oil on the pulverized surface, each man working in his own section, about twenty feet long, the driver filling the sprinklers by pumping from the barrels with a tin oil pump. The writer inaugurated this system of distributing oil during the mosquito campaign of the previous year (1905) and found it very satisfactory.

A load of coarse sand was dropped about every fifty feet on the oiled strip, and during the absence of the wagon in refilling the barrels this sand was spread by the men in the same manner that sand is applied over a newly grouted brick pavement in thin layers.

After one side was oiled and sanded, a strip on the other side was treated likewise, and the center strip was again plowed and harrowed, having become compacted by traffic, and also treated, after which the whole street was run over with a toothed harrow, and was then gone over and oiled and sanded a second time, but was not harrowed. The street was then thrown open to traffic.

This was all done the first week in July and until recently there has been comparatively little dust and no mud, nor has there been any more washing where formerly it was excessive after a hard rain, and we have had several hard rains this summer, one quite soon after the street was treated. I am of the opinion that the oil should have been renewed within sixty days.

We were, I think, fortunate in having rather hot weather in which to apply the oil. The gutters have still a good percentage of the oil retained, and the sod was enabled to make a good set, which of course reduces the wash. Time was taken in unloading one wagon (three 52-gallon barrels) and it took three men exactly one hour to dispose of the load over a surface of 15 x 100 feet, or 1,500 square feet. One man scattered with a shovel one wagon load (about 24 cubic feet) of sand over an area of 50 x 60 feet, or 3,000 square feet in fifteen minutes.

The oil was charged at \$1.59 per 44-gallon barrel.

Team, 7 days at \$3.00.....	\$21.00
Labor, 11 days at \$1.25.....	13.75
Foreman, 3½ days at \$1.50.....	5.25
<hr/>	
Total, labor account.....	\$40.00
Oil, 47.14 barrels at \$1.59.....	74.95
Sand, 35 loads at 75c.....	26.25
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Total materials.....	101.20
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Total, all items.....	\$141.20

(Concluded from SUPPLEMENT No. 1611, page 25815.)

SOURCES OF INDUSTRIAL ALCOHOL.—II.*

By DR. H. W. WILEY.

AVERAGE composition: Frazier, of the Cornell station, has collected analyses of a large number of different varieties of potatoes and finds them to have the following average composition:

	Per cent.
Water	75.00
Starch	19.87
Sugars and dextrin	.77
Fat	.08
Cellulose	.33
Ash	1.00

According to Maercker, the sugar content, including all forms of sugar, varies greatly. Perfectly ripe potatoes contain generally no sugar or only a fractional per cent. When potatoes are stored under unfavorable conditions, large quantities of sugar may be developed, amounting to as high as 5 per cent altogether. In general, it may be stated that the content of sugar of all kinds will vary from 0.4 per cent to 3.4 per cent, according to conditions.

Experience in Germany has shown not only that liberal fertilization with nitrogen is favorable to the production of a large crop of potatoes, but also that this is accomplished without decreasing the percentage of starch therein.

It is evident from results of experiments that the liberal applications of nitrogenous fertilizers increases the yield per acre of tubers and of starch to a very marked extent, although the average percentage of starch present is increased very little.

Of all the common root crops, the potatoes, including the yam and the sweet potato, are the most valuable for the production of alcohol, meaning by this term that they contain more fermentable matter for 100 pounds than other root crops.

While it is seen that sugar beets, carrots, and parsnips contain relatively large amounts of fermentable matter, these roots could not compete with potatoes even if they could all be produced at the same price per 100 pounds.

