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(72) DERKSEN, William E., CA
(73) DERKSEN, William E., CA

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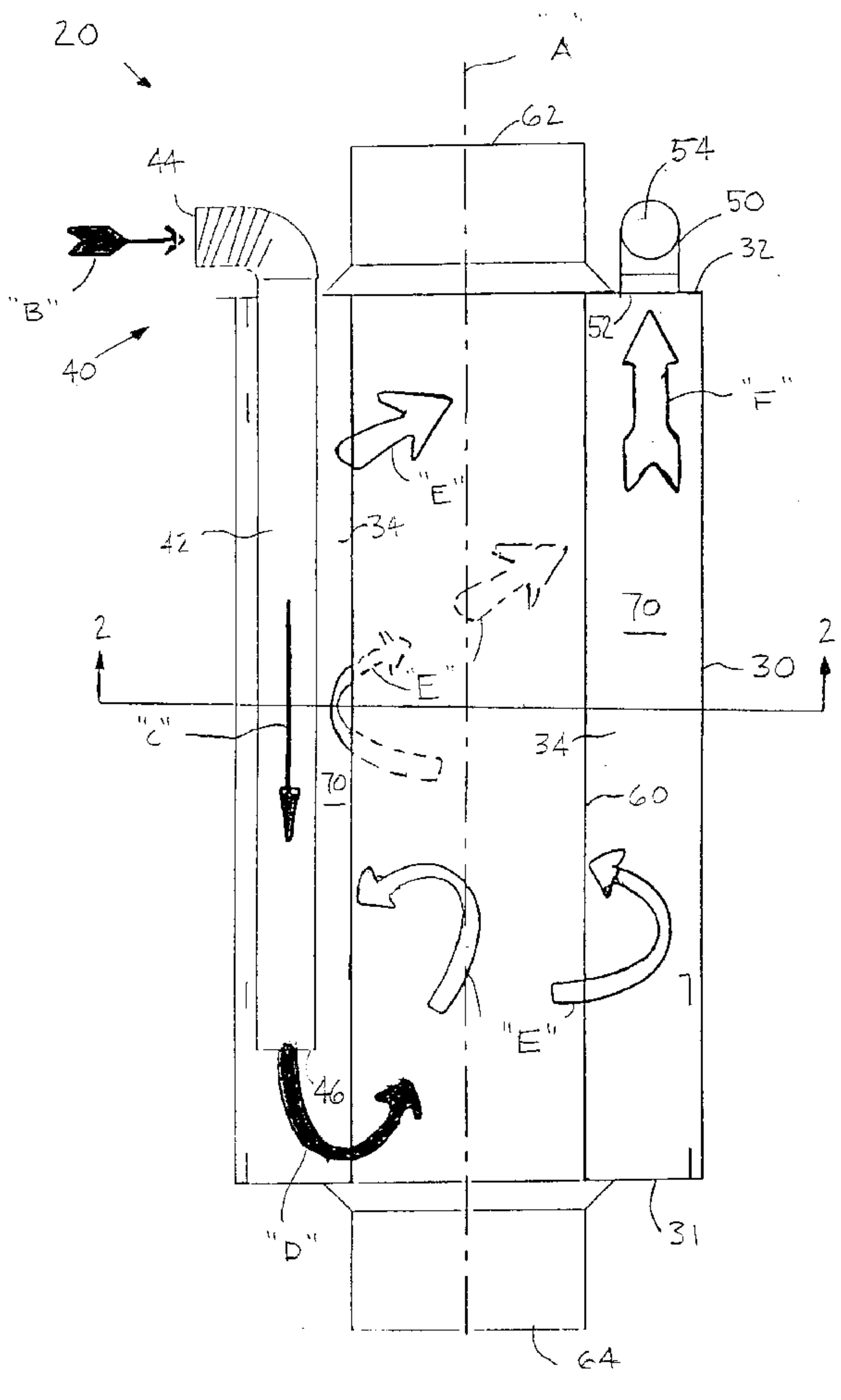
(54) **SYSTEME DE RECUPERATION DE CHALEUR ET ECHANGEUR DE CHALEUR UTILISE DANS CELUI-CI**

(54) **HEAT RECOVERY SYSTEM AND HEAT EXCHANGER THEREFOR**



(57) Un échangeur de chaleur servant à réchauffer le moteur et l'habitacle d'un véhicule par temps froid comprend un élément corps principal retenant un liquide et qui a un premier bout, un deuxième bout, un axe longitudinal principal s'étendant du premier bout au deuxième bout, et un intérieur substantiellement creux.

(57) A heat exchanger for use in warming the engine and passenger compartment of a vehicle during cold weather comprises a fluid retaining main body member having a first end, a second end, a main longitudinal axis extending from the first end to the second end, and a substantially hollow interior. An inlet and an outlet are

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Une entrée et une sortie sont montées sur l'élément corps principal en communication fluide avec l'intérieur substantiellement creux près du premier bout et du deuxième bout respectivement. Un passage de gaz d'échappement ayant une extrémité d'entrée et une extrémité de sortie en communication fluide l'une avec l'autre, pour raccordement en ligne avec le système d'échappement d'un véhicule, est monté dans l'élément corps principal en relation traversante, de sorte que l'intérieur creux de l'élément corps principal entoure substantiellement le passage de gaz d'échappement en relation de transfert de chaleur. Quand le système fonctionne, un fluide caloporteur arrive dans l'élément corps principal par l'entrée, passe du premier au deuxième bout de la partie corps principal à travers l'intérieur creux où la chaleur du passage de gaz d'échappement est absorbée, et s'en va par la sortie. L'échangeur de chaleur est utilisé dans un système de récupération de chaleur de manière que l'entrée soit raccordée en communication fluide à la sortie de liquide de refroidissement du moteur pour en recevoir le liquide de refroidissement, et la sortie est raccordée en communication fluide à l'entrée de liquide de refroidissement de la chaufferette à l'intérieur du véhicule, pour fournir à la chaufferette du liquide de refroidissement chauffé, lequel est ultimement retourné au moteur.

