

Chapter 3-A

HEAT

EXCHANGERS

OF A NEW BOOK BEING
CREATED ON THE PAGES
OF THE TRIBAL MESSENGER
BY STEVE BAER...

Heat exchangers are among the last things that a curious person ponders of all the objects that you find in junkyards. Discarded heat exchangers seem more useless than axles or gear wheels and their performance more remote. Heat exchangers along with axles, pulleys and gears make up a surprisingly large portion of the metal you find in junkyards. Most of the pictures in this section were taken at the ACME metal junkyard on North Second Street. There is no better place to educate yourself in the matter of heat exchangers than a junkyard - it would take several days to visit all the equipment where it is installed at work or displayed in a salesroom that you can see, pick up and closely examine in a few minutes at a large junk yard. The one danger in visiting junkyards is that it encourages only a limited part of one's design instincts. The piles of junk suggest uses for themselves rather than the needs suggesting the design of the equipment. It is a kind of backwards design.

Axles transfer energy by torque. The rigid shaft, turned at one end, commands the other end to do the same. In heat exchangers it is again a motion transferred through metal. But in this case it is by molecular trembling, heat, passing through the walls and along the fins of the exchanger. It is simple to pass energy by a shaft. Great beauty is found in many designs of the more sophisticated heat exchanger.

Metals vary greatly in their ability to conduct heat. Below are listed various materials with the quantity of heat (in BTUs) that will flow through a 1 ft. sq., 1" thick sheet in one hour if the temperature on one side is one degree F higher than the other side.

Copper	- 2700 BTU
Lead	- 250 BTU
Gold	- 2060 BTU
Silver	- 2900 BTU
Zinc	- 750 BTU
Aluminum-	- 1500 BTU
Iron	- 400 BTU
Air (still)	- 0.163 BTU
Water "	- 3.85 BTU
Oil "	- 1.2 BTU
Glass	- 5.8 BTU
Styrofoam	- 0.25 BTU
Glass Wool	- 0.25 BTU

As an example of what these rates of heat flow mean in terms of the strength of sunlight, we can see that a 1" thick piece of lead, to pass the heat of the direct sun through itself would have to be slightly more than one degree F hotter on the sunny side than the cold side - for the sun gives about 300 BTUs/sq. ft./hr. Lead is a relatively good conductor. For this same quantity of heat to pass through a good insulator such as styrofoam the temperature would have to be more than 1000 degrees F hotter on one side than the other (long before which the styrofoam would have burned up). You'll notice in the headings under the pictures of the heat exchangers such titles as liquid to air, liquid to liquid - but a glance at our list of conductivity of materials shows that air, water and oil are all very poor --so what sense is there in building a heat exchanger to pass heat to these substances when they can't pass it through themselves once they are given it? The trick is that these substances, gasses and liquids, must flow past or through the heat exchanger to make the exchanger function. Radiators on automobiles rely on the radiator fan and the motion of the car to push the air past the cooling fins and then there is a water pump to circulate the water within the radiator. The radiators in a building rely on

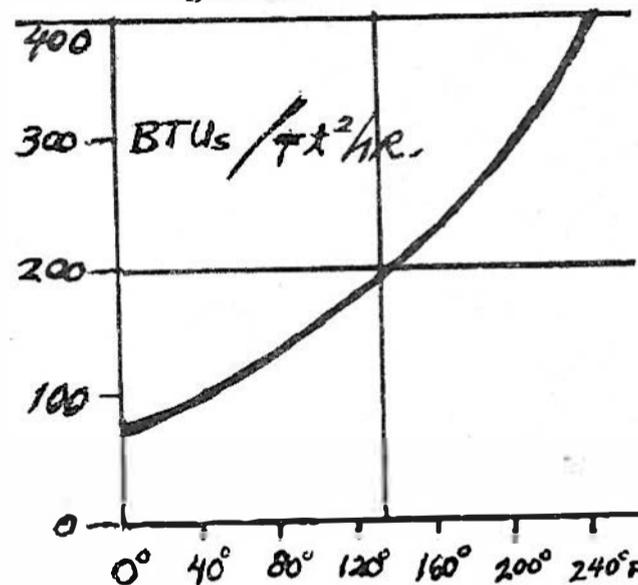
the convection currents of the heated air to keep taking the heat away.

This is usually the difficult part of the heat's journey - into and out of the exchanger, not through it. To accomplish this pumps, agitators and fans are used to keep presenting the surfaces of the exchanger with fresh matter to be heated or cooled.

It is quickly apparent after a glance at a liquid to gas heat exchanger that the transfer to gas is more difficult than to liquid, for much more surface is exposed to the outside air than to the inner circulating liquid. All in all, the progress of heat through a heat exchanger is like that of a jet traveller who must fight his way through traffic jams arriving at and departing from the rapid leg of his trip.

