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(54) **APPARATUS FOR RECLAIMING WASTE HEAT FROM A HEATING DEVICE FLUE PIPE**

(76) Inventor: **Larry Stanley DEARBORN**, Hermon, ME (US)

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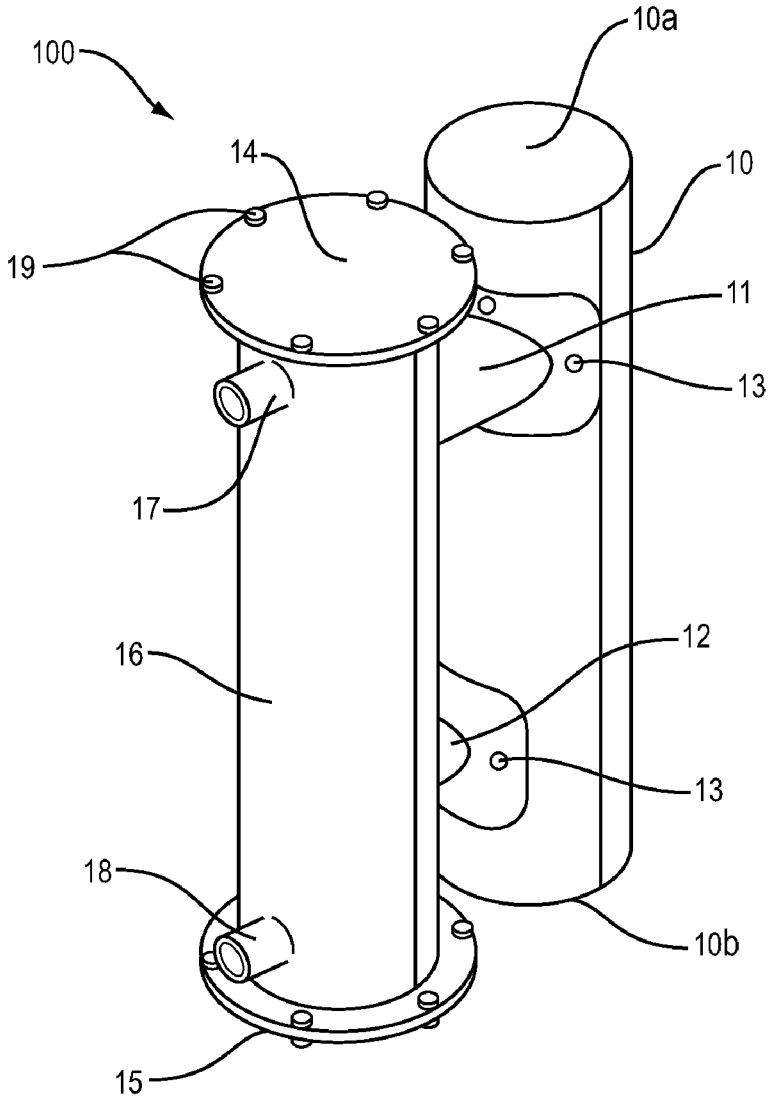
(57) **ABSTRACT**

A waste heat reclamation apparatus for reclaiming combustion gases from a heating unit. The apparatus includes a flue section that engages the given heating unit's flue stack and selectively bypasses flue gases into a bypass section of the apparatus. The bypass section includes a fluid jacket for heat transfer of waste heat in the flue gases to a heat absorbing fluid of a fluid-based heating system. The bypass section and flue section route flue gases by way of offset conduits which promotes swirling action of the flue gases within the bypass section. The fluid jacket also includes baffles which promote mixing of the heat absorbing fluid along a circuitous path. The swirling action and mixing in the circuitous path increase the efficiency of heat transfer without adding mechanical complexity to the apparatus.



