REV 2.11.08

Residential Solar Thermal Systems

Piggyback ™

RESIDENTIAL DRAINBACK

SINGLE ZONE SOLAR RADIANT FLOOR

MULTI ZONE SOLAR RADIANT FLOOR

LIFEBREATH SOLAR FORCED AIR

QUIETAIR HIGH VELOCITY DELIVERY

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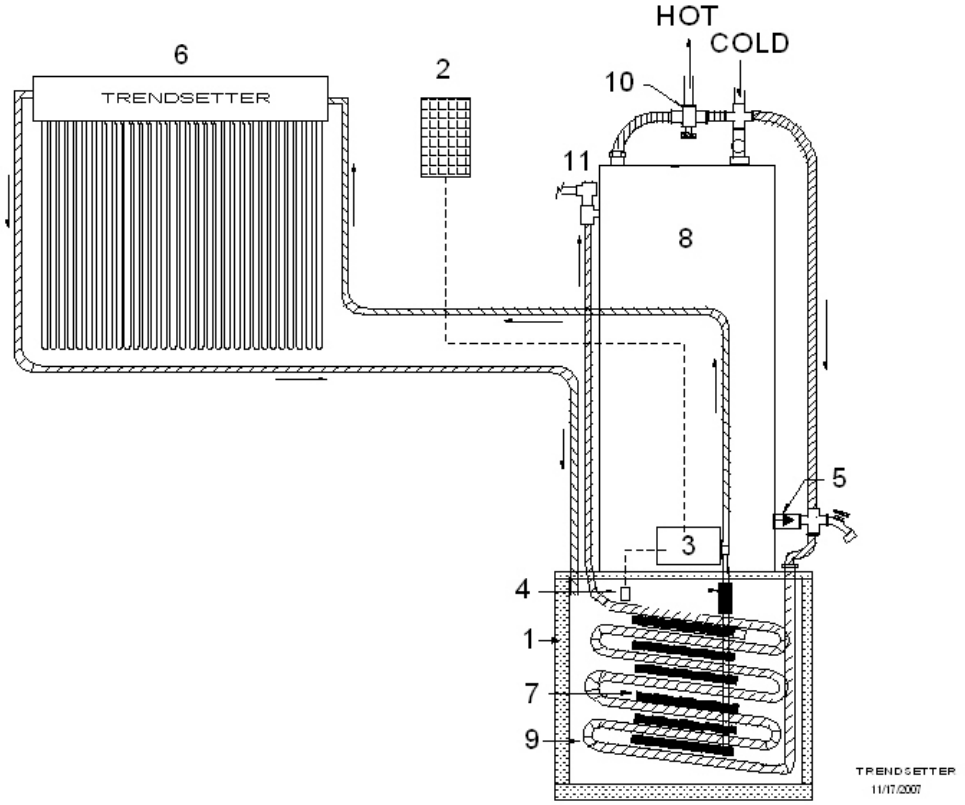
Piggyback ™



Solar Operation

The non pressurized ***solar storage tank (1)*** contains 40 gallons of tap water initially filled from a garden hose or the fill line. ***The auto fill (4)*** fills the tank to the proper level. The tank water does not mix with the potable hot water discharged at the fixtures. When the sun appears in the sky, the ***PV panel (2)*** receives sunlight and provides power to the ***dc pump (3)*** The water in the tank gradually heats up as water is circulated from the tank through the ***filter (13)*** to the Trendsetter evacuated tube ***solar collector (6)*** and back to the tank***.*** The ***phase change material (7)*** will melt as the water in the tank begins to exceed 115ºF. This process will significantly improve the thermal performance of the system.

Transfer of Solar Heat to the Water Heater

Cold water normally enters the ***water heater (8)*** through the cold inlet at the top of the tank. The internal plug (11) blocks off this path and diverts the cold water through the ***heat exchanger (9)*** to "solar heat" the water before it enters the tank at the ***P&T valve (11)*** location near the top of the tank. The ***check valve (5)*** prevents the cold water from entering the tank at the discharge port at the bottom of the tank.

