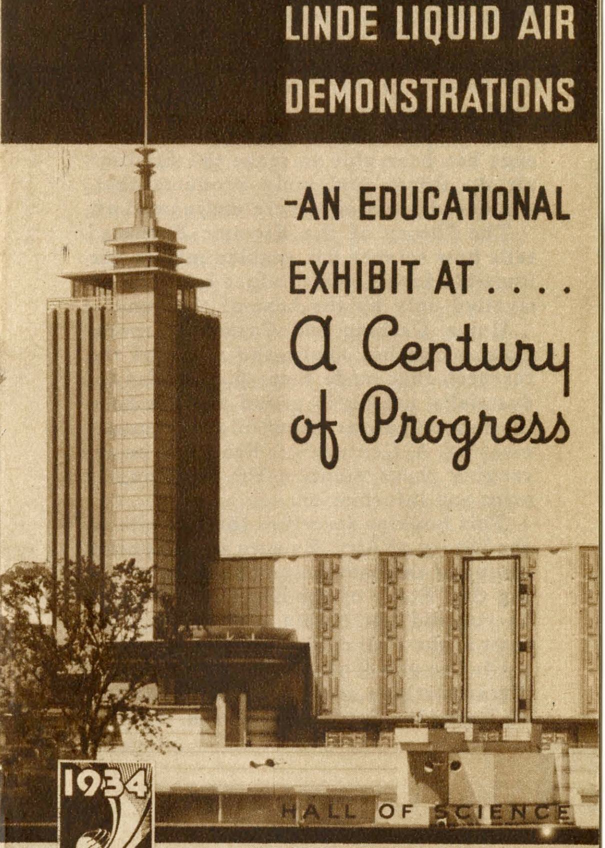
Story of Air and LINDE LIQUID AIR DEMONSTRATIONS



-AN EDUCATIONAL EXHIBIT AT . . . . A Century of Progress

1934
A CENTURY OF PROGRESS
CHICAGO

Sponsored by
UNION CARBIDE AND CARBON CORPORATION

Two Miracles of Modern Science

In these Basic Science Exhibits of A Century of Progress, you will see many wonderful records of man's conquest over the secrets of nature. Yet, of these, perhaps the most amazing are the "Story of Air" and the "Story of the Electric Furnace".

The "Story of Air" explains how science has been able to make the familiar air do things and yield products that, a hundred years ago, were undreamed of.

The "Story of the Electric Furnace" tells how science has enabled man to use invisible forces and produce heat that is rivalled only by the heat of the sun.

Union Carbide and Carbon Corporation, which has sponsored much of the research that made these discoveries industrially useful, is proud to have been invited to cooperate with the management of A Century of Progress in arranging these exhibits for your enjoyment and information.

This booklet describes the exhibits on the "Story of Air." Be sure also to obtain a copy of the companion booklet describing the "Story of the Electric Furnace." If you did not obtain this during your visit at the Hall of Science a copy will be mailed to you if you address a request to Union Carbide and Carbon Corporation, 30 East 42nd Street, New York, N. Y.

Things You Never Have Known About Air

Air, to most of us, is something we breathe or use compressed for filling tires. Actually, however, these are only a tiny part of all the uses that air can be put to.

For example, by turning air into liquid form, scientists can produce intense cold, hundreds of degrees below zero. By breaking air down into the various gases that compose it, scientists can give industry and the medical profession many valuable materials.

The "Story of Air" exhibits explain how science turns air into a liquid and how it removes from the air such gases as: oxygen, which is used for treating certain diseases and for oxy-acetylene welding and cutting; nitrogen for many industrial uses; helium for inflating balloons; neon for electric signs; and certain rare gases for scientific use.

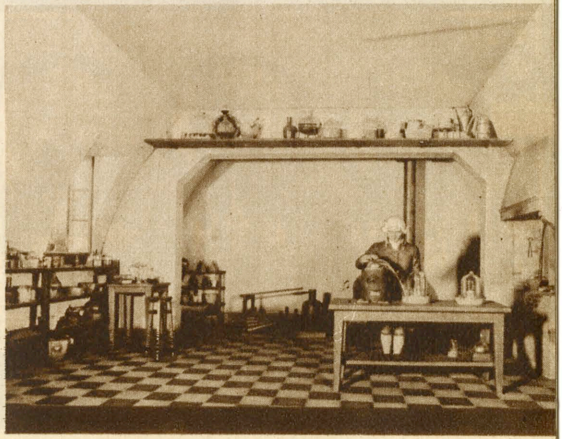
Actual demonstrations of the marvelous things that can be done with liquid air are being given in the Linde Liquid Air Demonstrations on the ground floor of the Hall of Science.

