

buildings are the History building, the Negro building, Dairy, etc.

Excellent means of transit to and around the grounds have been provided.

The amusement feature of all world's fairs has come to be regarded as a very important one, and in America this section is now universally known as the "Midway," in honor of the Midway Plaisance of the Chicago Exposition, but in the Tennessee Exposition a new name has been devised for this interesting center. It is called "Vanity Fair," after the show mentioned in "Pilgrim's Progress," which was seen by Christian in his journey through life. In the triangle of the ground many features which were attractive at the World's Fair will be in evidence, as well as a number of new shows. The Director General has, however, decided that there shall be no exhibitions which will be offensive to any one. Another of the special features which add to the beauty of the grounds will be what is known as a "gourd arbor." This will be a long avenue leading from the main entrance of the Auditorium to the walks of the western part of the park. A light, airy framework covers the walk, which will be overgrown with flowers and vines.

It is, of course, too early as yet to give any idea of what the exhibits will be, but there is every reason to believe that they will be so interesting that visitors will come from every State in the Union, and possibly from abroad. The foreign commissioner of the Exposition spent a long time in Europe, and obtained a large number of commercial exhibits from abroad. The chief officers of the Exposition are: Mr. John W. Thomas, president; Messrs. V. L. Kirkman, W. A. Henderson and John Overton, vice presidents; and Mr. Charles E. Curry, secretary. The Director General is Mr. E. C. Lewis. The buildings are under the direction of Mr. Robert T. Creighton, engineer, and the chief of the Bureau of Promotion and Publicity is Mr. Herman Justi, to whom we are indebted for courtesies.

French Waterways.

According to an official report recently issued there were in France, at the close of 1895, says the Engineering and Mining Journal, a total of 13,751 kilometers of interior navigable waterways, of which 8,833 kilometers were rivers, lakes, and other natural channels, and 4,913 kilometers were canals. The natural waterways include a number of rivers which have been made navigable for at least part of their length by dams, locks, or other artificial works. From 1878 to 1895 there was an increase of about 15 per cent in the total length reported, chiefly due to the improvement of rivers. These channels are under the control of the State, and

are divided by law into two classes. Waterways of the first class must be able to carry boats of 2 meters draught, and the locks, if there are any, must be able to pass boats 38.50 meters long and 5.20 meters beam. There are 4,204 kilometers which come up to these requirements; all the rest are of the second class. The

success, serving as a novel feature in many parades and making all its trips without a breakdown or accident of any kind. At one time it carried one hundred and four men, this being the entire crew of officers and men. The car was designed to run slowly through the street during a procession with its crew marching in

front, on both sides and in the rear, while many of the officers would ride, then during a long jump from town to town, officers and men would ride together. The boat, which is 37 feet long, was built on a construction car 26 feet long with 6 foot 6 inch wheel base, equipped with two 12-A, 30 horse power Westinghouse motors. It was constructed of sheathing and timber, the whole being covered with canvas painted and varnished. The hull was painted white, superstructure cream, ironwork bronze, guns, and anchor chain black, sponsons, lifeboats and turrets white. It was lighted with twenty-five incandescent lamps. Red fire was used on many occasions in the smokestack which gave it a decided martial appearance. After celebrating the victory, special parties were given an opportunity to enjoy the novelty

of a ride on the cruiser. A few days ago she was dismantled and will be erected on a raft at the pleasure park of the company (Fitchburg & Leominster Street Railway) in early spring. The boat was designed by naval architect W. W. Lapointe, and was constructed at the car house of the Fitchburg & Leominster Street Railway Company, under the direct supervision of its superintendent, W. W. Sargent. We are indebted for the foregoing particulars and for our engraving to the courtesy of the Street Railway Review.

Coal Consumption on a Cruiser.

The results of the thirty hours' coal consumption trial of the second-class cruiser Juno recently were as follows: Steam in boilers, 142 pounds per square inch; vacuum, port 27.1, starboard 26.1; revolutions, port 117.9, starboard 119; indicated horse power, 4,863; giving a mean speed of 16.3 knots per hour. The amount of coal used was 164 pounds per indicated horse power per hour. The Juno was taken into the Channel for a four hours' forced draught trial. The mean results recorded were: Steam in boilers, 149 pounds; in engines, 151 pounds; vacuum, starboard 26 inches, port 26.6 inches; revolutions, starboard 149.3, port 149.3; indicated horse power, starboard 4,832, port 4,939—total, 9,771; air pressure, 0.92 inch; speed, 20 knots, or half a knot in excess of contract. The vessel returned to Devonport Harbor, where she will be equipped for sea.

