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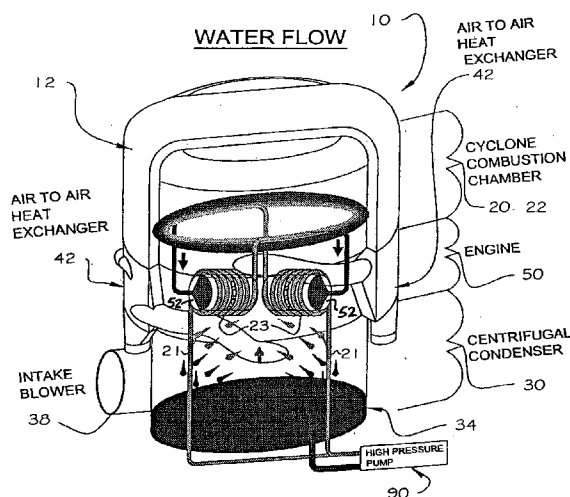
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(54) Title: **SPLITTER VALVE IN A HEAT REGENERATIVE ENGINE**



(57) Abstract: In a heat regenerative engine that uses water as both the working fluid and the lubricant, water is pumped through a single line of a coil that wraps around a cylinder exhaust, port, causing the water to be preheated by steam exhausted from the cylinder. The preheated water is then directed through multiple branch lines in a steam generator to produce high pressure super heated steam: A splitter valve at the juncture of the single line and multiple branch lines equalizes the flow among the multiple branch lines. A "Y" junction within the splitter valve minimizes turbulence as the flow of water and steam is directed into the multiple branch lines. Flow control restrictors in the splitter valve, allow unimpeded flow of fluid and steam towards the steam generator through each of the branch lines, while allowing any incremental over-pressure in any one branch line to "bleed" back to a branch line(s) bearing a lesser amount of pressure, thereby equalizing flow through the multiple branch lines.

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**SPLITTER VALVE IN A
HEAT REGENERATIVE ENGINE**

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BACKGROUND OF THE INVENTION

This application is a divisional patent application of co-pending
10 patent application serial no. 11/489,335 filed on July 19, 2006.

Field of the Invention

This invention relates to directing flow of fluid and steam from a
single line into multiple lines and, more particularly, to a splitter valve
15 at the juncture of a feeder line and multiple branch lines for equalizing
flow and pressure of fluid and steam among the multiple branch lines.

Discussion of the Related Art

20 In the art of steam generation it is known to direct water through
a metal tube (e.g., copper, aluminum, stainless steel) while exposing the
exterior surface of the tube to extremely high temperatures. Eventually,
after prolonged exposure to sufficient temperatures of heat, the water
traveling through the metal tube boils and turns into steam. Continuing

to expose the steam carrying metal tube to temperatures in excess of 1,200 degrees Fahrenheit will eventually cause the steam to become super heated steam. However, reaching super heated steam levels requires a substantial length of metal tube in order to provide sufficient
5 surface area for heat transfer. Accordingly, it has not been practical to generate steam within a compact area by directing water through a metal tube that is exposed to heat.

Splitting a feeder tube (i.e. feeder line) into multiple branch tubes (i.e. branch lines) having a combined cross-sectional area equal to the
10 feeder tube would effectively and significantly increase the tube surface area within the same volume of space. By increasing the tube surface area and decreasing the tube size, the efficiency of heat transfer is greatly improved. Additionally, the smaller tube diameter allows the tube to withstand higher pressures.

15 While such equalization of volumes and capacities between a single feeder line and multiple branch lines of reduced size would be balanced under static conditions, under the dynamic conditions of super critical high temperatures and high pressures, comparative flow among the smaller branch lines can become unbalanced. This can lead
20 to potential overheating and possible wall failure in the pipe that has lower flow volume (i.e. a lower amount of water and steam flowing therethrough). The present invention solves this problem by equalizing

flow and pressure in the multiple branch lines, even at high temperatures and pressure levels.

Objects and Advantages of the Invention

5 With the foregoing in mind, it is a primary object of the present invention to provide a valve device at the juncture of a single feeder line and multiple branch lines in a steam engine for equalizing flow and pressure of fluid and steam among the multiple branch lines.