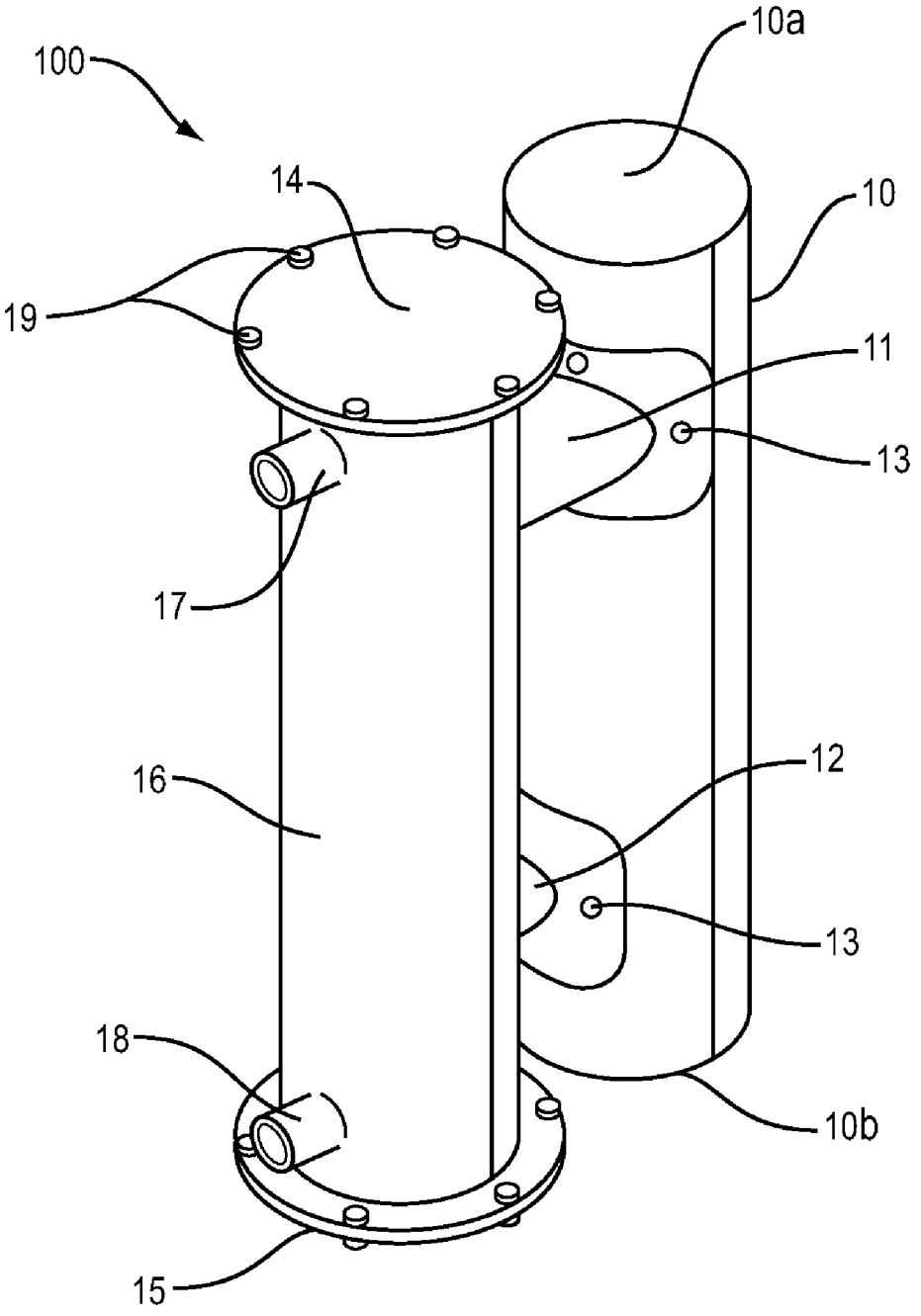


FIG. 1

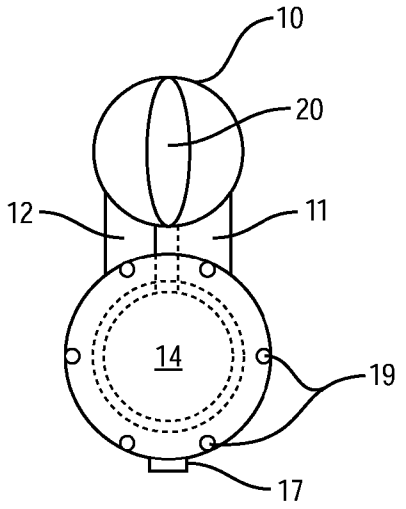


FIG. 2

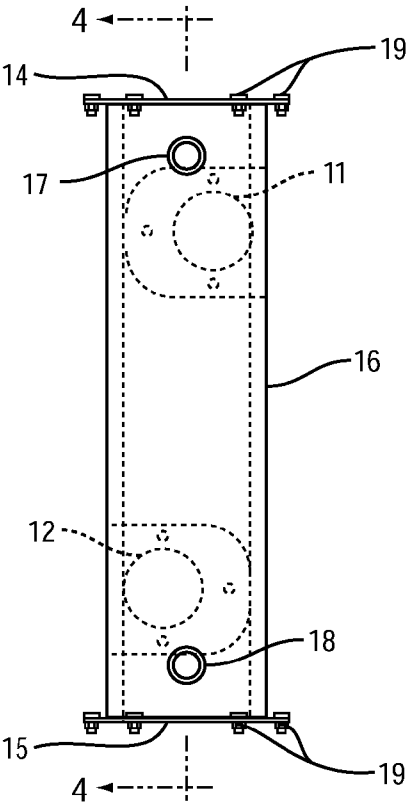
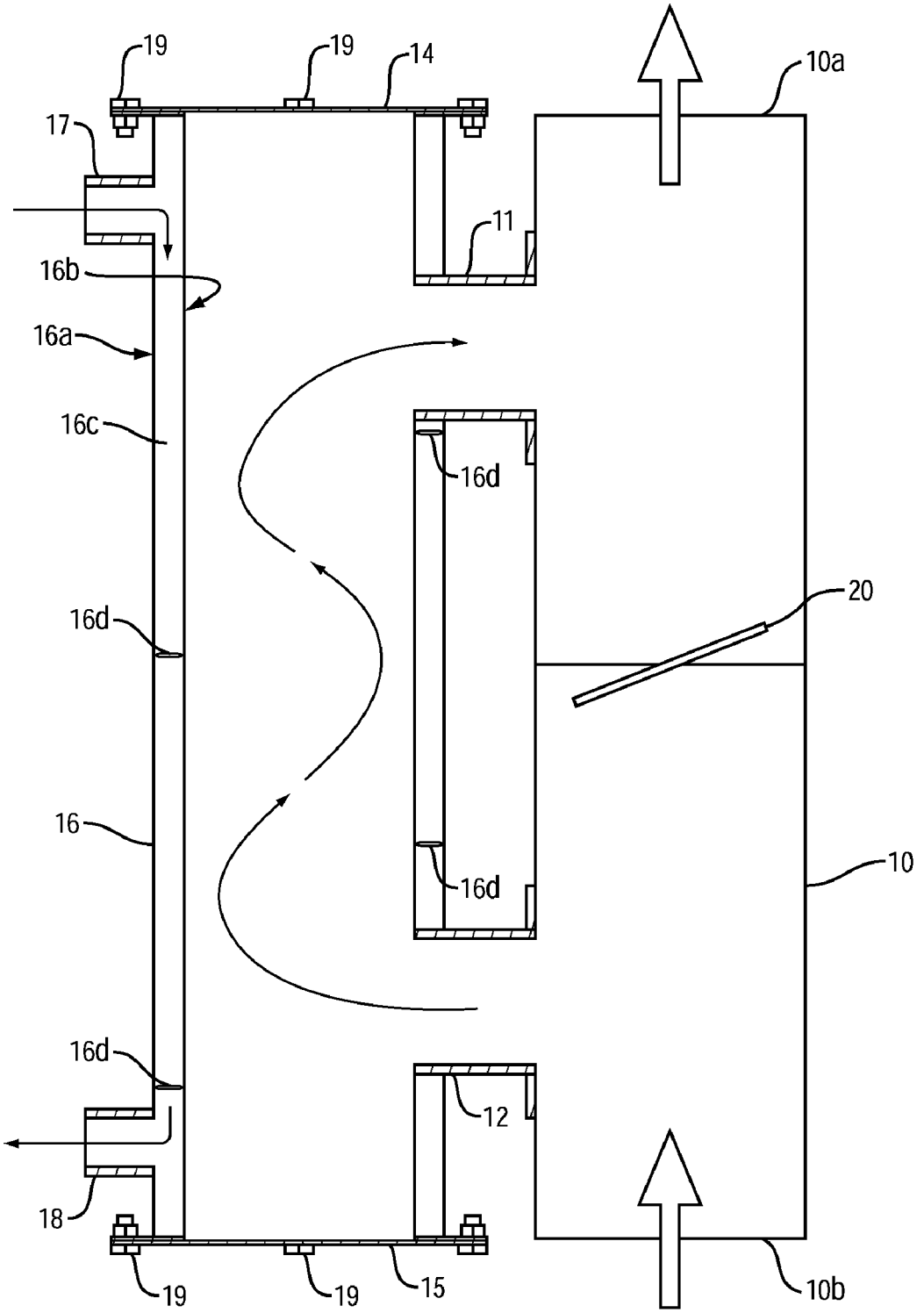


FIG. 3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19
14
10a
17
11
16b
16a
16c
16d
20
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19
19
15
10b

FIG. 4

APPARATUS FOR RECLAIMING WASTE HEAT FROM A HEATING DEVICE FLUE PIPE

FIELD OF THE INVENTION

[0001] The present invention relates generally to energy reclamation. More particularly, the present invention relates to reclaiming energy in the form of waste heat from a flue pipe of a heating device.

