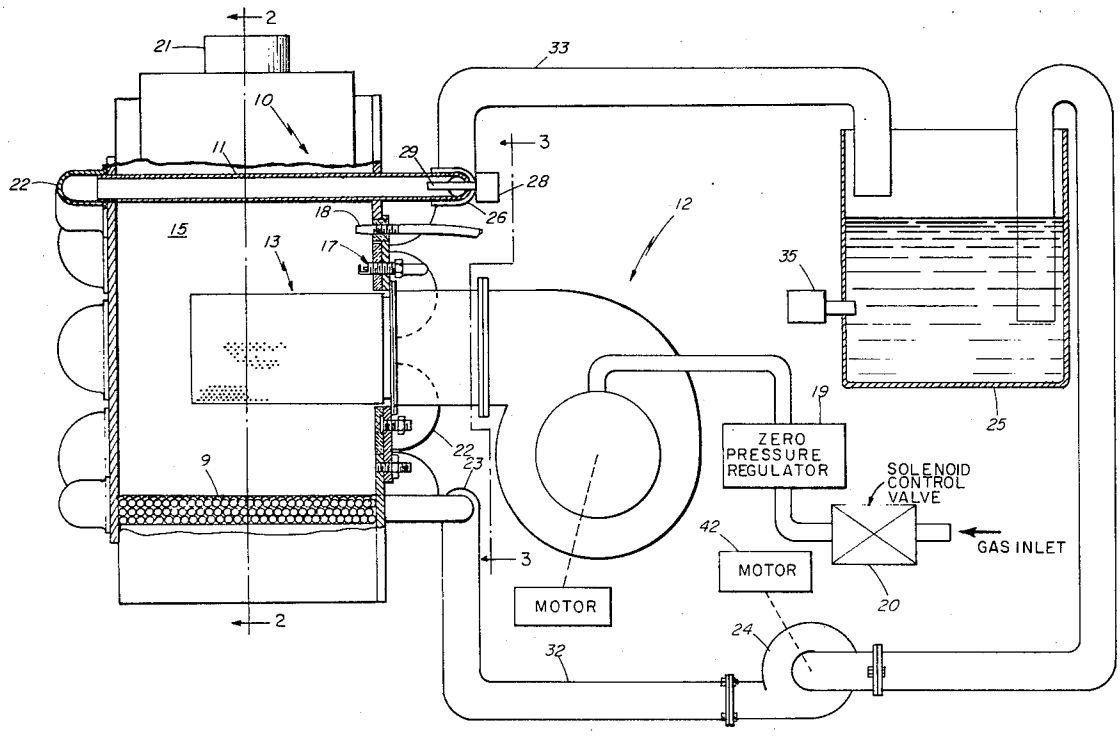
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Primary Examiner—William F. O'Dea
Assistant Examiner—William C. Anderson
Attorney, Agent, or Firm—Joseph D. Pannone; Milton D. Bartlett; Herbert W. Arnold

[57] **ABSTRACT**

An oil heating system in which two separate sections of a heat exchanger are heated by sections of the same burner flame and have separate thermostats, either of which can shut down the system if one section clogs.