A general review of all the data indicates that under the most favorable circumstances and with potatoes which have been bred especially for the purpose an average content of fermentable matter of about 20 per cent may be reasonably expected. It is thus seen that approximately 10 pounds of industrial alcohol can be made from 100 pounds of potatoes. If 60 pounds be taken as the average weight of a bushel of potatoes, there are found therein 12 pounds of fermentable matter, from which 6 pounds of industrial alcohol can be produced, or six-sevenths of a gallon. It has also been shown that at the prices quoted in 1905 the amount of Indian corn necessary for the production of a gallon of industrial alcohol costs not less than 15 cents. From this it is evident that the potatoes for alcohol making will have to be produced at a cost of not to exceed 15 cents per bushel, before

* Abstract of Farmers' Bulletin 288, issued by the Department of Agriculture.

they can compete with Indian corn for the manufacture of industrial alcohol.

Rice.—Composition.—Rice is not used to any great extent in this country for making alcohol, but it is extensively used for this purpose in Japan and some other countries, and has the largest percentage of fermentable matter of all the cereals.

The percentage of fermentable matter in rice is nearly 78 per cent. A bushel of rice weighs, unhulled, 45 pounds, hulled 56 pounds, and it therefore has about 34 and 43 pounds, respectively, of fermentable matter for the unhulled and the hulled rice. It is not probable that rice will ever be used to any extent in this country as a source of industrial alcohol, although it is used to a large extent in the manufacture of beverages, as for instance in beers, which are often made partly of rice.

Yield.—The area devoted to rice in the United States for the year 1905 was 482,479 acres, yielding 28.2 bushels per acre, or a total of 13,606,989 bushels, valued at the farm at 95.2 cents a bushel, or a total value of \$12,955,748. The largest rice-producing area is in Louisiana, in which there were 240,037 acres devoted to rice, yielding 25.8 bushels per acre, or a total production of 6,192,955 bushels, valued at 89 cents a bushel, or \$5,511,730. Texas, with a smaller acreage, namely, 214,490 acres, produces a yield of 31 bushels per acre, amounting to 6,649,190 bushels, worth \$1 per bushel, having a total value of \$6,649,190, a greater value than that of the crop in Louisiana. The other Southern States which produce rice yield only small quantities, the largest yield, besides those mentioned, being in South Carolina, in which 18,114 acres were reported as devoted to rice culture.

Rye.—Composition.—Large quantities of alcohol, chiefly in the form of alcoholic beverages, are manufactured from rye. It is, in connection with Indian corn, the principal source of the whiskies made in the United States. Rye, however, is not used to any extent in this or other countries for making industrial alcohol. Rye contains almost as much fermentable matter as Indian corn. A bushel of rye weighs 56 pounds. Wheat and other cereals, not mentioned above, are not used in this country to any appreciable extent in the manufacture of alcohol.

Yield.—The total acreage devoted to rye in the United States for the year 1905 was 1,730,159. The average yield per acre is given as 16.5 bushels, and the total production 28,485,952 bushels, valued at the farm at 61.1 cents per bushel and having a total value of \$17,414,138. The largest rye-producing State is Pennsylvania, in which there were 346,265 acres devoted to this cereal, with an average yield of 17 bushels per acre, and a total yield of 5,886,505 bushels, valued at 65 cents a bushel, with a total value of \$3,826,228. Other large rye-producing States in the order mentioned are Wisconsin, Nebraska, New York, and Michigan. A number of the Southern States make no returns for rye whatever.

Spelt.—This grain, which is botanically a variety of wheat, more closely resembles barley, and, though not yet grown to any great extent in this country, there is a tendency, especially in the West, to increase its cultivation for stock feeding, due chiefly to its prolific growth. Under favorable conditions as high as 73 bushels per acre have been reported by the North Dakota station, and the analyses given show 70 per cent of fermentable carbohydrates. The weight per bushel is about the same as that of oats. It would appear that this crop might be worthy of consideration as a profitable source of industrial alcohol.

