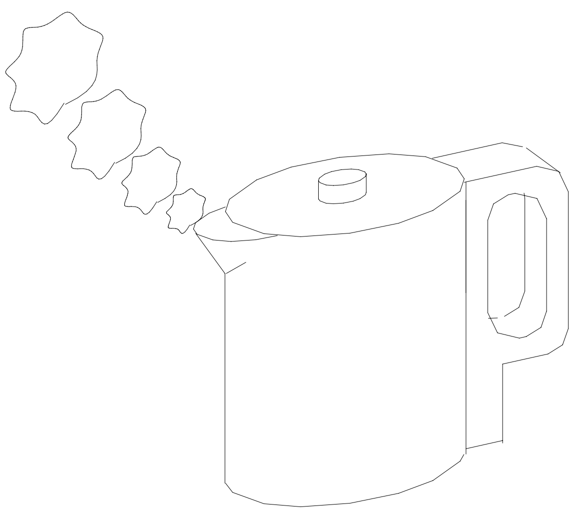
Fundamentals of Refrigeration

Evaporation

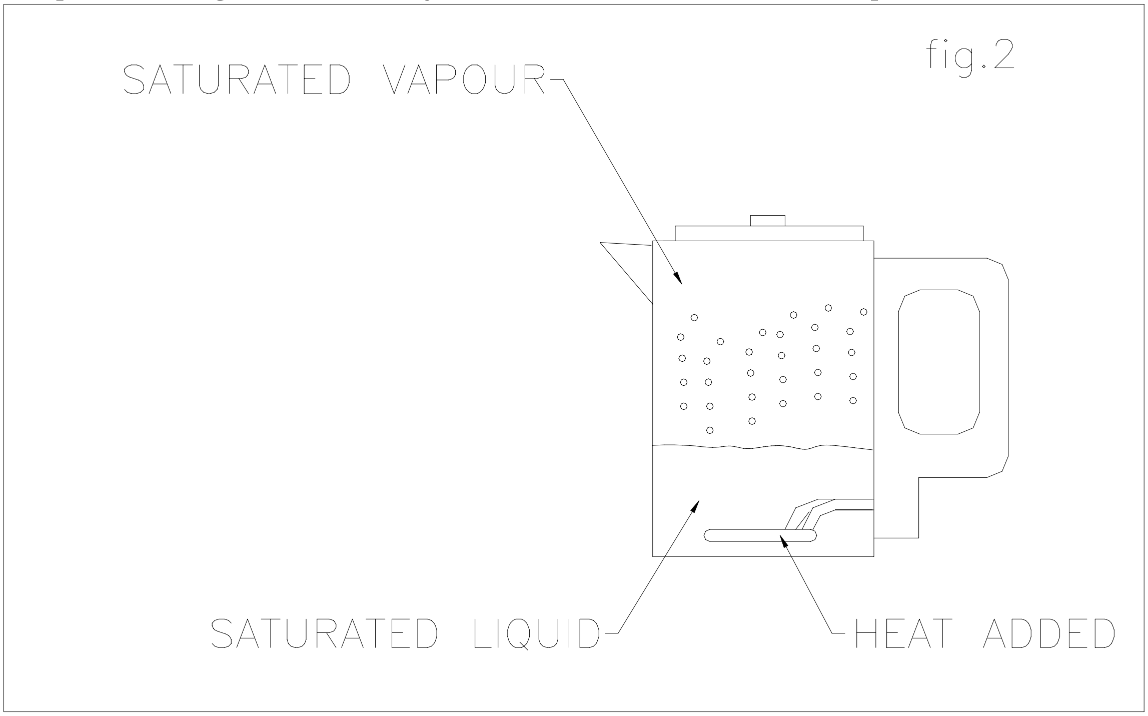
The picture on fig.1 here shows an evaporator.We generally call it a kettle.

fig.1



AN EVAPORATOR

The picture on fig.2 shows us why it should be considered as an evaporator.



