

that the superheater does work. This would seem to make impossible any overheating of the superheater. In view of the highly favorable character of all these conditions, it is likely that it will be found easier to maintain a superheater of the Schmidt design on a locomotive than in connection with any other type of engine, and, moreover, that the superheating in locomotive service may be a pronounced success, while in other classes of service its future is still problematical.

I would add that it is expected that two superheating locomotives of German manufacture are to be tested at St. Louis during the Fair by the Pennsylvania Railroad Company.

AQUATIC PRODUCTS AS FERTILIZERS.*

By CHARLES H. STEVENSON.

A FERTILIZER is any substance added to the soil for the purpose of producing a better growth of crops. The food required by plants is supplied in part from the atmosphere, but principally from the soil. If the supply of any one of the necessary ingredients be deficient, a small crop is the result; and the purpose of fertilizers is to supply the plant-foods lacking in the soil.

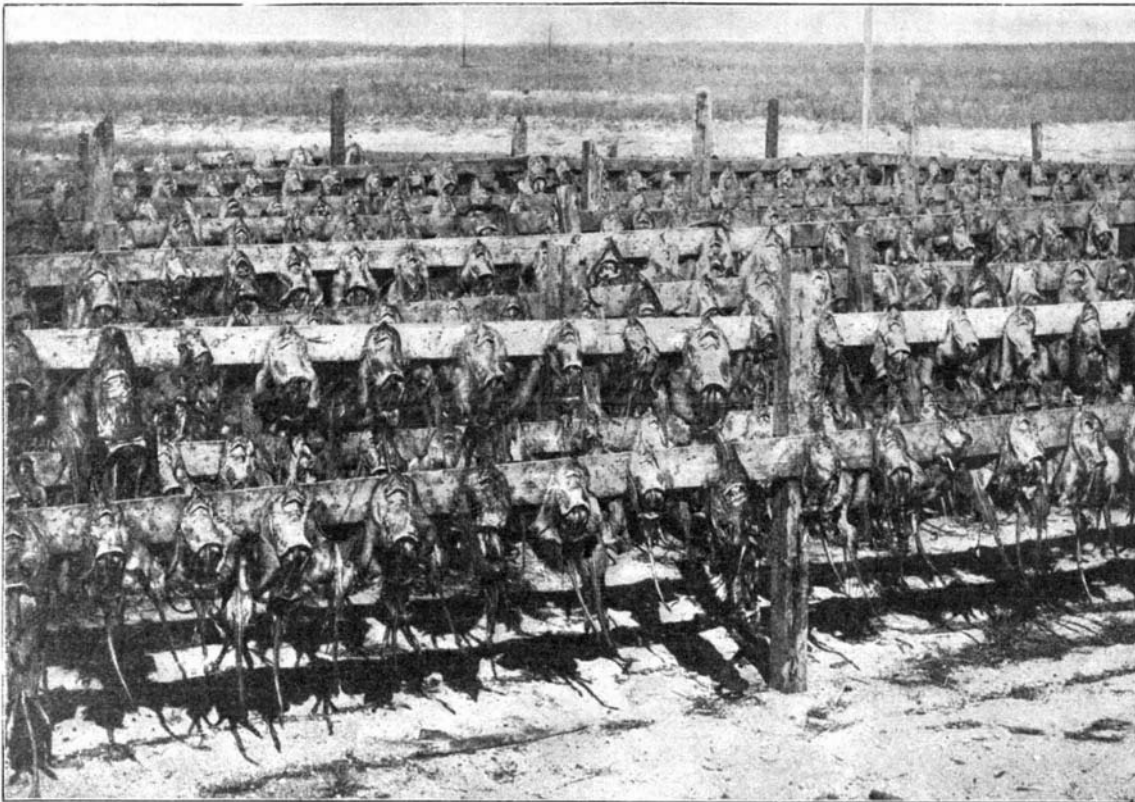
The general use of fertilizers is of comparatively recent origin, yet the preparation of these substances supports an extensive industry, employing a large amount of capital and many thousands of men. Compared with the immense quantities of barnyard materials, phosphate rocks, etc., the use of aquatic products for fertilizer is relatively small, yet it is by no means unimportant in the fishery industries.

Fish, seaweed, shells of mollusks and crustaceans, and various other aquatic products have long been known to possess rich fertilizing properties. All kinds of fish can be used for this purpose but, owing to the greater value of choice species as food, only

ter were unusually fat, thus removing an injurious ingredient, for which valuable uses were found. This resulted gradually in the establishment of factories for removing the oil, and likewise most of the water, so that the fertilizing substance might be in better condition for transportation. At present most of the fish used for fertilizer are treated in this manner, even the farmer-fishermen finding it more profitable to sell their catch at the factories and purchase the scrap; but large quantities of fish in a fresh state are yet used precisely as was the custom three hundred years ago.