10 Claims, 4 Drawing Figures



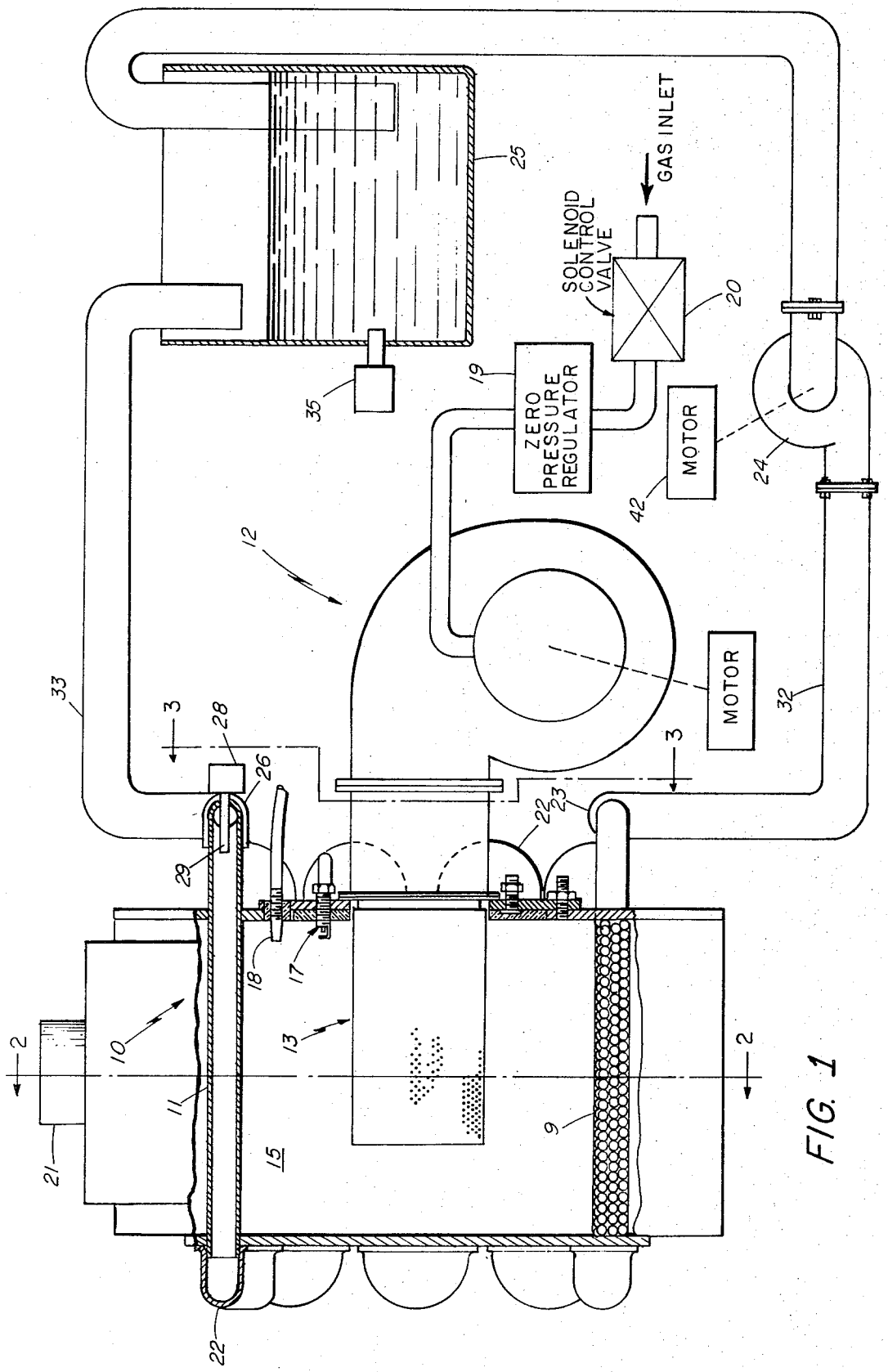

GAS INLET
SOLENOID CONTROL VALVE
ZERO PRESSURE REGULATOR
MOTOR
MOTOR
25
20
19
35
24
42
12
33
32
28
26
29
22
23
18
17
13
10
11
15
9
21
2
2
3
3
3