mounted on the main body member in fluid communication with the substantially hollow interior adjacent the first end and second end respectively. An exhaust flow passageway having an inlet end and an outlet end in fluid communication one with the other, for in-line connection with a vehicle exhaust system, is mounted in the main body member in throughpassing relation such that the hollow interior of the main body member substantially surrounds the exhaust flow passageway in heat transfer relation. In use, a heat transfer fluid ingresses the main body member through the inlet, flows from the first end to the second end of the main body portion through the hollow interior whereat heat from the exhaust flow passageway is absorbed, and egresses through the outlet. The heat exchanger is used in a heat recovery system such that the inlet is connected in fluid communication to a coolant outlet of the engine so as to receive liquid coolant therefrom, and the outlet is connected in fluid communication to a coolant inlet of a heater within the vehicle, so as to supply heated liquid coolant to the heater, and ultimately back to the engine.

ABSTRACT

A heat exchanger for use in warming the engine and passenger compartment of a vehicle during cold weather comprises a fluid retaining main body member having a first end, a second end, a main longitudinal axis extending from the first end to the second end, and a substantially hollow interior. An inlet and an outlet are mounted on the main body member in fluid communication with the substantially hollow interior adjacent the first end and second end respectively. An exhaust flow passageway having an inlet end and an outlet end in fluid communication one with the other, for in-line connection with a vehicle exhaust system, is mounted in the main body member in throughpassing relation such that the hollow interior of the main body member substantially surrounds the exhaust flow passageway in heat transfer relation. In use, a heat transfer fluid ingresses the main body member through the inlet, flows from the first end to the second end of the main body portion through the hollow interior whereat heat from the exhaust flow passageway is absorbed, and egresses through the outlet. The heat exchanger is used in a heat recovery system such that the inlet is connected in fluid communication to a coolant outlet of the engine so as to receive liquid coolant therefrom, and the outlet is connected in fluid communication to a coolant inlet of a heater within the vehicle, so as to supply heated liquid coolant to the heater, and ultimately back to the engine.

FIELD OF THE INVENTION

The present invention relates to heat recovery systems used in vehicles having an internal combustion engine and to heat exchangers for use in such heat recovery systems.

BACKGROUND OF THE INVENTION

It is well known in modern vehicles to heat the interior of a vehicle and defrost the windows, during cold weather, by using heat extracted from the vehicle's engine. The vehicle's cooling system for the engine uses liquid coolant to perform such heat extraction, which liquid coolant is passed through a heater core. The heat from the coolant is transferred to air blown over the heater core and into the passenger compartment of the vehicle.

During the first several minutes of operation of an internal combustion engine of a vehicle, the engine is still not warmed up to a steady state operating temperature. Therefore, only a minor amount of heat is produced. This is especially true for diesel engines, which typically produce less heat at a given power output. Accordingly, a vehicle having an internal combustion engine is warmed very slowly, which is undesirable during cold weather. Further, the defroster for the front window, and possibly the defroster for the rear window, rely on hot air obtained from front window or rear window defrosted until the vehicle has warmed up considerably. Thus, it may be unsafe to drive the vehicle during cold weather before the vehicle has warmed up.

Additionally, an internal engine cannot provide full power until a car is substantially warmed up. In some cases, especially if the car is several years old, it may not be able to be driven until the engine has warmed up to a nearly steady state operating temperature, thus delaying the driving of the vehicle.

Another very important consideration is that of air pollution. While an internal combustion engine is warming up, fuel combustion is incomplete, thus causing a significant amount of air pollution, especially with diesel engines. Indeed, many diesel engines provide slightly complete fuel combustion even when warmed up.

Another problem with large vehicles having an internal combustion engine is that there is not enough heat produced to properly warm the vehicle and to defrost the windows, even when the engine is running at a steady state operating temperature. Such deficiency of heated air at a steady state operating temperature is known to be common for large vehicles with diesel engines where the entire vehicle interior is being heated, such as school buses.

It is an object of the present invention to provide a heat recovery system and heat exchanger therefor, wherein the warm up time of the internal combustion engine is decreased significantly.

It is an object of the present invention to provide a heat recovery system and heat exchanger therefor, wherein fuel combustion during warm up is improved.

It is an object of the present invention to provide a heat recovery system and heat exchanger therefor, wherein fuel combustion of a diesel engine is improved even when warm.

It is an object of the present invention to provide a heat recovery system and heat exchanger therefor, wherein reduced pollution is produced during warming up of the internal combustion engine.

It is an object of the present invention to provide a heat recovery system and heat exchanger therefor, wherein heat is provided in the vehicle more quickly after starting of the internal combustion engine.

It is an object of the present invention to provide a heat recovery system and heat exchanger therefor, wherein no external fuel source is used.

It is an object of the present invention to provide a heat recovery system and heat exchanger therefor, that provides at least sufficient heat for large vehicles, such as school buses.

It is an object of the present invention to provide a heat recovery system and heat exchanger therefor, that helps provide sufficient heat for large vehicles having diesel engines.

It is an object of the present invention to provide a heat recovery system and heat exchanger therefor, that is relatively inexpensive to manufacture and install.

It is an object of the present invention to provide a heat recovery system and heat exchanger therefor, that may be readily retrofitted onto a vehicle.

It is an object of the present invention to provide a heat recovery system and heat exchanger therefor, wherein heat is absorbed from the exhaust system.

It is an object of the present invention to provide a heat recovery system and heat exchanger therefor, wherein heat is absorbed from the exhaust system using the liquid coolant of the vehicle's cooling system.