BACKGROUND OF THE INVENTION

[0002] In the field of heating, there have been numerous attempts at increasing efficiency of heating devices. In particular, combustion heating devices including furnaces and stoves fired by oil, wood, propane, natural gas, coal, and any other readily combustible fuel source all suffer from heat loss inherent to the combustion process. Specifically, a large percentage of heat generated by the process of combustion is lost during the venting of burned gases. This effectively means that useful heat is vented out of the flue pipe of the furnace or stove. In this manner, useful heat is wasted. Several attempts have been made to recapture this waste heat.

[0003] U.S. Pat. No. 2,567,452 issued to Strahan discloses a super-heater for furnaces and the like. This device provides a mechanism to divert flue gases into a series of parallel, V-shaped tubes. In effect, this multiplies the surface area of the existing flue and results in increased transfer of heat from the V-shaped tube surfaces to the surrounding airspace. This passive mechanism can be subject to significant creosote and soot build-up and difficulty in cleaning. As well, this mechanism relies solely upon air convection and can only provide additional heating to the immediately adjacent area.

[0004] U.S. Pat. No. 3,442,324 issued to Clay, Jr. et al. discloses a heat recovery device for turbine gases. This device provides a series of tubes within a duct through which hot gases exit. The tubes are within the primary flow path. The tubes include fins and allow passage of heat conducting fluid within each tube. In this manner, heat from the exiting gases is conducted onto the fins, into the tube, and thereby transferred to the heat conducting fluid flowing therewithin. This device is subject to maintenance difficulties as the relatively complicated tube structure is situated in the primary flow path of the hot gases.

[0005] U.S. Pat. No. 4,318,367 issued to Antonucci discloses an energy recovery device that can be installed in the exhaust of heat producing equipment. The device includes a conduit having a main and bypass chamber. Fluid conducting coils are also included and are mounted within the main chamber for passing fluid therethrough. To reduce the effect of leaked exhaust, a relief device operates to connect in parallel the main and bypass chambers in response to a differential pressure therebetween exceeding a predetermined magnitude. This device is subject to maintenance difficulties as the relatively complicated tube structure is situated in the primary flow path of the hot gases.

[0006] U.S. Pat. No. 4,373,473 issued to Grandmont discloses a heat recuperating water heating system having a water receiving enclosure to which is mounted a burner to provide a source of heat to the water. The products of combustion from this heat source are carried through a flue which is modified to include a manifold equipped with a continuous doubly wound coil defining inner and outer concentric loops. The loops are connected to a pair of conduits. A water circulator is mounted in one of the conduits and is electrically connected to the burner so that each time the burner operates, the circulator is also set in operation and provides a constant determined flow of water in the coil. This device is subject to maintenance difficulties as the relatively complicated tube structure is situated in the primary flow path of the hot gases.

[0007] U.S. Pat. No. 4,512,288 issued to Michaud discloses a heat recovery system that recovers heat from flue gases from a furnace or the like and a hot water cylinder. Flue gases are passed through a series of chambers in which coils are located. Water is passed through the coils in a direction opposite to flue gas flow to maximize heat transfer and the heated water is passed to either a heat radiating system or into preheater tank for the hot water supply. The coils for the heat radiation and water heating are in separate circuits and the flue gases from the hot water is passed only over the coil used for water heating. Pumps are used for water recirculation in both the heat radiating circuit and the water heating circuit. The system has application to domestic and industrial furnaces with small diameter exhaust vents. This device is subject to maintenance difficulties as the relatively complicated tube structure is situated in the primary flow path of the hot gases.

[0008] U.S. Pat. No. 5,097,801 issued to Burns discloses a waste energy hot water heater which extracts heat energy through heat exchange with flue gas from a primary heating device. The water heater has a removable heat exchanger and a flue gas bypass system to avoid overheating the heat exchanger. This device is subject to maintenance difficulties as the relatively complicated tube structure is situated in the primary flow path of the hot gases.

[0009] U.S. Pat. No. 5,406,934 issued to Cain discloses a heat recovery apparatus for increasing the efficiency of a furnace having a cold air return, a burner, a hot air outlet, and a hot air exhaust. The heat recovery apparatus includes a finned coiled heat exchanger located in the exhaust and having a water inlet and a water outlet. The water outlet is connected via a silicone tube to a second water inlet on a core heat exchanger located in the cold air return. The core heat exchanger has a water outlet connected via second silicone tube to a water reservoir tank. The water reservoir tank contains water and a pump submerged within the water. The pump has a third water inlet and a third water outlet. The third water outlet is connected via a third silicone tube to the water inlet of the coiled heat exchanger. Although this device purports to increase the efficiency of a non-high efficiency furnace, the added mechanisms provide additional complexity which can negate any increase to efficiency added by the device. Accordingly, a more complicated system is formed which may not produce any net efficiency gains.