10 It is a further object of the present invention to provide a splitter valve at the juncture of a single feeder line and multiple branch lines in a steam engine that equalizes flow and pressure of fluid and steam in the branch lines under dynamic conditions of super critical high temperatures and high pressures.

15 It is still a further object of the present invention to provide a splitter valve device at the juncture of a single steam feeder line and multiple steam branch lines, and wherein the splitter valve device is structured and disposed for equalizing flow volume and pressure levels among the multiple steam branch lines.

20 It is still a further object of the present invention to provide a splitter valve for use at the juncture of a single steam feeder line and multiple steam branch lines, and wherein the splitter valve is structured and disposed for bleeding "over-pressure" in any one steam branch line

back to a steam branch line(s) that has a lesser amount of pressure, thereby equalizing flow through the multiple steam branch lines.

These and other objects and advantages of the present invention are more readily apparent with reference to the detailed description and
5 accompanying drawings.

Summary of the Invention

The present invention is directed to splitter valve for use in a heat regenerative engine that uses water as both the working fluid and the
10 lubricant. In the heat regenerative engine, water is pumped through a single line of a coil that wraps around a cylinder exhaust port, causing the water to be preheated by steam exhausted from the cylinder. The preheated water is then directed through multiple branch lines in a steam generator to produce high pressure super heated steam. The
15 splitter valve is located at the juncture of the single line and multiple branch lines to equalize the flow among the multiple branch lines. A "Y" junction within the splitter valve minimizes turbulence as the flow of water and steam is directed into the multiple branch lines. Flow control restrictors in the splitter valve allow unimpeded flow of fluid towards the
20 steam generator through each of the branch lines, while allowing any incremental over-pressure in any one branch line to "bleed" back to a branch line(s) bearing a lesser amount of pressure, thereby equalizing flow through the multiple branch lines.

Brief Description of the Drawings

For a fuller understanding of the nature of the present invention, reference should be made to the following detailed description taken in conjunction with the accompanying drawings in which:

5 Figure 1 is a general diagram illustrating air flow through the engine;

Figure 2 is a general diagram illustrating water and steam flow through the engine;

10 Figure 3 is a side elevational view, shown in cross-section, illustrating the principal components of the engine;

Figure 4 is a top plan view, in partial cross-section, taken along the plane of the line 4-4 in figure 3;

Figure 5 is a top plan view of the splitter valve of the present invention; and

15 Figure 6 is a cross-sectional view of the splitter valve taken along line 6-6 in figure 5 and illustrating a flow control valve within the splitter valve.

Like reference numerals refer to like parts throughout the several views of the drawings.

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Detailed Description of the Preferred Embodiment

The present invention is directed to a splitter valve 26 for use in a steam engine 10. Referring initially to Figures 1-4, the engine 10

includes a steam generator 20, a condenser 30 and a main engine section 50 comprising cylinders 52, valves 53, pistons 54, push-rods 74, crank cam 61 and a crankshaft 60 extending axially through a center of the engine section.

5 In operation, ambient air is introduced into the condenser 30 by intake blowers 38. The air temperature is increased in two phases before entering a cyclone furnace 22 (referred to hereafter as "combustion chamber"). The condenser 30 is a flat plate dynamic condenser with a stacked arrangement of flat plates 31 surrounding an
10 inner core. This structural design of the dynamic condenser 30 allows for multiple passes of steam to enhance the condensing function. In a first phase, air enters the condenser 30 from the blowers 38 and is circulated over the condenser plates 31 to cool the outer surfaces of the plates and condense the exhaust steam circulating within the plates.
15 More particularly, vapor exiting the exhaust ports of the cylinders 52 passes over the pre-heating coils surrounding the cylinders. The vapor drops into the core of the condenser where centrifugal force from rotation of the crankshaft drives the vapor into the inner cavities of the condenser plates 31. As the vapor changes phase into a liquid, it enters
20 sealed ports on the periphery of the condenser plates. The condensed liquid drops through collection shafts and into the sump 34 at the base of the condenser. A high pressure pump 90 returns the liquid from the condenser sump 34 to the coils in the combustion chamber, completing

the fluid cycle of the engine. The stacked arrangement of the condenser plates 31 presents a large surface area for maximizing heat transfer within a relatively compact volume. The centrifugal force of the crankshaft impeller that repeatedly drives the condensing vapor into the cooling plates 31, combined with the stacked plate design, provides a multi-pass system that is far more effective than conventional condensers of single-pass design.