PRIOR ART

While various attempts have been made in the prior art to address the above discussed problems, and indeed some sophisticated systems exist overcome specific problems, none of the known prior art systems has addressed all of these problems.

United States Patent 4,087,047, to Wulf et al. discloses a heating unit for automotive vehicles wherein a heat exchanger is connected in heat absorbing relation with a portion of the exhaust system, and uses a conventional bi-directional heat pipe to transfer heat from the exhaust system to a second heat exchanger. The second heat exchanger transfers heat to an auxiliary coolant connecting line that is connected at one end to an outlet on the engine block and is connected at its other end to the existing cooling system at a heater controller. This system is unduly expensive as two heat exchangers, a heat pipe and an auxiliary connecting line for the coolant system are all required. Further, heat transfer from the exhaust system to the liquid coolant in the cooling system is inefficient as the first heat exchanger, heat pipe, and a second heat exchanger are used. The first heat exchanger that the exhaust system therefore must be extremely efficient for the system to be properly effective.

U.S. Patent 3,618,854 to Frank, discloses a vehicle heating system employing a critical point heat pipe. A vaporizable heat-pipe-working fluid having a critical point temperature substantially at the desired reference temperature transports heat from the heat source to the heat sink by means of the heat pipe when the temperature of the heat sink is below the reference temperature, and automatically terminates the heat exchange when the temperature of the heat sink reaches the reference temperature. The automatic termination of the heat exchange being the direct result of the properties of the heat-pipe-working fluid. This vehicle heating system does not use the coolant from the engine's cooling system and therefore does not improve engine warm-up time and does not improve combustion during engine warm up, and does not use heat from the vehicles exhaust.

U.S. Patent 4,146,176 to Beauvais *et al*. discloses an exhaust gas heating system utilizing a heat pipe. The heat pipe is connected at its evaporator end to a heat exchanger in the vehicle's exhaust system. The condenser end of the heat pipe is provided with heating fins disposed within the conventional heater case of a vehicle, so as to heat the vehicle. This exhaust gas heating system does not use the coolant from the engine's cooling system and therefore does not improve engine warm-up time and does not improve combustion during engine warm up.

U.S. Patent 4,775,102 to Negishi *et al*. discloses a space heating system utilizing engine exhaust heat, wherein a heat absorbing element is disposed within the exhaust system of a vehicle to absorb heat from the exhaust gases. A working fluid passage leads from the heat absorbing element to an expanded section that surrounds a second pipe. The working fluid passage continues on through a check valve device into a working fluid reservoir tank, and the leads back through a return flow pipe and another check valve to the origin of the working fluid passage at the heat absorbing element. This space heating system does not use the coolant from the engine's cooling system and therefore does not improve engine warm-up time and does not improve combustion during engine warm up.

U.S. Patent 4,958,766 to Toth *et al.* discloses an appliance for heating a motor vehicle with an internal combustion engine. A heat accumulator is in heat transfer connection with the exhaust pipe of the vehicle and with the space to be heated. The essential feature of the invention is that the heat accumulator is directly connected with an extended cooling circuit and has a circulating pump operating independently from the engine, and built in to an extended coolant circuit. The heat accumulator accumulates heat from the exhaust gases of the engine during ongoing engine operation, and the heat stored therein is used to pre-heat the coolant of the engine and to provide heat into the passenger compartment the vehicle, prior to starting of the engine. This appliance for heating a motor vehicle does not use the coolant from an engine's exhaust system to extract heat from the vehicle's exhaust.

U.S. Patent 5,398,747 to Miaoulis discloses an automotive vehicle auxiliary component heating method and system that uses lithium bromide as a heat exchange medium in a heat exchanger to extract heat from the exhaust system of a vehicle. A separate water evaporator and condenser circuit is used to heat various components of the vehicle before they are up to steady-state operating temperature, and to heat the interior of the vehicle. This auxiliary component heating method and system does not use the coolant from the engine's cooling system and therefore does not improve engine warm-up time and does not improve combustion during engine warm up.

U.S. Patent 4,705,214 to Johnson discloses an independent exhaust gas heating system for heating a motor vehicle passenger compartment. The independent exhaust gas heating system comprises a surge tank feeding a heat transfer medium to a pump, which circulates fluid through a heater core, a heat exchanger and a waste heater core, if necessary. The heat exchanger is connected to an engine exhaust system for heating the circulating medium by the engine exhaust gases. The heat system is completely independent of the vehicle's cooling system and therefore can be used in a vehicle not having a liquid based cooling system. This independent exhaust gas heating system does not use the coolant from the engine's cooling system and therefore does not improve engine warm-up time and does not improve combustion during engine warm up.

U.S. Patent 4,010,895 to Kofink *et al*. discloses a system for pre-heating a water-cooled vehicle engine and interior of the vehicle. A heating device powered by a liquid fuel generates heat before starting of the internal combustion engine, to pre-heat the internal combustion engine and the interior of the vehicle. This system for pre-heating a water-cooled vehicle engine and interior does not use heat from a vehicle's exhaust.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention, there is disclosed a heat exchanger for use in a heat recovery system used in a vehicle for warming the vehicle during cold weather. The heat exchanger comprises a fluid retaining main body member having a first end, a second end, a main longitudinal axis extending from the first end to the second end, and a substantially hollow interior. An inlet is mounted on the main body member in fluid communication with the substantially hollow interior adjacent the first end of the main body member. An outlet is mounted on the main body member in fluid communication with the substantially hollow interior adjacent the second end of the main body member. An exhaust flow passageway having an inlet end and an outlet end in fluid communication one with the other, for in-line connection with a vehicle exhaust system, is mounted in the main body member in throughpassing relation from the first end to the second end such that the hollow interior of the main body member substantially surrounds at least a portion of the exhaust flow passageway in heat transfer relation. In use, a heat transfer fluid ingresses the main body member through the inlet, flows from the first end to the second end of the main body portion through the hollow interior whereat heat from the exhaust flow passageway is absorbed, and egresses through the outlet.