[0010] It is, therefore, desirable to provide a device for reclaiming energy in the form of waste heat from a flue pipe of a heating device that is efficient, safe, and easy to maintain.

SUMMARY OF THE INVENTION

[0011] It is an object of the present invention to obviate or mitigate at least one disadvantage of previous heat recovery devices.

[0012] In a first aspect, the present invention provides an apparatus for waste heat reclamation from combustion gases, the apparatus including: a flue section for engagement with a flue stack, the flue section having a lower area and an upper area; an inflow conduit located in the lower area of the flue section; an outflow conduit located in the upper area of the

flue section; a bypass section connected to the flue section via the inflow conduit and the outflow conduit, the bypass section including an interior space; an inlet port located at one end of the bypass section near the upper area of the flue section; an outlet port located at another end of the bypass section near the lower area of the flue section; and a damper for selectively controlling flow of the combustion gases through the inflow conduit and the outflow conduit; wherein the inflow conduit and the outflow conduit are offset from a longitudinal axis of the apparatus.

[0013] In a further embodiment, there is provided an apparatus for waste heat reclamation from combustion gases, the apparatus including: a flue section for engagement with a flue stack, the flue section having a lower area for input of the combustion gases and an upper area for egress of the combustion gases; an inflow conduit located in the lower area of the flue section, the inflow conduit for selectively inputting the combustion gases therethrough; an outflow conduit located in the upper area of the flue section; the outflow conduit for selectively exiting the combustion gases therethrough; a bypass section configured to extract heat from the combustion gases and connected to the flue section via the inflow conduit and the outflow conduit, the bypass section being substantially formed by two concentric tubes and including an interior space located between the two concentric tubes, the interior space including a plurality of baffles to form a circuitous path for heat absorbing fluid so as to enable heat transfer from the combustion gases to the heat absorbing fluid; an inlet port located at one end of the bypass section near the upper area of the flue section, the inflow conduit accepting a cold return of the heat absorbing fluid from a fluid-based heating system; an outlet port located at another end of the bypass section near the lower area of the flue section; the outlet port providing, after the heat transfer, an exit for the heat absorbing fluid to the fluid-based heating system; and a damper for selectively controlling flow of the combustion gases through the inflow conduit and the outflow conduit; wherein the inflow conduit and the outflow conduit are offset from a longitudinal axis of the apparatus.

[0014] Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Embodiments of the present invention will now be described, by way of example only, with reference to the attached Figures.

[0016] FIG. **1** is a perspective view of a heat reclamation apparatus in accordance with the present invention.

[0017] FIG. **2** is a top view of the heat reclamation apparatus as shown in FIG. **1**.

[0018] FIG. **3** is a side view of the heat reclamation apparatus as taken from the left side of the apparatus in FIG. **1**.

[0019] FIG. **4** is a cross-sectional view of the heat reclamation apparatus taken along line **4-4** seen in FIG. **3**.

DETAILED DESCRIPTION

[0020] Generally, the present invention provides a heat reclamation apparatus for reclaiming energy in the form of waste heat from a flue pipe of a heating device. The apparatus is a self-contained unit that can be inserted into an existing flue stack between an existing heating unit and an existing chimney. Once installed in the existing flue stack, the apparatus is connected to an existing heating system such as, but not limited to, a hot water baseboard (HWBB) system. While an existing hydronic heating system like HWBB may utilize the present invention, it should also be readily apparent that the invention can successfully heat air as well as a fluid. As well, on outdoor wood boilers may benefit from the present invention. In this manner, the apparatus can capture waste heat exiting the flue and transfer it to the existing heating system.

[0021] With reference to FIG. **1**, a heat reclamation apparatus **100** is shown in accordance with the present invention. The apparatus **100** includes a flue section **10** and a bypass section **16**. While a vertical implementation is illustrated, it should be understood that the present invention may be equally suited for a horizontal implementation without straying from the intended scope of the present invention. The flue section **10** is dimensioned with openings **10***a* and **10***b* which readily enable connection to an existing flue stack (not shown). Such existing flue stack will typically have flue diameters in the range of 6 to 10 inches. Accordingly, the flue section **10** may be formed of various flue diameters and thereby provided in different sizes for the variety of existing flue stacks currently in use within the heating art. Such variation in sizing is, of course, well within the intended scope of the present invention.