Owing to its great abundance, combined with its non-edible qualities, the menhaden is the principal fish used for fertilizer in this country, and the quantity used annually is about 800,000,000 in number, or 240,000 tons round or live weight. Of these fully 99 per cent are handled at the factories, and the remainder are used in a fresh or green state. With the menhaden are taken some skates, sea-robins, bellows-fish, and other waste fish. Aside from a few that may be taken with the menhaden, and occasionally some river herring or alewives, no other fish are captured in the United States especially for fertilizer to any great extent.

Formerly nearly all waste produced in dressing fish for market was thrown away as useless; but in recent years, in the fisheries as in other industries, the utilization of waste material has been made a subject of careful investigation, and many substances formerly considered refuse are now found to contain elements of commercial value. The dressings at the fish markets and at the fishing centers, the refuse of canneries and boneless-fish factories, and even the carcasses of whales are turned to account in the production of fertilizer. In addition to these materials, the farmers use large quantities of seaweeds, horse-shoe crabs, oyster shells, clam shells, etc.



DRYING SKATES FOR MANUFACTURE INTO FERTILIZER, OPPOSITE PROVINCETOWN, MASS.

the non-edible ones and the waste parts are utilized. The menhaden is the only fish taken in great quantities in this country especially for conversion into fertilizer. The output of this species is very large, amounting to 30 per cent of the total catch of fish in the United States, and its capture maintains one of the most extensive and vigorously prosecuted of the American fisheries. Compared with that from menhaden, the quantity of fertilizer made from other fish is small, and only such are used for this purpose as cannot be profitably employed in any other way.

The original use of fish for fertilizing purposes was in a fresh or green state, and they were added to the soil directly after their capture, although, of course, no special effort was made to preserve their freshness. Before the advent of the colonists in America, the Indians were accustomed to manure their small crops of corn by placing one or more fish in each hill or by spreading them broadcast over the field, and this practice was followed by the early settlers. Owing to the original richness of the soil and the limited agricultural operations, the use of fertilizers was of comparatively small extent until the latter part of the eighteenth century. It appears that fish were then employed for this purpose all along the Atlantic seaboard from Maine to North Carolina wherever they were obtainable in sufficient quantities.

Fresh fish contain usually from 65 to 80 per cent of water and from 1 to 16 per cent of oil. Neither of these has any value as a fertilizer. On the contrary they decrease the portability and storage qualities of the constituents, and the presence of the oil is prejudicial to the decomposition of the fertilizer when applied to the soil.

Early in the nineteenth century the fishermen occasionally extracted the oil from the fish when the lat-

The total annual product of menhaden fertilizer in the United States according to the latest returns amounted to 85,830 tons, for which the producers received \$1,539,810. It is difficult to approximate the quantity of other fishery products used for fertilizer, but it is estimated that the waste fish of all kinds amount to about 20,000 tons, worth \$200,000; horse-shoe crabs, shells of shrimp, etc., 800 tons, worth \$16,000; shells and agricultural lime, 60,000 tons, worth \$150,000; and seaweeds, 250,000 tons, worth \$312,500, making a total estimated output for this country per year of 416,630 tons, worth \$2,118,310.

CONTEMPORARY ELECTRICAL SCIENCE.*

CHARGE OF AN ELECTRON.—J. S. Townsend compares the various values found for the charge of an electrolytic ion and an electron, and finds that the difference lies well within the limits of the probable experimental error. If E is the charge on a hydrogen ion or atom in a liquid electrolyte, N the number of molecules per cubic centimeter of a gas under normal conditions, then, since a known volume of hydrogen is evolved at the negative electrode when unit quantity of electricity passes through the liquid, the formula

$$N \times E = 1.22 \times 10^{20}$$

is established, E being measured in electrostatic units. In this formula the most probable value for N , according to Lord Kelvin, is 10^{20} , and 1.22×10^{-20} is not improbably an upper limit to the value of the charge in electrostatic units. Of the values determined from electrons liberated by Röntgen rays that of H. A. Wilson is probably the most reliable. By the method which he used he avoids the necessity of finding the number of drops in the cloud formed by the expansion of the conducting gas, and a very uncertain quantity is thus

eliminated from his calculations. He concludes from his experiments that "it may be considered established that e lies between 2×10^{-20} and 4×10^{-20} electrostatic units." The lower limit is in fair agreement with the value 1.2×10^{-20} found for E by taking $N = 10^{20}$. Therefore, the value 2×10^{-20} does not differ by more than the factor 2 from the most probable values which can be obtained from the electrolytic and electron methods.—J. S. Townsend, Phil. Mag., March, 1904.