Natural Thermal Convection

The ***water heater (8)*** is also passively thermally coupled through the heat exchanger connections at locations ***P&T valve (11)*** and ***check valve (5)***. The normal temperature of ***water heater (8)*** is 120ºF. Normally the temperature at the bottom of a tank type water heater would be approximately 90ºF when the top of the tank is 120ºF. Hot water wants to rise to the top because it is less dense than cold water. We use this principle to transfer the solar energy from the ***solar storage tank (1)*** to the ***water heater (8)*** once the temperature in the solar tank exceeds the water temperature at the bottom of the water heater tank.

Why the Thermal Convection System is Superior to Other Solar Water Pre-Heating Systems With Tank Type Back-ups.

Virtually all solar water heating systems pre-heat the make up cold water entering the water heater when hot water is drawn at the fixtures. This happens only during times that hot water is being used. The **Piggy Back**™ system does that and more because it:

- Saves space by positioning it under the existing water heater
- Transfers solar heat 24 hours a day by natural convection
- Makes its own solar electricity and uses no electrical power from the utility
- Passively optimizes solar storage capacity with phase change material
- Provides damping of temperature swings with phase change material

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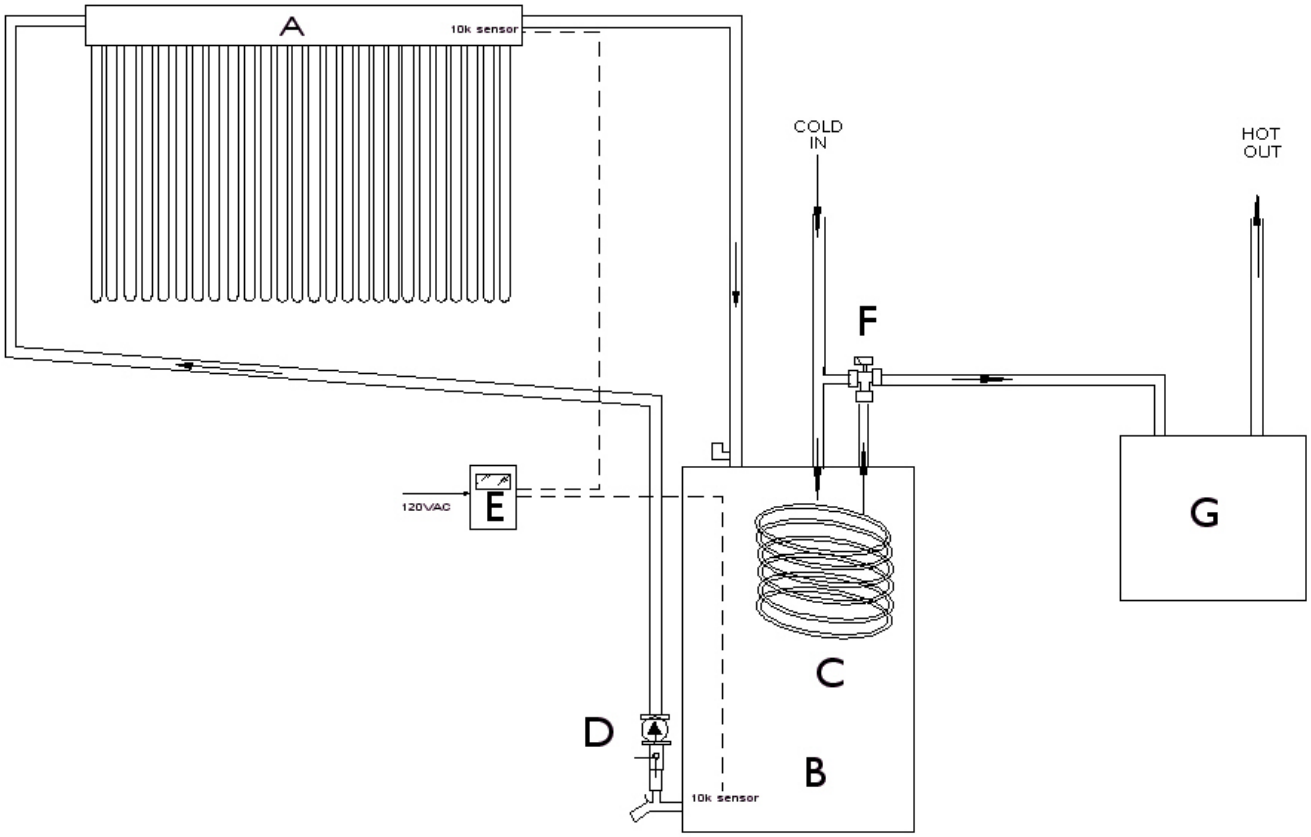

There are ***nine*** parts to the Trendsetter system.

