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(54) PROCESS HEATER SYSTEM

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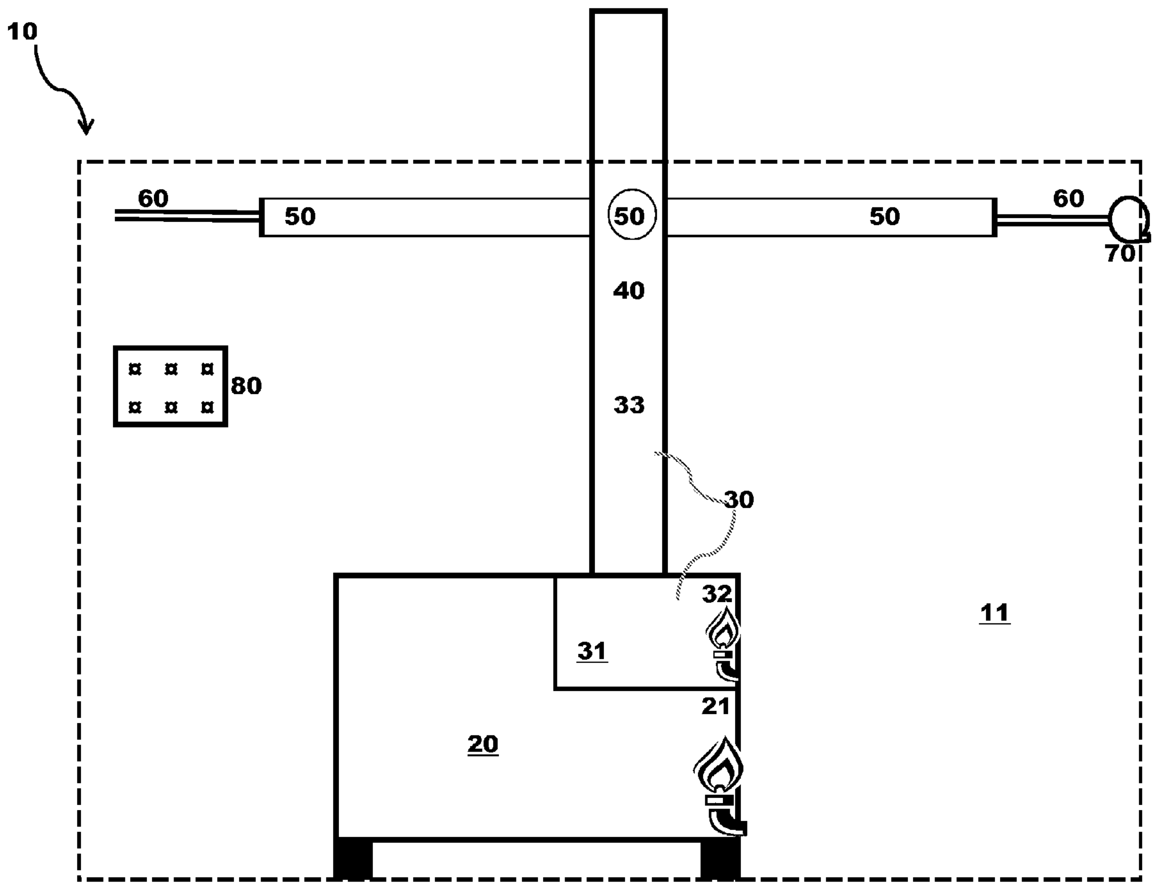
(52) **U.S. Cl.** **237/13**; 110/208; 110/210; 110/235; 110/229

(57) **ABSTRACT**

A process heater system (**10**) for an industrial envelope (**11**) comprises a main combustion chamber (**20**), an afterburner (**30**), and an exhaust stack (**40**). Retrofitted heat-recovery piping (**50**) receives combustion gas downstream of the after-burner (**30**) and uses it as a heat source for the industrial envelope. When the industrial load in the main combustion chamber (**20**) is paint, powder coating, varnish, epoxy, grease and/or oil, the secondary materials burned in the afterburner **30** can be considered alternative fuel, not solid wastes.