PHYSIOLOGICAL EFFECTS OF N-RAYS.—A. Charpentier has observed that N-rays exert a direct effect upon the human ear, and increase the sharpness of hearing while they act. On the other hand, the newly-discovered N'-rays diminish the sharpness of hearing, and generally have the opposite physiological effects to the N-rays. Some human tissues emit N'-rays, such as a muscle kept in a state of tension without actual contraction. It may be supposed that all physiological activities give rise to N-rays and N'-rays, and that in some of them one species predominates and in others the other species. This is the physiological analogy to the mixture of N-rays and N'-rays given out by a Nernst lamp.—A. Charpentier, Comptes Rendus, March 7, 1904.

PHYSIOLOGICAL ACTION OF N-RAYS AND CONDUCTED RAYS.—A. Charpentier has discovered two additional effects of N-rays. If a strong source of N-rays is placed about 4 centimeters behind the top of the skull, and a little above it, not only are faintly luminous objects perceived with greater brightness and detail, but in absolute obscurity a faint luminous cloud is perceived, evidently due to a slight excitement of the visual nerve center. The effect is distinctly shown when a copper wire is used to "conduct" the rays from the source to a small copper plate placed at the point indicated. The second new effect is objective, and consists in the enlargement of the pupil when the conducting plate is placed over the seventh cervical vertebra. The dilatation observed varies from $\frac{1}{2}$ millimeter to 1 millimeter. The apparent increase of luminosity previously mentioned is, however, not due to this enlargement of the pupil, as it remains the same if the objects are viewed through pinholes.—A. Charpentier, Comptes Rendus, February 1, 1904.

AN OPTICAL ANALOGY TO HERTZ'S GRATING EXPERIMENT.—F. Braun has succeeded in producing with ordinary light waves the effect produced by Hertz with a grating of parallel wires, which was found to reflect electric waves vibrating in a plane parallel to the wires while it freely transmitted those waves which vibrated at right angles to the wires. An attempt to discover this effect in the optical sphere had already been made by Du Bois and Rubens, who found a certain amount of polarization, but a greater transmission of parallel than perpendicular waves. But this is due to the fact that the finest gratings at the disposal of those physicists consisted of wires 0.01 millimeter thick. The author has succeeded better with wires disintegrated on a glass plate by means of a powerful electrostatic discharge. The disintegrated wire, usually of silver, showed a clear central line where it had lain on the glass. On each side of that there was a narrow band of metal. Outside that again, there were fine metallic needles in the form of very pointed isosceles triangles. Outside those, there was a zone of finely-divided metallic dust. On the border between the needles and the dust, the author discovered portions where light vibrating across the plane of the needles was transmitted more freely than light vibrating parallel to the needles. The author hopes to render the phenomenon more amenable to quantitative measurement by destroying a set of thin plates of a complex organic compound of gold in such a manner that only the gold remains. That ought to give a very fine and regular grating, which might be studied by means of Siedentopf and Szigmondy's ultra-microscopic method.—F. Braun, Sitzungsber. Akad. Wiss., Berlin, January 21, 1904.

NEW KIND OF N-RAYS.—R. Blondlot has found that besides the kind of N-rays already described, there exists another kind which reduces the luminosity of a feebly luminous surface instead of increasing it. The new kind, which he designates by N' , is specially abundant in the least refrangible part of the N-ray spectrum. On re-examining that part by means of an aluminium prism having a refracting angle of 60 or even 90 deg., he found an alteration between the two different kinds of rays in the spectrum. The following is a table of refractive indices (for aluminium) and wave lengths:

	Index.	$\mu\mu$
N'	1.004	3.0
N	1.0064	4.8
N'	1.0096	5.6
N	1.011	6.7
N'	1.0125	7.4
N	1.029	8.3
N	1.041	8.1

On plotting these results in a diagram, it is found that the first five values lie close together on a simple curve. Certain sources appear to emit N' -rays only, or predominantly. Among these are wires of copper, silver and platinum. Bichat has found that ethyl ether, brought into a state of forced extension by Berthelot's process, emits N' -rays. When that state is ended, either by a slight shock or spontaneously, the emission of N' -rays ceases instantly. N' -rays, like N-rays, may be stored up. Thus, if a piece of quartz is brought near a stretched copper wire, it emits N' -rays for some time after.—R. Blondlot, Comptes Rendus, February 29, 1904.

* From United States Fish Commission Report.

* Compiled by E. E. Fournier d'Albe in the Electrician.