The engine shrouding 12 is an insulated cover that encloses the combustion chamber and piston assembly. The shroud 12 incorporates air transfer ducts 32 that channel air from the condenser 30, where it has been preheated, to the intake portion of air-to-air heat exchangers 42, where the air is further heated. Exiting the heat exchangers 42, this heated intake air enters the atomizer/igniter assemblies in the burner 40 where it is combusted in the combustion chamber. The shroud also includes return ducts that capture the combustion exhaust gases at the top center of the combustion chamber, and leads these gases back through the exhaust portion of the air-to-air heat exchangers 42. The engine shrouding adds to the efficiency and compactness of the engine by conserving heat with its insulation, providing necessary ductwork for the airflow of the engine, and incorporating heat exchangers that harvest exhaust heat.

Water in its delivery path from the condenser sump pump 90 to the combustion chamber 22 is pumped through one or more main

steam supply lines 21 for each cylinder. The main steam line 21 passes through a pre-heating coil 23 that is wound around each cylinder skirt adjacent to that cylinder's exhaust ports (see figure 2). The vapor exiting the exhaust ports of cylinders 52 gives up heat to this coil, which
5 raises the temperature of the water being directed through the coil 23 toward the combustion chamber 22. Reciprocally, in giving up heat to the preheating coils 23, the exhaust vapor begins the process of cooling on its path through these coils preparatory to entering the condenser. The positioning of these coils 23 adjacent to the cylinder exhaust ports
10 scavenges heat that would otherwise be lost to the system, thereby contributing to the overall efficiency of the engine.

In the next phase, the air is directed through heat exchangers 42 where the air is heated prior to entering the steam generator 20 (see figures 2 and 3). In the steam generator 20, the preheated air is mixed
15 with fuel from a fuel atomizer 41 (See Figure 4). An igniter 43 burns the atomized fuel in a centrifuge, causing the heavy fuel elements to move towards the outer sides of the combustion chamber 22 where they are consumed. The combustion chamber 22 is arranged in the form of a cylinder which encloses a circularly wound coil of densely bundled
20 tubes 24 (see figure 3) forming a portion of the steam supply lines leading to the respective cylinders. The bundled tubes 24 are heated by the burning fuel of the combustion nozzle burner assembly 40 comprising the air blowers 38, fuel atomizer 41, and the igniter 43 (see

figure 4). The burners 40 are mounted on opposed sides of the circular combustion chamber wall and are aligned to direct their flames in a spiral direction. By spinning the flame front around the combustion chamber, the coil of tubes 24 is repetitively 'washed' by the heat of this combustion gas which circulates in a motion to the center of the tube bundle 24. Temperatures in the tube bundle 24 are maintained at approximately 1,200 degrees Fahrenheit. The tube bundle 24 carries the steam and is exposed to the high temperatures of combustion, where the steam is superheated and maintained at a pressure of approximately 3,200 psi. The hot gas exits through an aperture located at the top center of the round roof of the cylindrical combustion chamber. The centrifugal motion of the combustion gases causes the heavier, unburned particles suspended in the gases to accumulate on the outer wall of the combustion chamber where they are incinerated, contributing to a cleaner exhaust. This cyclonic circulation of combustion gases within the combustion chamber creates higher efficiency in the engine. Specifically, multiple passes of the coil of tubes 24 allows for promoting greater heat saturation relative to the amount of fuel expended. Moreover, the shape of the circularly wound bundle of tubes permits greater lengths of tube to be enclosed within a combustion chamber of limited dimensions than within that of a conventional boiler. Furthermore, by dividing each cylinder's steam supply line into two or more lines at entry to the combustion chamber

(i.e. in the tube bundle), a greater tube surface area is exposed to the combustion gases, promoting greater heat transfer so that the fluid can be heated to higher temperatures and pressures which further improves the efficiency of the engine.