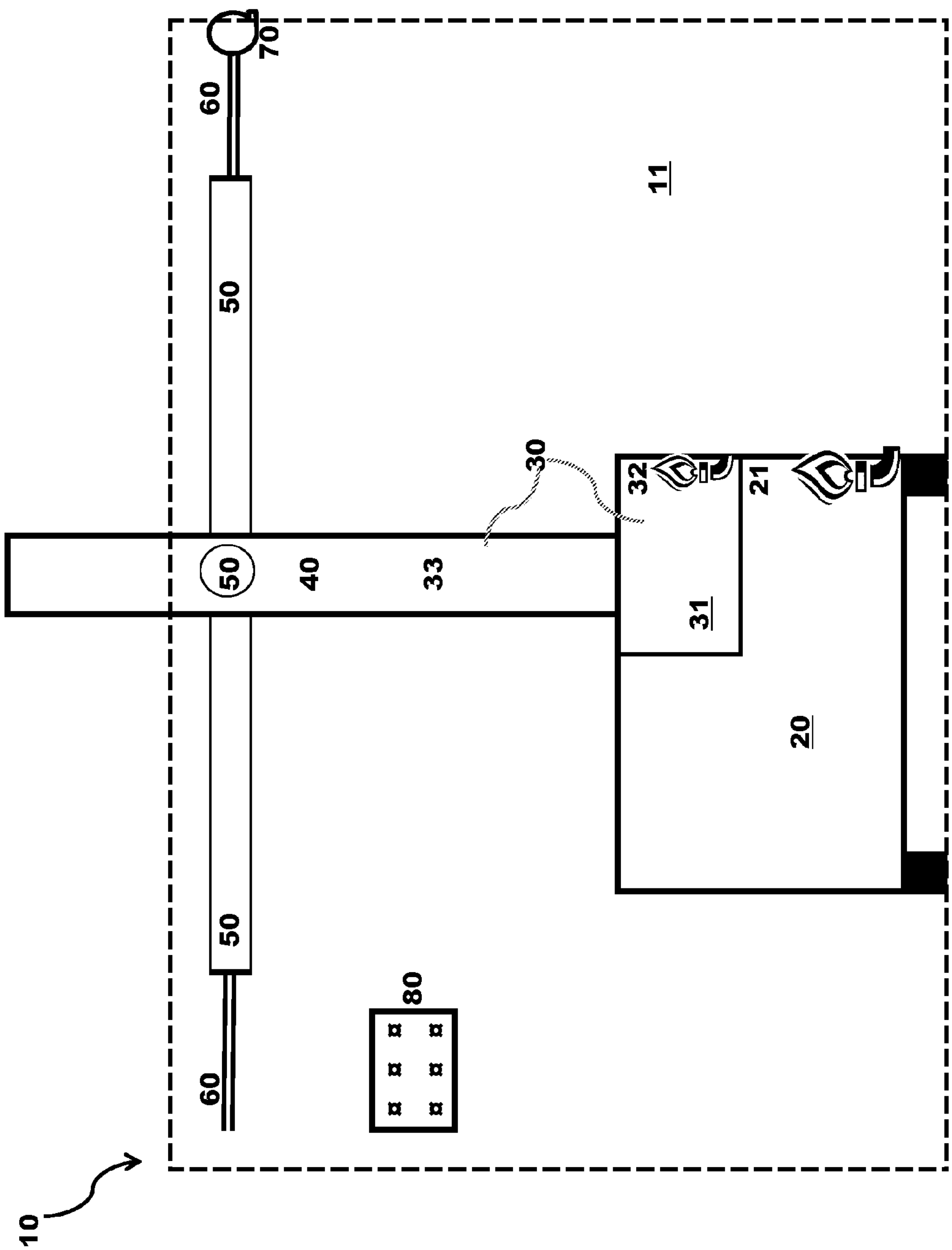


FIGURE 1

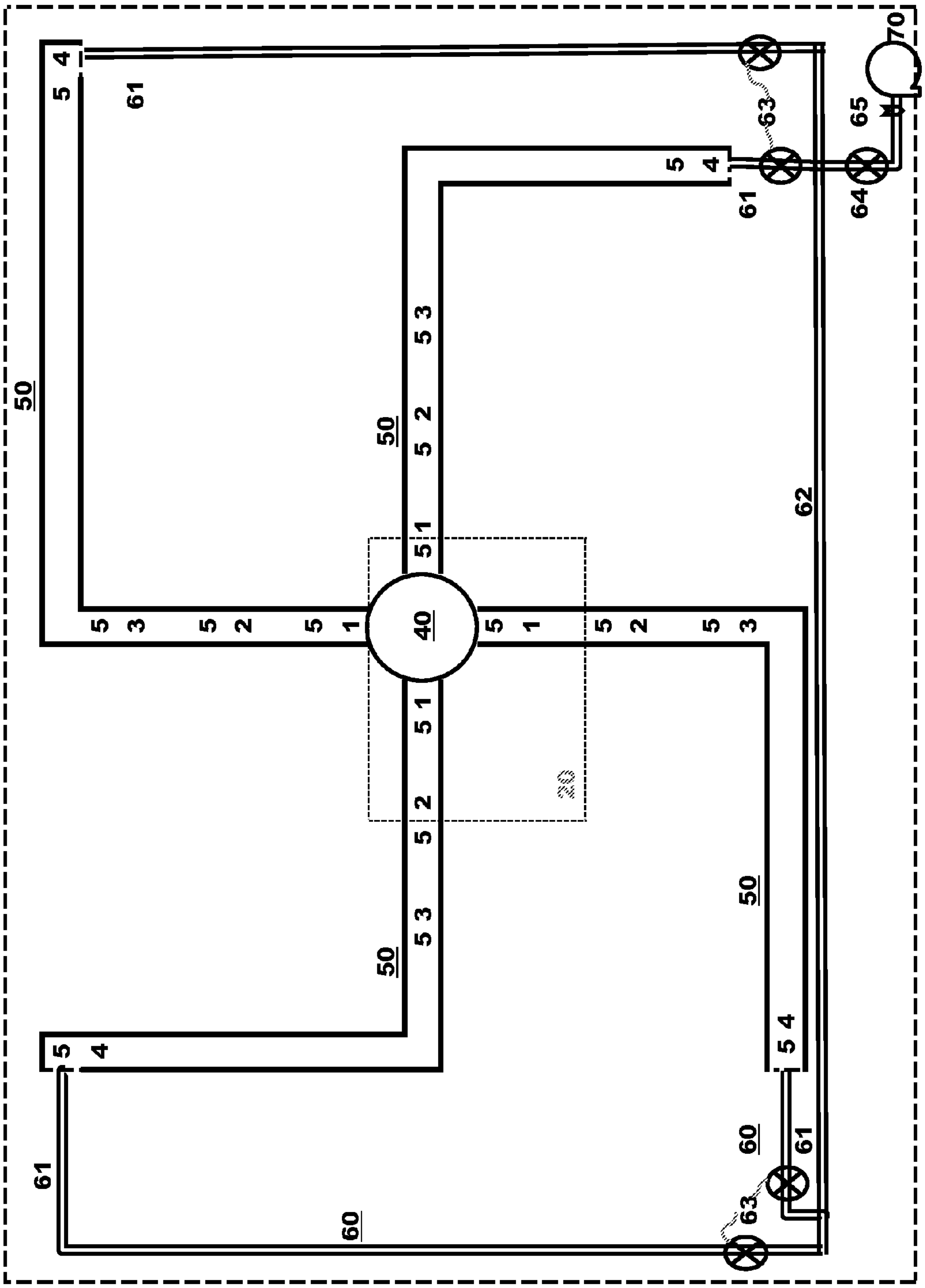


FIGURE 2

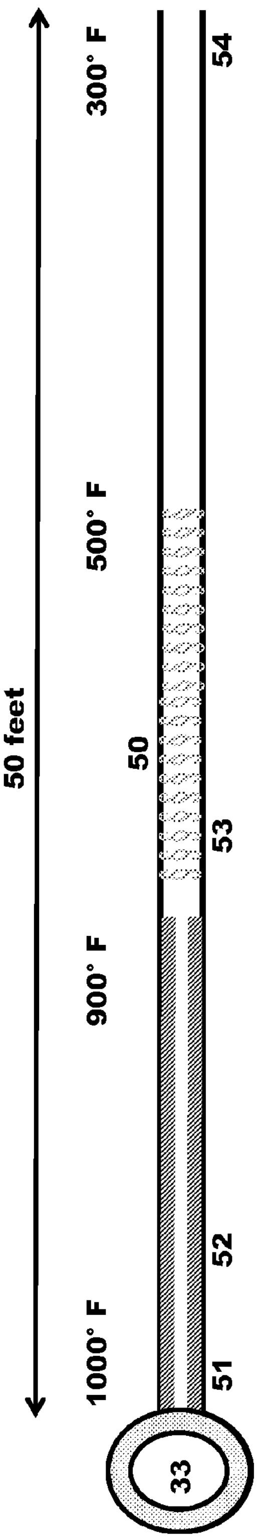


FIGURE 3

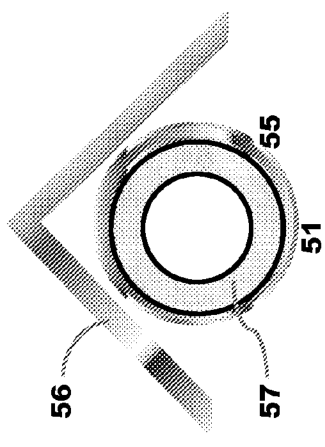