THE Rockefeller steamer Robert Fulton, 440 feet over all, is the largest steamer on the Great Lakes.

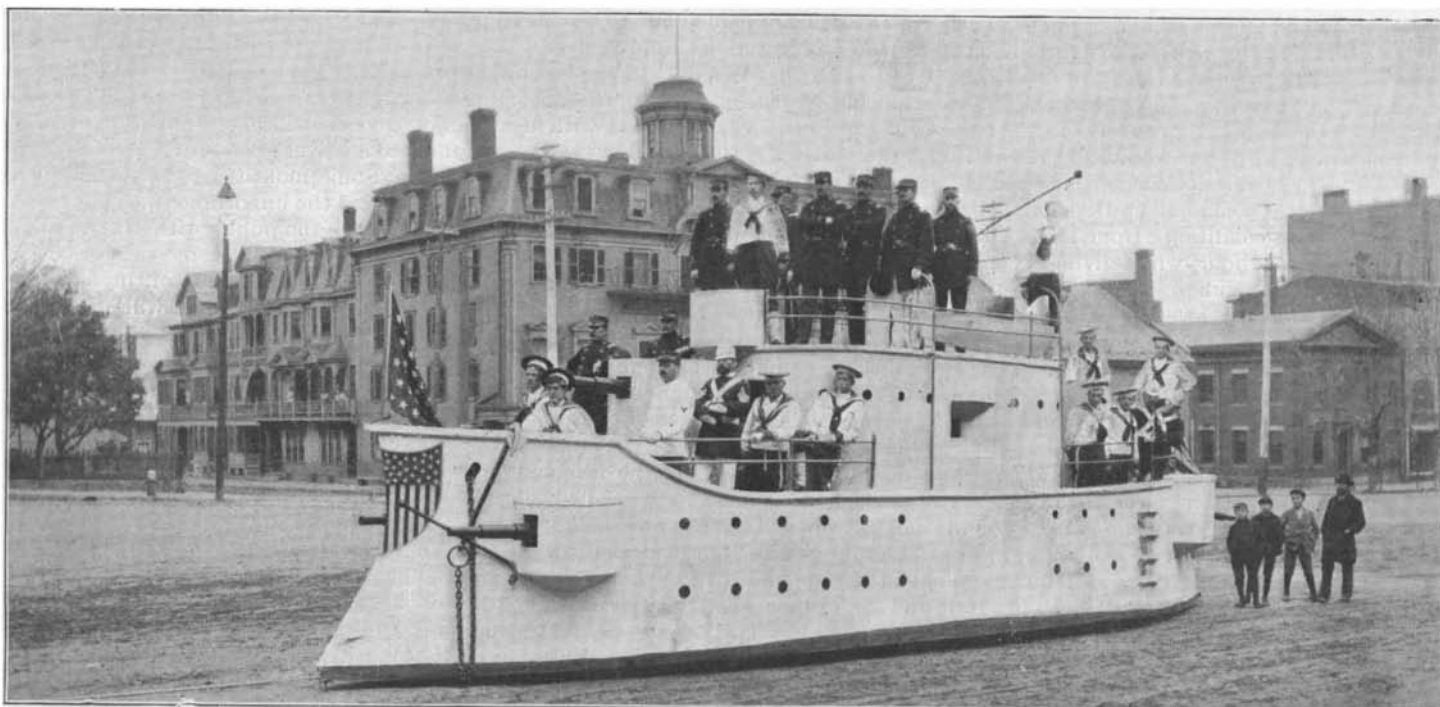


PARTHENON AND AUDITORIUM.

total quantity of freight moved on the rivers and canals in 1895 was 27,173,904 tons. Of this traffic 32.3 per cent was stone, brick, lumber, and building materials, 28.1 per cent was coal, and 7.4 per cent was iron, steel, and other metallurgical products. These three items make up 67.4 per cent of the total. The waterways were used, as might be expected, chiefly for the carriage of heavy freight, which must be moved at a low cost.

A TROLLEY MAN OF WAR.