Heat is added to the liquid (which in this case is water) causing it’s temperature to rise until it reaches its boiling point. When the liquid reaches its boiling point it begins to change into steam.

In order to change into steam the water requires additional energy from the heater element.The water temperature will not rise above the boiling point until all the liquid has been evaporated.This additional energy is known as latent heat.

Fig.3 shows the type of evaporator which we manufacture.

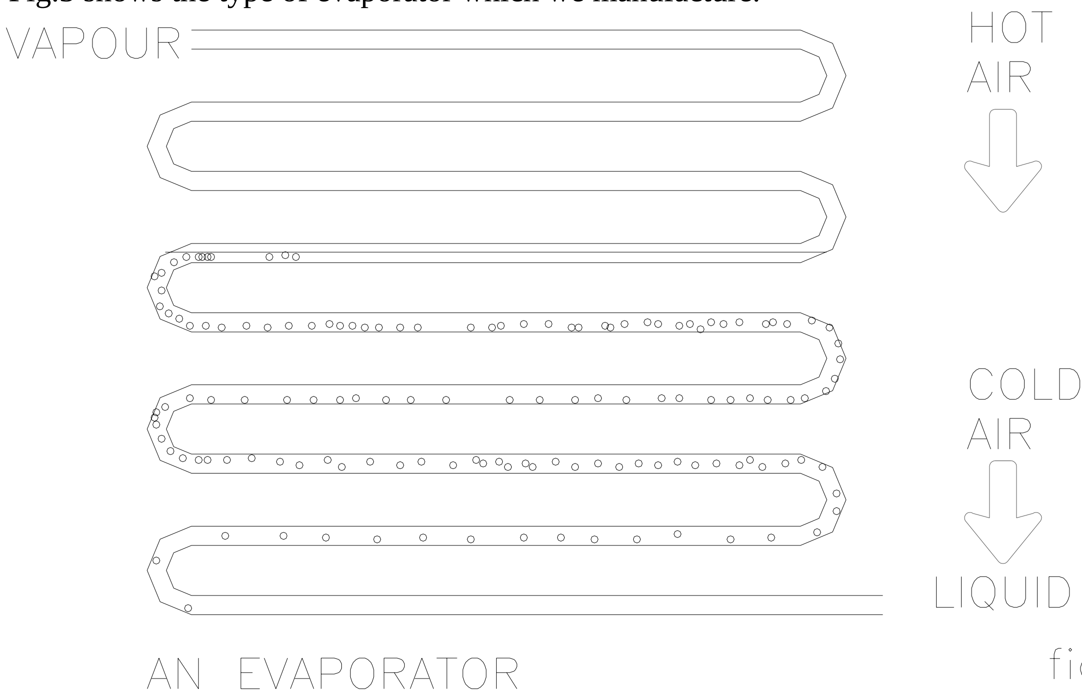
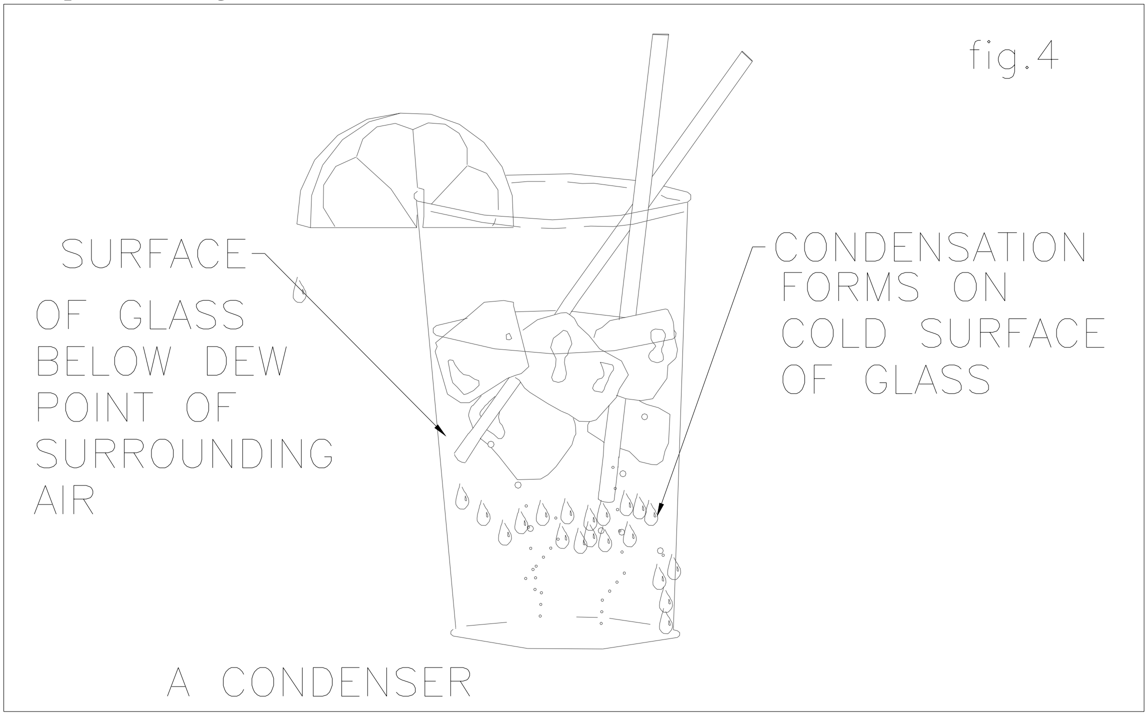