FIGURE 4

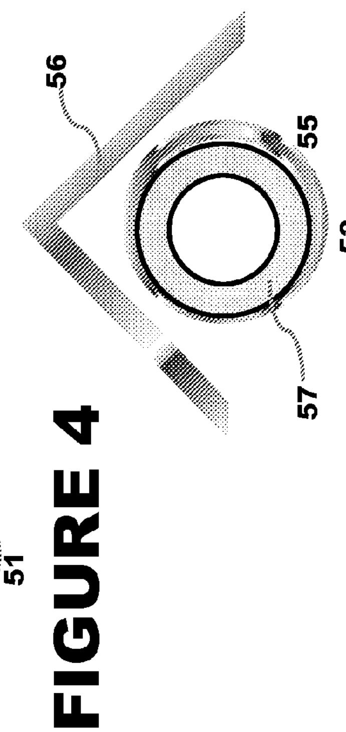


FIGURE 5

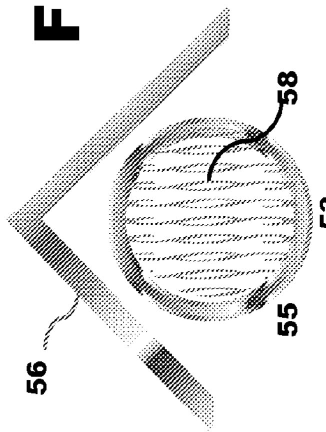


FIGURE 6

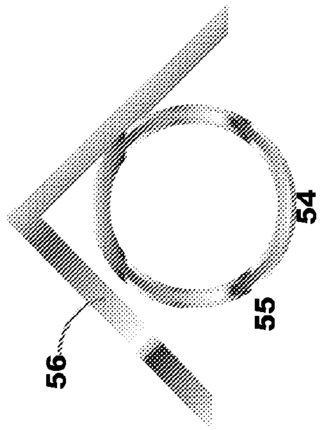


FIGURE 7

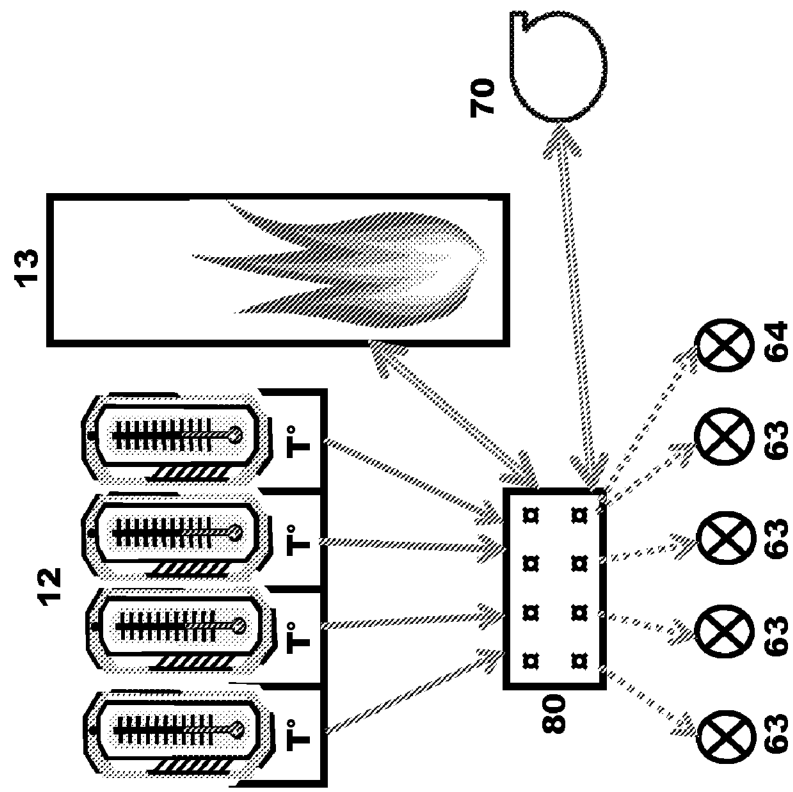