5 As the water exits the single line 21 of each individual cylinder's pre-heating coil on its way to the combustion chamber, it branches into the two or more lines 28 per cylinder forming part of the tube bundle which consists of a coiled bundle 24 of all these branched lines 28 for all cylinders, as described above. These multiple lines 28 are identical
10 in cross sectional area and length. The splitter valve 26, located at the juncture of the single line 21 to the multiple lines 28 (see figure 3), equalizes the flow between the branch lines (see figures 3, 15 and 6). The splitter valve includes a main body 100 with an inlet 102 for connection to the single feeder line 21 and a plurality of outlets 104 for
15 connection to each of the branch lines 28. A juncture 29 within the splitter valve 26 minimizes turbulence by forming not a right angle 'T' intersection, but a 'Y' intersection with a narrow apex 106. Flow control valves or restrictors include ball check valves 27 between the juncture 29 and outlets 104 that allow unimpeded flow of fluid towards the
20 steam generator 20 through each of the branch lines 28. The ball check valves 27 prevent back-flow into the feeder line 21. Instead, any incremental over-pressure in one line is caused to 'bleed' back to an

over pressure valve (pressure regulator) 46 to prevent over-pressuring the system.

While the present invention has been shown and described in accordance with a preferred and practical embodiment thereof, it is
5 recognized that departures from the instant disclosure are contemplated within the spirit and scope of the present invention.

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Claims:

1. A valve device for use at the juncture of a single steam line and multiple branch steam lines through which liquid and steam flow, said valve device comprising:

5 a main body;

 an inlet on said main body for connection to the single steam line;

 a plurality of outlets on said main body, each of said plurality of outlets being structured and disposed for connection to a respective one of the multiple branch steam lines;

10 a junction within said main body and between said inlet and said plurality of outlets for directing the flow of liquid and steam entering said inlet to each of said plurality of outlets; and

 flow control restrictors for allowing unimpeded flow of fluid and steam into each of the multiple branch steam lines and said flow control
15 restrictors being structured and disposed for equalizing pressure and flow of steam through the multiple branch steam lines.

2. The valve device as recited in claim 1 wherein said junction is structured and disposed to minimize turbulence as the flow of liquid and steam is directed to said plurality of outlets.

20 3. The valve device as recited in claim 2 wherein said flow control restrictors include ball check valves between said junction and said plurality of outlets for preventing back-flow of steam from over-pressure into the single steam line.

4. The valve device as recited in claim 3 wherein said flow control restrictors include over-pressure valves for releasing the over-pressure in any of said multiple branch steam lines.

5. A valve device for use at the juncture of a single steam line and
5 multiple branch steam lines through which liquid and steam flow, said valve device comprising:

a main body;

an inlet on said main body for connection to the single steam line;

a plurality of outlets on said main body, each of said plurality of
10 outlets being structured and disposed for connection to a respective one of the multiple branch steam lines;

a junction within said main body and between said inlet and said plurality of outlets for directing the flow of liquid and steam entering said inlet to each of said plurality of outlets;

15 flow control restrictors for allowing unimpeded flow of fluid and steam into each of the multiple branch steam lines and said flow control restrictors being structured and disposed for preventing back-flow of steam into the single steam line; and

over-pressure valves for releasing over-pressure in any of the
20 multiple branch steam lines.

6. The valve device as recited in claim 5 wherein said junction is structured and disposed to minimize turbulence as the flow of liquid and steam is directed to said plurality of outlets.

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7. The valve device as recited in claim 6 wherein said flow control restrictors include ball check valves.