fig.3

This works in exactly the same way as the kettle.Liquid refrigerant is passed into the inside of the tubes and heat from the air passing over the tubes causes the liquid to boil.As the energy is passed from the airstream to the refrigerant the air temperature will fall.

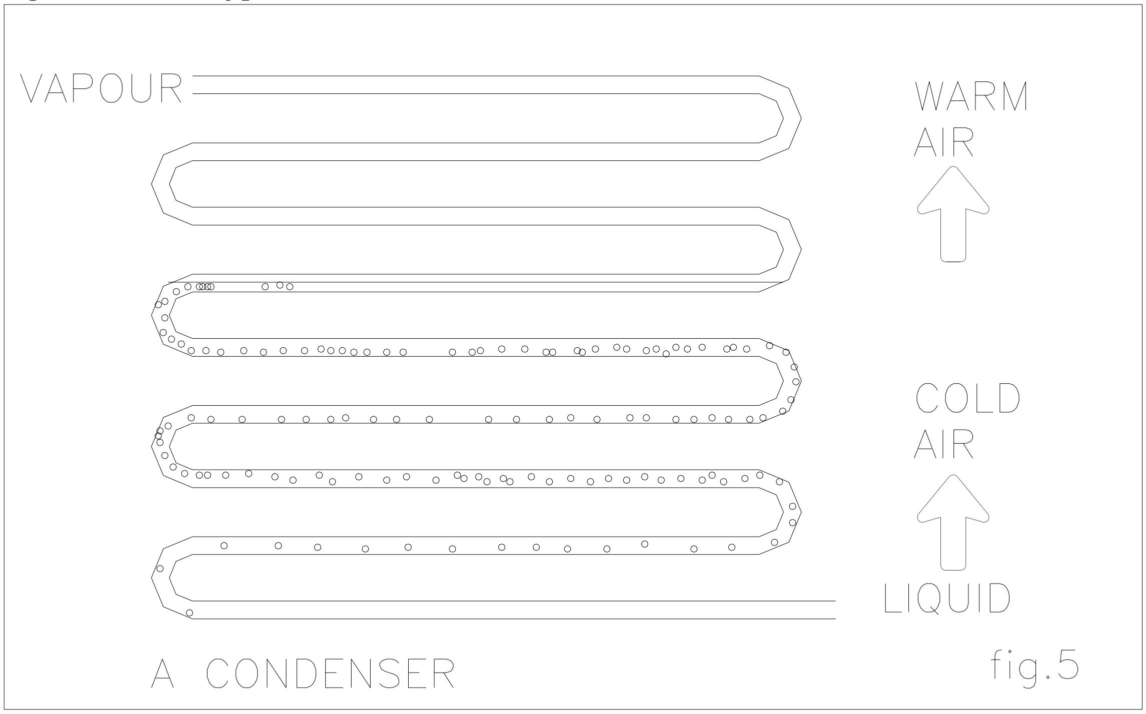
Condensation

The picture in fig.4 is a condenser.



You will all have seen how condensation forms on the surface of a cold glass in the Summer. This is caused by the glass absorbing the latent heat from the water vapour contained in the air surrounding the glass. This causes the vapour to return to a liquid state.

Fig. 5 shows the type of condensers which we make.



Note the similarity to the evaporator which we saw in fig.3. This time vapour at high temperatures is passed inside the tubes. Cold air is blown across the coils to remove the latent heat and the refrigerant turns into a liquid.

Saturation

I have previously mentioned that the changes of state take place without a rise or fall in the temperature in the medium being evaporated or condensed. This is known as the boiling point or saturation condition. If the refrigerant temperature rises it will become a gas,if it falls it will be a liquid and at the saturation condition it can exist in one or both of its states at the same time.