FIG. 1

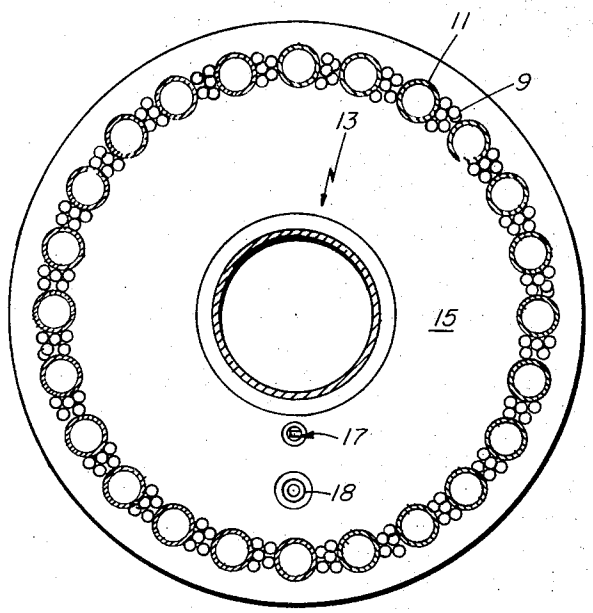


FIG. 2

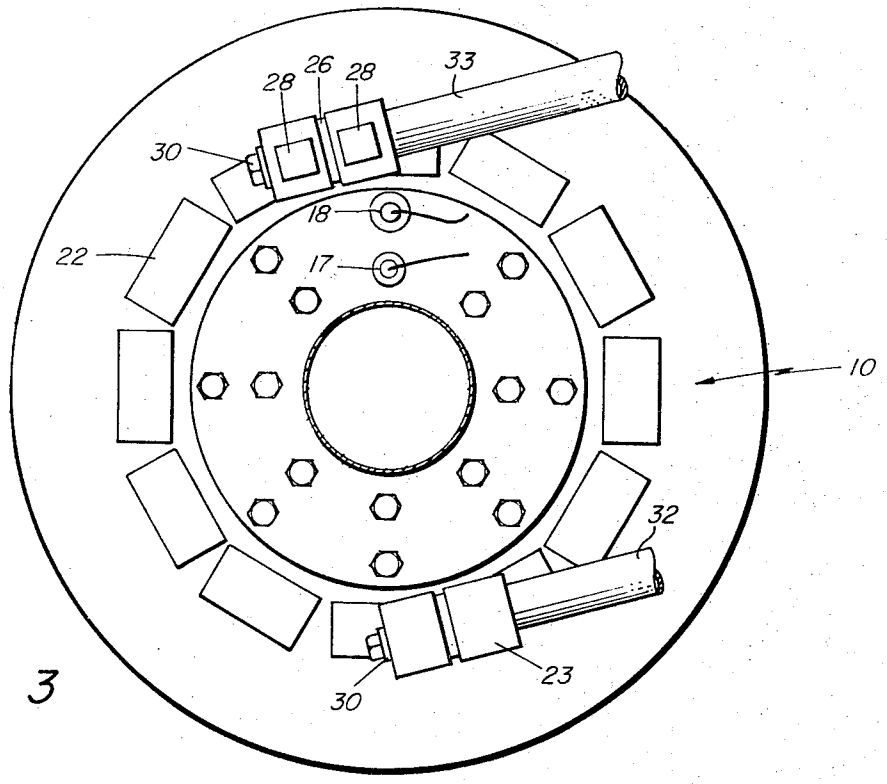


FIG. 3

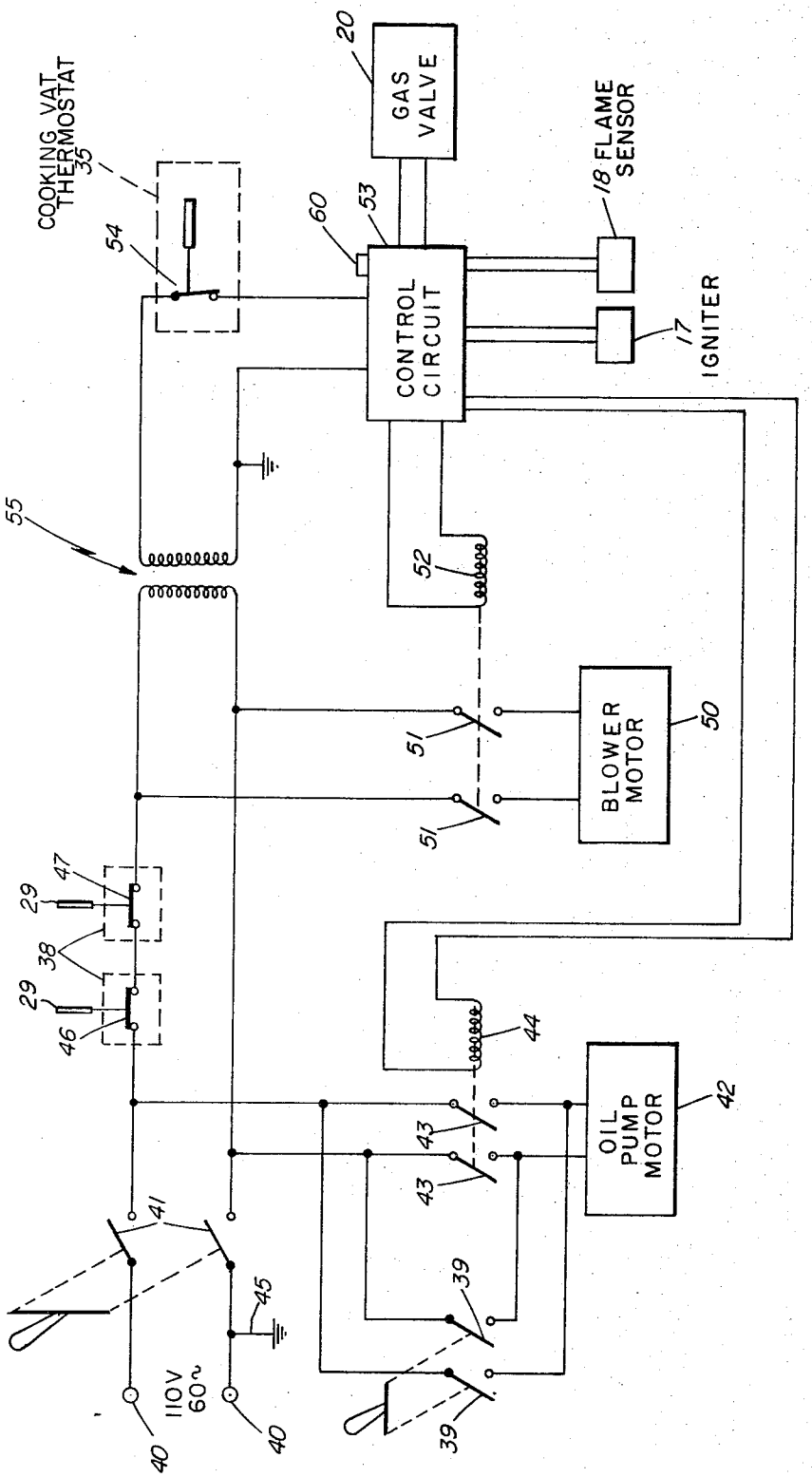

COOKING VAT THERMOSTAT
35
54
20
GAS VALVE
18 FLAME SENSOR
60
53
CONTROL CIRCUIT
17 IGNITER
55
52
51
51
BLOWER MOTOR
50
29
47
38
29
46
44
43
43
OIL PUMP MOTOR
42
41
45
39
39
110V 60~
40
40

FIG. 4

OIL HEATER PROTECTION SYSTEM

RELATED CASES

Application Ser. No. 10,334, filed Feb. 11, 1970, and now U.S. Pat. No. 3,704,748, by William H. Hapgood and assigned to the same assignee as this invention, is hereby incorporated by reference and made a part of this disclosure.

BACKGROUND OF THE INVENTION

In the aforereferenced copending application there is disclosed a heat exchanger comprising a plurality of bodies having surfaces predominantly curved in all directions bonded to sections of hollow tubes to form a heat exchanger. As further disclosed therein, such a heat exchanger produces a very uniform heating of fluid passing through the tubular elements so that organic fluids, such as cooking oil, may be heated without regions thereof becoming overheated and cracking to form carbon. If the fluid being heated contains foreign material, such as food particles which are being cooked in the oil, such particles tend to clog portions of the liquid side of the heat exchanger thereby producing an overheated condition which may damage the oil and/or the heat exchanger.

SUMMARY OF THE INVENTION

This invention discloses an oil heating system in which the oil being heated flows through a plurality of paths in parallel and the oil temperature in each path is separately sensed by separate temperature sensing elements in each of the parallel flow paths. Changes in the temperature of the oil being heated, either relative to the temperature of oil being heated in an adjacent path or relative to a preset level indicative of an overheated condition, shuts down the heat exchange system.

More specifically, the heat exchanger comprises a plurality of sets of tubes spaced in a cylindrical locus, each set comprising a plurality of vertical tubes connected together in series and bonded to a plurality of surface extensions providing for structural rigidity between adjacent tube members. A burner structure for supplying heat, located in the central plenum surrounded by the tubes, directs the products of combustion through the spaces between a matrix formed by bodies predominantly curved in all directions and bonded to the tubes. A pump supplies a liquid, such as cooking oil, to the inputs of each series of tubes and the outputs of each series of tubes supply heated oil to the heat utilization system, such as a chicken fryer.

