Scientific American.

ESTABLISHED 1845

MUNN & CO., - - - EDITORS AND PROPRIETORS.

PUBLISHED WEEKLY AT

No. 361 BROADWAY, - - NEW YORK.

TERMS FOR THE SCIENTIFIC AMERICAN.

(Established 1845.)

One copy, one year, for the U. S., Canada or Mexico..... .....**$3.00**
One copy, six months, for the U. S., Canada or Mexico..... ..... **1.50**
One copy, one year, to any foreign country, postage prepaid. £0 18s. 5d. **4.00**
Remit by postal or express money order, or by bank draft or check.

MUNN & CO., 361 Broadway, corner Franklin Street, New York.

The Scientific American Supplement

(Established 1876)

is a distinct paper from the SCIENTIFIC AMERICAN. THE SUPPLEMENT is issued weekly. Every number contains 16 octavo pages, uniform in size with SCIENTIFIC AMERICAN. Terms of subscription for SUPPLEMENT, $5.00 a year for the U. S., Canada or Mexico. $6.00 a year, or £1 4s. 8d., to foreign countries belonging to the Postal Union. Single copies 10 cents. Sold by all newsdealers throughout the country. See prospectus, last page.

Combined Rates.—The SCIENTIFIC AMERICAN and SUPPLEMENT will be sent for one year, to one address in U. S., Canada or Mexico, on receipt of *seven dollars*. To foreign countries, *eight dollars and fifty cents a year*, or £1 14s. 11d., postage prepaid.

Building Edition of Scientific American.

(Established 1885.)

THE BUILDING EDITION OF THE SCIENTIFIC AMERICAN is a large and splendidly illustrated periodical, issued monthly, containing floor plans and perspective views pertaining to modern architecture. Each number is illustrated with beautiful plates, showing desirable dwellings, public buildings and architectural work in great variety. To architects, builders, and all who contemplate building this work is invaluable.

Single copies 25 cents. By mail, to any part of the United States, Canada or Mexico, $2.50 a year. To foreign countries, $3.00 a year, or £0 12s. 4d. Combined rate for BUILDING EDITION with SCIENTIFIC AMERICAN, to one address, $5.00 a year. To foreign countries, $4.50 a year, or £1 6s. 9d. Combined rate for BUILDING EDITION, SCIENTIFIC AMERICAN, and SUPPLEMENT, $9.00 a year. To foreign countries, $11.00 a year, or £2 5s. 2d., postage prepaid.

Export Edition of the Scientific American

(Established 1878)

with which is incorporated "LA AMERICA CIENTIFICA E INDUSTRIAL," or Spanish edition of the SCIENTIFIC AMERICAN, published monthly, uniform in size and typography with the SCIENTIFIC AMERICAN. Every number contains about 100 pages, profusely illustrated. It is the finest scientific industrial export paper published. It circulates throughout Cuba, the West Indies, Mexico, Central and South America, Spain and Spanish possessions—wherever the Spanish language is spoken. THE SCIENTIFIC AMERICAN EXPORT EDITION has a large guaranteed circulation in all commercial places throughout the world. $3.00 a year, or £0 12s. 4d., postpaid to any part of the world. Single copies, 25 cents.

MUNN & CO., Publishers, 361 Broadway, New York.

☞ The safest way to remit is by postal order, express money order, draft or bank check. Make all remittances payable to order of MUNN & CO.

☞ Readers are specially requested to notify the publishers in case of any failure, delay, or irregularity in receipt of papers.

NEW YORK, SATURDAY, FEBRUARY 12, 1898.

Contents.

(Illustrated articles are marked with an asterisk.)

TABLE OF CONTENTS OF

Scientific American Supplement

No. 1154.

For the Week Ending February 12, 1898.

Price 10 cents. For sale by all newsdealers.

THE LIQUEFACTION OF AIR.*

If Baron Munchausen had recorded that he once came upon a people who were in the habit of changing air into the liquid state and carrying it around in vessels, the statement would have been regarded as a particularly happy effort of that accomplished artist. An assertion so at variance with all human experience would have failed to command belief, even if indorsed by the testimony of less impeachable witnesses than the observant baron.