A - Solar collectors- Apricus® Evacuated tubes

B – Solar Storage tank- Non-pressurized insulated water storage tank

C - Heat exchanger- 24 sq ft of copper finned tubing ¾" inside diameter

D - Solar pump - Pumps water through solar panels

E - Solar controller – Turns solar pump on and off automatically

F - Tempering valve- A safety device to cool down the solar hot water if necessary

G - Water heater-Use existing water heater or replace with tank-less water heater

The ***solar storage tank (B)*** contains tap water. One sensor is mounted at the ***solar collector (A)*** and one sensor is installed in a “dry dip tube” inside of the ***storage tank***. When the ***solar collector*** is hotter than the water in the ***storage tank***, the ***solar controller (E)*** powers the ***solar pump (D).*** The water is slowly circulated through the ***solar collector*** on the roof. The water in the ***storage tank*** will gradually rise in temperature. The water will rise 5°F-10°F in temperature between the time the water enters the ***solar collector*** and the time it leaves the ***solar collector***.

When hot water is used in the house, the cold water is pre-heated as it courses through the ***heat exchanger (C)*** immersed in the solar heated water stored in the insulated ***storage tank***. If the existing water heater is used as a back-up, the pre-heated water will reduce the energy normally needed to raise the water temperature entering the . water heater. For example, if the cold water entering the water heater is 60°F, the water heater will require fuel to raise the incoming water from 60°F - 120°F (8,617 BTU per 100 gallons). If the entering water temperature were raised to 100°F the fuel consumption would be reduced by 2/3rds. The same 100 gallons of hot water would consume only 2,878 BTU’s

If a ***tank-less water heater*** replaces the conventional tank type water heater, the tank-less heater will flash on to raise the water temperature. For example if the water temperature pre-heated by the solar, is 100 ^{o}F the ***tank-less*** unit will provide just enough energy to boost the pre-heated water an additional 20 ^{o}.

If the solar water in the tank reaches very hot or even scalding hot temperatures, incoming water will be drawn through the ***heat exchanger*** in the ***solar storage tank*** and through the ***tempering valve (F)***. The scalding hot solar water will be automatically mixed with cold water at the ***tempering valve*** to supply the desired 120°F (adjustable to 140°F) water temperature to the water heater.

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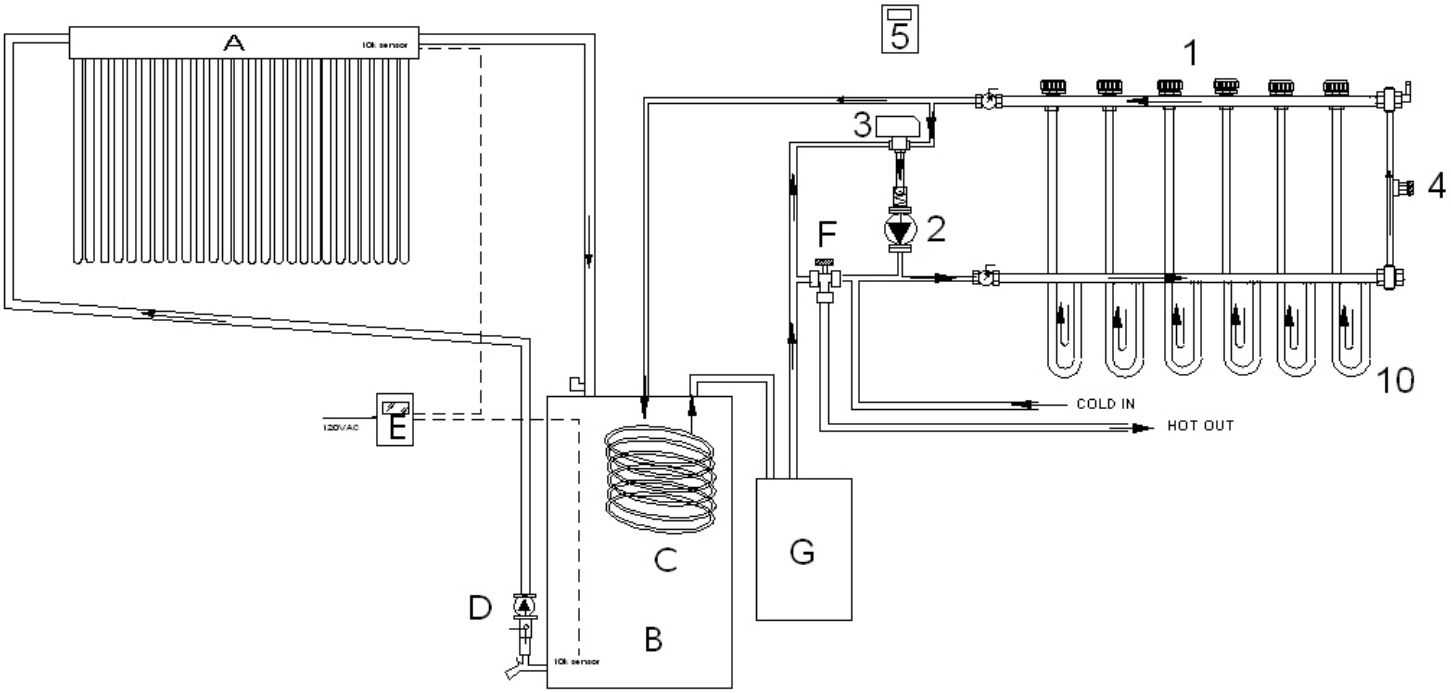
SINGLE ZONE SOLAR RADIANT FLOOR