While the comic papers have been cartooning military engagements of the future as between portable forts operating on trolley lines, it has remained for the enterprising superintendent, W. W. Sargent, of the Fitchburg & Leominster, Mass., Street Railway to actually build what to all appearances was a very formidable fighter. Like the steam locomotive copy



TROLLEY MAN OF WAR USED IN THE LATE CAMPAIGN.

built at Terre Haute, this new idea is suggestive of endless possibilities for future occasions of celebrations, parades, and novel special cars. The cruiser McKinley was operated through the principal streets of Fitchburg and surrounding towns during the late presidential campaign, and was in every way a

Notes on Acetylene.

The following notes on acetylene are extracted from recent technical journals:

A firm of Italian engineers has recently constructed some small cars which are propelled by motors driven by acetylene gas. The charge consists of acetylene gas dissolved in fifteen times its volume of air, and with this mixture it has been found unnecessary to use water for cooling the cylinders. The method of igniting the charge has not, however, been made known. According to the *Gaztekniker*, the motors maintain a speed of 600 revolutions throughout a working period of fifteen hours. The weight is only about 20 lb.; and 0.8 brake horse power is developed. The cost of working is said to be about 12 cents per hour.

At the ordinary monthly meeting of the Newcastle-on-Tyne and Northern Counties Photographic Association, Mr. John Watson read a paper on the use of acetylene for photographic purposes, which was admirably illustrated by a demonstration of the use of acetylene in the lantern. There was a good attendance of members and friends. In his very practical and interesting remarks, the lecturer considered this light very suitable for professional men, who, using a portrait lens, got a fully exposed plate at any time, no matter what the atmospheric conditions might be, with an exposure of about four seconds. He contended that in the very near future acetylene gas will be largely used for the purpose of lantern illumination. The light, which at the present time is largely used, is intensely white, in burning it has no smell, is absolutely safe, and, if not as good as the limelight, is very nearly so, and when once lit up it requires no attention.

Some actual trials have been made on the Swiss railway between Berne and Zurich of lighting by acetylene, with the following result: A kilogramme (2.2 lb.) of calcium carbide produces about 250 liters (9 cubic feet) of acetylene gas, the consumption of which is 0.7 liter (42 cubic inches) per candle power per hour, for flames varying between 20 and 30 candle power, being slightly greater for smaller lights. At the present price of \$10 per 10 kilogrammes of calcium carbide, a cubic meter (35 cubic feet) of acetylene costs 40 cents, giving the same light as five times the volume of compressed oil gas.

An acetylene gas motor, weighing 9 kilogrammes (20 pounds), giving out a brake power of 62 kilogrammes (448 foot pounds), and capable of working fifteen hours without being touched, has, it is stated by the *Rivista Tecnica Italiana*, been designed by Sig. Pedrell, of Parma, who has fitted it to a bicycle.

The method by which M. Raoul Pictet purifies acetylene is given in a recent issue of the *Gas World*. It is based upon the failure of certain chemical reactions when the material is exposed to low temperatures. At -50°C . (-58°F .) sulphuric acid does not act upon acetylene, but it does act upon the impurities usually found in that gas when made from calcium carbide; and therefore the gas, as it is formed from the carbide, is passed through that acid, which retains the impurities. The purified acetylene is then more manageable and more easily liquefied, while its obnoxious odor, its liability to spontaneous ignition (through the presence of phosphureted hydrogen), and its action upon metals are very largely got rid of, while the light produced is intensely white and bright.

One kilogramme (2.2 pounds) of calcium carbide should yield about 300 liters (10 cubic feet) of acetylene gas. A good burner, says *l'Electro-chimie*, specially designed for this gas, should give an illuminating power of nearly fifty standard candles, at a pressure of 40 millimeters ($1\frac{1}{2}$ inch of water), with a consumption of 30 to 35 liters (about 1 cubic foot) of acetylene per hour; and some burners made by MM. Ducretet et Dejeune only consume, under the same conditions, from 11 to 12 liters (mean 0.38 cubic foot) per hour, while giving a light of nearly twenty standard candles. Acetic acid retards the action of water on the calcium carbide, this effect being all the more marked in proportion to the quantity of acetic acid contained in the solution.