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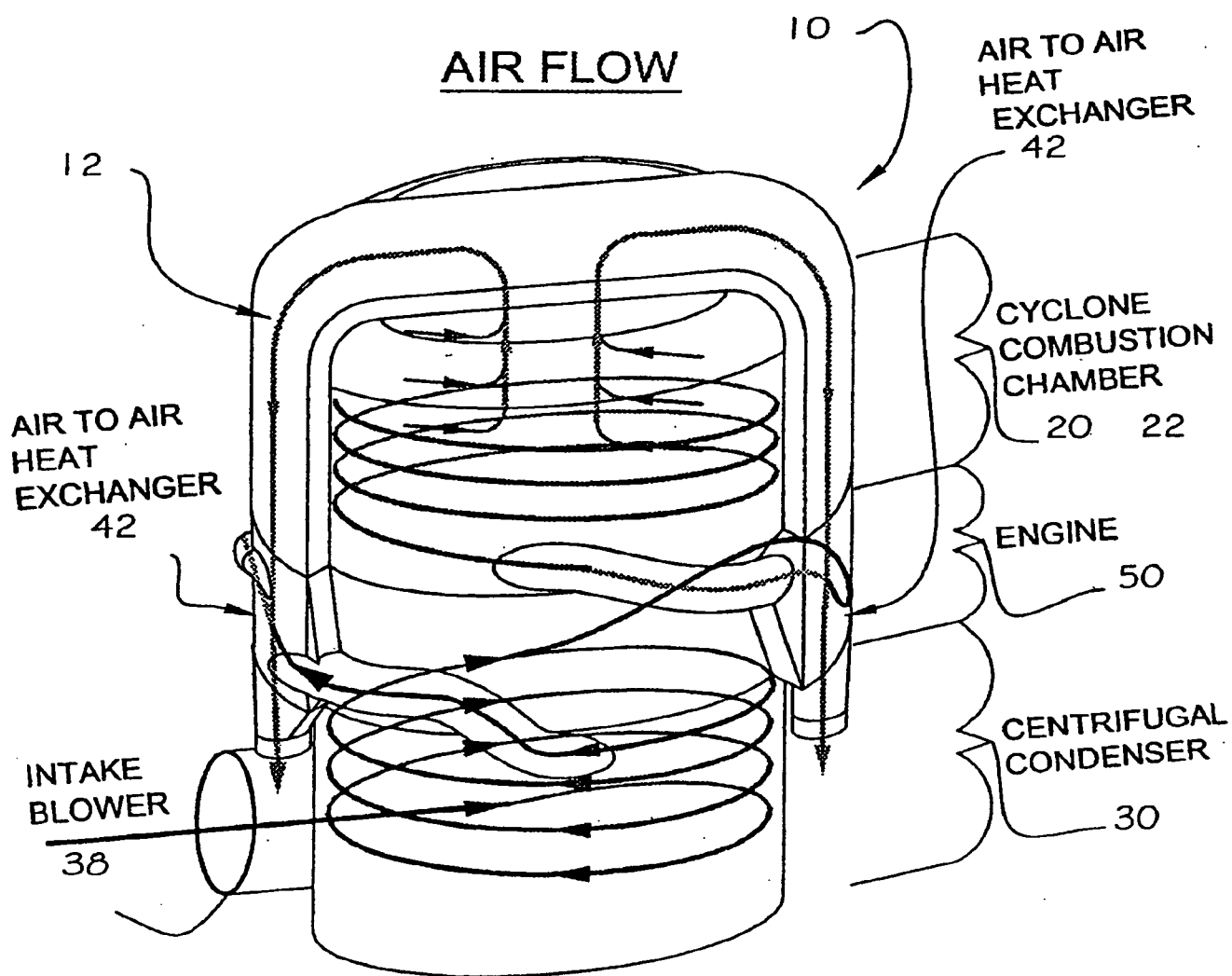


