whole is not enriched by this process, the surface soil is, and this concentration of nitrogen in a smaller soil area may greatly facilitate the growth of a succeeding shallow-rooting and quick-growing crop. Drechsler[1] has attempted to show that such an enrichment of the surface soil is impossible. He argues, that, since the roots develop chiefly where they find food, if they find their supply of nitrogen chiefly in the subsoil, they will develop chiefly there, and consequently will not enrich the surface soil. It is not difficult to show, however, that this reasoning is fallacious. It is no more difficult to conceive that nitrogen should be transferred from the subsoil roots to the surface-soil roots, if the latter found an abundant supply of mineral matters at hand, than it is to conceive that both nitrogen and ash ingredients may be transferred from the roots to the aerial parts of the plant, provided the latter find a sufficient supply of carbon dioxide. Let us suppose the surface soil to be absolutely destitute of nitrogen to the depth of six inches, and that the nitrogen of the seed is sufficient to supply the growth of a root down into the nitrogen-bearing layers below. A plant would certainly grow under such conditions; and, when the crop was harvested, its stubble and what roots it had formed in the upper six inches of the soil would contain nitrogen, and the surface soil would be enriched to just this extent at the expense of the subsoil.

It would appear, then, that such an enrichment of the surface soil is possible. But few experiments calculated to demonstrate its actual occurrence have been made. The problem is not an easy one. It is difficult to take samples of a soil which shall be truly average samples; and the percentage differences are so small that they may easily be hidden by an error in sampling. Analyses by Dehérain and by Lawes and Gilbert, however, appear to show that such a gain does take place.

Finally, the relative power of different plants to assimilate nitrogen has an important bearing on this question. Wagner has rendered it probable that leguminous plants are able to assimilate freely the comparatively insoluble nitrogen of the soil, while the cereals require their nitrogen in an easily soluble form. If this is true, one of the functions of enriching crops may be assumed to be to gather the nitrogen of the soil which is unavailable to other crops, concentrate it in its roots and stubble, and yield it up again by decay to the following crop.

On the whole, it does not seem difficult to account for the effects of enriching crops without supposing that they draw materially from the nitrogen of the air, while not excluding the possibility of their so doing. Whether our agriculture is flourishing, as Lawes and Gilbert maintain, at the expense of the accumulated nitrogen of past centuries, or whether there are processes by which free nitrogen is brought into combination again in quantities sufficient to balance the evolution of free nitrogen which we know to be continually going on, is as yet an unsettled question.

H. P. ARMSBY.

[1] *Journ. f. landw*, xxxi. 30.

NATURAL GAS.

A LECTURE on the subject of natural gas was delivered at the Franklin institute on Saturday evening, Dec. 18 last, by Mr. Charles A. Ashburner, geologist in charge of the State geological survey. The lecturer stated that natural gas was by no means a recent discovery. Even its utilization for the purposes of the mechanic arts had been successfully attempted in China, where, by pipes of bamboo, it had been conveyed from natural wells to suitable furnaces, where, by means of terra-cotta burners, it was consumed. In the confines of Persia, in the south of France, and in our own western states, burning-springs had long been known. When Lafayette visited this country in 1821, the inn in the town of Fredonia, N. Y., was illuminated in his honor by gas procured from a neighboring well. It is, however, only within recent years that natural gas has arisen to any importance in its bearing on the mechanic arts. At present the great iron and glass works of Pittsburg and of other places are supplied with natural gas as their only fuel, and millions of cubic feet are yearly consumed in Pittsburg and similarly situated cities.

Of the origin of natural gas there seems to be no reasonable doubt. It arises from the decomposition of forms of animal or vegetable life embedded in the rocks in suitable situations. The gas is not believed to be generated continuously, but merely to be stored in porous or cavernous rocks overlaid by impervious strata. When these collections are tapped, the gas is set free, but a new supply is not being formed to take its place. The position at which the gas is found is very variable, depending upon the force of gravity and upon the position of the porous layer in which the gas is confined. The lecturer entered into an accurate description of the localities in which the gas was found, and gave the reasons why it was hopeless, from geological grounds, to look for natural gas east of the Alleghenies. The region in which the gas is found is practically embraced in that portion of Pennsylvania west of the Alle-

gheny Mountains, and extending a very short distance into Ohio, New York, and West Virginia, and it is also stated to have been found in a very limited extent in Illinois and Kansas.