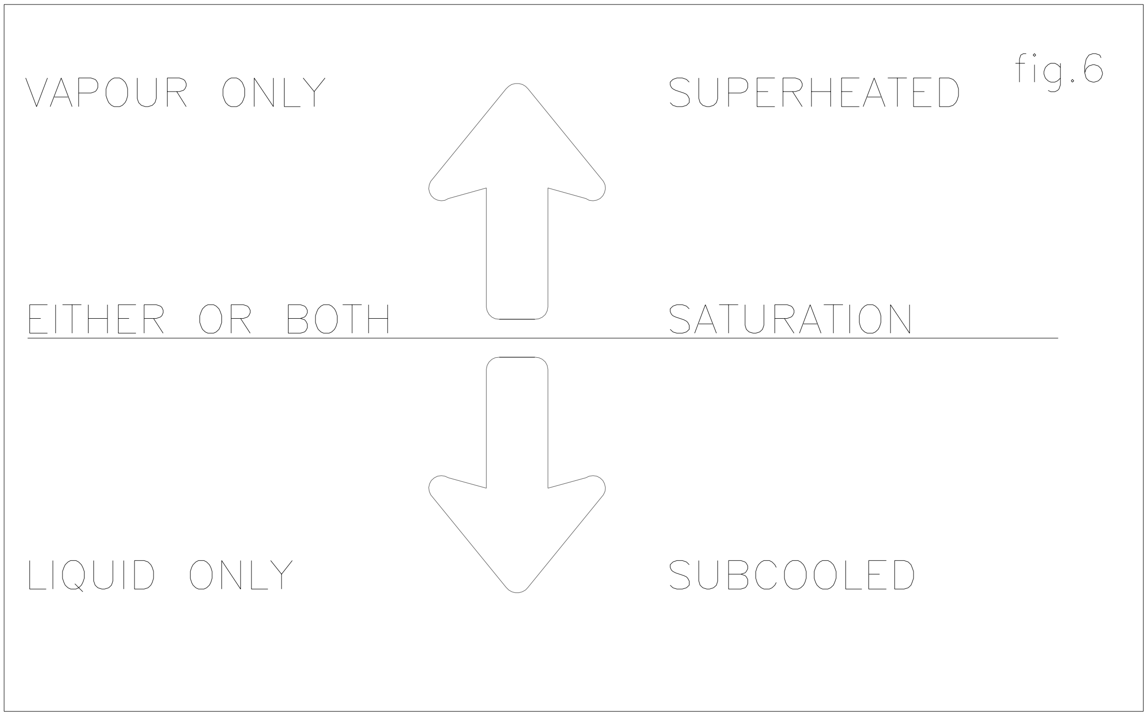