FIGURE 9

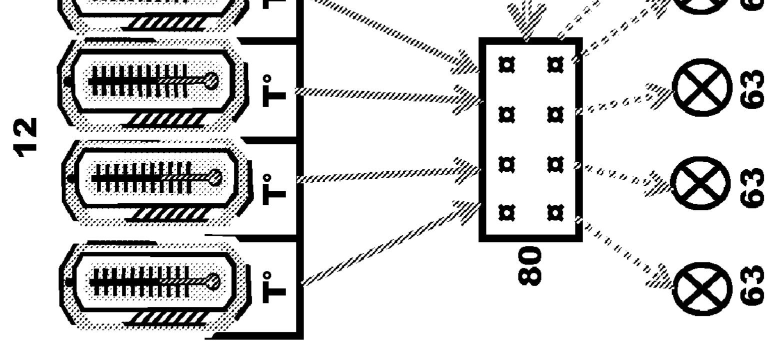


FIGURE 8

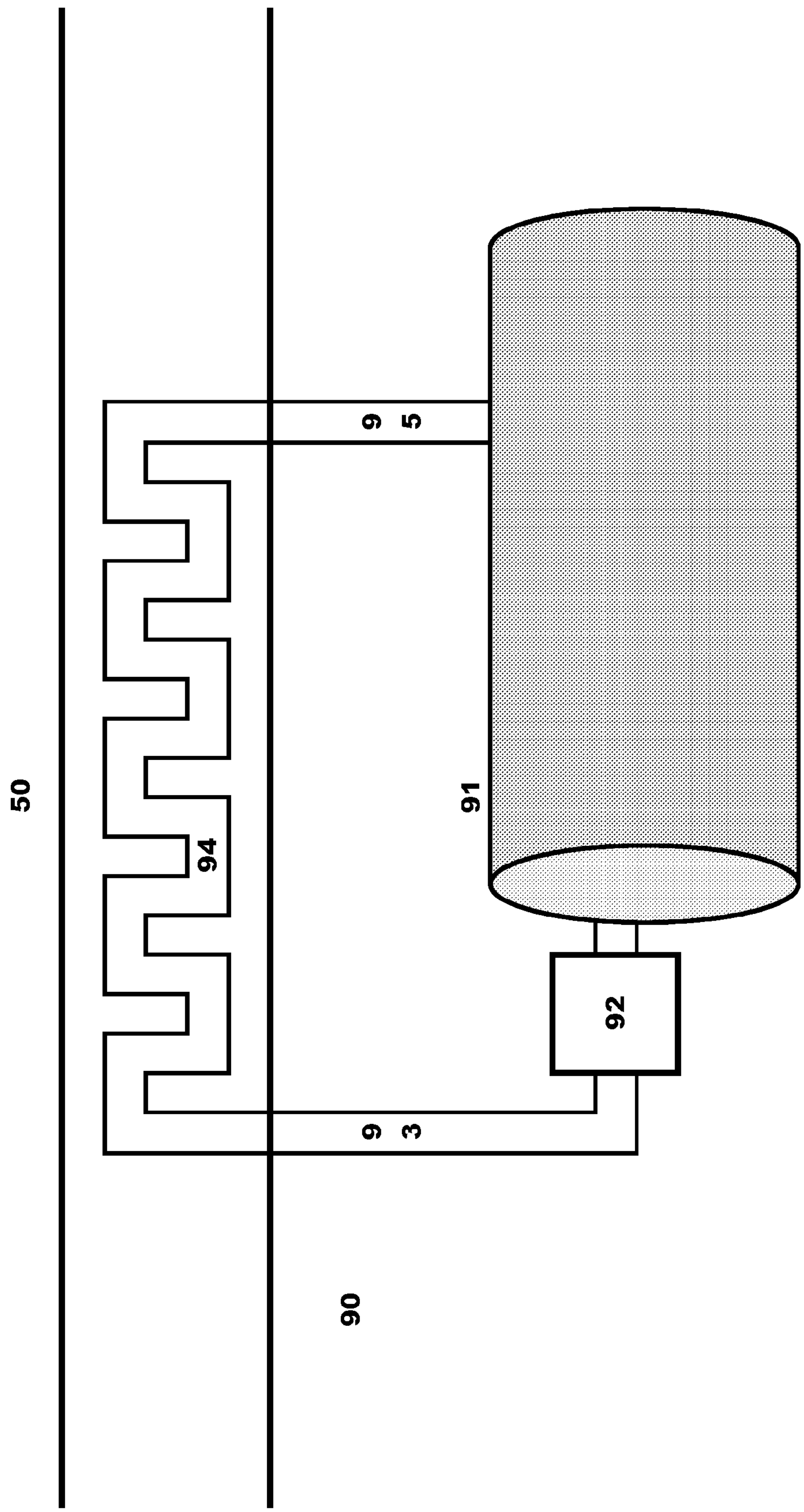


FIGURE 10

PROCESS HEATER SYSTEM

RELATED APPLICATION

[0001] This application claims priority under 35 U.S.C. 119(e) to U.S. Provisional Patent Application No. 61/370,804 filed on Aug. 4, 2011. The entire disclosure of this provisional application is hereby incorporated by reference.