We are speaking of a bygone age. To-day the public knows better than to deny a statement offhand merely because it contradicts or does not agree with its common experience. The loophole of escape from unexplained phenomena in the days of our forefathers was by assertion of flat disbelief or ascription to witchcraft or the devil. To day, at the first announcement of the wonderful, the public neither believes nor disbelieves; for the incredibly rapid march of science and discovery has taught the world that the marvels and impossibilities of yesterday may easily become the commonplace facts of to-day. But two brief years ago it was whispered from across the ocean that a certain German professor had succeeded in passing light through so-called opaque bodies—wood, leather, the flesh—and the technical press announced the fact with a prefatory "it is said," "a contemporary reports," etc., neither affirming nor caring to deny a statement apparently so preposterous. To-day the fluoroscope is a toy that has lost its charm, and an X-ray equipment is a necessary part of the surgeon's outfit.

The liquefaction of air is another of those feats of experimental science which, having their birth in the laboratory, ultimately graduate into the broader field of the industrial arts, and lose all their wonder as they become useful and familiar to the public. It must not be supposed, however, that because it has only now become possible to produce liquid air in commercial quantities, therefore the principles of its liquefaction are new or only of late discovery. It has long been known that air, like any other gas, was theoretically capable of liquefaction, and that its condensation was merely a question of suitable apparatus. To Prof. Dewar, of Glasgow, belongs the credit of first liquefying air in limited quantities, the necessary reduction of temperature being achieved by a successive series of evaporations. The process, however, was too costly to have any commercial value.

The economical liquefaction of air in large quantities has been recently accomplished by Mr. Charles E. Tripler, of New York, after several years of experimental work. Two and a half gallons of the liquid were recently sent from his laboratory to Prof. Barker, of the University of Pennsylvania, and its properties were exhibited in an extremely interesting series of experiments during a lecture delivered by Prof. Barker to his class and a company of invited guests. This was the first public exhibition of the kind of this article in the United States.

The laws governing the existence of air in the liquid or gaseous state are the same as those for water—to take a substance with which we are most familiar. Above a certain temperature and pressure (212° F. and atmospheric pressure at the sea level) water exists as a vapor; from 212° F. to 32° F. at the same pressure it is a liquid, and below that temperature it is a solid. In its normal condition air, as we know it, is a gas, just as in its normal condition water is a liquid; but if we lower the temperature or increase the pressure, or both, of air to a sufficient degree, we reach a point at which condensation takes place. The liquefaction point of air under normal atmospheric pressure is 311·8° below zero by the Fahrenheit scale.

Mr. Tripler's method of liquefaction is based upon the fact that, if a gas be compressed and allowed suddenly to expand, it absorbs the heat of the surrounding medium, thereby producing intense cold. He compresses air to 2,000 pounds to the square inch, passes it through a coil and permits it to issue from a needle point orifice. There it expands and cools. This cold stream of air circulates around a second coil through which compressed air is flowing, reducing the temperature of the latter. The air issuing from this second coil has its temperature lowered to a point due to its own expansion, plus the cold imparted from the first expansion. The expanded and extremely cold air from the second coil is used similarly to cool a third coil, the air in which is brought down to a temperature of 311·8° F. and below, at which it condenses and flows from the end of the coil in a liquid stream.

In the course of his lecture Prof. Barker made a number of curious experiments with the liquid, illustrating the operation of the laws governing the formation of solids, liquids and gases. When it was poured into a tumbler it boiled until it had absorbed the heat of the glass. The cold gas given off condensed the moisture in the air above the glass, which fell in the form of hoar frost. A piece of tin thrust into the liquid made it boil and the tin was rendered as brittle as glass. Copper and platinum were not so affected, and it is evident that these metals will make suitable receptacles for this new liquid. When it was boiled over a furnace the ebullition was, of course, excessive; but the moment water was poured into the boiling liquid, the former was instantly frozen. Alcohol and mercury were frozen when brought in contact with the new product. The liquefaction point of the two constituents of air is different, that of oxygen for given pressures being several degrees higher than that of nitrogen. Hence, as the temperature of the liquid rises, the nitrogen is the first to escape as a gas. The remaining liquid is proportionately rich in oxygen—a fact which is proved by the bluish tint which a standing vessel of the liquid assumes if exposed to the air. Just what the economic value of this new and extremely interesting product is, time will show; but in experimental work in the laboratory it will be certain to find a ready field of usefulness.