In accordance with another aspect of the present invention, there is disclosed a heat recovery system for use in a vehicle having a internal combustion engine and an engine cooling system using liquid coolant flowing through a circuit from the internal combustion engine to a heater in the vehicle, for rapidly heating the liquid coolant during cold weather. The heat recovery system comprises a heat exchanger having an exhaust flow passageway adapted for in-line connection with a vehicle exhaust system, a main body portion having a substantially hollow interior and being positioned in heat exchange relation with the exhaust flow passageway, an inlet connected in fluid communication to a coolant outlet of an internal combustion engine so as to receive liquid coolant therefrom, and an outlet connected in fluid communication to a coolant inlet of a heater within the vehicle, so as to supply heated liquid coolant to the heater, and ultimately back to the internal combustion engine.

Other advantages, features and characteristics of the present invention, as well as methods of operation and functions of the related elements of the structure, and the combination of parts and economies of manufacture, will become more apparent upon consideration of the following detailed description and the appended claims with reference to the accompanying drawings, the latter of which is briefly described hereinbelow.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features which are believed to be characteristic of the heat exchanger and the heat recovery system, according to the present invention, for use in a vehicle having an internal combustion engine, as to the invention's structure, organization, and use, together with further objectives and advantages thereof, will be better understood from the following drawings in which a presently preferred embodiment of the invention will now be illustrated by way of example. It is expressly understood, however, that the drawings are for the purpose of illustration and description only, and are not intended as a definition of the limits of the invention. In the drawings:

Figure 1 is a cut-away top plan view of the preferred embodiment of the heat exchanger according to the present invention;

Figure 2 is a cross-sectional view taken along section line 2-2 of Figure 1;

Figure 3 is a simplified pictorial view of a first embodiment of the heat recovery system according to the present invention; and

Figure 4 is a simplified pictorial view of a second embodiment of the heat recovery system of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made to Figure 1, which shows the preferred embodiment heat exchanger of the present invention, as indicated by the general reference numeral 20. The heat exchanger 20 is for use in a heat recovery system used in a vehicle, which heat recovery system is for warming a vehicle during cold weather, as will be discussed in greater detail subsequently. The heat exchanger 20 may be used with the heat recovery system of the present invention as depicted in Figure 2, or with other conventional heat recovery systems, as long as the heat exchanger 20 is installed in place in an exhaust system of a vehicle, preferably close to the engine end of the exhaust system so as to receive the exhaust gases when they are their hottest.

The heat exchanger 20 comprises a substantially cylindrical main body member 30 having first end 31 and a second end 32. Preferably, the main body member 20 is elongate so as to increase the heat transfer area in the heat exchanger 20 and has a longitudinal axis "A" extending from the first end 31 to the second end 32. The main body member 30 defines a substantially hollow interior 34 in which heat transfer fluid 70 is retained and flows through, as will be discussed in greater detail subsequently. The main body member 30 must of course be fluid retaining so as to preclude the unwanted escape of the heat transfer fluid 70 therefrom.

An inlet 40 comprises an elongate inlet tube 42 mounted on the main body member 30 adjacent the second end 32 thereof. The elongate inlet tube 42 extends along the substantially hollow interior 34 of the main body member 32 and terminates near the first end 31 thereof. The inlet 40 is in fluid communication at its ingress end 44 with a source of heat transfer fluid 70 and in fluid communication at its egress end 46 with the substantially hollow interior 34 of the main body 30 adjacent the first end 31 thereof.

An outlet member 50 is mounted on the main body member 30 and has an ingress end 52 in fluid communication with the substantially hollow interior 34 of the main body 30 adjacent the second end 32 thereof, and also has an egress end 54 in fluid communication with the heater core of the vehicle that the heat exchanger 20 is installed in.

A substantially straight exhaust flow passageway 60, preferably in the form of a tubular pipe, is mounted in the main body member 30 so as to be substantially centrally disposed therein and so as to be oriented along the main longitudinal axis "A". The exhaust flow passageway 60 may also be non-straight -- or in other words bent, or even folded -- for a variety of reasons including muffling of noise, increasing its size of contact surface in the main body member 30, and so on. The exhaust flow passageway 60 has an inlet end 62 and an outlet end 64 in fluid communication one with the other. The inlet end 62 extends outwardly from the first end 31 of the main body member 30 and is connected in exhaust receiving relation to the exhaust system of a vehicle, preferably directly to the exhaust manifold. Similarly, the outlet end 64 extends outwardly from the second end 32 of the main body member 30 and is connected in exhaust emitting relation to the remainder of the exhaust system of a vehicle. Conventional muffler clamps (not shown) may be use to securely connect the exhaust flow passageway 60 to an exhaust system of a vehicle.

The exhaust flow pipe 60 is mounted in the main body member 30 and throughpassing relation from the first end 31 to the second end 32 such that the hollow interior 34 of the main body member substantially surrounds the exhaust flow passageway 60 in heat transfer relation. Exhaust gases flow in the exhaust flow passageway 60 from the second end 32 to the first end 31 of the hollow interior 34 of the main body member 30.

In use, the heat transfer fluid 70 ingresses into the main body member 30 through the inlet 40, by flowing into the ingress end 44 of the elongate inlet tube 42, as indicated by arrow "B", through the elongate inlet tube 42, as indicated by arrow "C", and out of the egress end 46 of the elongate inlet tube 42, as indicated by arrow "D", so as to be adjacent first end 31 of the main body member 30. The heat transfer fluid 70 flows from the first end 31 to the second end 32 of the main body member 30 generally around the exhaust flow passageway 60, as indicated by arrows "E", whereat heat from the exhaust flow pipe 60 is absorbed. The heat transfer fluid 70 then egresses through the outlet 50, as indicated by arrow "F". It can be seen that there is no baffling disposed between the first end 31 and the second end 32 of the main body member 30. By omitting such baffling, the chance of cavitation of the heat transfer fluid 70 is minimized.