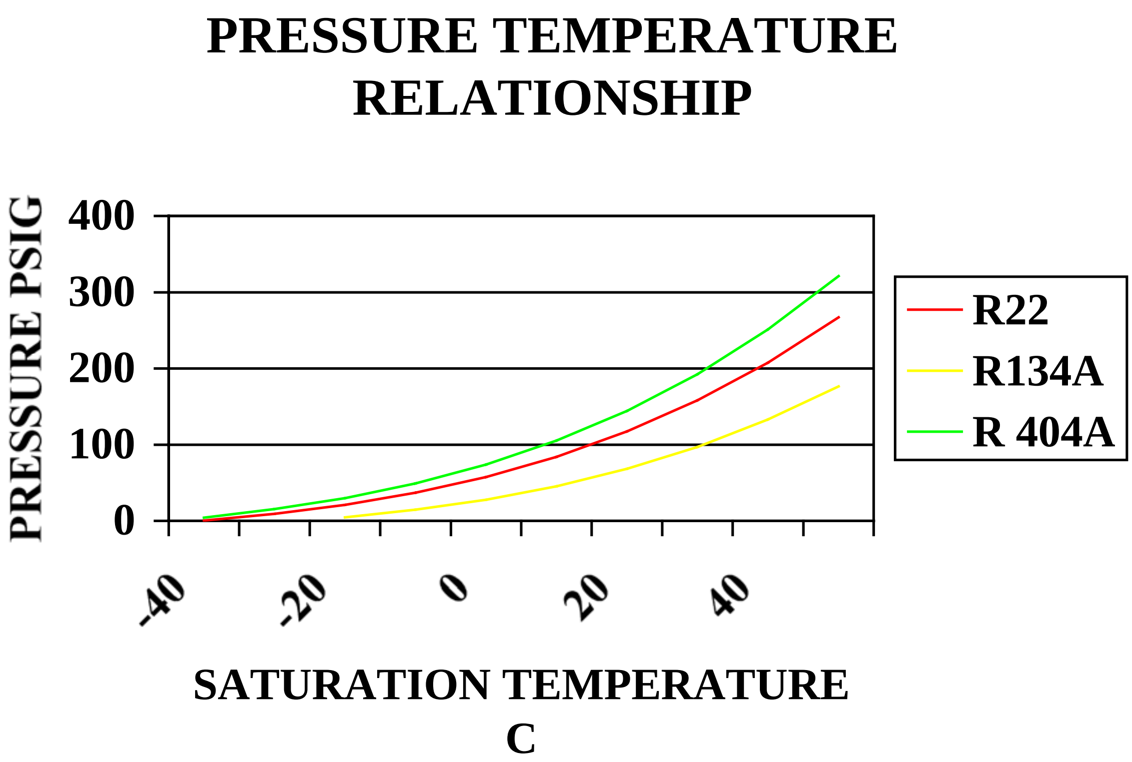