* A series of valuable papers on this subject, by various authors, including Prof. Dewar, has been published in the following numbers of the SCIENTIFIC AMERICAN SUPPLEMENT: 846, 932, 948, 967, 970, 972, 1042.

FALSE ECONOMY.

The reluctance of Congress to push forward the coast fortifications proves that the sound business principles which govern men in the conduct of their private business are too often forgotten or violated in the administration of public affairs.

No one who is entitled to speak intelligently on the subject denies that the wealthy cities on the United States seaboard are at the mercy of an attacking fleet. Our coastline is so extensive and the number of ships in our navy is relatively so limited that every one of our seaports should be in a position to repel, unaided by the fleet, a hostile attack. At present not one of them could do this. Admirable as are the plans of fortification drawn up by the War Department, they still exist, thanks to the indifference of Congress, largely upon paper.

Adequate fortifications are to the protected city what insurance is to a building. No good business man would think of putting up a factory without placing an adequate insurance upon it. No nation in the world but one would dream of allowing its wealthiest cities to lie exposed to the attack of any petty state that can afford to buy a cruiser or two from foreign and competitive nations that are only too ready to furnish them. Looked at from a purely business standpoint, the few million dollars asked for fortifications are to be spent in taking out an insurance upon the thousands of millions of property which are now exposed to possible destruction.

This year's fortifications bill has suffered, as usual, a reduction at the hands of the House Committee, and the knife has been applied so effectively that less is to be conceded than for the two years previous, and the War Department's estimate is cut down two-thirds. Two years ago the appropriation was $7,377,888, and last year $9,517,141. This year a request was made for $13,378,571, whereas the bill as reported provides for only $4,144,912.

The policy of the present Congress may, perhaps, have been influenced by the fact that our foreign relations are less strained than they were when the liberal appropriations of two years ago were made. But it should be remembered that the building of fortifications and guns of the modern costly type is not or should not be emergency work. Activity in this line should never be determined by the aspect of political affairs. To return to our comparison, no one thinks of waiting until his neighbor's house is on fire before taking out an insurance upon his own.

GROWTH IN OUR EXPORTS OF AMERICAN LOCOMOTIVES.

The American locomotive is evidently winning favor in the foreign countries into which it has been introduced. Whether the disastrous strike of the engineers in Great Britain has had anything to do with the large number of orders which have recently been placed in this country or not, it is a fact that the foreign trade has been growing at a steady pace and helped materially to keep our builders busy during the past few months. Japan in particular has shown her satisfaction with the American locomotives which she has already purchased by sending in large orders for more. Her first purchases were made in 1894, when fifteen locomotives were ordered. This was followed by twenty-three in 1895 and another twenty-three in 1896. The figures for the current year will undoubtedly show a considerable increase over its predecessor. Our best customer is Brazil, to which country eighty-four locomotives were shipped in the year ending in June, 1897. Russia comes next with a total of seventy-four, while Mexico purchased twenty-three and Chile twenty-two.

There are many reasons why the American machine should give good satisfaction to these foreign countries. In the first place, it is considerably cheaper (35 to 40 per cent) than the European machine, and the lessened cost is obtained, thanks to our improved machinery and economical shop management, without any sacrifice of quality. It is possible that the American locomotive does not show so much bright work and costly painting as the European engine, but in all points that affect its efficiency it is fully up to the standard.

