

# The Industry of "Mining the Air"

Engineers Extract From the Atmosphere the Rare Gases Used to Improve Electric Lamps, Supply Materials for Colored "Neon Signs," and for Many Other Industrial Uses

WHEN the British scientist Cavendish in 1785 first discovered that there were gases in the atmosphere other than nitrogen and oxygen, and concluded that they did not amount to "more than the 1/120th part of the whole," it is extremely improbable that he thought an important industry would some day be built upon that tiny fraction.

Such an industry nevertheless has appeared, and within the last decade has grown to be an important one. From a small fraction of less than 1/100 of the atmosphere, engineers now extract the rare gases needed to improve electric lamps, supply materials for colored "neon" signs, and fulfil the requirements of many less well-known industrial uses.

The extent and nature of the industry of "mining the air" was revealed last week at the Chemists' Club, New York, by Dr. Floyd J. Metzger, vice-president in charge of research and development of the Air Reduction Company and director of research of the U. S. Industrial Alcohol Company and the U. S. Industrial Chemical Company. The occasion was the presentation to Doctor Metzger of the Chemical Industry Medal for 1934, in recognition of his researches in the rare gases, upon the results of which much of the new industry has been built.

Aside from water vapor, carbon dioxide and various "impurities," the air contains varying amounts of eight gases. The greatest part of the air is nitrogen, more than 78 per cent. Oxygen amounts to nearly 21 per cent. The other six, all together, represent less than 1 per cent. of the atmosphere.

The most common is argon, totaling more than nine-tenths of one per cent. Neon, helium, hydrogen, krypton, and xenon are found only as traces, neon being present in the ratio of about one part in 65,000 of air; xenon, the rarest of all, one part in 11,000,000.

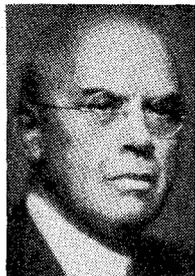
The atmosphere has been a source of commercial nitrogen and oxygen since before the War, and now practically all of these elements used in industry are obtained from it. Oxygen finds many uses, ranging from medicine to the treating of metals, the bulk of the supply being devoted to the operation of oxyacetylene torches for welding and metal cutting. Commercial nitrogen also has many uses, the most important being the manufacture of ammonia, which

in turn is used in making fertilizer, explosives, and other commercial nitrates.

Nitrogen and oxygen are obtained from the air by compressing and cooling it until a critical point is reached, at which the air liquefies. The gases can then be separated simply by allowing the liquid to boil, which it does at the very low temperature of about 195 degrees below zero Centigrade (320 degrees below zero Fahrenheit). At this temperature the nitrogen, having a lower boiling-point than oxygen, evaporates. The process is exactly like that of distillation of alcohol.

The problem of extracting the rare gases is somewhat more complicated. Recovery of argon is easiest, because it is most abundant. The boiling-point of this element falls between that of oxygen and nitrogen, being approximately ten degrees above the boiling-point of nitrogen and three degrees below that of oxygen. In the apparatus now used for the continuous commercial production of these gases, the argon is withdrawn at a point where the oxygen-vapor is richest in argon, and contains only a little nitrogen.

The argon in the gas thus withdrawn amounts to between 5 and 7 per cent. It must be reliquefied and further distilled, which purifies it to about 65 per cent. argon,



Dr. Floyd J. Metzger

## Composition of the Atmosphere

Element	By Volume	By Weight	Boiling Point (Centigrade)
Nitrogen	78.03 per cent.		-195.814
Oxygen	20.99 per cent.		-182.963
Argon	0.94 per cent.		-185.84
Hydrogen	1 part in 10,000		-252.54
Neon	1 part in 65,000	1 lb. in 44 tons	-246.3
Helium	1 part in 200,000	1 lb. in 725 tons	-268.98
Krypton	1 part in 1,000,000	1 lb. in 173 tons	-152.9
Xenon	1 part in 11,000,000	1 lb. in 1,208 tons	-107.1

the impurity being mainly oxygen and a little nitrogen. Further purification is accomplished chemically, by burning the oxygen with an exact proportion of hydrogen, and removing the nitrogen by combining it with alkali metals or metallic calcium at high temperatures.

The pure argon gas thus obtained is used extensively to fill electric light bulbs. It has practically replaced nitrogen for this purpose. Nitrogen-filled lamps, in their turn, had replaced the old vacuum bulbs. Now it has been demonstrated that these lamps would be a third more efficient—that is, give a third more light for the same amount of current—if they were filled with a mixture of xenon and krypton.