Each of the series of tubes has at its output a temperature sensor which provides an indication of the heat of the oil. Since the resistance to the flow of oil for a given temperature is made approximately the same for each series of tubes in the heat exchanger, supplying the liquid to the inputs of each series from a common pump insures that substantially the same pressure drop appears across each series of tubes. Thus, if one of the sets of tubes begins to clog, the flow of oil through that set decreases and the net result is an increase in the output temperature of the oil.

In accordance with this invention, the oil temperature outputs of the flow paths is preferably sensed by individual thermostats controlling normally closed switches connected in series so that if the temperature

of the oil in one of the paths rises substantially above a predetermined temperature, the switch controlled by the thermostat in that path will open and cause the burner to shut down.

It is contemplated that the principles of this invention may be used with any type of high performance heat exchanger, for example heat exchangers transferring heat at a rate in excess of 50,000 BTU's per hour per square foot of heat exchanger surface contacting the fluid being heated, or where the fluid is being heated close to upper temperature limits above which damage can occur to the fluid and/or the heat exchanger. For example, in the case of cooking oil, overheating of the oil causes a charring or cracking of the oil, producing a deterioration in taste or other quality of food product. Such heat exchangers can, for example, be finned tube structures or conventional fin heat exchangers in which a direct flame is exposed to the finned structure.

BRIEF DESCRIPTION OF THE DRAWINGS

Other and further objects and advantages of this invention will be apparent as the description thereof progresses, reference being had to the accompanying drawings wherein:

FIG. 1 illustrates an elevation view of a system embodying the invention;

FIG. 2 illustrates a transverse sectional view of the structure shown in FIG. 1 taken along line 2—2 of FIG. 1;

FIG. 3 illustrates a transverse sectional view of the structure shown in FIG. 1 taken along line 3—3 of FIG. 1; and

FIG. 4 illustrates a schematic diagram of a control circuit embodying the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 1 through 4, there is shown a heat exchange module 10 consisting of a plurality of tubes 11 spaced in a cylindrical locus and bonded together with a plurality of spheres 9 to form a heat exchanger.

A burner 13, supplied by a blower 14, is positioned in the plenum 15 defined by the tubes 10. Burner 13 preferably comprises an apertured cylindrical metal member through which a fuel-air mixture is supplied by blower 14 to the interior of the plenum 15 defined by the cylindrically spaced tubes 11.

The fuel-air mixture is ignited by an igniter 17 which may be, for example, a pilot light or a spark plug, and the presence or absence of the flame is sensed by a flame sensing device 18 which may be, for example, a thermocouple, an electronic flame sensor, or a bimetallic switch.

The fuel-air mixture preferably comprises gas supplied to the input blower from a zero pressure regulator 19 through a solenoid control valve 20 from a gas source. The blower 12 thoroughly mixes the gas and blows it through the apertures in the burner 13 where it is ignited by igniter 17 and directed radially outwardly through the apertures between the spheres 9 to transfer heat to the heat exchanger 10. The burner, igniter, flame sensor, pressure regulator and control valve, as well as the details of the heat exchanger 10, are illustrated herein by way of example only, and any desired source of fuel, such as fuel oil, as well as any desired heat exchanger configuration and igniter or flame

sensor can be used in accordance with this invention.

The zero pressure regulator **19** supplies gas to the input of the blower **12** at or slightly below atmospheric pressure so that if for any reason the blower **12** fails and/or the solenoid valve **20** sticks, the zero pressure regulator reduces the pressure of gas to zero at the input of the blower **14** so that no gas leaks through the regulator into the system. When the blower **14** starts, on the other hand, a slight vacuum is created at its input causing gas to be supplied through the regulator **19.** In addition, variations in blower speed or other conditions, such as back pressure on a chimney vent **21** through which the products of combustion are vented, will produce a variation in the input vacuum of the blower, thereby proportionally varying the amount of fuel supplied through the regulator **19** and maintaining a substantially constant and, hence, pollution-free fuel-air mixture over a wide variety of operating conditions. For additional details of such a system, reference may be had to the aforementioned copending application Ser. No. 10,334 which is now U.S. Pat. No. 3,704,748.