[0022] The flue section **10** may also be configured to include openings **10***a* and **10***b* that form male and/or female ends. For example, flue section **10** may be configured with a 7 inch diameter for installation of the apparatus into a 7 inch diameter existing flue stack where the opening **10***a* may be slightly reduced to a 6.75 inch diameter and the opening **10***b* may be slightly enlarged to a 7.25 inch diameter thus, respectively, forming male and female ends which mate to the existing flue stack upon removal of a section thereof.

[0023] With further regard to FIG. **1**, the flue section **10** is attached to the bypass section **16** by way of an outflow conduit **11** and inflow conduit **12**. As shown, the inflow conduit **12** is located at a lower area of the flue and bypass sections **10**, **16** and the outflow conduit **11** is located at an upper area of the flue and bypass sections **10**, **16**. While ends of the flue section **10** are open, the ends of the bypass section **16** are sealed by way of caps **14**, **15**. These caps **14**, **15** are circular plates attached via bolts **19** at flanges formed along the edges of ends of the bypass section **16**. The inflow conduit **12** and outflow conduit **11** along with the flue section **10**, bypass section **16**, and caps **14**, **15** are all formed from a sufficiently durable material to withstand temperatures normally associated with combustion gases from any combustion heating appliance. Preferably, a heavy gauge steel construction can be used to satisfy this requirement. It should also be understood that, although bolts **19** are shown, any manner of removable attachment may be used to connect the caps **14**, **15** to the ends of the bypass section **16** without straying from the intended scope of the present invention. The requirement of removability of the caps **14**, **15** is to enable cleaning of the interior of the bypass section **16** which will be further explained hereinbelow.

[0024] The bypass section **16** as shown in FIG. **1** also includes inlet port **17** and an outlet port **18**. These ports **17**, **18** are formed, respectively at the upper and lower areas of the bypass section **16**. The bypass section **16** is formed by two concentric tubes with an interior space (visible as element **16***d* as later described with regard to FIG. **4**). The inlet port **17**

is connectable to a cold return of a fluid based (e.g., hydronic) heating system (not shown) and the outlet port **18** is correspondingly connectable to a heated supply of such system. Flow of a heat transfer fluid, such as water, glycol, or any other suitable heat-absorbing fluid, occurs from the inlet port **17** through the interior space (element **16***d* in FIG. **4**) of the bypass section **16** and out from the outlet port **18**.

[0025] FIG. **2** shows a top view looking down towards the apparatus **100** of FIG. **1**. Here, an internal damper **20** is shown in a partially open position within flue section **10**. The internal damper **20** is formed by a weighted plate that is hinged in a manner so as to pivot in and out of an obstructing position within the flue section **10**. It should also be noted that the outflow and inflow conduits **11**, **12** are each offset at opposite sides of a longitudinal center. Such offset is a useful feature of the present invention and will be further described hereinbelow with regard to the flow of flue gases. FIG. **2** also shows the top-most cap **14** and the array of bolts **19** located along the periphery of cap **14**. As well, inlet port **17** is visible protruding beyond the outer periphery of the cap **14** from the side of the bypass section **16**.

[0026] With regard to FIG. **3**, there is shown a side view of the apparatus **100** taken along the side shown in FIG. **1** that includes the inlet and outlet ports **17**, **18**. Here, the offset mentioned above between outflow and inflow conduits **11**, **12** (shown by dotted line) can be clearly seen relative to line **4-4** which is indicative of the central longitudinal axis of the apparatus **100**. The inlet and outlet ports **17**, **18** are placed at far opposite ends from one another in order to maximize the distance traveled by the heat transfer fluid therebetween. As well, caps **14**, **15** are visible along with bolts **19** retaining the caps **14**, **15** in place.

[0027] Operation of the apparatus in accordance with the present invention will now be described with regard to FIG. **4**. Here, the apparatus **100** is shown in cross-section as the view taken along line **4-4** from FIG. **3**. The normal flow of heated gases is shown by way of upward arrows within flue section **10**. Heated gas enters flue section **10** at opening **10***b* and exits flue section **10** at opening **10***a*. The path taken by the heated gas depends upon whether the damper **20** is in an open or a closed position. As shown, the damper **20** is in a partially open position for purposes of illustrating the damper. If the apparatus **100** were not in use, the damper **20** would be placed into a fully open position such that heated gas is allowed to flow unimpeded and directly from opening **10***b* through flue section **10** to opening **10***a*. However, during use of the apparatus **100**, the damper **20** would be placed into a fully closed position whereby flow of the heated gas is sent instead from opening **10***b* into the inflow conduit **12** through the bypass section **16** and then out of the outflow conduit **11** and exiting through opening **10***a*. The advantageous offset arrangement of the inflow and outflow conduits **12**, **11** mentioned above provides a swirling effect (indicated by curved arrows) within the bypass section **16**. This swirling effect slows flow of the heated combustion gases so as to promote and enhance the transfer of heat from the heated gases to the heat transfer fluid which itself flows in a generally opposite direction from inlet port **17** to outlet port **18**.