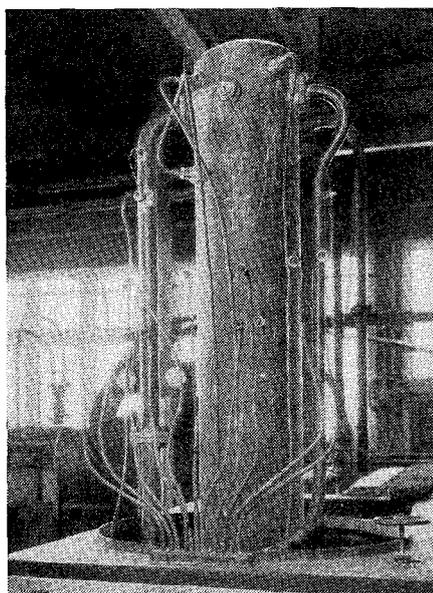
It has been estimated that the total electric light bill of the United States is \$620,000,000 a year. If nitrogen were still being used instead of argon, the bill would be about \$125,000,000 a year larger. The substitution of a mixture of krypton and xenon for argon would decrease the present cost another \$200,000,000 a year, or about half a million dollars a day.

The extraction of these latter gases is at present an extremely difficult process. Even if it were possible to recover every trace it would be necessary to process 173 tons of air for every pound of krypton, and 1,208 tons for each pound of xenon.

These gases liquefy at temperatures considerably above the boiling-points of the other constituents of the atmosphere, therefore tend to accumulate in oxygen. By drawing off the oxygen, and subjecting it to repeated fractional distillations, the krypton and xenon finally can be segregated as impurities in a small amount of liquid oxygen.

The liquid is then withdrawn from the system and allowed to evaporate, the vapor containing about 5 per cent. krypton and xenon, and the rest oxygen. This gas is purified with the aid of "activated" charcoal at low temperatures. The charcoal, prepared by special heat and chemical treatment, acts somewhat like a sponge, but a selective one—for instance, a sponge

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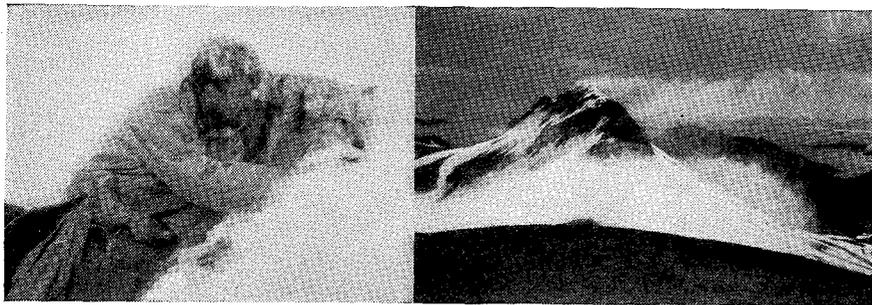


Courtesy of the Air Reduction Company

Top section of an argon distilling column, the part pictured being about eight feet tall. The apparatus is capable of producing 4,000 cubic feet of pure argon daily

## Are Aleutians the Source of America's Weather?

Father Hubbard, Alaskan Explorer, Believes Meeting of Air-Currents There Governs the Climate of the Continent



The beginning of a storm in the Aleutian Islands: a view of a wind-swept peak. (Left) Father Hubbard and his dog Katmai digging in during a 100-mile gale

Last April the Rev. Bernard R. Hubbard, widely known as the "Glacier Priest" because of his extensive Alaskan exploration, predicted a devastating drought for the Middle West. The drought certainly arrived. Last week, in an interview for *THE LITERARY DIGEST*, Father Hubbard made another forecast—that the coming winter will be a normal one, and not, as some observers have foretold, a season of exceptional cold.

Such forecasts are notoriously dangerous, for the weather is fickle and subject to change on short notice. The explanation offered by Father Hubbard for his predictions is interesting, and fits in with the classical theory of air-mass movements.

In brief, the explorer believes that most storms that move across the North American Continent originate in or near the Aleutian Islands, that curved row of rocky islets and shoals extending outward from the Alaska Peninsula into the Pacific Ocean. Down from the north, through Bering Strait, sweep the cold currents of the Arctic waters, bringing with them cold air-masses from the region of the Pole. These currents, coursing southward through the Bering Sea, are caught and stopped by the Aleutians.