BACKGROUND

[0002] An industrial process heater can comprise a main combustion chamber, an afterburner, and an exhaust stack. The main combustion chamber volatizes an industrial load (e.g., dry paint, powder coating, varnish, epoxy, oil, and/or grease). A supplemental combustion chamber which is a first zone (or zone one) of the afterburner, completes the combustion of non-hazardous volatized organic material. Combustion gas passes from the supplemental combustion chamber to a second zone (or zone two) of the afterburner. The combustion gas dwells for at least half a second in the afterburner, and then passes to the exhaust stack for exhaust outside the envelope of the industrial facility.

SUMMARY

[0003] A system is provided wherein stack-exhaust heat is captured and transmitted for use as an energy source for the industrial envelope. For example, the stack-exhaust heat can be used to radiantly heat the envelope of the industrial facility. Alternatively, the recovered heat can be used to heat water or another liquid. In either or any event, material combusted in the afterburner is a recycled alternative fuel, not a solid waste.

DRAWINGS

[0004] FIG. **1** is a schematic side view of a process heater system for an industrial zone.

[0005] FIG. **2** is a schematic top view of the process heater system.

[0006] FIG. **3** is a schematic view of a radiant-heat pipe straightened to show temperature distribution along its length.

[0007] FIGS. **4-7** are sectional views of different regions of the radiant-heat pipe.

[0008] FIGS. **8** and **9** are each diagrams of heating control procedures.

[0009] FIG. **10** is a schematic view of a liquid-heating cycle for the process heater system.

DESCRIPTION

[0010] Referring now to the drawings, and initially to FIG. **1**, a process heater system **10** for an industrial envelope **11** is shown. The system **10** comprises a main combustion chamber **20**, an afterburner **30**, an exhaust stack **40**, and heat-recovery piping **50**. As is explained in more detail below, the piping **50** captures heat normally lost through the exhaust stack **40** and converts it into heat for use within the industrial envelope **11**.

[0011] The main combustion chamber **20** has a gas burner **21** and volatizes the industrial load. In other words, the industrial purpose of the process heater is performed in the main combustion chamber **20**. This purpose can comprise, for example, heat cleaning fixtures, parts, and/or equipment to remove non-hazardous material that is not a solid waste.

[0012] The afterburner **30** comprises a supplemental combustion chamber **31** having its own gas burner **32** and in communication with the main combustion chamber **20**. Often, as illustrated, the supplemental chamber **31** is within the same package perimeter as the main combustion chamber. The supplemental chamber **31** is considered the first zone of the afterburner **30** and its function is to complete the combustion of non-hazardous volatized organic material transported from the main chamber **20**.

[0013] The afterburner **30** comprises a second zone **33** located downstream of the supplemental combustion chamber **31**. This second zone **33** can be, as illustrated, outside the package perimeter of the chambers **20** and **31**, and vertically aligned with the exhaust stack **40**. The afterburner **30** can be sized so that combustion gas dwells therein for at least half a second. From the afterburner **30**, combustion gas passes to the exhaust stack **40** for exhaust outside the industrial envelope **11**.

[0014] The heat-recovery piping **50** can comprise a network of pipes which each include an adapter region **51**, an inlet region **52**, an intermediate region **53**, and an outlet region **54**. The adapter region **51** is connected to the exhaust stack **40** to receive combustion gas therefrom. An existing exhaust stack **40** can be retrofitted with the adapter region **51**.

[0015] The heat-recovery piping **50** can project, turn, and extend to effectively cover the industrial envelope **11**. For example, as is best seen by referring additionally to FIG. **2**, four pipes can extend tangentially outward from the exhaust stack **40** at settings that are approximately 90° apart. That being said, in some facilities fewer pipes (e.g., a single pipe) or more pipes may be sufficient/necessary to accommodate the relevant industrial envelope **11**.

[0016] The pipes **50** are preferably positioned close to the ceiling and horizontally oriented. For example, the pipes **50** can be hung about twelve to sixteen feet over the floor of the industrial envelope **11**. Lower heights are possible, but may require shielding to prevent overheating of personnel. Higher heights are also possible, but may result in lost heat (e.g., about 1% per foot). The pipes **50** can be supported by beams, girders or joists. The piping **50** may also be gradually sloped downward (e.g., about ¼ inch per each ten feet length) to prevent water accumulation.