The specific gravity of acetylene, as compared with air, is 0.91, and one liter = 1.6 pints of liquid acetylene at a temperature of 32°F ., weighs 450 grains = $157\frac{1}{2}$ ounces, and is evaporated into 375 times its volume at the ordinary pressure, 760 millimeters = 29 inches. Like carbonic acid, when liquefied, acetylene passes into the state of snow if allowed to escape from the receiver in which it is liquefied; and this snow, on evaporating, lowers the temperature 182°F . At the temperature of 68°F ., the pressure in the receivers containing liquefied acetylene is 42.8 atmospheres = 628 pounds per square inch; and it becomes 68 atmospheres = 1,000 pounds per square inch at 986°F . These pressures are higher if the liquid, at these temperatures, fills the receiver. On account of these high pressures, and as this gas is endothermic, the cylinder containing liquid acetylene must be handled with great care, and the escape of acetylene at the closing cock of the receiver, or at the reducer of pressure, is difficult to avoid. For these reasons the use of liquid acetylene, says *l'Electro-chimie*, should be placed under strict control.

The Commercial Navies of the World.

The latest edition of the "Repertoire General de la Marine Marchande," published by the Bureau Veritas, contains the usual general summary of the steamships belonging to the different maritime nations, and measuring 100 tons gross and upward, as also the accustomed list of sailing vessels measuring 50 tons net and upward, and likewise a list of the smaller vessels which are classed in the Veritas Register. The following table shows the number of steamers of over 100 tons, and the collective gross tonnage belonging to the sixteen principal maritime nations—that is, whose aggregate gross steam tonnage surpasses 100,000 tons.

	Steamers, 1896.	Gross tons. 1896.
Great Britain and colonies.....	5,690	10,245,577
Germany.....	881	1,360,472
France.....	532	933,244
United States.....	477	761,707
Spain.....	365	519,315
Norway.....	551	494,612
Italy.....	222	344,523
Holland.....	204	320,794
Japan.....	267	313,563
Russia.....	314	277,302
Austria-Hungary.....	156	254,269
Denmark.....	265	248,773
Sweden.....	427	233,777
Greece.....	107	144,975
Brazil.....	314	139,305
Belgium.....	66	139,300

Besides the steam tonnage set forth in the above table, there are 2,667 small steamers (below 100 tons), measuring altogether 415,069 tons gross. The number of existing steamers whose measurement is between 5,000 and 6,000 tons is 131; between 6,000 and 8,000 tons, 59; those over 8,000 tons, 25, and of these eight are of more than 10,000 tonnage, viz., the *Campania*, *Friedrich der Grosse*, *Georgic*, *Lucania*, *New York*, *Paris*, *St. Louis* and *St. Paul*. The general total of the steamers of over 100 tons is given in the *Repertoire* as 11,155, representing 17,089,596 tons gross and 10,761,025 tons net. The sailing tonnage is divided among the principal maritime nations as follows—thirteen nations possessing sailing tonnage of over 100,000 tons.

	Ships. 1896.	Net tons. 1896.
Great Britain and colonies.....	8,726	3,267,625
United States.....	3,881	1,358,467
Norway.....	2,801	1,176,174
Germany.....	1,096	566,973
Italy.....	1,692	472,002
Russia.....	1,753	363,046
Sweden.....	1,444	285,665
France.....	1,425	252,940
Greece.....	1,059	246,196
Turkey.....	1,247	241,096
Spain.....	1,115	167,143
Denmark.....	795	149,843
Holland.....	642	139,649

The Meteor Fell at His Feet.

The remarkable experience of witnessing a meteor flashing across the firmament, watching it in its course and seeing the stone drop to earth within a few yards of where one is standing comes to but few people, yet such a happening occurred recently to a citizen of Albina, Oregon, says the *Portland Telegraph*. It was shortly after 10:30 p. m. that Mr. Hall started to go to his lodgings. Reaching the corner of Rodney Avenue, he was startled by a sudden illumination of the sky toward the east. Gazing aloft, he saw what at first he took to be a ball from a Roman candle fired from some pyrotechnic display incident to the many processions. As the flaming globe approached, however, it assumed such size that the Roman candle supposition was precluded. Nearing the earth, the oncoming ball of fire could be seen to be bringing with it a trail of bluish sparks, which left the main body with a peculiar cracking sound resembling the snapping of charcoal.

Barely missing the roof of a house, the visitant from the heavens took a long, swooping flight, as though repelled by the earth's surface, finally alighting in a bed of hardpan, burying itself to a depth of some five inches. The distance from where Mr. Hall was standing to where the meteor alighted was so slight that he had a fair view of that portion of the meteor exposed. From this came a shower of sparks, much the same as though the component parts of the meteoric visitor contained a percentage of saltpeter.