Together, these exhibits and demonstrations reveal air as one of the most wonderful substances in the world. You will find them to be among the most interesting sights of A Century of Progress.

The Story of Air

LAVOISIER'S LABORATORY. A Diorama.

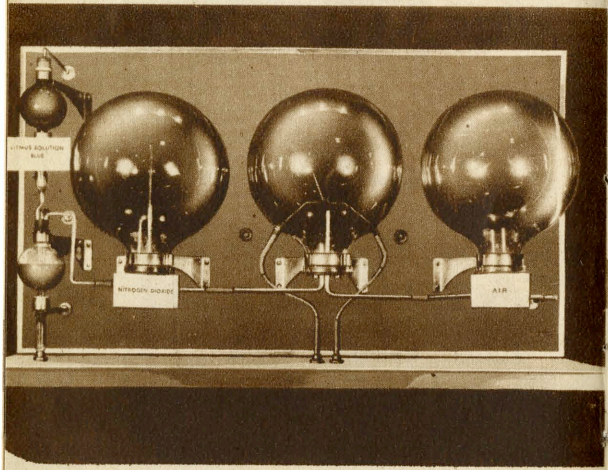
The air we breathe is such an intimate part of our daily life that we seldom give it more than momentary consideration. Throughout the Middle Ages, air was considered to be an element; and it was only about 150 years ago that early scientists discovered that it was really a mixture of several gases. About 1780, Lavoisier, in France, showed that about one-fifth of the air consisted of the element oxygen; and that oxygen was the active constituent supporting life and combustion. A reproduction of his laboratory in 1774 is shown here. With these crude implements, he and contemporary scientists made many important discoveries in the field of chemistry.

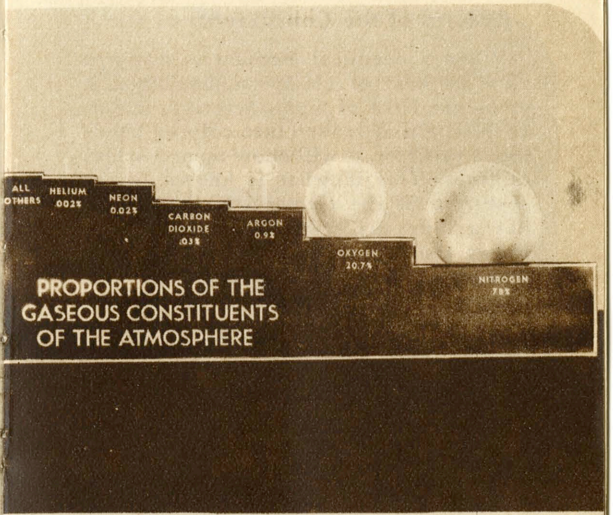


Air Is a Mixture

In this exhibit, the oxygen and nitrogen of the air are shown combining to form nitrogen dioxide.

The two most abundant gases in air are oxygen and nitrogen. Both are invisible and hard to detect unless combined into something that can be seen which would prove their existence. An electric arc is formed between the two wires in the center bulb, and the oxygen and nitrogen combine as this arc passes through them. In combining, they form an oxide of nitrogen known as nitric oxide. Nitric oxide is a colorless gas; and when cooled, it unites with more oxygen to form nitrogen dioxide — a brown, poisonous gas.





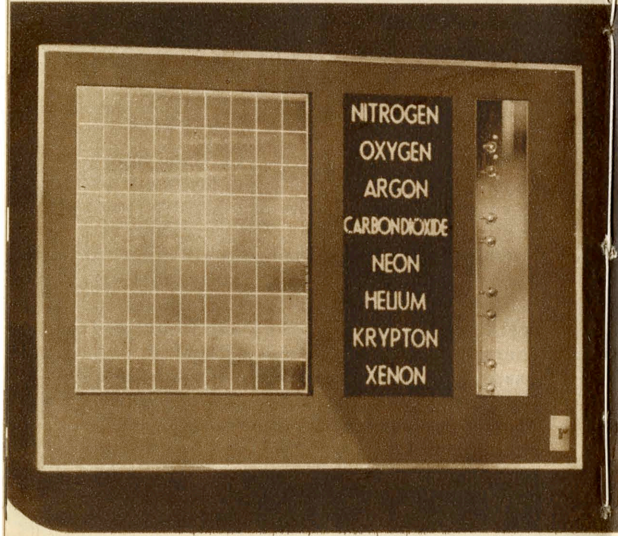
Composition of the Atmosphere

Here the sizes of the various bulbs show approximately the proportions of the various gases in the atmosphere, and the figures below give the percentages.