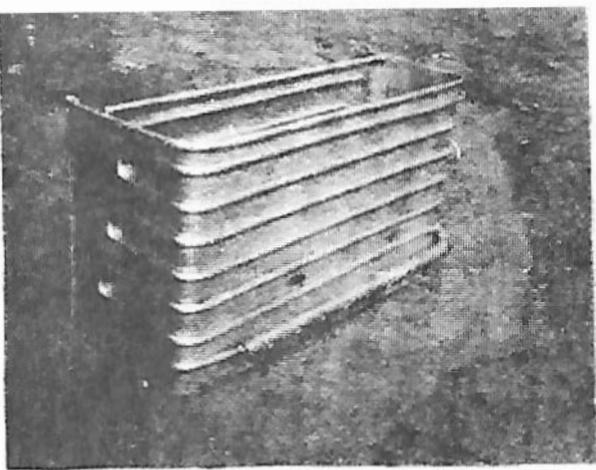
Heat transfer is generally broken into three categories; conduction, convection and radiation. We have listed values of conductive transfer and mentioned the function of convection in moving matter past hot or cold surfaces. Radiation is another powerful transfer mechanism wherever there are marked differences in temperature between two surfaces. All of our energy from the sun arrives by radiation. There is no material between us and the sun to carry heat by conduction or convection.

Radiant Energy
From a Black
Surface



1. LIQUID - AIR

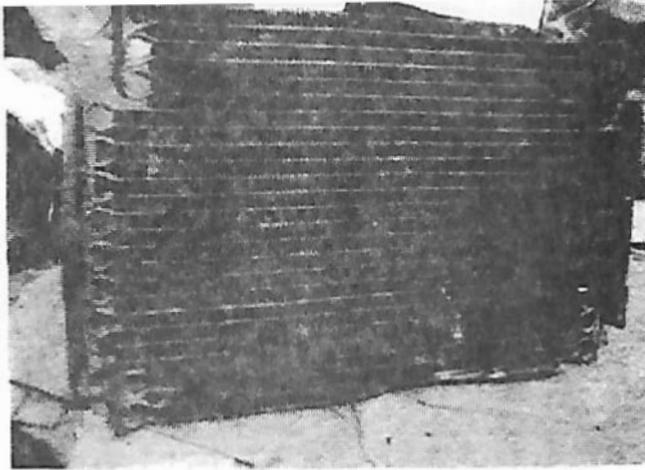
An aluminum box with aluminum tubes bonded to the box. The tubing appears to be soldered to the flat sides. This is part of a refrigerator or freezer. Chilled liquid is pumped through the tubes. The liquid takes away the heat which has traveled through the sides of the box, the bond between box and tubing and finally the walls of the aluminum tube itself. Many of the elements of heat exchangers exist in series and thus, as with a chain, the performance is no better than the poorest component.



2. LIQUID - AIR

This heat exchanger is made by bonding together two steel sheets which have been specially formed so that flow channels remain after the two sides are together. Notice the large header with smaller flow channels leading from it. This particular exchanger is made of steel and used in refrigerators.