Sugar Beets.—The sugar beet is often used directly as a source of alcohol. Working on a practical scale in France, it has been found that from 10,430 tons of beets there were produced 183,624 gallons of crude alcohol of 100 deg. strength. The beets contain 11.33 per cent of sugar. From 220 pounds of sugar 15.64 gallons of alcohol were produced. The weight of pure alcohol obtained is a little less than one-half the weight of the dry fermentable matter calculated as sugar subjected to fermentation. About 18 gallons of alcohol are produced for each ton of sugar beets employed.

Sweet Potatoes.—Yield and Composition.—The sweet potato has not been used in the United States for the making of alcohol. In the Azores great quantities of sweet potatoes are grown for this purpose, and make an alcohol of fine quality, which is used to a large extent in fortifying port wines. There are large areas in the United States, especially in the Southern States, where the sweet potato can be grown in great abundance. The experiments at the South Carolina station show that as high as 11,000 pounds of sweet potatoes can be grown per acre. The percentage of starch is markedly greater than in the white or Irish potato. In all cases over 20 per cent of starch was obtained in the South Carolina sweet potatoes, and in one instance over 24 per cent. As high as 2,600 pounds of starch were produced per acre.

In addition to starch, the sweet potato contains notable quantities of sugar, sometimes as high as 6 per cent being present, so that the total fermentable matter in the sweet potato may be reckoned at the minimum at 25 per cent. A bushel of sweet potatoes weighs 55 pounds, and one-quarter of this is fermentable matter, or nearly 14 pounds. This would yield, approximately, 7 pounds, or a little over 1 gallon of 95 per cent alcohol. It may be fairly stated, therefore, in a general way, that a bushel of sweet potatoes will yield 1 gallon of industrial alcohol. The average yield of sweet potatoes, of course, is very much less than that given in the South Carolina reports, where heavy fertilization was practised. On

plots to which no fertilizer was added the yield was about 8,000 pounds of sweet potatoes per acre, yielding in round numbers 1,900 pounds of starch. The quantity of sugar in the 8,000 pounds is about 350 pounds, which, added to the starch, makes 2,250 pounds of fermentable matter per acre. This will yield 1,125 pounds of industrial alcohol of 95 per cent strength, or approximately 160 gallons per acre.

The yield of sweet potatoes in the above computation must be regarded as exceptionally high. A safer calculation will be based upon the yield of 100 bushels of sweet potatoes per acre, a little above the average of the yield of the potato, or a total of 5,500 pounds per acre. One quarter of this amount is fermentable matter—about 1,400 pounds—which would yield, approximately, 700 pounds of 95 per cent alcohol, or 100 gallons of 95 per cent alcohol per acre. In addition to the sugar in the form of sucrose, or common sugar, which the sweet potato contains, there is also an appreciable amount of non-crystallizable sugars. The total sugars in the sweet potato have not been over-stated in the above estimate. In fact, the contrary, rather, is true, since the two sugars together probably average about 6 per cent of the weight of the potato. If the average quantity of starch in the sweet potato is 20 per cent, which is rather a low estimate, the total fermentable matter in the sweet potato is 26 per cent instead of 25 per cent, as estimated above.

Effect of Storage on Composition.—Experiments have shown that the quantity of starch diminishes and the quantity of sugar increases on storing. Further, it may be stated that in the varieties of sweet potatoes which are most esteemed for table use there is less starch and perhaps more sugar than are stated in the above examples. In one instance of an analysis made on the 7th of January of stored potatoes, the starch had fallen to a little less than 13 per cent, while the sugars had increased to over 11 per cent. The total quantity of fermentable matter, however, as will be seen, had not been greatly changed, although there was probably a slight loss.