FIG. 1

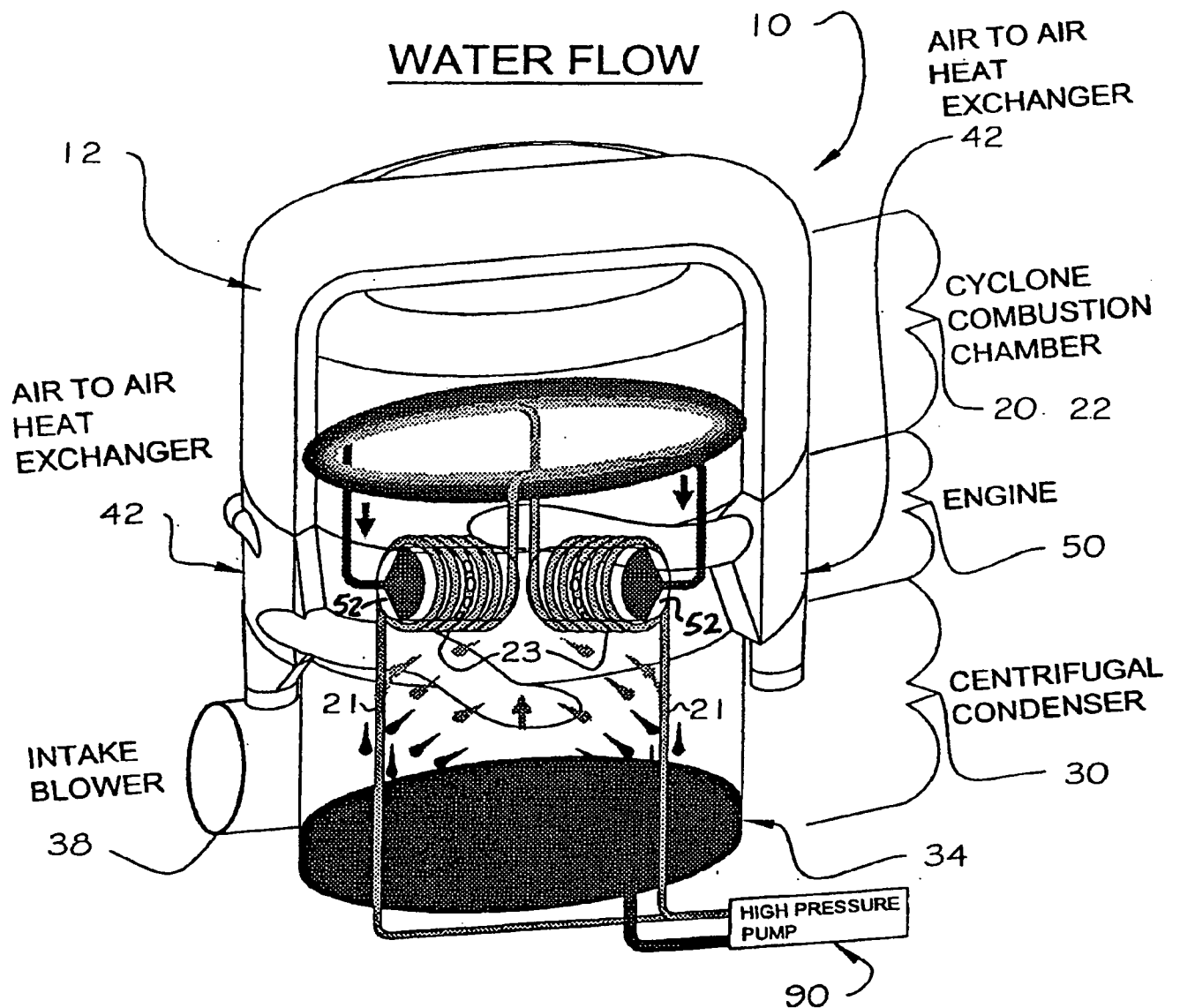


FIG. 2