[0017] As is best seen by referring additionally to FIG. **3**, combustion gas entering the pipe **50** will be at an extremely high temperature (e.g., at least 1000° F., at least 1100° F., at least 1200° F., at least 1300° F., at least 1400° F., about 1500° F. etc.). And preferably combustion gas exiting the pipe **50** will be at a much lower temperature (e.g., less than 800° F., less than 700° F., less than 600° F., less than 500° F., less than 400° F., about 300° F., etc.).

[0018] As shown in FIGS. **4-7**, the radiant-heat-pipe regions **51-54** can each include a cylindrical housing **55** forming the gas passage. The housing **55** is made of material (e.g., radiant galvanized steel) which allows infrared heat to be emitted therefrom. The piping **50**, and thus the housing **55**, can have an OD dimension in the range of 3-5 inches (e.g., 4 inches). The heat-recovery piping **50** can also include roof-like reflectors **56** along its length to insure that any radiant heat directed upward will be reflected downward towards the desired heating area.

[0019] In the adapter region **51** and the inlet region **52**, the heat-recovery piping **50** includes insulation **57** on its inside surface as shown in FIGS. **4-5**. This insulation **57** is provided to lower the radiant heat emitted by the corresponding housing **51** in regions **51**/**52** and to help retain the intense heat for transportation to regions **53** and **54**. The intermediate region

53 can include a turbulator **58** to spin the combustion gas along the interior surface of the pipe. The intermediate region **53** and the outlet region **54** can be without interior insulation.

[0020] Returning now back to FIG. **2**, the process heater system **10** can additionally comprise tail piping **60** and an exhaust device **70**. The tail piping **60** conveys the now cooler combustion gas to the exhaust device **70**. To this end, it can comprise, as illustrated, a branch **61** connected to the outlet region **54** of each radiant-heat pipe **50** and a common branch **62** connecting each branch **61** to the exhaust device **70**. The exhaust device **70** (e.g., a vacuum pump or exhaust fan), pulls fluid through the pipes **50**/**60** and into a safe region of the atmosphere outside the industrial envelope **11**. Dampers **63** can be provided in each tail pipe **60** to monitor the flow rate of combustion gas therethrough. A damper **64** can be provided on the common branch **62** and a drain **65** (for accumulated moisture) can be provided upstream of the exhaust device **70**.

[0021] As is shown in FIGS. **8** and **9**, a controller **80** can receive input from a thermostat **12** and convey instructions to the exhaust device **70** and/or the dampers **63**. If the industrial envelope **11** includes a conventional space heater **13** as shown in FIG. **9**, the controller **80** can likewise control it.

[0022] The exhaust device **70** can be continuously run to provide the system **10** with a "self-sealing" feature insuring that combustion gas does not escape into the industrial envelope **11**.

[0023] As is shown in FIG. **10**, the process heater system **10** can additionally or alternatively incorporate a liquid-heating cycle **90** (e.g., a tank **91**, a pump **92**, inlet tube **93**, heat exchanger **94**, and outlet tube **95**). With the cycle **90**, the liquid is heated by the combustion gas passing through the heat-recovery piping **50** and stored in a tank **91**. This liquid (e.g., water) can be used for locker room showers, industrial processing steps, or other applications requiring a heated fluid.

[0024] Thus, the system **10** is a process heater unit with an afterburner **30** and a heat recovery system (**50**, **60**, **70**, **80**, **90**). The material combusted in the afterburner **30** is fuel used to provide heat or other energy for the industrial envelope **11**. This fuel material is recycled and legitimately used as an alternative fuel or ingredient. It can be produced and used for energy recovery from a non-hazardous valuable commodity secondary material with meaningful heating value and without contaminants significantly higher in concentration than traditional fuel. When the industrial load in the main combustion chamber **20** is paint, powder coating, varnish, epoxy, grease and/or oil, the secondary materials burned in the afterburner **30** are not solid wastes.

[0025] Although the process heater system **10**, the main combustion chamber **20**, the afterburner **30**, the exhaust stack **40**, and/or the heat-recovery elements (**50**, **60**, **70**, **80**, **90**) have been shown and described with respect to a certain embodiment or embodiments, it is obvious that equivalent alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification and the annexed drawings.