The most important economic locality is that in the immediate vicinity of Pittsburg, which supplies that city with the fuel for the vast iron and glass works and for numerous private dwellings. There are 6 natural gas companies in that city, managing 107 wells, and supplying the gas through over 500 miles of pipe, of which 232 miles are situated in the city proper. The total area of pipe leading into Pittsburg is given as 1,346,608 square inches, and the total capacity of the lines is estimated at over 250,000,000 cubic feet of gas per day. The largest company is the Philadelphia natural gas company, which supplies over 400 manufactories and over 7,000 dwellings with the entire amount of fuel consumed. The composition of natural gas varies greatly, both in specimens from different wells and in those from the same well at different times. In general terms, it can be described as a mixture of hydrogen, nitrogen, and marsh-gas, with occasionally higher carbon compounds. It burns with a nearly colorless flame, and gives off no odor or deleterious matter.

In speaking of the use of natural gas for domestic purposes, Mr. Ashburner pointed out the great advantages which a gaseous fuel has over a solid one like coal, and stated his belief that the greatest of the advantages of the discovery of natural gas was that it had proven the great economy and practical utility of such fuel. A thousand cubic feet of gas was calculated to equal in heating capacity 55 pounds of coal. He stated that the use of natural gas for domestic purposes would not have been possible without the inventions of Mr. Westinghouse of Pittsburg, two of whose inventions the lecturer illustrated. One of these inventions was intended to prevent leakage from gas-pipes, and to locate leaks accurately when they occurred. The leaking gas is conveyed to the nearest lamp-post and there consumed. Another invention was a most ingenious pressure regulator, which not only regulates the pressure at which the gas is supplied to the burners, regardless of the pressure in the mains, but, in the event of the pressure in the mains dropping to zero, automatically shuts off all gas from the house; nor is it possible to turn the gas on again, without violence to the regulator, until every source of escape of gas larger than a pin-hole leak has first been corrected. A model of the regulator was exhibited. The lecture was illustrated by drawings and maps and by a small working model of a well-boring apparatus.

In answer to inquiries, the lecturer stated that the source of natural gas was certainly capable of exhaustion, but that he did not think there was any imminent danger of such a calamity. The sources of supply would certainly last many years; and he believed, that, before they would give out, a method of producing an artificial gas would be invented which would perfectly supplant the present natural gas. The cost of natural gas could not be compared with our coal-gas, for the reason that the natural gas was not sold by meter. The consumer makes a yearly contract with the company to supply him with light or fuel, or both, at certain rates. A house containing twelve rooms costs, to heat and light, from $70 to $90 a year. The use of the gas is most satisfactory; for, by means of an automatic regulator, every room of a house may be kept at a temperature not varying two degrees, regardless of the condition of the outside temperature or the pressure on the mains. Defects and troubles were met with from lack of understanding how to properly regulate the supply or the combustion.

In reply to the question as to whether he thought it wise for the city of Philadelphia to lease the gas-works for a term of years, Mr. Ashburner replied, that, as a business-man, he would say that any scheme for supplying the ordinary form of coal-gas was, at the present time, extremely uncertain as a business venture. He believed that a very short time would demonstrate that there was a method of generating a fuel gas which would totally supplant all present modes of heating, and that electricity had already solved the problem of illumination. We were in a transition stage with regard to both heating and light, and for these reasons, and from this standpoint, he would regard any movement as undesirable at this time.

PURITY OF ICE.

THE state board of health of New York has recently published a report on the purity of ice from Onondaga Lake, the Erie canal at Syracuse, and Cazenovia Lake, being the ice-supply of Syracuse. The local board of health regarded that cut from Onondaga Lake as being detrimental to health. Into this lake discharges the creek of the same name; and into the creek is discharged the sewage of the city of Syracuse, which amounts to five millions of gallons daily. At the time the inspection of this lake was made, there was a margin of from one to four feet wide of black, putrefying organic matter along the shores. The analyses of the ice from this lake showed that it contained probably from ten to twelve per cent