Utilization of Waste Material or By-Products.—Stalks of Indian Corn and Sorghum.—The stalks of sweet corn, field corn, and sorghum contain large quantities of sugars, and also considerable amounts of starch at the time of the hardening of the starch in the seeds. When sweet corn is harvested for the market its stalk contains considerable quantities of fermentable matter, as has already been stated. Large quantities of this material are grown in the United States every year, and after the harvest of the sweet corn for the market the stalks are utilized chiefly for fodder. In the curing of the stalks for fodder the sugars ferment and disappear. If these stalks could be used economically they would add largely to the raw materials from which alcohol could be made. The technical difficulties, however, attending the utilization of the stalks are so great that it is doubtful whether means can be devised whereby their use may be made profitable for alcohol making. Notwithstanding this, it is a matter which is well worthy of investigation, because if stalks of sweet corn and field corn could be utilized they would place at the disposal of the manufacturer an almost inexhaustible source of raw material from which alcohol might be made. At the present time, however, there is no immediate probability of the economic utilization of this material.

The stalks of sorghum, as is well known, contain very large quantities of fermentable matter at the time of ripening. All of these bodies—that is, the stalks of sweet corn, field corn, and sorghum—contain, in addition to the sugar, notable quantities of starch and gum, which after conversion into a sugar, by malt or otherwise, add greatly to their value for alcohol making. In so far as the question of raw materials is concerned there are no other sources available in the United States so abundant as those found in sweet corn, field corn, and sorghum stalks.

The great difficulty encountered in connection with the utilization of these materials is that the season in which these stalks are suitable for utilization in the manufacture of alcohol is very limited. For instance, in the vicinity of Washington none of these stalks would be available until the latter part of July, and their availability would not continue later than the middle or the end of October under the most favorable circumstances. This gives at most a manufacturing period of only two or three months. The cost of preserving the stalks for a longer period would probably be so great under present conditions as to preclude the possibility of the remunerative manufacture of alcohol therefrom. In consideration, however, of the tremendous extent of this source of supply, it seems advisable that those in charge of the agricultural experiment stations and other experimental investigators throughout the country should study the possibilities of manufacturing industrial alcohol at remunerative rates, at least during a part of the year, from these waste products of the maize crop.

Molasses.—The utilization of the waste materials from the sugar factories and sugar refineries for the purpose of making alcohol is a well-established industry. The use of these sources of supply depends, of course, upon the cost of the molasses. When the sugar has been exhausted as fully as possible from the molasses the latter consists of a saccharin product, containing considerable quantities of unfermentable carbohydrate matter, large quantities of mineral salts, and water. In molasses of this kind there is probably not more than 50 pounds of fermentable matter to 100 pounds of the product. Assuming that a gallon of such molasses weighs 11 pounds, it is seen that it contains 5½ pounds of fermentable matter, yielding 2¼

pounds of industrial alcohol of 95 per cent strength. It requires about 3 gallons of such molasses to make 1 gallon of industrial alcohol. The quantity of molasses made in the United States as a residual product from the sugar manufacture is difficult to determine. For each ton (2,240 pounds) of sugar produced we may assume that there are 62½ gallons of molasses. Placing the total output of sugar in the United States at 400,000 tons, beet and cane combined, would give a yield of molasses of 25,000,000 gallons.

The quantity of molasses produced in Cuba is three or four times as great as that produced in the United States, thus affording a very extensive source of production of industrial alcohol should it prove profitable to make it from this material. The above data show that when the price of molasses delivered to the refineries falls as low as 5 or 6 cents a gallon it may be considered a profitable source of alcohol.

In 1905, 13,500,000 gallons of alcohol were produced in France from beet-root molasses. The production from this source is decreasing—in 1901 almost double the above amount was made.

Wood Pulp and Sawdust.—Many attempts have been made to produce alcohol for industrial purposes from sawdust, wood pulp, or waste wood material. The principle of the process rests upon the fact that the woody substance is composed of cellulose and kindred matters which, under the action of dilute acid (preferably sulphuric or sulphurous) and heat, with or without pressure, undergo hydrolysis and are changed into sugars. A large part of the sugar which is formed is non-fermentable, consisting of a substance known as xylose. Another part of the sugar produced is dextrose, made from the true cellulose which the wood contains.