[0028] As mentioned above, the bypass section **16** is formed by two concentric cylinders that include an outer wall **16***a* and an inner wall **16***b*. The interior space **16***c* formed between the outer and inner walls **16***a*, **16***b* is dimensioned to allow flow of the heat transfer fluid therewithin. Generally speaking, this configuration can be described as a "water jacket" that surrounds the interior of the bypass section **16**. As mentioned, flow of the heat transfer fluid within this water jacket occurs into the inlet port **17** and out of the outlet port **18** as indicated by arrows as shown. This results in a flow of the heat transfer fluid that is in an opposite direction to the flow of the heated combustion gases. This maximizes the length of time that heat transfer can occur.

[0029] Further enhancing heat transfer, there are provided baffles **16***d* that are partial blockages of the interior space **16***c*. The baffles **16***d* can be formed by any configuration of material such as, but not limited to, ½ or ¼ arcuate plates affixed between the outer and inner walls **16***a*, **16***b*. These baffles **16***d* may vary in size, spacing, and shape in order to provide a desired circuitous route of the heat transfer fluid in a manner that further maximizes heat transfer into the heat transfer fluid through the inner wall **16***b* from the heated combustion gases.

[0030] The heat transfer fluid and the fluid based heating system are not described herein as they are consider to be elements outside the scope of the present invention. The inlet port **17** and outlet port **18** are shown in simplified form. However, it should be well understood by one of ordinary skill in the heating art that ports **17**, **18** may be formed by any well known connection mechanism that includes direct welding to copper piping, compression fit plumbing connectors, threaded piping, or any other appropriate coupling mechanism without straying from the intended scope of the present invention. The present inventive apparatus **100** is applicable for use within any fluid based heating system such as, but not limited to, a hot water baseboard system, a radiant heat system, a domestic hot water supply, a stand-alone heating system such as a hot-tub, or any other fluid-based heating unit, mechanism, or related system. Likewise, the present inventive apparatus **100** is applicable for use in conjunction with any heating device that emits heated combustion gases via a flue.

[0031] In terms of operation and maintenance of the present inventive apparatus **100**, it should be further understood that the damper **20** may be a manual device or may be electromechanically actuated. Safety features including automatic opening of the damper **20** during a power failure (which may cause circulation of the heat transfer fluid to cease and thereby overheat) can also be provided to the present apparatus **100**. Such electronics and electromagnetic actuators are themselves well known elements and as such are not further described herein. Still further, the heat exchanging nature of the bypass section **16** may also lead to well-known creosote buildup within the bypass section. The damper **20** may be designed to automatically open when such buildup prevents adequate and safe flow of heated combustion gases therethrough. Again, such details related to this automated feature are well within the skill of those in the electromechanical damper art.

[0032] As noted above, bolts **19** are provided to retain the caps **14**, **15** upon the ends of the bypass chamber. The caps **14**, **15** may also be provided to completely encapsulate the interior space **16***c* in a fluid-tight manner as an alternative to a more permanent end portion (not shown) affixed to the ends of the interior space **16***c*. Advantageously, the caps **14**, **15** are removable so as to enable clearing of soot, creosote, or any other debris or buildup within the bypass section **16**. Other alternatives to the bolts **19** are possible such as quick-release clamp devices, hinged plates, or the like without straying from the intended scope of the present invention and the intended ability for easy maintenance.

[0033] Still further, it should be readily apparent to one of ordinary skill in the art that the apparatus **100** may be formed of any suitably durable and heat resistant material. Likewise, the components of the present inventive apparatus **100** may be formed as shown in the accompanying figures or may otherwise be more integrated such that the flue section **10** and the bypass section **16** are formed integrally with the outflow and inflow conduits **11**, **12**. Likewise, any manner of metal-working may be utilized in the formation of the present inventive apparatus **100** including, but not-limited formation in part or in whole by way of sheet metal stamping, molding processes, casting processes, or the like. It should be understood that the present inventive apparatus **100** may either be quickly and easily installed by removal of an existing section of flue stack (i.e., retrofitting) or easily installed in new construction of a heating appliance's flue stack.

[0034] The above-described embodiments of the present invention are intended to be examples only. Alterations, modifications and variations may be effected to the particular embodiments by those of skill in the art without departing from the scope of the invention, which is defined solely by the claims appended hereto.