<u>SINGLE ZONE</u>* -** There are ***six additional parts to the radiant floor system

#1 Master stainless steel manifold- Distributes and regulates flow to individual radiant floor loops

#2 System pump - Circulates hot water through the floor

#***3 Mixing valve*** -Controls supply water temperature in the floor by sensing supply and return temperatures

#4 Pressure By-pass valve – One adjusts proper flow through the manifold

#5 Thermostat – Activates radiant floor part of system when space heating is required

#10 PEX tubing- Distributes the heat to the house from the hot water coursing through tubing in the floor

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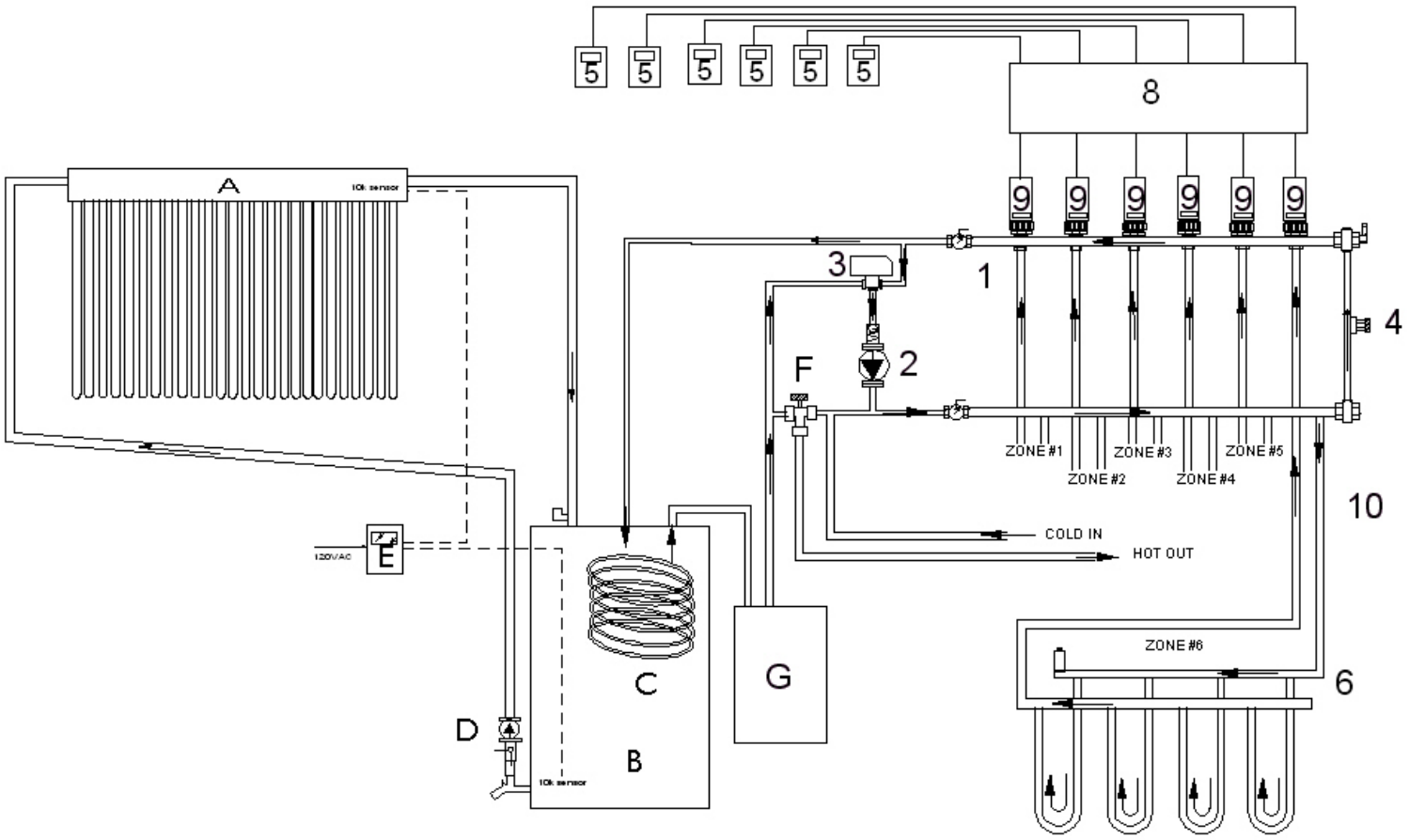
This system combines solar water heating ***plus*** an efficient space heating system. The amount of solar contribution will vary with the size of the solar water heating system selected. When the ***thermostat (5)*** calls for heat, the **system *pump (D)*** starts pumping water. The water is split by the ***supply manifold (1)*** into loops of ***PEX tubing (10)*** and returns through the ***return manifold (1)*** with the flows being balanced by viewing the flow meters on the manifold. The ***mixing valve (3)*** monitors the temperatures of the water entering the tubes in the floor and the temperature of the returning water. The valve blends the water returning from the floor with make-up hot water from the ***tank-less water heater (G)***. The cooler return water enters the ***heat exchanger (C)*** in the ***solar tank (B)*** to absorb available solar heat before returning to the ***tank-less water heater*** which may be required to further elevate the water temperature. The ***pressure by-pass valve (4)*** on the manifold is set regulate the total flow through the floor by proportioning the pressure and allowing a measured amount water to return to the system without circulating through the tubes in the floor.