Going over to the spot where the fragment of some heavenly body broken loose in space had alighted, he found the meteor still at a white heat. Having no means of handling it, he informed some people there of the phenomenon he had witnessed.

Hall and two other men then returned to the lot. On the way an empty lard kettle was picked up, and reaching the spot an attempt was made to scoop the fragment of a disintegrated planet into this plebeian receptacle. The piece of the meteor, on being moved, emitted fumes so pungent and nauseous as to drive the meteor hunters away. After waiting some minutes for the stone to cool, the party again tried to get it into the kettle, but were again driven back by the odor of the gases. A third attempt was, however, successful, and the meteor was borne back to Turner's.

The piece is of an irregular shape, much resembling a lump of hard clay that had broken loose from a cut and rolled to the roadbed below.

Science Notes.

Dr. Nansen has ordered a yacht of about twenty tons burden and intends to continue his studies on the coast of Norway and Spitzbergen with it.

Mr. William Crookes, F. R.S., who has been experimenting with the alleged new element "lucium" has arrived at the conclusion that it is not an elemental substance at all, but simply impure yttrium.

A recently discovered mountain lake on the island of Fernando Po is situated at an altitude of 1,330 meters and is 1,170 meters long and 800 meters wide. High mountains surround the lake and a waterfall leaps into it, but there is no visible outlet.—*Prometheus*.

A new lamp shade invented by A. Von Kozlowski, says the *Gewerbe Zeitung*, Vienna, is made hollow, to be filled with a suitable liquid, such as a very dilute solution of sulphate of copper with a slight addition of ammonia. This shade absorbs the heat and reflects the light, at the same time giving it an agreeable color.

According to the *Comptes Rendus*, there has been considerable interest in scientific balloon exploration recently in France. A number of captive balloons were sent up from different stations in the night between November 13 and 14, and at the same time free balloons ascended from other stations. The free balloon sent off from Paris rose to the height of 15,000 meters, and recorded a temperature of -60°C .

When the Cornell scientific party was in Greenland last summer an extensive collection of botanical specimens was made, but as nearly all the species were new to the collectors, it was not known how valuable the collection was. As it turns out, practically all are rare and valuable. As there are many duplicates, the National Museum at Washington and the museums of various universities will be enriched as well as that at Cornell. There are in the collection specimens of full grown forest trees less than three inches in height.

Prof. Wm. P. Blake, Director of the Arizona School of Mines, reports, says the *Engineering and Mining Journal*, the occurrence of wolframite, or tungstate of iron, at several localities in the southern part of Pima County, Ariz., specially in the Arivica mining district, where it is associated with gold-bearing quartz. This occurrence of an ore of tungsten in auriferous quartz veins is rare and unusual, but has been before noted by Prof. Blake at Murray, Idaho, where there is a vein of tungstate of lime, or the species scheelite, alongside of a gold-bearing quartz vein.

The coldest region on earth is the country around Werchojansk, in Siberia, says *Prometheus*, where the thermometer sometimes falls below 68°C Centigrade below zero (90°F Fahrenheit below zero). The average temperature of January is 49°F Fahrenheit below zero. Notwithstanding this rough climate, more than 10,000 people inhabit that region. As the air is generally calm and dry in winter, the cold is not felt very much. The variations of the temperature within twenty-four hours are very great in summer; in May, for instance, the thermometer will sometimes rise to 85°F Fahrenheit during the day and fall to freezing point at night.

An apparatus for testing the durability of bicycle wheels described in *Umland's Wochenschrift* consists of a frame receiving the bicycle wheel and weights corresponding to the average weight of a rider. The wheel to be tested rests with its tire on a large pulley rotated by machinery, and the pulley has on its rim a series of projections of various width and height. The wheel thus strikes the projections and is subjected to the same strain as when striking obstacles on the road. The test is continued for about twelve hours, the pulley being rotated at such a rate of speed as to give the wheel a number of revolutions corresponding to a travel of about 170 miles.

Some months ago an article in the *Home Journal* urged the importance of some systematic effort to familiarize the public with the distinguishing characteristics of the different varieties of mushrooms. Now a society for the study of this subject has been organized in Philadelphia. It will meet every two weeks, and members will read papers on such topics as "Mushrooms That Have Helped Me." The organizers say that there are about two hundred and thirty-five edible kinds of mushrooms to be found around Philadelphia, and that tons of the delicious food go to waste, simply because people have a horror of what are known as toadstools, though the really poisonous varieties are few.