What is claimed is:

1. An apparatus for waste heat reclamation from combustion gases, said apparatus comprising:

a flue section for engagement with a flue stack, said flue section having a lower area and an upper area;

an inflow conduit located in said lower area of said flue section;

an outflow conduit located in said upper area of said flue section;

a bypass section connected to said flue section via said inflow conduit and said outflow conduit, said bypass section including an interior space;

an inlet port located at one end of said bypass section near said upper area of said flue section;

an outlet port located at another end of said bypass section near said lower area of said flue section; and

a damper for selectively controlling flow of said combustion gases through said inflow conduit and said outflow conduit;

wherein said inflow conduit and said outflow conduit are offset from a longitudinal axis of said apparatus.

2. The apparatus as claimed in claim **1**, further including a plurality of baffles located within said interior space of said bypass section, said interior space and said plurality of baffles forming a circuitous path for heat absorbing fluid passing from said inlet port to said outlet port.

3. The apparatus as claimed in claim **2**, further including at least one removable cap located at one end of said bypass section so as to facilitate maintenance of an inner surface of said bypass section.

4. The apparatus as claimed in claim **3**, further including first and second ones of said at least one removable cap each located at opposite ends of said bypass section.

5. The apparatus as claimed in claim **3**, further including a plurality of fasteners for removably securing said at least one removable cap to said bypass section.

6. The apparatus as claimed in claim **5**, wherein said plurality of fasteners include threaded bolts, said bypass section including at least one flange upon which said at least one removable cap is secured via said threaded bolts.

7. The apparatus as claimed in claim **2**, wherein said bypass section is substantially formed by two concentric tubes, said interior space being located between said two concentric tubes, and said plurality of baffles being formed by interspersed arcuate sections connecting said two concentric tubes.

8. The apparatus as claimed in claim **2**, wherein said flue section, said bypass section, said outflow conduit, said inflow conduit, said inlet port, said outlet port, said plurality of baffles, and said damper are each formed from a material suitable for high temperature exposure.

9. The apparatus as claimed in claim **8**, wherein said material is steel.

10. The apparatus as claimed in claim **2**, wherein said inlet port and said outlet port are formed to accept plumbing through which said heat absorbing fluid moves.

11. An apparatus for waste heat reclamation from combustion gases, said apparatus comprising:

a flue section for engagement with a flue stack, said flue section having a lower area for input of said combustion gases and an upper area for egress of said combustion gases;

an inflow conduit located in said lower area of said flue section, said inflow conduit for selectively inputting said combustion gases therethrough;

an outflow conduit located in said upper area of said flue section; said outflow conduit for selectively exiting said combustion gases therethrough;

a bypass section configured to extract heat from said combustion gases and connected to said flue section via said inflow conduit and said outflow conduit, said bypass section being substantially formed by two concentric tubes and including an interior space located between said two concentric tubes, said interior space including a plurality of baffles to form a circuitous path for heat absorbing fluid so as to enable heat transfer from said combustion gases to said heat absorbing fluid;

an inlet port located at one end of said bypass section near said upper area of said flue section, said inflow conduit accepting a cold return of said heat absorbing fluid from a fluid-based heating system;

an outlet port located at another end of said bypass section near said lower area of said flue section; said outlet port providing, after said heat transfer, an exit for said heat absorbing fluid to said fluid-based heating system; and

a damper for selectively controlling flow of said combustion gases through said inflow conduit and said outflow conduit;

wherein said inflow conduit and said outflow conduit are offset from a longitudinal axis of said apparatus.

12. The apparatus as claimed in claim **11**, further including a first removable cap and a second removable cap each located at opposite ends of said bypass section.

13. The apparatus as claimed in claim **12**, further including a plurality of fasteners for removably securing each said first removable cap and said second removable cap to said bypass section.

14. The apparatus as claimed in claim **13**, wherein said plurality of fasteners include threaded bolts, said bypass section including flanges located at each end of said bypass

section upon which said first removable cap and said second removable cap are secured via said threaded bolts.

15. The apparatus as claimed in claim **14**, wherein said plurality of baffles are formed by interspersed arcuate sections connecting said two concentric tubes.

16. The apparatus as claimed in claim **15**, wherein said flue section, said bypass section, said outflow conduit, said inflow conduit, said plurality of baffles, and said damper are each formed from a material suitable for high temperature exposure.

17. The apparatus as claimed in claim **16**, wherein said inlet port and said outlet port are formed to accept plumbing through which said heat absorbing fluid moves, respectively, to and from said fluid-based heating system.

* * * * *