The tubes **11** are connected at their ends by means of header connectors **22** into two groups of a series of tubes **11,** each of said groups comprising, for example, 12 tubes connected in series, one group of the tubes **11** defining one side of the plenum **15** and the other group defining the other side of plenum **15.** In accordance with the invention, the inputs of both groups of tubes are supplied through an input manifold or header **23** with a liquid to be heated. As shown herein by way of example, pump **24** pumps oil from a vat **25** to the header **23** and thence through the heat exchanger **10** by forcing the oil through both groups of tubes **11** in parallel to an output manifold or header **26.**

Each of the two pipes **11** connected to the header **26** has a separate thermostat **28** mounted on the outside of the header with a temperature sensing probe extending into the end of the respective tube **11** so that each thermostat **28** responds to the temperature of the oil emerging from the end of that tube **11** in which its thermostatic probe **29** is positioned. As shown here, each of the headers **23** and **26** may be, for example, two tees having their legs attached to the tubes **11** and their adjacent arms coupled together to form a manifold, one end of which is plugged by plugs **30.**

The unplugged end of the manifold or header **23** is connected via a pipe **32** to the oil pump **24** and the unplugged end of the manifold or header **26** is connected to an output pipe **33** which returns heated oil to the vat **25.** While, as illustrated herein by way of example only, the system is used for heating oil to a temperature of, for example, 350° Fahrenheit, suitable for cooking purposes, it is contemplated that the system of this invention can be used to heat fluid for any desired purpose. Such a system is particularly useful where the fluid to be heated must be maintained below a predetermined upper temperature limit where damage to the liquid could occur in the case of heating organic liquids.

In order to insure that no regions of the heat exchanger exceed the upper temperature limit where damage to the oil will occur in areas where the heat exchanger contacts the oil, the outputs of both groups are sensed individually by the thermostatically controlled relays **28** by means of the individual temperature probes **29** extending into the tubes **11.** In the event of failure of the pump **24,** or of the blockage of one of the groups of the heat exchanger, the flow of oil through one or both paths of the system is reduced to a level where the temperature of the oil arriving at either of the temperature sensing probes **29** exceeds a limit set somewhat below the maximum limit of, for example, 400° Fahrenheit, to which the oil can safely be heated, and the burner is shut off in response to the thermostat whose probe **29** sensed an oil temperature above the preset limit. Thus, it may be seen that if the first group of the tubes **11** has the flow therethrough slightly decreased due to blockage, the back pressure on the oil pump **24** will be slightly increased, forcing more oil through the second group of tubes and slightly reducing the temperature of the oil at the output of said second group. However, the output temperature of the oil at the first group of tubes will be raised due to the reduced flow of oil therethrough, and if the blockage becomes sufficiently great, the temperature of the oil at the output of the first group will exceed the preset limit and the thermostat **28** sensing the first group will shut off the burner.

An example of a control utilizing the structure of FIGS. **1–3** is illustrated in FIG. **4** wherein power, for example 110 volts AC 60 cycle, supplied at input terminals **40** is connected through a master control switch **41** to oil pump motor **42** mechanically connected to the oil pump **24.** Oil pump motor **42** preferably is energized whenever power is supplied to the system by closure of the switch **41** but, if desired, motor **42** may be controlled, as shown, through a set of normally open contacts **43** actuated by a solenoid **44** controlled by the control circuit. One side of the 110 volt power supply is preferably grounded to the system, as indicated at **45,** and the other side is connected through normally closed switches **46** and **47** in thermostats **38** after passing through master switch **41.** Switches **46** and **47** are respectively actuated by the temperature sensing elements **29** in the thermostats **38** so that if either of the switches **46** or **47** opens, the portions of the control circuit fed therethrough will be de-energized, whereas the oil pump motor **42** being energized from the source **40** prior to switches **46** and **47** will continue to pump if manually operated switch **39** bypassing contacts **43** is closed.

A blower motor **50** mechanically connected to blower **14** is energized through the contacts **46** and **47** and the solenoid controlled normally open contacts **51.** Contacts **51** are closed by energization of a solenoid **52** which is energized from a control circuit **53.** Control circuit **53** derives power from a transformer **55** whose primary winding is connected to source **40** through the contacts **46** and **47.** The secondary winding of transformer **55** feeds power to control circuit **53** through the normally closed contact **54** of thermostat **35** which senses the temperature of the oil in the vat **25.** The control circuit **53** is a conventional flame failure control circuit which supplies the proper ignition voltage to igniter **17** and senses the presence or absence of the flame by the flame sensor **18** in accordance with well-known practice. Preferably, the 110 volts supplied to the input terminals **40** is reduced by transformer **55** to 24 volts or less, depending on the particular details of the control circuit used. Thus, the voltage supplied at the thermostat **35** attached to a vat adjacent to which personnel are working is below that presenting a substantial shock hazard.