Cazal and Catrin (*Annales de l'Institut Pasteur*, ix, 12; *Centralblatt für innere Medizin*, December 12, 1896) have investigated from the bacteriological standpoint the question of how far books are capable of conveying disease. A book from a hospital circulating library was found to contain a number of saprophytes, and in addition a few pathogenic germs, staphylococci and the *Bacillus subtilis*. Even a new book, fresh from the publisher, was not sterile, but showed only harmless bacteria. The authors infected several books with known pathogenic species, and a few days later implanted bits of the leaves in culture media. The streptococcus, the pneumococcus, and the diphtheria bacillus were thus found to be communicable by books, but the typhoid organism and the tubercle bacillus gave negative results.

Progress in American Tea Culture.

BY GEORGE ETHELBERT WALSH.

The prospects of making tea an American product would be poor indeed if it were not for the energy and perseverance of Dr. Charles U. Shepard, who has spent a good part of his life in experimenting with tea plants on his Pinehurst farm in South Carolina, and whose annual crop of leaves creates a little sensation in that branch of the commercial world which deals in imported teas. The success of the Pinehurst tea gardens is made more important in view of the floods of cheap, inferior teas that have been imported into this country to the detriment of the trade since the tariff was reduced; for the sole aim of the owner of the Pinehurst farm is to produce a quality of tea that will command the highest prices in the market. In his own words, "Asiatic cheap labor, at six to eleven cents daily wages, precludes competition in the inferior sorts."

In 1892 the first crop of tea ever raised in this country was cured and sold in our own markets, but the total product did not exceed 150 pounds, as only the small and tender leaves were picked. Since then the crop has steadily increased, and the prices realized for the Pinehurst tea have exceeded \$5 per pound. The yield of the tea plants has proved as high as that of the best Indian gardens of the same age, and the rate of production at Pinehurst has averaged 250 to 500 pounds from every garden of 1,500 plants. This rate could be greatly increased if the large leaves were picked, but the small, young leaves are the only ones suitable for the manufacture of the high grade teas.

The original tea plants of the Pinehurst farm were planted in the old gardens near Summerville, South Carolina, before the war, and they were neglected for nearly twenty years thereafter, growing wild in clumps and thickets in spite of their uncongenial surroundings. Dr. Shepard obtained possession of the gardens, and while some of the plants were transferred to better situations and soil, many were left standing in their original locations. From these early planted shrubs the present Pinehurst crop was raised. At the same time the owner obtained consignments of seed from our consuls in China. These have obtained a good age now, and the plants are vigorous growers. A great part of the deterioration of the tea plant in China has been the result of neglect, and consequently the shrubs from similar seeds planted at Pinehurst have produced finer foliage than those in China. This improvement in the Chinese tea plants through careful cultivation has been one of the most encouraging features of the work at the South Carolina garden.

But most of the crop heretofore gathered in this country has been of the Assam hybrid plants. The true Assam tree is a vigorous grower, with leaves seven or eight inches long and three inches broad, capable of producing twenty-five crops of young leaves in a season, but cold interferes with the proper development of this variety, and it cannot be profitably grown outside of a small part of British India. In its natural, unpruned state the plants frequently attain a height of thirty or more feet. Intermediate between this large tea plant and the small Chinese variety, there are many kinds that have resulted from hybridization. These hybrids represent good and bad teas, with all the possible modifications between the two extremes. In gardens where hybrid seeds are planted indiscriminately, both the broad and narrow leaves are found, and also inferior and extra fine tea leaves.

In experimenting with tea growing in this country, the question of varieties early occupied the attention of Dr. Shepard, and it required considerable study and comparison of data to ascertain just what results might be expected from the leading plants of China and Ceylon. A comparison of the records of the climate of Charleston, a short distance from Pinehurst, and those of other tea-growing countries over a period of ten years, showed that it was not an impossible thing to raise tea in parts of South Carolina. The mean yearly climate was about the same as that of the upper stations of Ceylon, but much warmer than in Japan. The winter season in Upper Ceylon, however, rarely brought ice, while at Pinehurst its appearance is nothing unusual. In Japan frost and ice are common. The rainfall in Ceylon is much greater than in either Pinehurst or Japan. From these observations, it is apparent that South Carolina has too little rainfall and too great extremes of climate to produce the finest tender varieties of Ceylon tea. Artificial irrigation partly supplies the first deficiency, and the protection of the tea gardens by windbreaks made of trees helps to offset the second disadvantage.