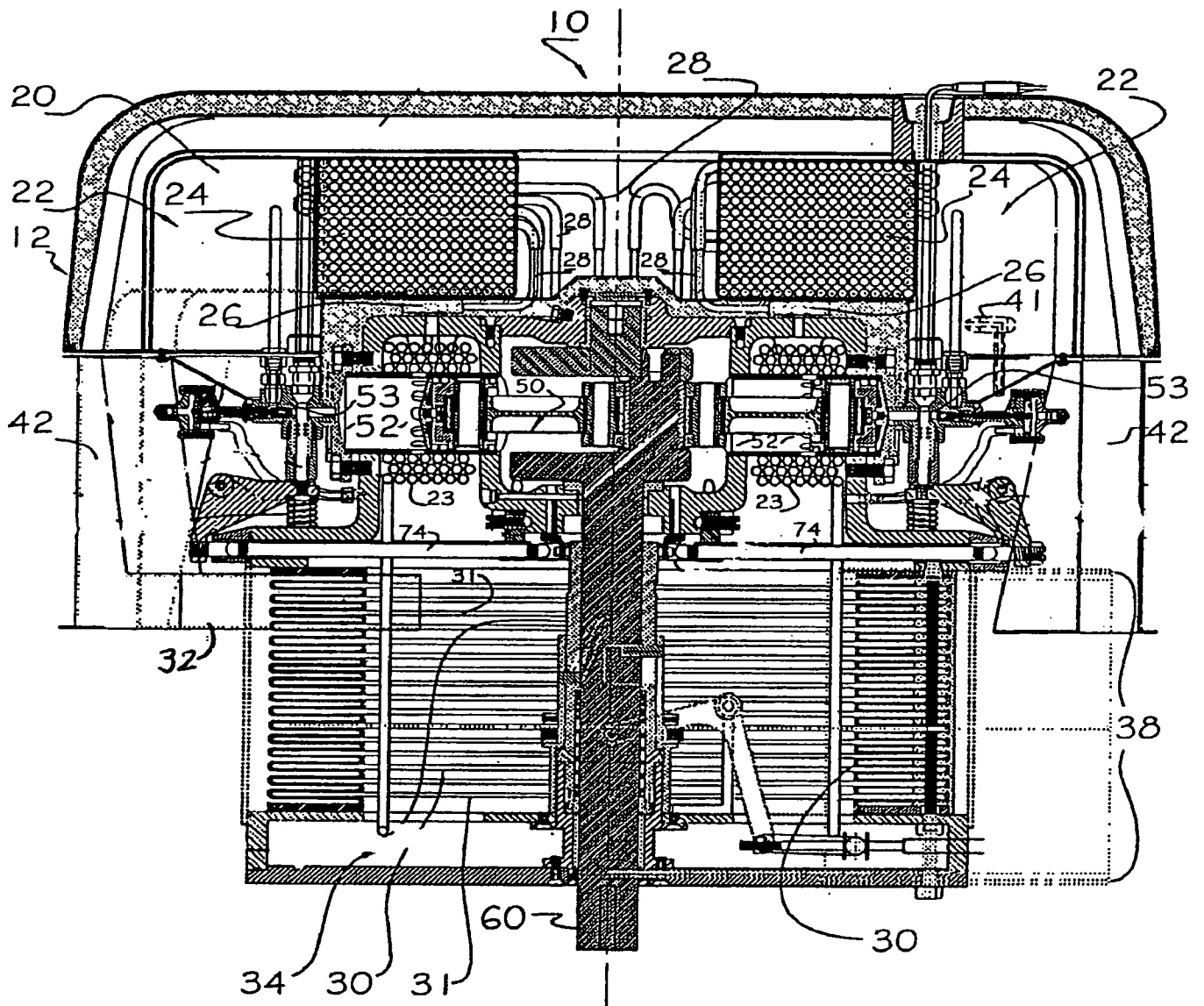
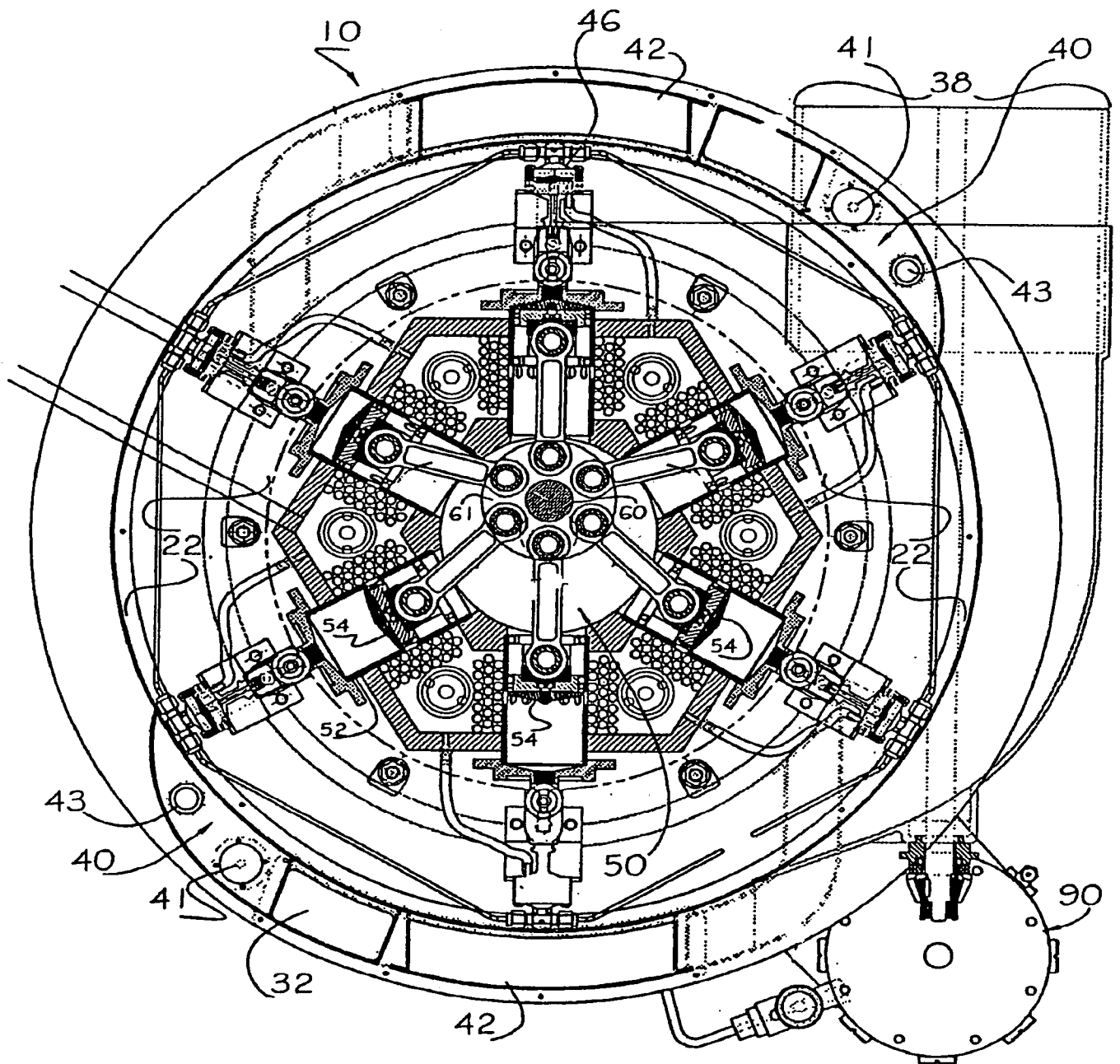