Of the gases that make up air, oxygen ranks first in commercial importance. It is used in the oxy-acetylene process of welding and cutting of metals, in oxygen therapy for the treatment of certain diseases, and in various chemical processes. Nitrogen from the air is used a great deal in fertilizers, explosives, and other chemicals. The rarer gases, such as argon and neon, are used in electric light bulbs and in the familiar luminous tubular signs.

Spectra of the Constituents of Air

When a chemical element is made to glow by heat or electrical discharge, it gives out light of a characteristic color. If this light is broken into colored bands like a rainbow, it will show up as a series of lines. This is what is known as the spectrum of the element. Each element has a different spectrum. This exhibit shows the spectra of the various gases making up air. By the use of this phenomenon, helium was discovered in the sun thirty years before it was found on the earth.



Air in Combustion

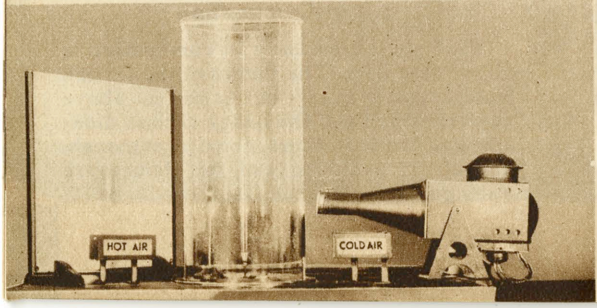
That air is necessary in combustion is illustrated here. The flames in the trough burn brightly in air; but as the jar above is overturned and the heavy carbon dioxide gas from it flows down the trough, the air is excluded and the flames are extinguished.

Principles Involved in the Liquefaction of Air

The separation of the various constituents of air by the Linde process involves the application of four fundamental principles which govern the liquefaction of air or any other gas. These four fundamental principles are explained in the following four exhibits:

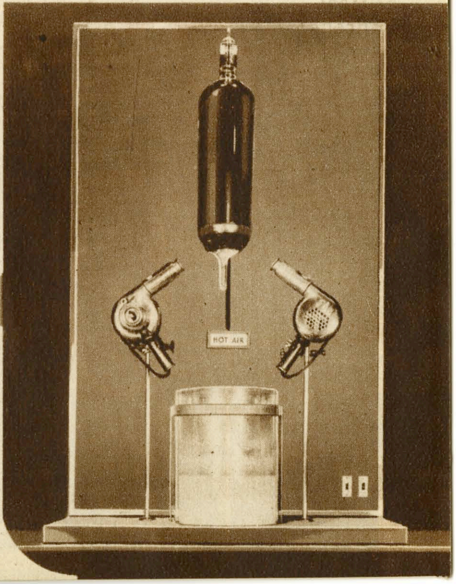
Critical Temperature

Every gas has a critical temperature, above which no amount of pressure will liquefy the gas. In this exhibit, a gas called ethane is used. Air is not used because the high pressure and low temperature necessary would be unobtainable with simple apparatus. Ethane gas has a critical temperature of 89.8 degrees Fahrenheit and a critical pressure of 717 pounds per square inch. When the hot air raises the temperature above 89.8 degrees Fahrenheit, the ethane in the small glass tube is gaseous, and no amount of pressure will liquefy it. But when the cold air is turned on and the temperature falls below 89.8 degrees, the ethane immediately liquefies, as can be seen by the shadow of the liquid on the screen.