Note to reader: If building in a predominantly cooling climate with radiant floor heating we recommend either:

1. **Spacepak®** mini-duct high velocity delivery system which uses 2" PVC
2. **A/C split** system which uses individual air handlers in each room or
3. **Concealed wall** mounted units in individual rooms

Most radiant floor construction has less air movement and heat loss through outside air infiltration. We strongly recommend (and is required by code) using an **HRV (Heat Recovery Ventilation System)** if your house has been constructed "tight" air infiltration standards. The HRV should provide 2 CFM or fresh air per 100 square feet of living space.



<u>MULTIPLE ZONE SYSTEM</u>* –** There are ***three additional parts to the multi-zone system

#6 Distribution and return manifold – Typical for each zone to supply several loops within one zone

#8 Zone valve controller – Accept input from multiple thermostats

#9 Zone valve actuators – Actuators activated by the controller to regulate temperatures in different heating zones of the house

The system ***"wakes up"*** when one or more of the ***thermostats*** (5) show a demand for heat. The difference between the multi and single zone system is that the individual loops are now individually monitored and controlled by separate thermostats**.** Each zone uses ***zone actuators*** (9) to turn on and off individual zones as demanded by each thermostat input**.** Additional branches may be required within a single loop depending on the configuration and area of each separate zone. For example if a single zone covers an area of 500 square feet, that loop would require two branches. That is if the tubing were placed 8-9" on center, 700 lineal feet of tubing would require two 350' branches. The **zone valve controller** (8) supplies power to the thermostats, zone valves and circulation pump.

