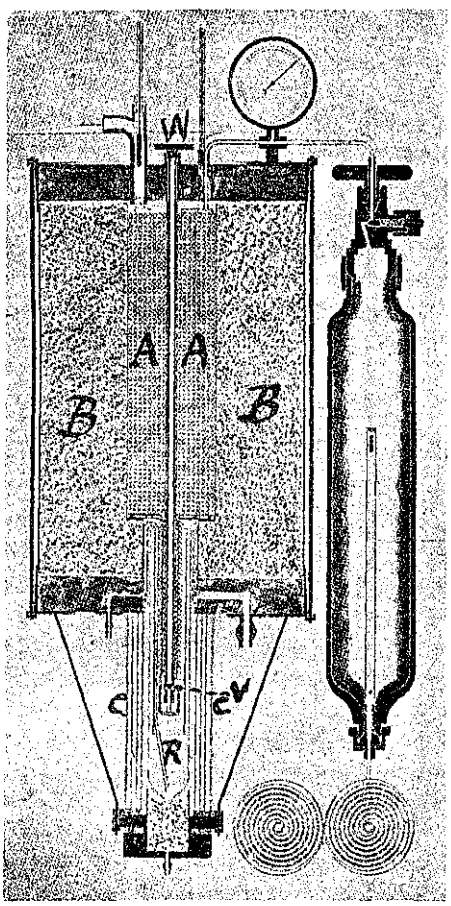
This, then, is the principle of the apparatus constructed and patented by Linde in Germany, by Hampson in England, and J. Tripler in America, for the liquefaction of air. In the words of one of these inventors "The apparatus depends upon a method by which a moderate amount of refrigeration, produced by the expansion of gas, may be accumulated and intensified till it reaches the point at which the gas used becomes liquid under atmospheric pressure. The method consists in directing all the expanded gas, immediately after its expansion, over the coils which contain the compressed gas that is on its way to the expansion point. The cold developed by expansion in the first expanded gas is thus communicated to the on-coming compressed gas, which consequently expands from, and therefore to, a lower temperature than the preceding portion. It communicates in the same way its own intensified cold to the succeeding portion of compressed gas, which, in its turn, is made colder, both before and after expansion, than any that had gone before. This intensification of cooling goes on until the expansion-temperature is far lower than it was at starting; and if the apparatus be well arranged the effect is so powerful that even the small amount of cooling, due to the free expansion of gas through a throttle-valve, may be made to liquefy air without using other refrigerants."

The illustration shows an apparatus of this kind, capable of yielding a quart of liquid air per hour. All that is necessary is to attach to the pipe carrying the gauge a pump capable of rapidly compressing air to about one hundred atmospheres. On starting the pump liquid air soon begins to accumulate in the glass vessel which forms the lower part of the apparatus. In the drawing showing a section of the apparatus A A represents the coils of pipes for conveying the air to and from the expansion-valve V, which valve is controlled by the wheel W; B B is simply a packing of wool, or other substance, to keep out the external heat. The liquid drops into the glass receiver, R, which is surrounded with concentric glass cylinders like lamp chimneys (marked C in the section) in order to protect the liquid from the heat of the atmosphere.

I have seen the apparatus at work in London delivering liquid air with great regularity and perfectly automatically, requiring nothing but the engine and air-pump necessary for the supply of the compressed air.



The peculiar properties of liquid air are chiefly due to its exceedingly low temperature, which is about 344 degrees below the freezing point. Owing to this temperature being its boiling point it cannot, in the open air, ever have a higher temperature, just as water, unless under pressure, cannot be heated above 212 degrees Fahr. Pieces of ice placed in it cause it to boil with explosive violence, quicksilver plunged in it becomes exceeding hard, and, of course,