### The Source of Storms

From the south, meanwhile, comes the warm Japan Current, bringing with it masses of warm, moist air from the balmy Pacific. These contrasting air-masses meet at the Aleutians, and the great cyclonic whirls are begun which bring with them weather changes for the Continent.

The cyclonic storms move eastward because of the rotation of the earth. They pass over the shore-line of the Continent at about Vancouver Island, where small whirls are split off by the mountains, to move southward into California. The main masses continue eastward, and, somewhere, in the region of the Great Lakes, they encounter more masses of cold air sweeping southward from Hudson Bay.

On account of the momentum of the Aleutian storms, the Hudson Bay air-masses are swept aside, Father Hubbard believes, and are caused to move across upper Quebec and Labrador instead of descending into New England.

Last spring he perceived less snow on the Rockies than usual, and soon afterward received word from Eskimo friends in the Aleutians that the weather there was colder than it had been for several years. For some unexplained reason the Japan Current was not coming as strongly as in the past, with the result that the usual storms were not being formed over the islands. On this circumstance the explorer based his prediction, later amply fulfilled, that there would be fewer rain-bearing storms for the Middle West during the summer.

The period of abnormal weather in the Aleutians is now over, he said last week. Storms are again being formed over the islands. This will result in normal weather for the Middle West and the East—warmer weather than last year because the storms sweeping across the Continent will again deflect the cold air-masses moving southward from Hudson Bay. "When it is cold in the Aleutians it will be cold in New England," he said, "but when the weather is normal in the islands it will be normal throughout the Continent."

Father Hubbard, who last summer penetrated parts of the Aleutians hitherto unexplored by white men, will return next summer to study the languages and tribes of the Eskimo. As in past exploration trips, he will probably be accompanied by students of Santa Clara University, where he is head of the department of geology.

### Correlating Eye and Voice

A method of studying the movements of the eye in reading aloud, and correlating them with the actual pronunciation of the words, has been announced in *Science* by Prof. Joseph Tiffin of Iowa University.

Photographic records of the eye and the "sound track" produced by the voice show that the voice lags about a second behind the eye. This may be taken as a measure of the speed of thought: the time required for the mind to recognize the word and transmit the necessary orders to the speech apparatus. The record also shows that the eye does not travel smoothly along a line of type, but proceeds by a series of jerks.

## Science Snap-shots

**Welded Houses:** Foreshadowing a day when single family houses will have steel frames, put up inexpensively and noiselessly by welding, experts have been experimenting with welded steel for this use. The largest house built by this method, so far, is being erected in the Ottawa Hills residential section of Toledo, Ohio.

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**Migratory Bird Reserve:** The Federal Government is planning to spend \$1,000,000 to provide a resting and nesting place for wild ducks, wild geese and other migrating birds on the Snake River, a small tributary of the Niobrara River, in Cherry County, Nebraska. Marshes and a lake of about 10,000 acres will be made by damming the stream. The site is on the main flyway of birds migrating between the Mexican Gulf district and Western Canada.

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**New Depth-Finder:** Capt. R. S. Patton, director of the United States Coast and Geodetic Survey, has announced the development of improved apparatus for obtaining depths under water by means of echo sounding. The new equipment is fast and sensitive: it can take twenty soundings a second in depths from six to 120 feet, and therefore at a cruising speed of ten miles an hour obtains a sounding every ten inches. It will measure differences in depth within an accuracy of about one inch.

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**Grapes From South Africa:** A new pest-eliminating treatment, consisting of subjecting the fruit to high temperatures for a brief period, has enabled growers of grapes in South Africa to enter their product on the American market for the first time this winter. Hitherto an embargo has been enforced against South African grapes on account of insect pests.

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**"Aging" Wood With Gas:** Manufacturers of imitation antique furniture, designers of art wood interiors, and builders of motion-picture sets supposed to show ancient woodwork are obtaining the desired effect of antiquity by treating the wood with the flame of an oxy-acetylene blow-torch, it was reported recently in *Oxy-Acetylene Tips*. The job is finished by rubbing down and applying filler, oil and wax.

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**Warm Winds Aloft:** The air-layer 145 to 220 miles above the earth, called the ionosphere, is fairly constant in temperature, and is disturbed by warm winds having a temperature of 300 degrees Kelvin, or about eighty degrees Fahrenheit, it was reported recently to the *Physical Review*, by Dr. E. O. Hulburt of the Naval Research Laboratory. The ionosphere winds blow in all directions from the point directly beneath the sun, and their paths are similar to those of streams of a liquid poured on a rotating sphere.