To this must be added the simplicity and accessibility

of our machines—a feature of the greatest value in countries where skilled labor is comparatively scarce. The American locomotive bears the stamp of the practical men who have evolved it. It is essentially a "handy" machine. Moreover, the fact that its design has been modified by the requirements of the rough track and roadbed of our early railroads make it singularly well adapted to the new roads which are being built in such countries as Russia and Japan. The bar frame, the equalizing lever and the swinging truck combined give to the American locomotive a vertical and lateral flexibility which enables it to ride safely over track which would ditch a plate-frame engine before it had run a mile. It is also greatly in its favor that the generous proportions of its boiler give it a reserve capacity which must always render it popular with the superintendent and his staff of engineers.

In four years our exports of locomotives have risen from 195 to 338, and if the present rate of growth keeps up, we may hope before long to take a leading position in this important branch of the industry.

GUN OF NEW TYPE SUCCESSFULLY TESTED.

A very interesting and highly satisfactory preliminary test of a new type of steel gun was conducted during the latter part of January, at the Sandy Hook Proving Ground. The gun, which is of the 5-inch rapid-fire class, is so simple in construction that no drawings are needed to describe it to our readers. It is made of a single forging of steel, which, having followed the course of manufacture usual for large gun forgings, was, at a proper stage of manufacture, cooled from the interior from such temperature as to produce properly disposed initial strains of such intensity as would place the wall of the gun in the best condition to resist interior pressure.

The manufacture of the gun is due to the suggestions of Capt. F. E. Hobbs, Ordnance Department, United States army, who pointed out several years ago to the chief of ordnance the advantages that could be obtained in the manufacture of guns by applying to forgings a modification of the Rodman principle of casting guns; that the process as applied to forgings could be made to produce exactly the initial strains desired; that these strains could be easily increased or diminished at little cost and that guns so made, while quite as strong, would be much cheaper to make than those built up.

An experimental forging made under Capt. Hobbs' direction at the Bethlehem Iron Works showed such excellent results, on being cut up and carefully examined, that the chief of ordnance ordered this 5-inch gun to be manufactured.

The thickness of metal which the gun should have and the proper initial strains to be applied to give great strength were computed by Capt. R. Birnie, ordnance department, from his formulæ on the strength of guns. Capt. Birnie was an early convert to the methods of manufacture proposed, and has materially assisted Capt. Hobbs in perfecting the details of plans.

The gun is fitted with Gordon's breech mechanism, uses fixed ammunition, smokeless powder, a projectile weighing 55 pounds, can be fired from six to ten times per minute, depending upon the conditions of loading and aiming, and has a range of more than six miles. In the Sandy Hook tests a velocity of over 2,700 feet per second at the muzzle was shown, and in the special high pressure test to which the gun was subjected, pressures were registered of nearly 50,000 pounds per square inch.

The method of manufacture can be applied to forgings of any size that can be turned out by the steel-producing plants of the country; consequently, the caliber of gun which can be made of a single forging may be, to-day, set at 8-inch, but, by using this method, the number of parts in guns of larger caliber could be much reduced, while the guns themselves would be stronger.

It is probable, also, that the commercial engineering interests of the country will be found ere long following the lead of the ordnance department in this latest improvement in the treatment of steel forgings, as they did many years ago, in demanding for their structures oil-tempered and annealed steel forgings, after that department of the army had shown conclusively, by careful experimental investigation and by actual test, the safety and superiority of such metal.

A BRIEF REVIEW OF SOME BRANCHES OF THE WORK, SCIENTIFIC AND PRACTICAL, OF THE HEALTH DEPARTMENT OF THE CITY OF NEW YORK.

In view of the fact that the daily papers have called attention to a bill introduced in the legislature, by which it is proposed to curtail to a great extent the powers of the New York City Board of Health, it will be of interest to the readers of the SCIENTIFIC AMERICAN to know just what this board has accomplished in the last few years.