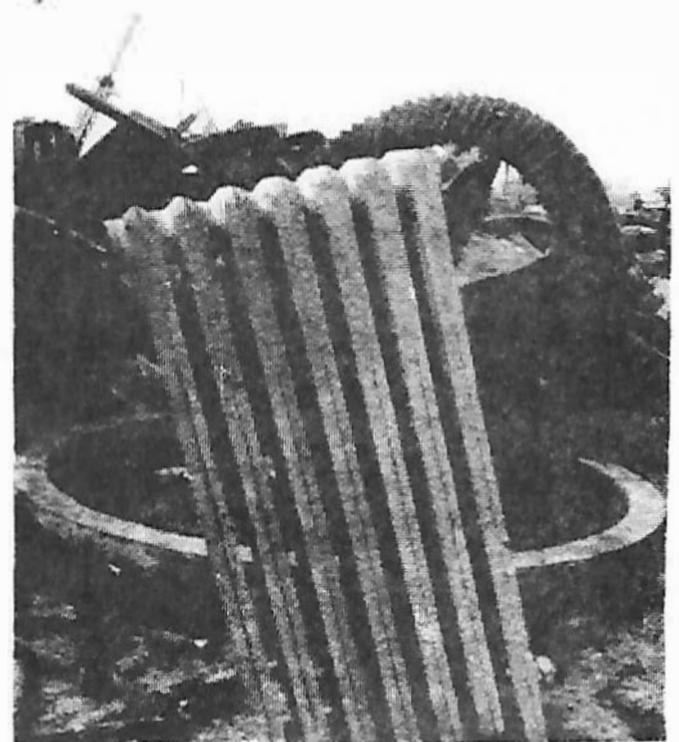
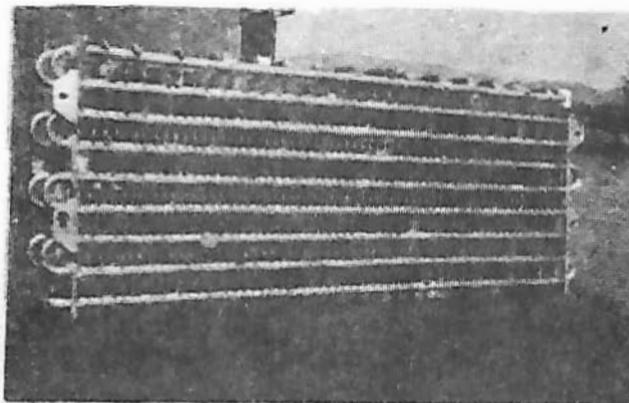
Both this exchanger and the previous one are the same configuration as photos #10, 11 which are solar heat collectors. The solar heat collector is not an air-liquid exchanger but instead a radiant energy to liquid exchanger. It is possible that these old refrigerator parts might be bent flat and used as solar collectors. The one I saw at the junkyard which had been straightened would not work because the flow channels had dimpled in when the sheet was flattened out.



This is a standard steam radiator of the kind that you find in numerous old buildings - it is made of cast iron. Steam enters at the top, condenses in the radiator and drains back to the boiler as water. These are kept very much hotter than the rooms they heat and much heat is given off, as their name indicates, by radiation. Why is the radiator painted white instead of black? Black surfaces are the best radiators. At the wave length at which these radiate heat they are not white but instead black. Most white paints are like this; white in visible light, grey or black in infrared. Aluminum paint remains shiny even in the infrared.

4. LIQUID - AIR

This is made entirely of aluminum; the fins are press fit in place. It is one continuous tube; you can see the front and back banks connected at the lower left.

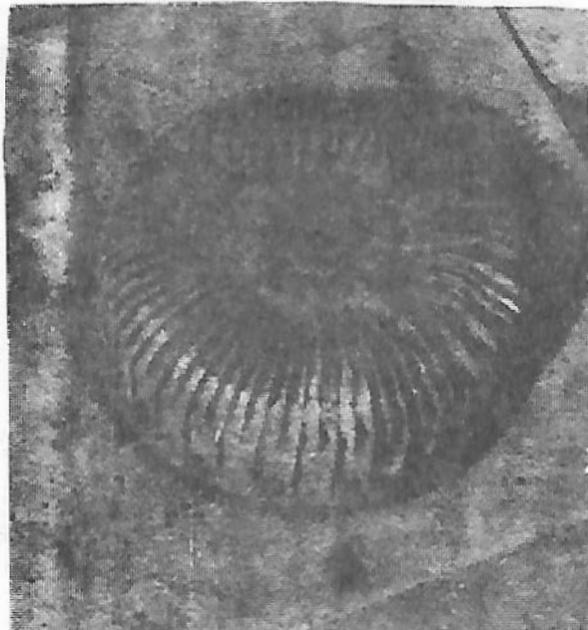


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The Chapter on Heat Exchange will be completed in the next issue of the Tribal Messenger.

5. LIQUID - AIR

The fins are to disipate heat to the air. You see similar arrangements on cylinder heads of motorcycle engines and on air compressors. Notice the gear teeth around this part - evidently it turned or something turned around it. Many such devices rely on convection to carry away the heated air but a fan or the motion of the engine itself as in a motorcycle greatly increases the rate of heat transfer. Convection can work effectively to move heated air if the air is confined to a chimney so that it can develop draft.



3. LIQUID - AIR

This is an automobile air conditioner heat exchanger. It is all made of steel. There is no problem of rusting since the liquid that normally circulates through the tubes is freon. The fins that can be seen folded back and forth between the tubes are merely pressed in place and rely on a press fit for heat conduction. I once placed such a heat exchanger at the exit of a solar chimney. The heat exchanger was connected by tubing to a 10-gallon tank placed several feet above it. It heated the 10 gallons of water above 120 degrees. This is one fairly promising method of heating water in a region like New Mexico where you can't expose water in flat plate collectors because the water will freeze and rupture the tubing. A solar chimney forces hot air through a radiator during the day; at night the radiator, which has water in it, is sufficiently protected by heavy walls to prevent freezing. These radiators are very cheap at junkyards. I do not know how long they would last with water in them.