Reference will now be made to Figure 3 which shows a first preferred embodiment of the heat recovery system 80 of the present invention for use in a vehicle having an internal combustion engine 82 and a conventional engine cooling system, as indicated by the general reference numeral 84. The engine cooling system 84 employs a coolant pump 86 to circulate the coolant 88 within the engine 82. Above a predetermined temperature, a thermostat 90 opens and permits the liquid coolant 88 to flow past the thermostat 90, exit the engine 82 through a liquid coolant outlet 92 and pass through a circuit 94 to the radiator 96. The coolant pump 86 draws the liquid coolant 88 back from the radiator 92. An essentially separate circuit 97 permits flow of the liquid coolant 88 from another liquid coolant outlet 98 and through a heater core 99 in the vehicle, whereat the liquid coolant 88 provides heat to the interior of the vehicle. Again, the coolant pump 86 draws the liquid coolant 88 back from the heater core 99.

The heat recovery system of the present invention, as indicated by the general reference numeral 80, comprises a heat exchanger 102 having an exhaust flow pipe 104 adapted for in-line connection with a vehicle exhaust system 106. A main body portion 108 has a substantially hollow interior 110 and is positioned in heat exchange relation with the exhaust flow pipe 104. An inlet 112 is connected in fluid communication to a liquid coolant outlet 114 of the internal combustion engine 82 so as to receive liquid coolant 88 therefrom. An outlet 116 is connected in fluid communication with the inlet line of the coolant pump 86, so as to supply heated liquid coolant 88 to the engine 82. As depicted in Figure 4, the heat recovery system 80 is connected to the internal combustion engine 82 essentially in parallel with the heater core 99. As is readily apparent, the heat recovery system 80 as disclosed is for use during cold weather, for rapidly heating the liquid coolant 88 and returning it directly to the internal combustion engine 82.

Reference will now be made to Figure 4 which shows a second preferred embodiment of the heat recovery system 80 of the present invention for use in a vehicle having an internal combustion engine 82 and a conventional engine cooling system, as indicated by the general reference numeral 84. The engine cooling system 84 is identical to the one in Figure 3 and like reference numerals will be used to indicate like parts. Further, the heat recovery system of the present invention, as indicated by the general reference numeral 80, is identical to the one in Figure 3 and like reference numerals will be used to indicate like parts. However, it can be seen in Figure 4, that the outlet 116 of the heat exchanger 102 is connected in fluid communication with the heater core 99. As depicted in Figure 4, the heat recovery system 80 is connected to the internal combustion engine 82 essentially in series with the heater core 99. As is readily apparent, the heat recovery system 80 as disclosed is for use during cold weather, for rapidly heating the liquid coolant 88 and passing it through the heater core 99 before returning it to the internal combustion engine 82.

In the first and second preferred embodiments, as depicted in figures 3 and 4, the inlet 112 of the heat exchanger 102 is connected in non-valved relation to the liquid coolant outlet 114 of the internal combustion engine 82, such that the flow of liquid coolant 88 through the heat exchanger 102 is non-divertible. Such a non-divertible connection would be acceptable in large trucks having diesel engines, such as school buses, where a large amount of heat is required at all times during cold months, and lowers the cost of manufacturing and installation, and also simplifies the installation process. The thermostat 90 and the radiator of the cooling system 84 would merely operate in a conventional manner once the liquid coolant reaches a predetermined temperature. In testing during cold winter months, it has been found with the heat recovery system 80 and the heat exchanger 20 of the present invention, that the radiator thermostat switches into cooling mode in about half of the time as compared to not having the same installed.

It can be seen that the present invention provides many advantages over the prior art. Namely, the warm up time of the internal combustion engine is decreased significantly; fuel combustion during warm up is improved; fuel combustion of a diesel engine is improved even when warm; reduced pollution is produced during warming up of the internal combustion engine; heat is provided in the vehicle more quickly after starting of the internal combustion engine; no external fuel source is used; sufficient heat is provided for large vehicles, such as school buses, even those having diesel engines; the present invention is relatively inexpensive to manufacture and install, and may be readily retrofitted onto a vehicle; heat is absorbed from the exhaust system using the liquid coolant of the vehicle's cooling system, and thus a non-renewable resource is effectively used.

The present invention is applicable to various types of vehicles, such as automobiles, trucks, buses, boats, airplanes, and so on, and is also applicable in industrial applications in conjunction with stationary internal combustion engines.

Other variations of the above principles will be apparent to those who are knowledgeable in the field of the invention, and such variations are considered to be within the scope of the present invention. Further, other modifications and alterations may be used in the design and manufacture of the present invention without departing from the spirit and scope of the accompanying claims.

I CLAIM:

1. A heat exchanger for use in a heat recovery system used in a vehicle for warming the vehicle during cold weather, said heat exchanger comprising:

a fluid retaining main body member having a first end, a second end, a main longitudinal axis extending from said first end to said second end, and a substantially hollow interior;

an inlet mounted on said main body member in fluid communication with said substantially hollow interior adjacent said first end of said main body member;

an outlet mounted on said main body member in fluid communication with said substantially hollow interior adjacent said second end of said main body member; and

an exhaust flow passageway having an inlet end and an outlet end in fluid communication one with the other, for in-line connection with a vehicle exhaust system, and mounted in said main body member in throughpassing relation from said first end to said second end such that said hollow interior of said main body member substantially surrounds at least a portion of said exhaust flow passageway in heat transfer relation;

wherein, in use, a heat transfer fluid ingresses said main body member through said inlet, flows from said first end to said second end of said main body portion through said hollow interior whereat heat from said exhaust flow passageway is absorbed, and egresses through said outlet.