It is not the province of this article to go into an extended account of all the work of this department. Such an account can be found in the reports of the board to the Mayor. A summary statement of the most important work only can be given. The work of the department to which we shall refer might aptly be placed in two divisions—first, scientific research, and, second, the practical application of the same in the interests of public health. The whole of this work is in charge of the sanitary superintendent, who, with the co-operation of his divisional superintendents, has been enabled to make a truly marvelous showing in the sanitary condition of the city.

The research work, which is mainly carried on by the division of pathology and bacteriology, includes the study of the cause and effect of diseases, and their prevention and cure.

Every facility has been offered for this. Competent investigators with fully equipped laboratories are at their disposal.

Careful study has been made of the more important contagious diseases, so that the department is prepared to cope with any epidemic that might occur.

This division also makes and prepares for administration to the people the following antitoxic remedies: Diphtheria antitoxin for the prevention and cure of diphtheria; tetanus antitoxin, for the prevention and cure of lockjaw; vaccine virus, for the prevention of smallpox; tuberculin, for the diagnosis of tuberculosis (consumption); mallein, for the diagnosis of glanders in horses.

Other biological products of the laboratories that are being tested with a view of ascertaining their usefulness are: Typhoid antitoxin, for the cure of typhoid fever; streptococcus antitoxin, for streptococcic infection, such as occurs in erysipelas, tuberculosis, puerperal fever, scarlet fever, septicæmia, etc.; pneumococcus antitoxin, for the cure of pneumonia; antirabic virus, for the prevention of hydrophobia.

It is in the practical application of the products of the laboratories that their effectiveness is demonstrated. This is probably best seen in the treatment of diphtheria by antitoxin. The number of deaths caused by this disease have been reduced over fifty per cent since the use of this remedy was inaugurated, and it is needless to add that it has also been robbed of many of its most appalling features.

The department has diagnosis laboratories, where the bacteriological diagnosis of diphtheria, tuberculosis and typhoid fever is made.

During the year 1896, 25,049 cultures were examined for diphtheria bacilli; 1,856 specimens of sputum from cases of suspected tuberculosis were examined for tubercle bacilli; 16,796 vials of diphtheria antitoxin were issued; 918 cases of diphtheria were treated in their homes by the medical attaches of the laboratories, and 1,214 persons were immunized.

The diagnosis laboratories are of great benefit to the physicians of the city, in confirming their diagnoses. They are utilized by the physician in the following manner: A case of diphtheria, for example, occurs in the private practice of a physician; he makes a culture from the throat of the affected person, and sends it to the laboratory for examination. The day following that on which the culture is made he receives a report from the laboratory, which states whether or not the diphtheria bacillus is present. Stations are located at convenient places throughout the city, where physicians can obtain the culture tubes and where they can leave the tubes after the culture has been made. Collections are made from these stations every afternoon. In the cases of tuberculosis and typhoid fever the suspected discharges are sent to the laboratories in the same way, and are examined there bacteriologically.

A special corps of inspectors is assigned to the administration of diphtheria antitoxin, and, on request, one of these inspectors will visit a person suffering from diphtheria in any part of the city, day or night, and administer diphtheria antitoxin, under the supervision of the attending physician.

Dwellings and tenement houses where tuberculosis exists are under sanitary supervision and, as occasion calls for, are inspected and disinfected. There were over ten thousand inspections and disinfections for this disease alone in the year 1897. A number of tenement houses which were unfit for habitation, on account of their bad sanitary condition, have been condemned and torn down.

The disinfecting plant of the department is equipped with the necessary appliances to meet the needs of a city of the importance of New York. It is provided with apparatus for disinfecting by dry heat, steam, formalin gas and sulphur. Medical supervision of the public schools is exercised to the extent of keeping contagious diseases out of them.

Food products are kept under close watch, so that, as fas as possible, the people are given the benefit of only the purest and best. Milk cows in the city have been inspected, for the purpose of ascertaining the existence of tuberculosis among them, and where cows have been found affected with this disease they have been removed from the herds.

Horses suffering from glanders are also removed to places where they do not become a source of danger to other animals.