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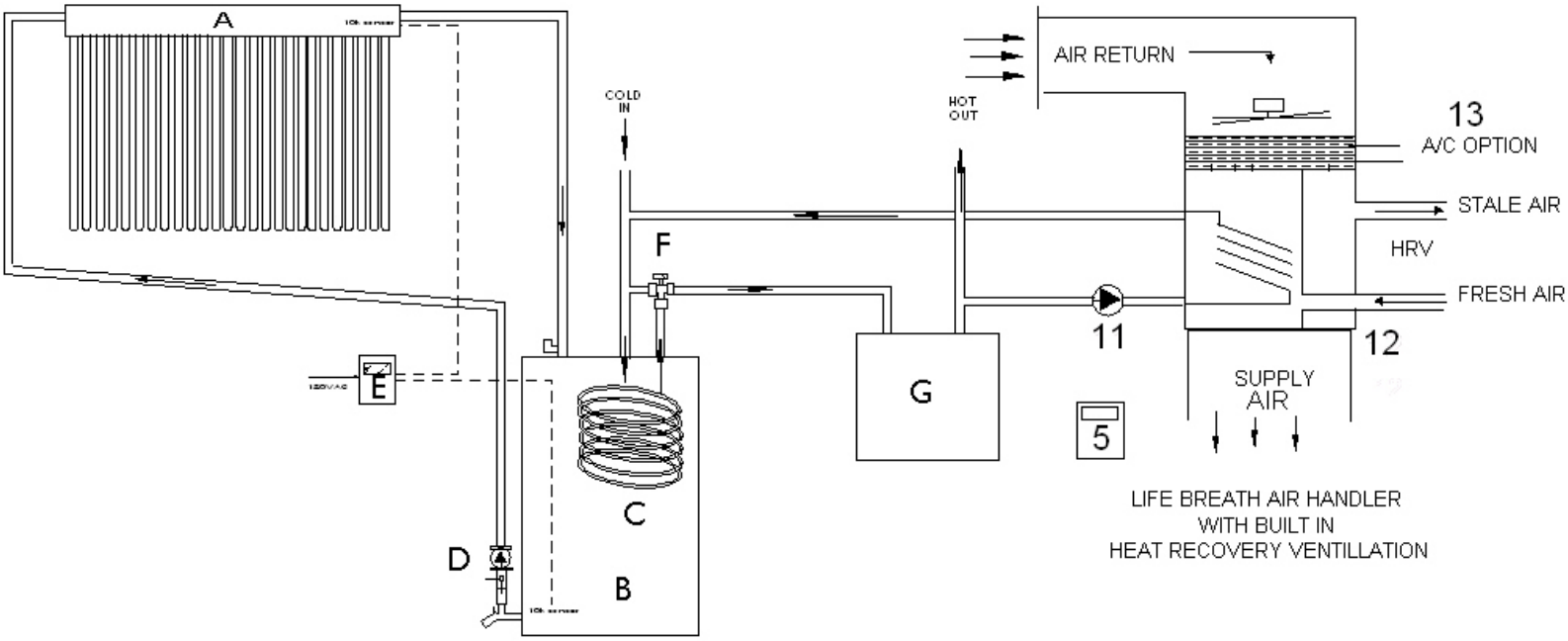
LIFEBREATH SOLAR FORCED AIR



LIFE BREATH – There are ***three*** additional parts to the LIFE BREATH system

#11 Zone circulator – This pump is not necessary if a "G" tank type water heater is used however it ***may*** be necessary to incorporate a Taco 009 booster pump if "G" is a tank less water heater.

#12 LIFE BREATH – This is a self contained forced air heater combined with a heat recovery ventilator and filters. It installs the same as a forced air unit however the heat source is hot water passing through a heat exchanger. It has its own small internal circulating pump