In operation, when the master switch **41** is turned on, power is supplied through normally closed contacts **46** and **47**, the transformer **55**, and normally closed contact **54** to control circuit **53**, thereby supplying igniting power to the igniter **17**, the solenoids **52** and **44** energizing the oil pump motor **42** and the blower motor **50**, and the normally closed solenoid control valve **20**. When valve **20** opens, fuel flows through the regulator **19** to the input of the blower **12** where it is mixed with air and supplied to the plenum **15** and ignited by the igniter **17**. In accordance with well-known practice, if the control circuit **53** is energized for a predetermined time, such as ten seconds, and a flame does not appear in the plenum **15** to be sensed by the flame detector **18**, a timing circuit in the control circuit **53** de-energizes the solenoids **52** and **44** and the valve **20**, thereby shutting down the system and requiring a manual reset, for example, by means of a button illustrated diagrammatically at **60** for re-energization of the system.

This completes the description of the invention illustrated herein. However, many modifications thereof will be apparent to persons skilled in the art without departing from the spirit and scope of this invention. For example, the system could be used in a closed system for heating liquids other than oil, and other types of burner systems having, for example, sonic atomization of fuel oil could be used.

In addition, it is contemplated that the principles of this system may be used in a variety of control circuits, such as bridge circuits in which the switches **46** and **47** are replaced by resistors which vary with temperature so that a different temperature oil supplied to these resistors would unbalance the bridge to produce a shutdown of the system. The temperature at which the switches **46** and **47** open could be set at the desired temperature of the oil in the vat **25** and used to control such temperature directly as well as being safety devices, thereby eliminating the need for the thermostat **35**. Accordingly it is contemplated that this invention be not limited to the particular details thereof disclosed herein except as defined by the appended claims.

What is claimed is:

1. A heat exchange system comprising:
- a source of heat comprising the products of combustion;
- a heat exchanger supplied with heat from said source comprising a plurality of paths having their inputs connected to the common plenum of a header structure for the flow of a common fluid from said header structure through said paths in parallel;
- the surface area of said heat exchanger exposed to said products of combustion being substantially greater than the surface area of said heat exchanger defining said paths;
- means for separately sensing the temperature of said fluid through at least a plurality of said paths; and
- means controlled by said sensing means for controlling at least parts of the operation of said system.

2. The system in accordance with claim **1** wherein said fluid comprises an organic liquid.

3. The system in accordance with claim **1** wherein said fluid comprises cooking oil.

4. The system in accordance with claim **1** and including means for pumping said fluid through said heat exchanger to a heat utilization load.

5. The system in accordance with claim **4** wherein said heat utilization load comprises a receptacle for cooking food.

6. The system in accordance with claim **5** wherein said fluid comprises cooking oil.

7. A heat exchanger comprising:
- a source of heat;
- a heat exchanger comprising a plurality of paths for the flow of a common fluid therethrough;
- means for separately sensing the temperature of said fluid through at least a plurality of said paths;
- means controlled by said sensing means for controlling at least parts of the operation of said system;
- means for pumping said fluid through said heat exchanger to a heat utilization load;
- said heat utilization load comprising a receptacle for cooking food;
- said fluid comprising cooking oil;
- a plurality of groups of tubular elements; and
- the tubular elements of each of said groups being connected in series.

8. The system in accordance with claim **7** wherein said tubular elements are spaced in a substantially cylindrical locus and are bonded to a plurality of spheres.

9. The system in accordance with claim **7** wherein said tubes are spaced around a central plenum containing said source of heat which is transferred to said fluid at a rate in excess of 50,000 BTU's per hour per square foot of effective heat exchange surface contacting said fluid.

10. The system in accordance with claim **1** wherein said source of heat comprises a burner supplied by a blower whose input is supplied with gaseous fuel from a substantially zero pressure regulator.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,830,221 Dated August 20, 1974

Inventor(s) William H. Hapgood

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Claims

Column 6, line 21, Claim 7, delete "exchanger" and insert therefor -- exchange system --.

Signed and Sealed this

thirtieth Day of *September 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

FORM PO-1050 (10-69)

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