REFERENCE NUMBERS

[0026] **10** process heater system
[0027] **11** industrial envelope
[0028] **12** thermostats
[0029] **13** space-heating unit
[0030] **20** main combustion chamber
[0031] **21** main combustion burner
[0032] **30** afterburner
[0033] **31** supplemental combustion chamber
[0034] **32** supplemental combustion burner
[0035] **33** second zone of afterburner
[0036] **40** exhaust stack
[0037] **50** heat-recovery piping
[0038] **51** adaptor region
[0039] **52** inlet region
[0040] **53** intermediate region
[0041] **54** outlet region
[0042] **55** housing
[0043] **56** reflector roof
[0044] **57** interior insulation sleeve
[0045] **58** turbulator
[0046] **60** tail piping
[0047] **61** separate branches
[0048] **62** common branch
[0049] **63** dampers for separate branch
[0050] **64** damper for common branch
[0051] **65** moisture drain
[0052] **70** exhaust device (vacuum pump)
[0053] **80** controller
[0054] **90** liquid-heating cycle
[0055] **91** tank
[0056] **92** pump
[0057] **93** inlet tube
[0058] **94** heat exchanger
[0059] **95** outlet tube

1. A process heater system (**10**) for an industrial envelope (**11**), comprising:
- a main combustion chamber (**20**) wherein an industrial load is combusted;
- an afterburner (**30**) comprising a supplemental combustion chamber (**31**) in communication with the main combustion chamber (**20**) and a second zone (**33**) in communication with the supplemental combustion chamber (**31**);
- an exhaust stack (**40**) receiving combustion gas from the second zone (**33**) of the afterburner (**30**) and exhausting it outside the industrial envelope (**11**); and
- heat-recovery piping (**50**) receiving combustion gas downstream of the second zone (**33**) the afterburner (**30**) and transmitting it for use within the industrial envelope (**11**), whereby material combusted in the afterburner (**30**) is fuel used to provide energy for the industrial envelope (**11**).

2. A process heater system (**10**) as set forth in claim **1**, wherein the afterburner (**30**) is sized so that combustion gas dwells therein for at least half a second.

3. A process heater system (**10**) as set forth in claim **1**, wherein the industrial load in the main combustion chamber (**20**) is paint, powder coating, varnish, epoxy, grease and/or oil.

4. A process heater system (**10**) as set forth in claim **1**, wherein the material combusted in the afterburner (**30**) has a meaningful heating value and is without contaminants significantly higher in concentration than traditional fuel.

5. A process heater system (**10**) as set forth in claim **1**, wherein the main combustion chamber (**20**) volatizes the industrial load.

6. A process heater system (**10**) as set forth in claim **1**, wherein the main combustion chamber (**20**) has a gas burner (**21**).

7. A process heater system (**10**) as set forth in claim **1**, wherein the industrial purpose of the main combustion chamber (**20**) is to heat clean fixtures, parts, and/or equipment to remove non-hazardous material.

8. A process heater system (**10**) as set forth in claim **1**, wherein the afterburner (**30**) comprises a supplemental combustion chamber (**31**).

9. A process heater system (**10**) as set forth in claim **8**, wherein the supplemental combustion chamber (**31**) has its own gas burner (**32**).

10. A process heater system (**10**) as set forth in claim **8**, wherein the supplemental combustion chamber (**31**) is in communication with the main combustion chamber (**20**).

11. A process heater system (**10**) as set forth in claim **8**, wherein the supplemental chamber (**31**) is in the same package perimeter as the main combustion chamber (**20**).

12. A process heater system (**10**) as set forth in claim **8**, wherein the supplemental combustion chamber (**31**) combusts non-hazardous volatized organic material transported from the main combustion chamber (**20**).

13. A process heater system (**10**) as set forth in claim **1**, wherein the afterburner (**30**) comprises a second zone (**33**).

14. A process heater system (**10**) as set forth in claim **13**, wherein the second zone (**33**) is located downstream of a/the supplemental combustion chamber (**31**).

15. A process heater system (**10**) as set forth in claim **13**, wherein the second zone (**33**) is outside of the package perimeter of the main combustion chamber (**20**).

16. A process heater system (**10**) as set forth in claim **13**, wherein the second zone (**33**) is vertically aligned with the exhaust stack (**40**).

17. A process heater system (**10**) as set forth in claim **1**, wherein the heat-recovery piping (**50**) projects, turns, and extends to effectively cover the industrial envelope (**11**).

18. A process heater system (**10**) as set forth in claim **1**, wherein four pipes extend tangentially outward from the exhaust stack (**40**) at settings that are approximately 90° apart and wherein each pipe (**50**) includes an adapter region (**51**) connected to the exhaust stack (**40**) to receive combustion gas therefrom.

19. A process heater system (**10**) as set forth in claim **18**, wherein the exhaust stack (**40**) is retrofitted with the adapter region(s) (**51**).

20. A process heater system (**10**) as set forth in claim **18**, wherein the exhaust stack (**40**) is manufactured to include the adapter region(s) (**51**).

* * * * *