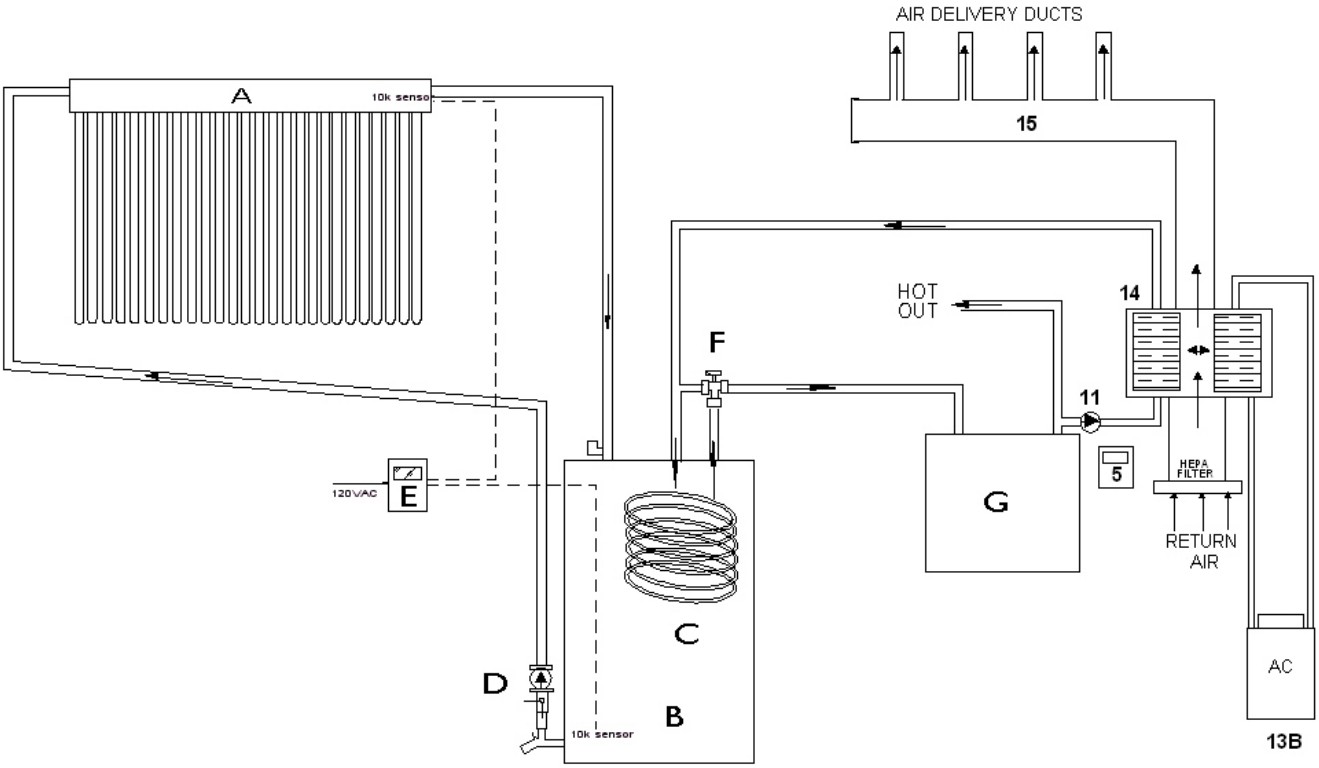
#13 AC coil – This is the same AC coil and compressor that is normally installed in a standard forced air heater

The Life Breath system (12) installs just like a forced air system with two exceptions. In a conventional F/A system heat is generated by gas burners. A large fan blows air around the heat exchange chamber to heat the return house air drawn through a heat exchange chamber. The Life Breath pumps hot water through coils (similar to a car radiator) instead of the gas burner. Life Breath has

its own pump built into the unit. If (G) is a tank type water heater, installation requires only a ½" or ¾" hot water supply and return to the water heater. If a tank less water heater is used a booster pump will be required to boost the pressure to reliably operate the tank less heater. The Life Breath is also a heat recovery ventilator with a secondary high performance filtration chamber. This requires installing a 4" (aluminum dryer exhaust hose) fresh air supply and stale air return.

A standard air conditioning coil (13) can be installed as with any forced air unit.

QUIET AIR DELIVERY



The **QuietAir** system operates in the same way that the Lifebreath system works with the following differences

- The air handler comes with both heating and A/C coils installed
- The Spacepak does not have a heat recovery ventilation (HRV) function
- The air handler operates at higher air pressure (1.5" H_2O)

The air ducts for the QuietAir are "mini" 2" flex PVC pipe plumbed through the interior wall framing. The high velocity delivery system uses diffusers at the exit from the tubes.

Trendsetter has special 2" insulated recycled PE ducting that can be buried beneath a concrete slab. This system is extremely energy efficient and easy to install.