FIG. 3



TOP VIEW

FIG. 4

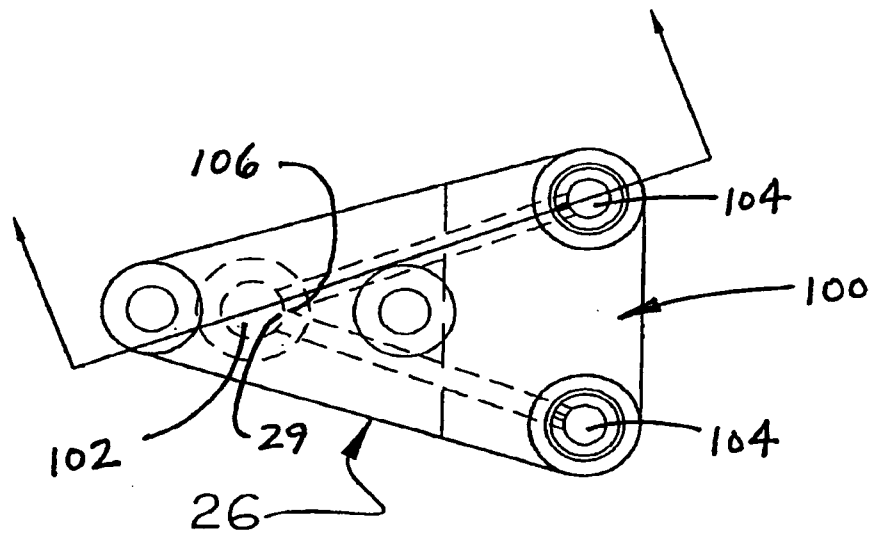


FIG. 5

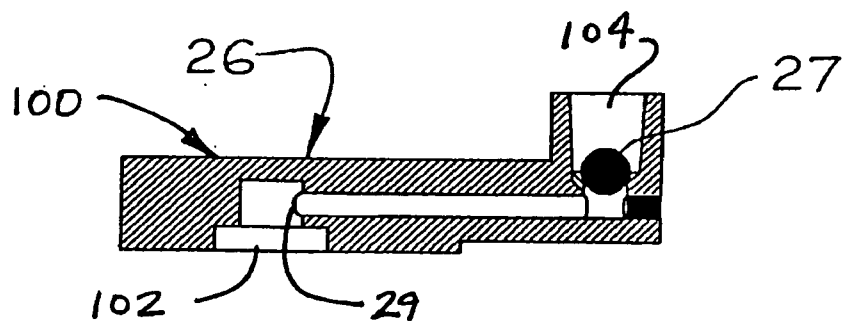


FIG. 6