The yield of alcohol in many of the experiments which have been made has not been very satisfactory. It is claimed, however, by some authors that paying quantities of alcohol are secured. In Simonsen's process for the manufacture of alcohol one-half per cent sulphuric acid is employed and from four to five parts of the liquid heated with one part of the finely comminuted wood for a quarter of an hour under a pressure of nine atmospheres. It is claimed by Simonsen that he obtained a yield of 6 quarts of alcohol from 110 pounds of air-dried shavings. Another process which has been tried in this and other countries for converting comminuted wood into alcohol is known as Classen's. The comminuted wood is heated for fifteen minutes in a closed apparatus at a temperature of from 248 deg. to 293 deg. F. in the presence of sulphurous acid (fumes of burning sulphur) instead of sulphuric acid. It is claimed by the inventor that he has made as much as 12 quarts of alcohol from 110 pounds of the air-dried shavings. There is reason to doubt the possibility of securing such high yields in actual practice as are claimed in the above processes. That alcohol can be made from sawdust and wood shavings is undoubtedly true, but whether or not it can be made profitably must be determined by actual manufacturing operations.

Waste Products of Canneries, etc.—There are a great many waste products in the fruit industry, as well as in the canning industry, which contain sugar and starch, and it has been proposed to use these for the manufacture of alcohol. It is true that all waste products which contain sugar or starch may be used for alcohol-making purposes, but it is doubtful if many of them will be found of a character which will permit their use in competition with other materials containing larger quantities of fermentable matter. The principal waste materials which may be considered in this connection are the refuse of wine making, fruit evaporating, and canning industries, especially the waste of factories devoted to the canning of tomatoes and Indian corn. In addition to this, the waste fruit products themselves, which are not utilized at all, as, for instance, the imperfect and rotten apples, tomatoes, grapes, etc., may be favorably considered. The quantity of waste products varies greatly in different materials.

The quantities of waste material in grapes and apples, as shown by Lazenby, are as follows: About 25 per cent of the total weight in grapes, with the exception of the wild grape, where it is about 60 per cent; with apples the average percentage of waste was found to be 23.8 per cent from twenty-five varieties. This included the waste in the core, skin, and the defective apples caused by insects, fungi, bruises, etc. In general it may be said that in the preparation of fruits for preserving purposes about 25 per cent of their weight is waste, and this, it is evident, could be utilized for the manufacture of alcohol. If apples be taken as a type of fruits, we may assume that the waste portions contain 10 per cent of fermentable matters, which, however, is perhaps rather a high estimate. Fifty per cent of this might be recovered as industrial alcohol. Thus, each 100 pounds of fruit waste in the most favorable circumstances might be expected to produce 5 pounds of industrial alcohol. The quantity of waste which could be utilized for this purpose would hardly render it profitable to engage in the manufacture. A smaller percentage could be expected from the waste of the tomato, where the quantity of sugar is not so great. In the waste of the sweet-corn factory the amount of fermentable matter would depend largely on the care with which the grain was removed. There is usually a considerable quantity of starchy material left on the cobs, and this, with the natural sugars which the grown cobs contain, might yield quite large quantities of fermentable matter. It would not be profitable to erect distilleries simply for the utilization of waste of this kind, but if

these wastes could be utilized in distilleries already established it might be profitable to devote them to this purpose.

SAFEGUARDS AGAINST FIRE.*

Good fire protection necessitates first, that the least amount of combustible material should be used in constructing a building; second, that the construction should be such that it would tend to limit a fire to the place of origin; third, that the furnishings should be so arranged that the possibilities for fire are reduced to a minimum; and, fourth, that means for the ready extinguishment of a fire should be provided at well chosen places. Underwriters' boards and associations substantially recognize the importance of these precautions, but property owners do not always give them the consideration which they deserve.

For economical and other reasons, the work of the fire protection engineer should be done conjointly with that of the architect and the structural engineer. Proper consideration for the possibility of fire at the time of preparing building plans not only means a large saving in the cost of installing private fire protection apparatus, but also permits of its arrangement so as to be most effective.