2. The heat exchanger of claim 1, wherein said fluid retaining main body member is substantially cylindrical.

3. The heat exchanger of claim 1, wherein said fluid retaining main body member is elongate.

4. The heat exchanger of claim 1, wherein said inlet comprises an elongate inlet tube mounted on said main body member adjacent said second end thereof and extending to near said first end thereof.

5. The heat exchanger of claim 1, wherein said exhaust flow passageway is oriented along said main longitudinal axis.

6. The heat exchanger of claim 1, wherein said exhaust flow passageway is substantially straight.

7. The heat exchanger of claim 1, wherein said exhaust flow passageway is substantially centrally disposed in said main body member.

8. The heat exchanger of claim 1, wherein said exhaust flow passageway extends outwardly from both of said first and second ends of said main body member.

9. A heat recovery system for use in a vehicle having a internal combustion engine and an engine cooling system using liquid coolant flowing through a circuit from the internal combustion engine to a heater in the vehicle, for rapidly heating the liquid coolant during cold weather, said heat recovery system comprising:

a heat exchanger having an exhaust flow passageway adapted for in-line connection with a vehicle exhaust system, a main body portion having a substantially hollow interior and being positioned in heat exchange relation with said exhaust flow passageway, an inlet connected in fluid communication to a coolant outlet of an internal combustion engine so as to receive liquid coolant therefrom, and an outlet connected in fluid communication to a coolant inlet of a heater within the vehicle, so as to supply heated liquid coolant to the heater, and ultimately back to said internal combustion engine.

10. The heat recovery system of claim 1, wherein said inlet of said heat exchanger is connected in non-valved relation to a coolant outlet of an internal combustion engine such that the flow of liquid coolant through said heat exchanger is non-divertible.