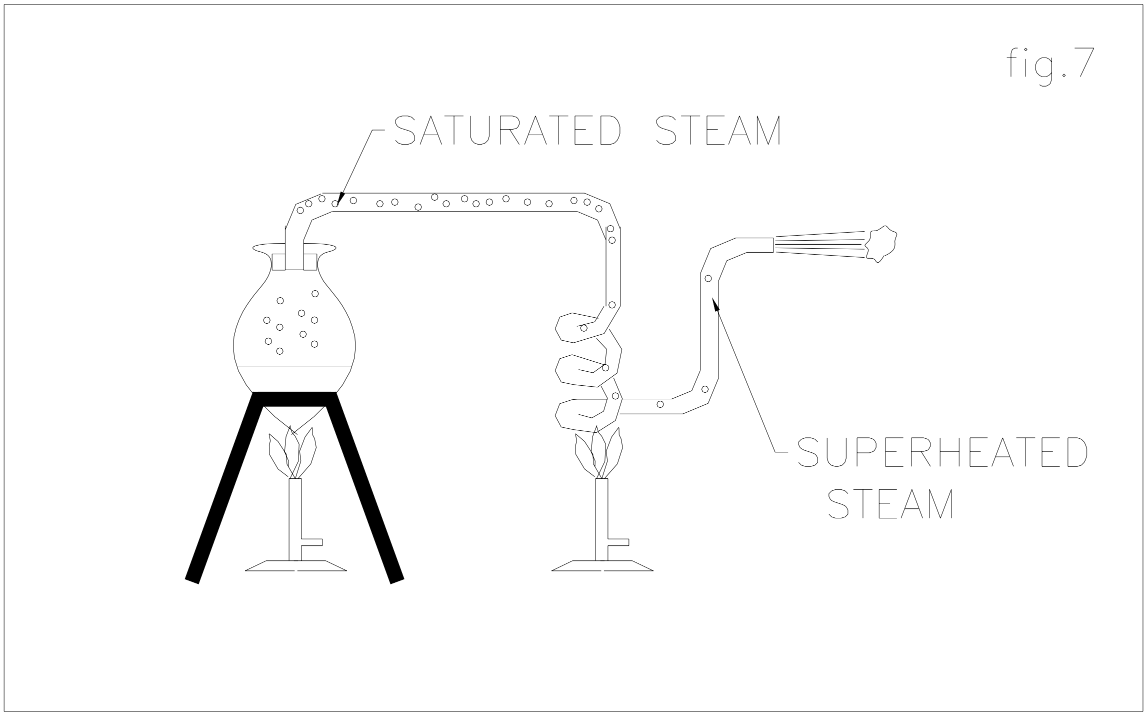
fig.6

Pressure/temperature relationship



The boiling point of any single component refrigerant will change according to the pressure which is acting upon it. As the pressure in the refrigerant increases ,the boiling point also increases and conversely as the pressure falls so does the boiling point.

The boiling points are referred to as condensing temperatures or SDT (saturated discharge temperatures) in condensers and evaporating temperatures or SST (saturated suction temperatures) in evaporators.



Superheat

Let us consider a single component refrigerant whose pressure is being controlled at a constant condition .If the vapour is heated above the saturation point it is said to be superheated. Superheated vapour cannot exist if it is in direct contact with saturated liquid. Figure 7. shows steam being superheated. The water and steam in the boiling vessel are at a saturation condition relating to the local pressure. When the saturated steam passes through the second heating coil it absorbs energy and becomes superheated. We will
be returning to superheat later as it is very important in the control strategy of refrigerant cooling coils.

Subcooling

Let us now consider a single component refrigerant at a fixed pressure in a liquid state. If we pass the liquid through a cooler its temperature will fall. The difference in temperature between the saturation temperature and the measured temperature is called the subcooling effect which is expressed in temperature units°C or °F. As an example of this let us consider water from the cold tap. The temperature of this water is usually about 5°C. The normal boiling point or saturation point of water at atmospheric pressure is 100°C so our tap water is said to be subcooled by 95°C. Hot water will still be subcooled by whatever the difference between is temperature and the boiling point is. Subcooling is important in the expansion and evaporating parts of the refrigeration cycle.

Two phase flow

Two phase flow takes place in liquid drain lines between the outlet of the condenser and the inlet of the liquid receiver. Refrigerant leaving the condenser is at saturation, which means that it can exist in two states at the same time. It is therefore quite normal to have a mixture of liquid and vapour mixed up together as the refrigerant leaves the condenser. If the liquid drainage arrangement has been correctly designed,any vapour which has formed in the liquid receiver will burp its way back to the condenser through the liquid which is continuing to enter the receiver.