The tea fields of Japan, which more closely resemble those of South Carolina than any other, send us annually 50,000,000 pounds of tea. The Ceylon and India tea growths are not so popular in this country, as the leaves are strong, and delicate and light infusions are preferred here. Carefully selected Indian and Ceylon seeds are expensive when brought to this country, but when they once become established they are vigorous growers. The cost of eighty pounds of the seeds delivered in this country averages about \$50, but as only about one-fourth of them are good for anything when they arrive here, the cost is much greater than appears at first. Many of

the seeds sent here do not represent the varieties that are claimed for them, and this is another source of worry and disappointment. Of the many pounds of seed imported for the Pinehurst farm, only very few have yielded satisfactory results, and now more reliance is placed upon the cuttings for propagation than upon the imported seeds. The gardens are so well established that there is ample stock on hand for increasing the number of plants from cuttings.

During the few severe winters we have had, the tea plants at the Pinehurst farm have suffered more or less, but the number actually killed is not great enough to discourage any one embarking upon the enterprise. The winter of 1892-93 was severe enough to kill a few of the tea plants, and to impair the vigor of others. The winter of 1894-95 was another severe test of the plants.

The experiences so far seem to point to the conclusion that tea plants can be raised at a profit in South Carolina either from seed or from cuttings, and that the Chinese and Japanese sorts are better adapted to the climate than the India or Ceylon teas, although many of the Assam hybrids develop into tolerably luxuriant plants. The crop must of necessity be of a high order, and to accomplish this only the young leaves can be picked. The question of profit, however, is not settled when good plants and leaves have been produced. The cost of picking and curing the leaves is much higher than in China, Japan, India or Ceylon, and herein lies the real difference between the industry in this country and the Oriental lands. A high tariff on tea would prevent the importation of many of the inferior grades now brought into this country, and incidentally it might help tea growing in the South. But better than this would be the invention of machinery for reducing the cost of picking and curing. The substitution of machinery for manual labor would immediately bring into existence a considerable industry in tea raising.

The industry at present is not attractive to the average farmer, for a tea garden of only a few hundred acres would involve the expenditure of considerable money, with no prospects of getting any profits back inside of five or six years. If a central curing factory could be established in the best tea growing districts, it might be possible to induce farmers to cultivate ten or twenty acres of tea plants as an investment for the future. Even with the present prices paid for labor in the South, the best quality of teas can be raised at a good profit, or at least, this has been the case for several years on the Pinehurst farm. The picking is the most expensive work, but, while long and tedious, it is not arduous labor, and women and children can do it equally as satisfactory as men.

The Formation of Natural Bridges.*

Prominent among the rock formations which have attracted the attention of student and sightseer alike are the arches of solid stone spanning deep chasms and forming an unbroken union between massive cliffs on either side. Were they more common, they would be, perhaps, less noted; but so far, very few of them have been brought to public notice, and it is probable they are of rare occurrence. The opinion has been advanced by some geologists that natural bridges are the remains of former caverns. It frequently happens that the roof of an underground chamber approaches so near to the surface of the earth as to be unable to support the weight of rock and soil above it; consequently it gives way, forming a sink hole. If this process continues a sufficient length of time, the entire roof will fall in and the cavern become an open ravine. Sometimes, however, one portion of the roof may be so thick or so strong as to hold its position after all that part to either side of it has disappeared; and this fragment which remains constitutes what is known by the name of a "natural bridge." While this theory is simple and may be correct in regard to some of these formations, it is clearly erroneous when applied to others. Caverns are usually very tortuous, seldom preserving the same direction or level for any considerable distance, and there are very few whose shape is such that they could under any circumstances be converted into open ravines. Still, such do exist; and the above theory is satisfactory concerning bridges found under such conditions. But there are at least three other varieties of these formations for which it cannot account; and for each of them a separate explanation is necessary.