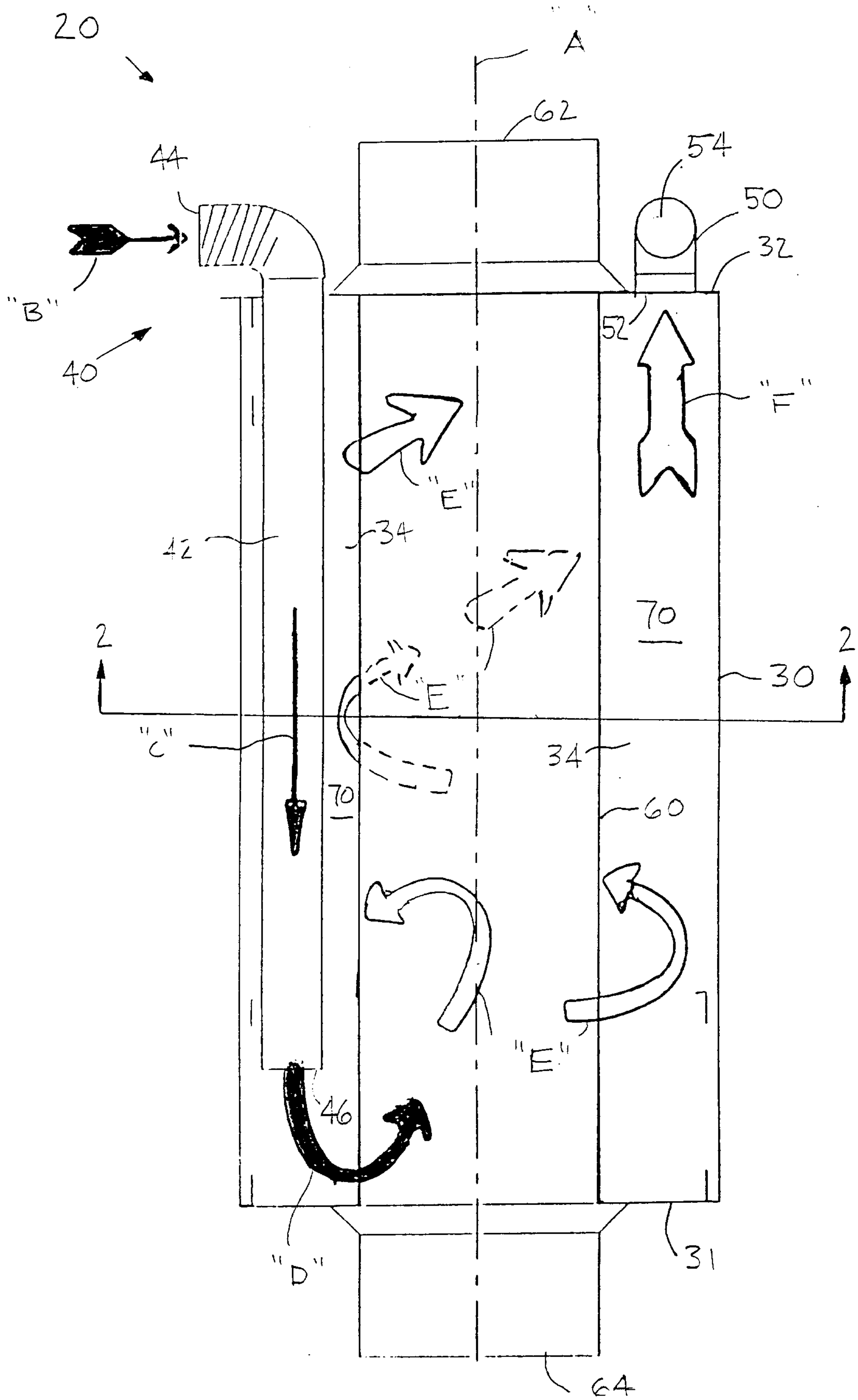

FIG 1

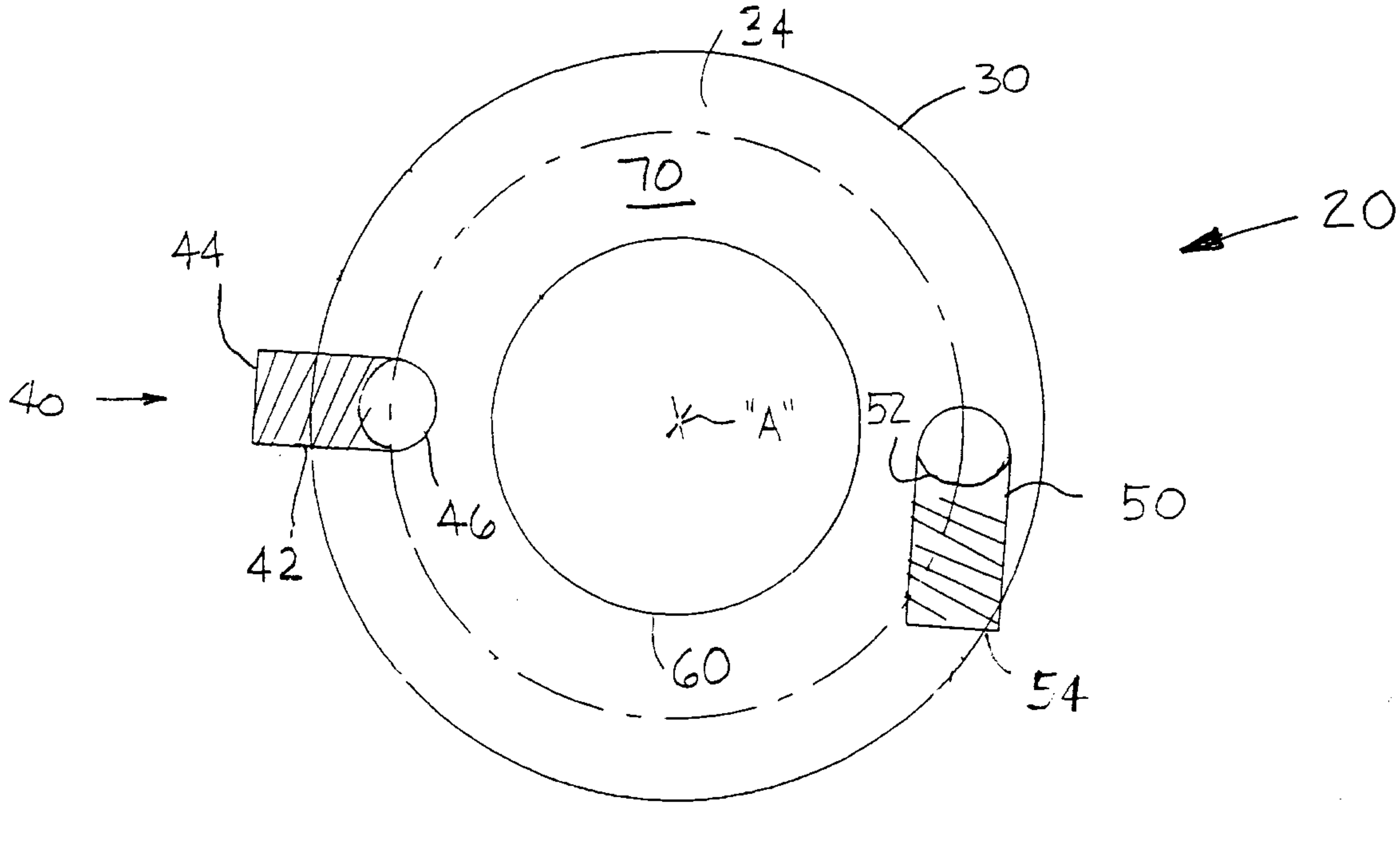
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FIG 2

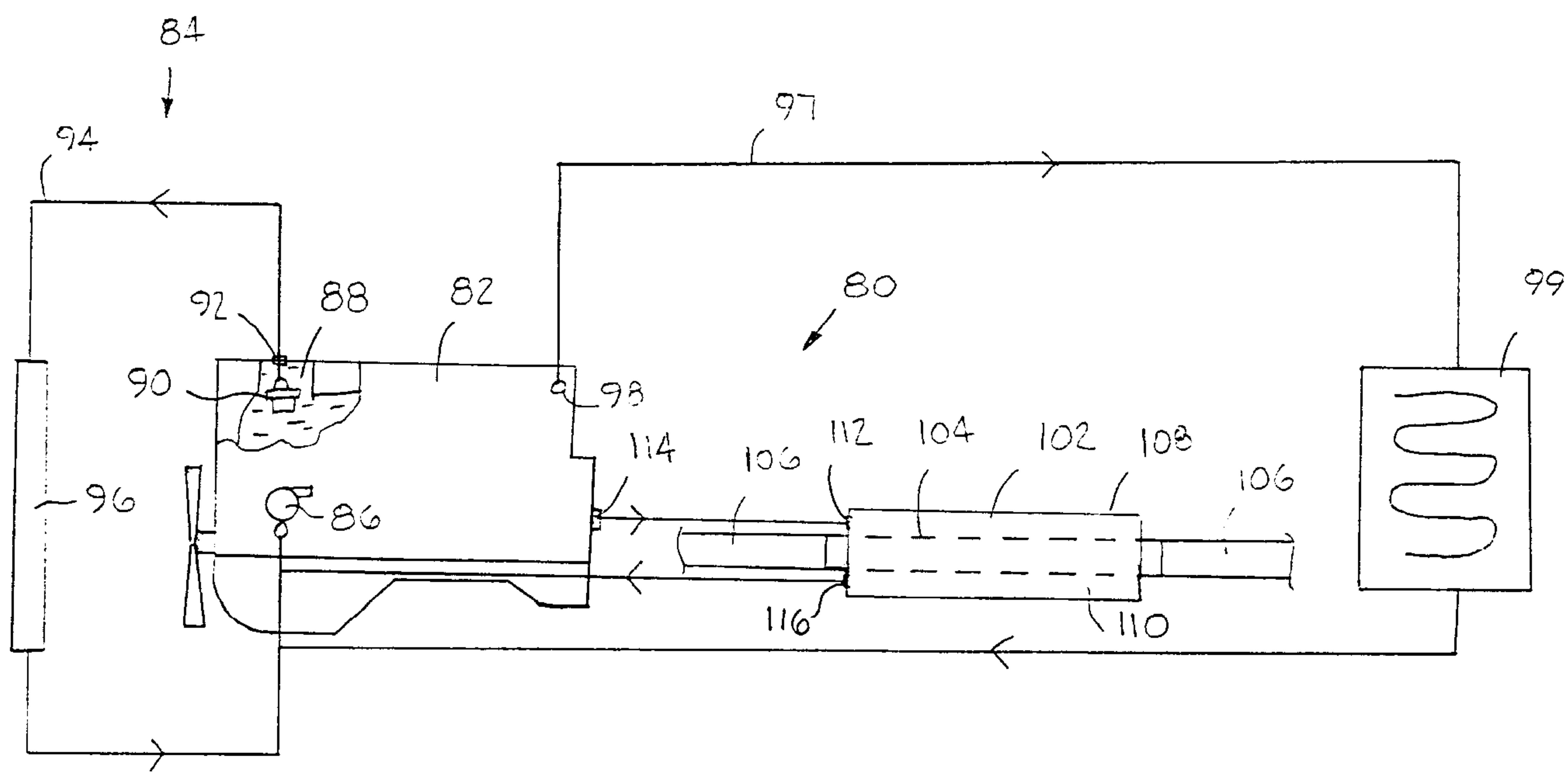
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FIG 3