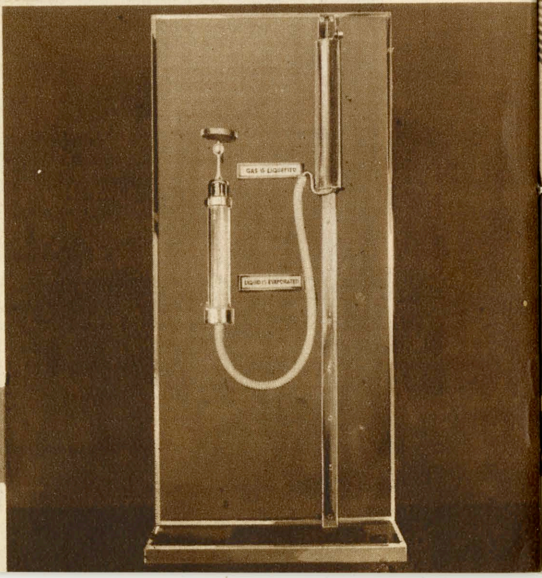
Effect of Temperature

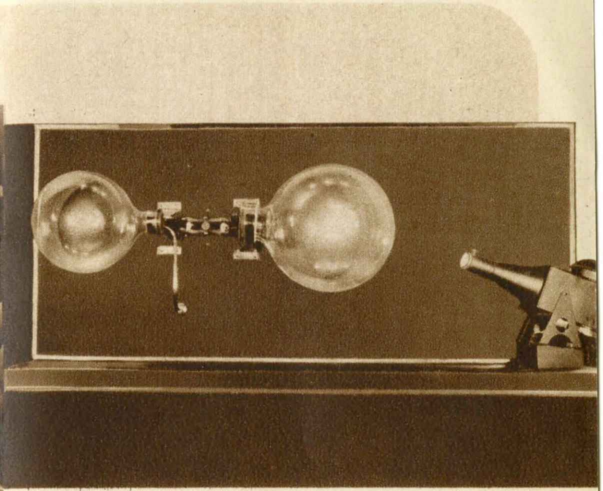
When air or any gas is cooled to extremely low temperatures, it gradually contracts to a liquid and then to a solid that looks like ice. This exhibit is a visual demonstration of a gas liquefying and then freezing to a solid. The brown gas in the large tube is nitrogen dioxide, used instead of air because it will freeze at a much higher temperature. As the tube is lowered into the cooling bath of 112 degrees below zero (Fahrenheit), the brown gas liquefies and then freezes quickly to a white solid. When the tube is pulled up again and warm air from the two blowers is turned on, the solid first melts to a liquid and then evaporates to become again the brown gas.



Effect of Pressure

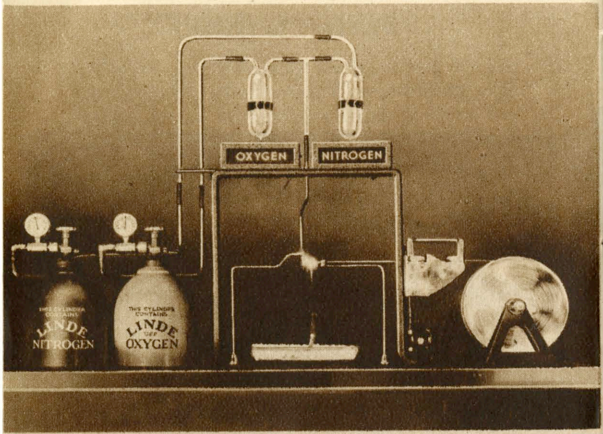
Air or any gas may be liquefied by the application of pressure, providing the temperature of the gas used is kept below its critical temperature. The familiar gas, ether, is used in the glass tube of this exhibit. At the right is a column of mercury. As the mercury container is raised, the mercury flows through the metal hose and up into the glass tube, forcing the ether into a smaller and smaller area until it finally liquefies, as can be seen as it condenses into small drops in the extreme top portion of the glass tube. Then, as the mercury column is lowered, the pressure is decreased, and the ether becomes a gas again.





Cooling by Expansion

When air is compressed, heat is given off; and when the pressure is released, heat is rapidly re-absorbed. This gives a method of securing low temperatures as illustrated in this exhibit. On the left, a vacuum is maintained in the smaller bulb, which is connected through a valve to the large bulb filled with air. Periodically the valve opens and the air from the larger bulb expands rapidly into the smaller bulb. That this causes a fall of temperature is illustrated by the fact that the moisture in the air remaining in the large bulb condenses into a cloud that can be seen forming whenever the valve is opened.



Oxygen is the Constituent of Air That Supports Combustion

Oxygen combines readily with most substances; while the other constituents of air, such as nitrogen, are rather inactive. Here coiled iron wire is moved along until it comes in contact with an electric arc. The heat from the arc quickly causes it to become incandescent. When oxygen is flowed from the pipe above, the iron burns like paper. When the oxygen is replaced by nitrogen, the burning stops immediately. The fact that iron burns readily in oxygen is utilized in oxy-acetylene cutting.

Liquid Air Boiling on Ice

The kettle in this exhibit contains liquid air, which is hundreds of degrees colder than ordinary ice. In fact, so far as the liquid air is concerned, ice is a very hot substance. Consequently, the liquid air in the kettle absorbs heat from the ice—just as water would from a hot stove—and boils quite merrily. The vapor coming out of the spout is not steam, though it looks like it. It is a mist that is precipitated from the warm surrounding air when the colder air from the kettle blows out.

The Periodic Table of Chemical Elements

For the first time in history, every o
of the earth's 92 chemical elements h
been gathered for a single exhibit. Th
exhibit is the Periodic Table of Chemic
Elements—the huge central feature in t
Great Hall of the Hall of Science.

Of these 92 elements, about half ha
been contributed by Union Carbide a
Carbon Corporation.