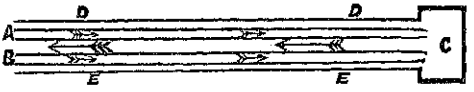
theatre, whose walls had been the witnesses of so many great discoveries.

The process adopted by Professor Dewar in accomplishing his task was by no means a simple one, and before these rebellious gases could be said to be entirely subdued, it remained to find a means of liquefying them easily and cheaply. This has been done by Carl Linde, of Munich, who makes use of a method first suggested by Siemens, more than forty years ago, and applied by him to what is, at first sight, a totally different matter—to wit, the construction of what are now known as regenerative furnaces.

The idea which led to the building of these furnaces, and to the most recent methods of air liquefaction, is so simple, or admirable in its results, and so far-reaching in its applications, that I propose, at the risk of making this article too technical, and, therefore, to most people, too tedious, to endeavour to explain it. Imagine two pipes, A and B, the one conveying a combustible gas, such as coal gas, the other the air necessary to its burning, and suppose that the gas and air both flow in the directions indicated by the small arrows, and pass



from the ends of the pipes into the space C, where the gas is burnt at the expense of the air; and, further, suppose that after the burning has taken place, the hot gases which pass off from the flame are led back through the larger tube, D D, E E surrounding the smaller ones, A and B, the hot gases, therefore, travelling in the direction of the larger arrows. The effect of this arrangement will be that the hot gases will give up their heat to the gas and air coming the other way along A and B, so that these gases will arrive at C already hot, and when they burn, the temperature in C will be very much higher than if the gases had arrived cold; but this high temperature in C will cause the gases, flowing back along D E, to be much hotter than before, and this will cause the gas and air in A and B to be much more heated, so that these gases will arrive in C hotter than they did when first heated; but arriving hotter and burning in C as before, the temperature of C will be further raised, and hotter gas will pass back along D E, heating still further the arriving gases. It is evident that the process would go on indefinitely, the heat in C always rising, were it not for the inevitable loss of heat through the walls of C, which eventually becomes so great as to prevent further increase. There is, besides, a limit, beyond which the materials of the pipes and the chamber C would be destroyed by the heat.

This is the idea which has been so successfully applied, with many differences in detail, in the "regenerative" furnaces which are now largely employed in iron works, glass and porcelain works, and also in the manufacture of coal gas.

It is but a small, but very important, step from this regeneration of heat to the regeneration of cold. Suppose that for some reason or other the gases passing through A and B, on mixing in C, became colder instead of hotter, then the cold mixtures passing along D E would cool the arriving gases, which, on mixing, would become colder still, and the cold mixture, going back along D E, would still further cool the gases in A and B, so that gradually an exceedingly low temperature would be obtained in C. The only difference between this regeneration of cold and the process first mentioned, is that the mixing of the gases in C is supposed to cause a fall in temperature instead of a rise.

Now, compressed air, when it is allowed to expand, falls in temperature, so that if compressed air be pumped into A and B and allowed to expand at small valves placed at the end of those pipes in C, the expanded air will go back along D E colder, and will thus cool the arriving compressed air, the process of gradual cooling going on precisely as above described. It is clearly, in this case, unnecessary to have the two pipes A and B—one would suffice.