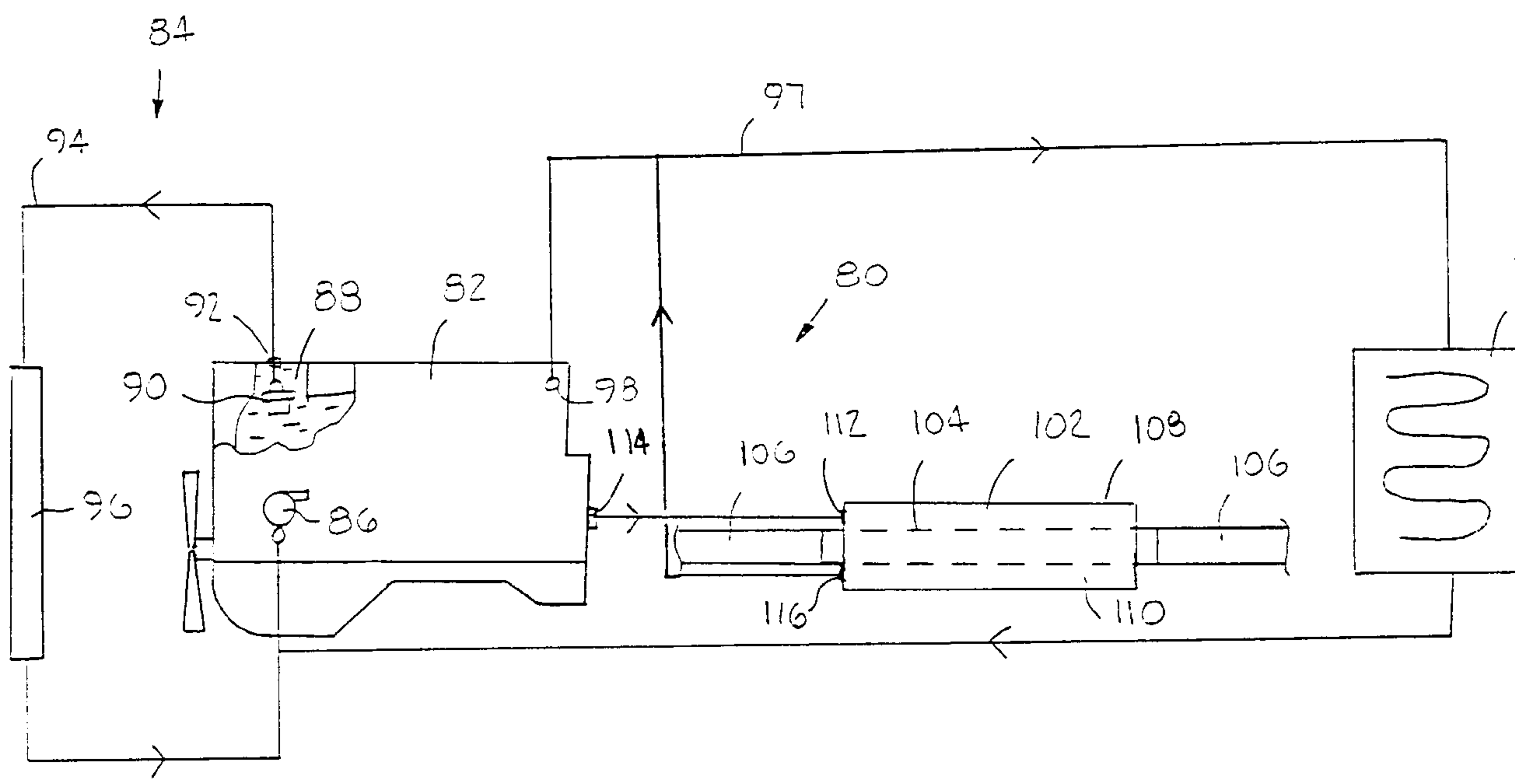
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FIG 4