A bucket of water or of chemical solution, if intelligently used, is nearly always sufficient to put out a fire if readily available near the incipient blaze. But a bucket of water is not always handy, and frequently there is no one near to use it; consequently, good fire protection must necessarily depend upon distributed automatic devices. The usefulness of the automatic sprinkler is pretty generally recognized by property owners and underwriters. It is worthy of note that the rates of insurance on Class C buildings equipped with these are lower than on Class A buildings, without them.

Sprinklers are not intended to check conflagrations, but to extinguish or control fires in their incipency. In a properly installed sprinkler system, the presence of fire is made known by the striking of a mechanical alarm which is operated by a water motor set in motion by the opening of one or more fusible heads. The electric alarm is uncertain of operation and should be installed only as auxiliary to the mechanical alarm. A very complete alarm system may be seen at the Pacific Hardware and Steel Company's building in San Francisco. Not only are the mechanical alarms set in operation, but drop annunciators indicate the section of building, the story, and the portion of floor where the head is discharging.

Inside stand pipes with hose constantly attached, and approved chemical extinguishers are of great value in augmenting protection afforded by automatic sprinklers.

Ridge, cornice and window sprinklers are efficient in lessening the danger from exterior fires. While metal-clad wooden frames containing ordinary glass are poor apologies for fireproofing, properly constructed metal frames fitted with wire glass and used in conjunction with window sprinklers connected to proper water supplies are equal if not better than any shutter manufactured. The latter soon deteriorate from weather and lack of attention, and are rarely closed when they should be. Roof tanks of gravity flow, except as secondary supplies to sprinkler systems, are practically useless for fire purposes when the discharge is less than fifty feet below the tank bottoms.

Basement reservoirs with flexible and non-deteriorating linings and flowing wells, both of sufficient capacity and furnishing suction for steam or gasoline-driven pumps, are the solution of perfect private water supplies in sections susceptible to seismic disturbances. This point is borne out by the operation of pumping plants at the Palace Hotel, Merchants' Exchange, Western Electric Company, and Center's Wells after the earthquake of April 18. The building of the Western Electric Company was saved from destruction more through the private water supply than by its wire-glass windows. Electrically-driven pumps are impracticable on account of uncertainty in the supply of current.

Fire is a chance occurrence which breaks out without any warning; hence, fire-fighting apparatus should be as self-sustaining as possible, as well as fool-proof.

Apprenticeship schools in operation during working hours under the charge of a trained teacher are effective means of developing the mentality of the organization and at the same time of getting in close touch with the employee early in his career, and the longer he stays with the concern and the more money is spent on his improvement the more valuable he becomes as an asset and the greater the effort should be made to retain him in the organization. Schools should be established in the factory during evenings for the purpose of helping the employee to advance in the organization. Energy, coupled with character and knowledge, guided by tact and discretion, will open the avenues of achievement. Care should be taken, however, not to coddle the organization. Coddling engenders weaklings. Extending opportunities so that the employees can help themselves develops self-reliance, self-respect, and, at the same time, regard for the management. Such a policy promotes a strong and healthy organization. Employees are quick to feel any interest taken in their welfare and as quick to reciprocate. To increase the efficiency of an organization so that each employee is not only a passenger in the enterprise but effectively pulls his own weight is the function of Industrial Engineering. To do this with a spirit of honesty and fair dealing between em-

* Abstracted from an address delivered before the Structural Association on September 6, 1906, by Mr. George J. Wellington, fire protective engineer.

ployer and employee is a delicate mission. It embraces a wide field of activity in the world of advance in which industry is the leading exponent. Apart from the practical results obtainable by the foregoing methods of management, lies the fact that it is by instituting only the highest methods that employers are utilizing their privilege as men and citizens to help in the march of mankind toward progress and lightenment.

