The porous, fibrous, or textile material with which the conductor is covered, or which is inserted between the layers of the insulating medium, is better for having its porosity preserved as much as possible consistently with the required strength of the cable.

The precise mode of laying on the fibrous materials may vary according to circumstances, but he prefers to lay them on when used in the form of threads or strands in a long spiral direction; and, when more than one layer is used, each layer is better for being put on in the direction opposite to the former one; or, where economy is not a great object, they may be braided on. When in the form of tapes or strips, they may either be wrapt spirally around, or laid longitudinally along the insulated or uninsulated wire, and folded round it; the latter mode being preferable, as it gives greater strength. In all cases, he recommends the employment of a soft, adhesive insulating medium, which shall adhere to the fibrous material as well as to the surface of the more solid insulating substance used for the several castings in order to prevent the layers from sliding over each other. He does not, however, confine himself to any of these plans, but merely recommends them as among the best modes of combining the porous or fibrous substances with the insulated material.

As telegraph cables are usually constructed, the gutta percha or other insulating substance which encloses the conductor, acts the part of a Leyden jar, the internal conductor serving as the inner coating, and the water as the outer coating; and his object is to interpose a fibrous or porous substance between the wire and the insulating coating, in order to prevent the contact of the metal with the homogeneous surface of the insulating medium; and, for a similar reason, he also puts on the outer layer or layers of porous and insulating materials, viz: to prevent the water, or other external conductor, from coming in contact with and forming an external coating to the insulating sheath, which more immediately includes the conductor.

Where two or more conductors are to be embodied in the same cable, he takes the requisite number of conductors prepared in any of the ways aforesaid, and either binds them together with the porous materials before described, and then covers them with insulating medium, or unites and covers them with insulating medium at once; or he applies the porous, fibrous, or textile material and the insulating medium over the whole, when thus united, in alternate layers, as before described.

*On the Annual Yield of Nitrogen per Acre in Different Crops.** By
J. B. LAWES, F.R.S., F.C.S., and J. H. GILBERT, Ph.D., F.C.S.

In a paper given last year at the Dublin Meeting, on the question of the Assimilation of Free Nitrogen by Plants, and some allied points, the authors had stated in general terms, that the amount of nitrogen yielded per acre, per annum, in different crops—even when unmanured—was considerably beyond that annually coming down, in the forms

* From the London Chemical Gazette, No. 385.

of ammonia and nitric acid, in the yet measured and analyzed aqueous deposits from the atmosphere. The investigations then referred to were still in progress; and a desirable introduction to the record of the results would obviously be, to illustrate by reference to direct experiment, that which had been before only assumed, regarding the yield of nitrogen in our different crops. To this end, had been determined, the annual produce of nitrogen per acre, in the case of various crops, which were respectively grown for many years consecutively on the same land; namely, wheat, 14 years; barley, 6 years; meadow hay, 3 years; clover, 3 years out of 4; beans, 11 years, and turnips, 8 years. In the majority of the instances referred to, the yield of nitrogen had been estimated, both for the crop grown without manure of any kind, and for that with purely mineral manure—that is, excluding any artificial supply of nitrogen. It was the object of the present communication to give a summary view of some of the facts thus brought to light.

Beans and clover were shown to yield several times as much nitrogen per acre as wheat or barley. Yet the growth of the leguminous crops, *carrying off* so much nitrogen as they did, was still one of the best preparations for the growth of wheat; whilst *fallow* (an important effect of which was the accumulation within the soil of the available nitrogen of two years into one), and *adding nitrogenous manures*, had each much the same effect in increasing the produce of the cereal crops.

Other experimental results were adduced, which illustrated the fact, that 4 years of wheat, alternated with *fallow*, had given as much nitrogen in the 8 years as 8 crops of wheat grown consecutively. Again, 4 crops of wheat, grown in alternation with *beans*, had given nearly the same amount of nitrogen per acre as the 4 crops grown in alternation with fallow; consequently, also much about the same as the 8 crops of wheat grown consecutively. In the case of the alternation with *beans*, therefore, the whole of the nitrogen obtained in the beans themselves was over and above that which was obtained during the same series of years in wheat alone, whether it was grown consecutively, or in alternation with fallow.

Interesting questions arose, therefore, as to the varying sources, or powers of accumulation, of nitrogen in the case of crops so characteristically differing from one another as those above referred to.

It has been found that the leguminous crops, which yielded in their produce such a comparatively large amount of nitrogen over a given area of land, were not specially benefited by the direct application of the more purely nitrogenous manures. The cereal crops, on the other hand, whose average yield of nitrogen under equal circumstances was comparatively so small, were very much increased by the use of direct nitrogenous manures. But it was found that, over a series of years, only about $\frac{1}{10}$ ths of the nitrogen annually supplied in manure for wheat or barley (in the form of ammonia salts or nitrates), were recovered in the immediate increase of crop. Was any considerable portion of the unrecovered amount drained away and lost? Was the supplied nitrogenous compound transformed in the soil, and nitrogen in some form

evaporated? Did a portion remain in some fixed and unavailable state of combination in the soil? Was ammonia, or free nitrogen, given off during the growth of the plant? Or, how far was there an unfavorable distribution, and state of combination, within the soil, of the nitrogenous matters applied directly for the cereal crops—those, such as the leguminous crops, which assimilated so much more, gathering with greater facility, and from different ranges of soil, and leaving a sufficient available nitrogenous residue within the range of collection of a succeeding cereal crop? These questions, among others which their solution more or less involved, required further elucidation, before some of the most prominent of agricultural facts could be satisfactorily explained.

Comparing the amount of nitrogen yielded in the different crops, when grown without nitrogenous manures as above referred to, with the amount falling in the measured aqueous deposits, as ammonia and nitric acid, it appeared, taking the average result of the analysis of three years rain, that all the crops yielded considerably more, and some very much more, than so came down to the soil. The same was the case when several of the crops had been grown in an ordinary rotation with one another, but without manure, through two or three successive courses. Was this observed excess in the yield over the yet measured sources, at all materially due merely to exhaustion of previously accumulated nitrogenous compounds within the soil? Was it probably attributable chiefly to the absorption of ammonia or nitric acid from the air, by the plant itself, or by the soil? Was there any notable *formation* of ammonia or nitric acid, from the free nitrogen of the atmosphere? Or, did plants generally, or some in particular, assimilate this free nitrogen?

As already intimated, some of the points which had been alluded to were at the present time under investigation; the authors having in this, the able assistance of Dr. Pugh. Others, it might be hoped, would receive elucidation in the course of time. There, of course, still remained the wider questions—of the original source, and of the distribution and circulation of *combined nitrogen* in the soil, in animal and vegetable life on the earth's surface, and in the atmosphere above it?

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, February 17, 1859.

John C. Cresson, President, in the chair.

John Agnew, Vice-President.

I. B. Garrigues, Recording Secretary. } Present.

The minutes of the last meeting were read and approved.

Letters were read from the K. K. Geologischen Reichsanstalt, Vienna, Austria; and Edward Miller, Esq., of St. Louis, Missouri.