Investigations made by the department, showing that the dust in the street cars and various public places is often infectious, led to the enactment of an amendment to the Sanitary Code prohibiting spitting on the floors of street cars, ferry boats and other public conveyances, and requiring that all companies should post in their cars, boats, etc., printed notices forbidding this.

It is safe to assume that New York is as jealously guarded in the matter of public health as any city in the world.

EXCAVATIONS AT BRANCHIDÆ.

The Archäologischer Anzeiger contains in its current number (1897.2) a letter of great architectural interest from M. Haussonllier respecting the excavations on the site of the Branchidæ Temple of Apollo at Delphi. Some account has already appeared in the Bulletin de l'Académie des Inscriptions et Belles Lettres, January 15, and M. Haussonllier's letter to the Anzeiger is supplementary to this. It is illustrated by a photographic view of the front of the temple as at present disengaged. M. Haussonllier reports as follows:

The whole of the principal façade of the temple is now laid bare. It stood on a basis of seven steps, further subdivided to form an approach of thirteen steps, extending over the five central intercolumniations. This approach was shut in north and south by two pylons placed against the thirteenth column, starting from the angle column. These pylons, therefore, stand exactly where the line of the cellar wall, if produced, would fall. They would seem to have been intended to serve as bases to sculptural groups never actually erected. The principal facade of the temple was never completely finished. Both the steps near the pylons bear mason's marks, which would have disappeared in the final process of finishing. The facade consisted of ten columns, not one of which is standing. Of the bases of these columns, two were taken to the Louvre by Rayet and Thomas in 1873; the remaining eight have now come to light.

Like the steps and pylons, none of the bases are completely finished off. The bases are richly ornamented and pure in style, but unquestionably the most interesting point is the peculiar and so far unique character of the capitals. These are decorated with two heads of divinities, each taking the place of a volute; between the two heads in the middle of the capital is the head of a bull. This last feature has, of course, appeared before in Greek capitals, but no example hitherto has been known of the head of a god as a decoration to a capital. The two gods represented in the Didymaean capitals are Apollo and Zeus; one head of a bull has also been found. All three heads are fine specimens of decorative sculpture—large and impressive in style, and recalling in some respects the Pergamene school. The frieze also was adorned with sculptures of similar character, including a series of heads of Medusa—one placed above each capital.

A number of inscriptions complete the architectural interest of the excavations, among them a record of the expenses incurred in the erection of the temple. From these inscriptions we learn the regulations in force during the building and many of the architectural terms employed, and more important still, the date of the temple; the work of building was in full course in the middle of the second century B. C. Altogether the Didymaean Temple forms now an important chapter in the history of Greek architecture.—Architecture and Building.

THE CURRENT SUPPLEMENT.

The current number of the SUPPLEMENT, No. 1154, contains a number of articles of prime importance. "Chief Joseph and the Nez Percé War" describes some interesting events in connection with the recent Indian wars. "The Lateen Ice Boat," by H. Percy Ashley, describes the construction of a speedy ice craft. It is accompanied by full working drawings and particulars which will enable the amateur to construct such a boat. This article is published in response to many inquiries which we have received from our readers. "The Italian Marble Mountains of Serravezza" is the subject of a most interesting and unusual article. These quarries were opened at the beginning of the sixteenth century by Michelangelo, but could not be worked in his time by reason of lack of means of transportation, but at the present time the quarries are producing marble which is superior to that of Carrara. "The Trans-Mississippi and International Exposition at Omaha" is an article which describes the new exposition which will open June 1, 1898, and will continue open for five months. It is illustrated by a bird's eye view and illustrations of some of the buildings. "The Philosophy of Hyper-Space," by Prof. Simon Newcomb, is an interesting address. "The Liquefaction of Air and the Detection of Impurities (Separation of Helium from the Gas of the King's Well, Bath)" is an article by Prof. James Dewar.

G. D. BRILL, the Cornell graduate recently appointed director of a model farm and agricultural school at Wuchang, China, by Viceroy Chang Chi Tung, has now been appointed special Commissioner of Agriculture to China by Secretary Wilson, of the United States Department of Agriculture.