SCIENCE NOTES.

During the past four hundred years there has been most significant, although gradual, development of university organization. This has been a necessary result of the evolution of knowledge. The medieval universities found a reason for the dissemination of a system of scholarship which had little to do with the affairs of men of learning based chiefly, if not wholly, upon conventional systems of abstract knowledge, Aristotelian logic, transmitted with little or nothing from the masters of antiquity, constituted essentially all they had to offer to their students. The education consisted almost entirely of certain exercises, this intellectual inheritance practically unchanged through the centuries of its transmission. This mental training had essentially no relation to or bearing upon the actual things of human experience, nor had it much effect upon national life or upon any of the varied interests of the community.

In the *Astrophysical Journal*, Mr. H. M. Reese describes an experiment in illustration of the performance of diffraction gratings. "The scheme was to produce, on the surface of mercury, ripples emanating from a series of equidistant points distributed along a straight line." To produce these a thin sheet of iron was cut into the form of a comb of sixteen teeth, spaced 5 millimeters apart, and attached to the lower prong of an electrically-driven tuning fork arranged to vibrate in a vertical plane. This comb was set near the edge of a tray of mercury in such a way that the teeth would dip into the surface. When the ripples were examined stroboscopically it was seen that near the comb they mixed together chaotically; but at a moderate distance they resolved themselves into several series of regular rectilinear wave-trains, which advance in different directions and are symmetrically distributed. These correspond to the spectrum of zero order—moving out in a direction normal to the comb—and spectra of orders one and two on each side. An image of the ripples can be projected on a screen. To do this most successfully it must be arranged so that the projecting lens receives as much light as possible from the source. This is brought about if a converging beam from a lantern is incident upon the mercury and the projecting lens is placed at the point of convergence of this beam after reflection.

An interesting and well authenticated account is given by Landreth, in *Proc. Amer. Phil. Soc.*, of an instance of persistent vitality in seeds. Lieutenant Greely, commander of the Lady Franklin Bay expedition, which sailed north in 1881, took out seeds of various vegetables noted for their antiscorbutic properties. Some of these were sown at Fort Conger, 81 deg. 44 min. north, but the attempt was not successful. This station was abandoned in 1883. In 1899, sixteen years later, the abandoned station at Fort Conger was discovered by Lieut. Peary, commander of the North Polar expedition. Among other things found was a packet of radish seed in an open box in the attic of the fort. These seeds had been exposed during sixteen years to a winter temperature of 60 deg. to 70 deg. F. below zero. The seeds were sent home and remained until the spring of 1905, when they were sown and 50 per cent produced perfectly normal plants. The original seed was harvested certainly not earlier than 1880, and consequently was twenty-three years old when sown. The question is raised as to whether the electrically charged atmosphere, so constant in northern regions, has the effect of prolonging germinative force. It has been observed that the atmospheric electric currents add quite 100 per cent to the rapidity of plant growth, and to the development of color and strength of perfume.

Not less important than the service which science can render to existing industries and their extension is that which it can contribute to the problem of ascertaining and rendering available for the manufacturer vast undeveloped resources. Our own experience and the example of other countries have shown that such work cannot be systematically carried on by private enterprise. Upon its successful accomplishment depends, not only the unrestricted supply of the necessary raw materials for which the manufacturer looks in increasing quantity, but also the prosperity of the country which produces these materials. This success can only be brought about by a combined effort on the part of the manufacturer and of the government. The manufacturer can provide information as to the materials he needs. The preliminary work of discovering suitable material by scientific means, as several foreign governments have already recognized, must be endowed, directed, and carried on with imperial funds. It cannot be expected that private enterprise will take steps to explore the resources of little-known countries on the chance of a particular material being discovered, nor can the work, as a rule, be successfully done by this means. Experience shows that the most effective manner of promoting the commercial development of a new country is for the government to carry out systematically with its own officers the preliminary work of exploration and examination of the natural