As a type of the first class may be taken the most famous and perhaps the largest natural bridge in the world; namely, that in the Shenandoah Valley of Virginia which gives its name—Rockbridge—to the county in which it is found. In this instance, the strata terminate at the river hills on one side, and rise to the surface of the ground beyond the bridge on the other. Water sinking into the earth sought an outlet toward the James River by following the lines of separation between the strata; and dissolving the limestone through which it flowed, produced a tunnel or underground passage open at both ends. The upper strata were much less affected by this erosion than the lower; for a smaller amount of water made its way into them,

besides which they were, from their position, compressed and hardened and thus better enabled to resist the destructive process. When this passage became well defined the wear was almost entirely at the bottom and ends; the central portion suffering no further change except that resulting from atmospheric agencies. No cave has ever been discovered whose ramifications bear the slightest resemblance to those produced by surface drainage, nor one in which the various branches from a central chamber lead, without exception, to the surface of the ground at different points. In Hardy County, West Virginia, a considerable stream, known as Lost River, completely disappears within a few rods, the water sinking between the strata of a syncline and reappearing on the other side of the mountain in a number of great springs whose united waters form the Cacapon River. The rock is a hard, compact shale or slate; if it were limestone or other mineral soluble in water, there would be at this point a tunnel two miles long. Probably in this manner was formed the tunnel in Scott County, Virginia, through which a public road once ran, and which is now utilized by a railway company.

The tunnel and natural bridges of Carter County, Kentucky, which may serve as a type of the second class, had their beginning and development in a somewhat different manner, by reason of the difference in the geological conditions. Here the surface rock is a very hard carboniferous limestone, passing by a continually increasing admixture of quartz sand into a typical sandstone below. As soon as a depth is reached at which the sand becomes appreciable in amount, false or cross bedding is very marked. Water passing through the upper layers dissolved more or less of the lime which acts as a cement for this sandy material, and when an outlet was once made below, the disintegration proceeded rapidly, until the nearly pure sand rock at the bottom was reached. In this way have been created two bridges, each surpassing in some respects that of Virginia, and a tunnel several hundred yards in length. Riffles and shallows, alternating with deep pools, are common in the streams of this region; but there are no underlying strata, at least none at present within reach, through which other streams may burrow. Four large caves in the vicinity have been thoroughly explored; and there is no point in any one of them where it would be possible for a bridge to form having any resemblance to those existing. The only similarity in the formation of the two phenomena is that both are results of underground drainage; and in none of them could the causes that have produced the one class have given rise to the other.

The third class which remains to be explained may be found in the massive, bedded limestone of the devonian and subcarboniferous deposits, better known in various localities as the "mountain," "cliff," or "cavern" limestone. Such stone, being formed under the ocean, must contain a large amount of water; when it is elevated above the sea level, this water drains away, and the stone must shrink, just as green wood does when it is seasoned. In this way are formed seams, or "joints" as they are called, which extend for a considerable distance downward, sometimes almost vertical. Surface water finding its way into these gradually enlarges them, forming sink holes or "natural wells." Under ordinary circumstances, this water will continue to make its way downward, forming a cave, or it will reappear at different places in the shape of springs. If, however, there should be a stream or a deep ravine in the immediate vicinity, the water may reach this by following the lines of separation in or between the strata; and by constantly enlarging the passage thus made, it may form in time a ravine whose sides are united by the higher beds of the rocks through which it has bored its way. The famous "arched rock" at Mackinac Island may be taken as a type of bridges formed in this manner. Near the Kentucky caves above mentioned is a natural bridge formed somewhat in the manner as those last described; but the rock in which it occurs is a sandstone instead of a limestone. Several yards back from the brink of a precipice is a vertical crevice in ground which is dry except immediately after a rainfall. Storm water, flowing into this and reaching the surface again near the foot of the bluff, has eroded the stone until it now presents an arch resembling that of Mackinac, but much larger in all its dimensions.

Counting Blood Corpuscles.

Dr. Judson Daland, of Philadelphia, has invented an instrument for counting blood corpuscles, according to the Physician and Surgeon. It works on the centrifugal force principle, and accomplishes the measurement by means of comparative bulks. A quantity of blood is placed in a finely graduated tube and the latter revolved at a speed of about 1,000 revolutions a minute. The corpuscles divide by force of gravity, and form on the side of the tube in easily traceable divisions of red corpuscles, white corpuscles, and serum. The new method permits of larger, and consequently more representative quantitatives being used in experimenting, besides doing away with actual microscopic counting.—New York Medical Times.

* Popular Science News.