Scientific American.

ESTABLISHED 1845

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

PUBLISHED WEEKLY AT

No. 361 BROADWAY, - - NEW YORK.

TERMS TO SUBSCRIBERS

One copy, one year, for the United States, Canada, or Mexico $3.00
One copy, one year, to any foreign country, postage prepaid. £0 16s. 5d. 4.00

THE SCIENTIFIC AMERICAN PUBLICATIONS.

Scientific American (Established 1845) .... $3.00 a year
Scientific American Supplement (Established 1876) .... 5.00 "
Scientific American Building Edition (Established 1885). .... 2.50 "
Scientific American Export Edition (Established 1878) .... 3.00 "

The combined subscription rates and rates to foreign countries will be furnished upon application.

Remit by postal or express money order, or by bank draft or check.

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

NEW YORK, SATURDAY, AUGUST 3, 1901.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

FUTURE RECONSTRUCTION OF THE BROOKLYN BRIDGE.

In another column will be found an explanation of the causes which led to the recent partial failure of the Brooklyn Bridge. Our readers will probably agree with us that the collapse was due to indifferent construction, coupled with an inspection which, to say the least, was not any too thorough. The system of connecting the suspenders to the floor is poor and liable to introduce strains for which the parts were not proportioned. In the general reconstruction of the floor system of the bridge which undoubtedly will have to be undertaken at the earliest opportunity, the design of this detail of the bridge must be radically altered. It is manifestly difficult to hang a massive floor having a total horizontal movement of 14 inches to a cable which has practically no horizontal movement, by hinged connections which are only 20 to 24 inches in length. The best thing to do would be to make the trusses continuous across the center of the bridge and cut them either where the overhead diagonal stays commence, or else at the towers. The first would be a preferable position for the slip joints, for the reason that the fixed overhead stays form with the floor system a kind of cantilever construction, and the central portion of the span between them would thus act somewhat as the central supported span of a true cantilever bridge. There would be no difficulty in making connections between the suspenders and the floor system, at these points in the bridge, the great length and the flexibility of the former precluding any necessity for hinged connections.

The recent accident will serve the good purpose of forcibly directing attention to the fact that the bridge is carrying heavier loads than are desirable. This is the second occasion on which this condition of things has caused failure of the bridge. Two or three years ago it was manifested by the buckling of the stiffening trusses. Now it is the suspenders that are giving away. The first accident was not nearly so serious as the second; but they both show that there are weak places in the floor system which only require an extra bunching of the traffic, or the combination of excessive movement of the trusses with rather careless maintenance, to produce a breakdown. The main cables and the suspenders themselves when properly connected up and cared for are sufficient for the loads which the bridge is carrying, but the stiffening trusses are altogether too light to give the necessary rigidity to the structure. There is no question that the time has come for putting in more modern and stronger trusses, even if it should involve an increase in weight and the substitution of heavier suspenders for those which are now in place. We think it is quite within the resources of modern engineering to carry out this reconstruction, piecemeal, without interfering with the traffic. If this should be impossible, advantage will have to be taken of the completion of the new East River Bridge and of the ferries, to which traffic will have to be diverted while the change is being made.

The recent closing of the bridge and the enormous discomfort thereby occasioned are another reminder of the fact that the city authorities have ever been slow to realize the enormous and ever-accelerating rate at which the city of New York is growing, and its traffic requirements multiplying. We have seen this illustrated in the matter of the water supply, in the matter of the Rapid Transit tunnel, in the inadequate provision for public schools, and in other directions where the inconvenience, while not so widely felt, was, nevertheless, equally real. Those who are intrusted with the care of the city's interests, plan and build for an increase in the municipal demands of the city which, by the time the improvements are ready, is found to be immeasurably above the estimate. The Rampapo affair, bad as it was, has surely served the purpose—at least we hope it has—of teaching us that it is high time we made further and very much more extensive arrangements for securing an adequate water supply. The present overcrowded condition of the Brooklyn Bridge, and the fact that this splendid structure has been loaded up to, and almost beyond the safe limit imposed by good engineering, is another object lesson to the same effect. We sincerely hope that the new East River Bridge will be rushed to completion, and Suspension Bridge Number Three prosecuted with a speed that is commensurate with the urgent needs of traffic between Manhattan and Brooklyn. Bridge work is of necessity, because of its size and mass, slow in construction, and it is far better to be a little beforehand than very much behindhand in works of this kind.

RECENT DEVELOPMENTS IN THE BRITISH NAVY.

BY OUR ENGLISH CORRESPONDENT.

The energetic and progressive policy of the British Admiralty is being maintained in view of the keenness that is being exhibited by the various Continental powers in the struggle for the supremacy of the seas. The Naval Department has recently decided upon its new naval programme, and it is of a most extensive character. In the selection of this programme the experience and suggestions of naval officers and experts in the fleet were obtained, so that the Admiralty might gain a comprehensive insight into the defects of the existing vessels and consider suggested improvements. These suggestions have been adopted with liberality in the designing of the new vessels.

In connection with the first-class battleships a new type of this class of vessel is to be built, exceeding in armament any other vessel afloat or in course of construction for the English navy and equal in every respect to the vessels designed for any other of the powers. These new battleships, three of which are to be laid down immediately, are to be of 16,500 tons displacement. This exceeds the previous latest battleships by 1,500 tons. They will be 20 feet longer, being 420 feet over all, with a beam of 75 feet and a draught of 26¾ feet. Their engines will develop 18,000 I. H. P. and they will run on an eight hours continuous steam trial at not less than 18½ knots, an increase of ½ knot.

Their protection will be similar to that of the recent "London" class of battleships, with several developments, including an armored belt from the lower protected deck to a small height above the water line of 9-inch armor, and thence to the main deck of a thickness of 8 inches, and this will be continued over the whole length between the barbette and the heavy guns.

A peculiar feature will be introduced which has not hitherto been attempted in any English vessels. The plan of placing the 6-inch guns in casemates is to be abandoned. The ten guns of this caliber will be inclosed in a battery with 7-inch armor, and the battery will be divided by traverses to diminish the effect of any shell that may happen to penetrate the armor. In addition to the four 12-inch guns which form the normal armament of this type of battleship throughout the world, four 9.2-inch guns are to be introduced. These guns are of tremendous power and will considerably strengthen the armament of the vessel. They will be placed on mountings similar to those which have been recently placed on the "Cressy" and which have proved so conspicuously successful. They will be protected by 6-inch or 7-inch armor, and will have a direct forward and aft fire. By this means the ship will get a forward fire of two 12-inch, two 9.2-inch and two 6-inch guns, and an aft fire of the same formidable character. This means that presuming all the guns to be fired simultaneously an aggregate weight of 2,660 pounds of metal—nearly 1¼ tons—will be fired from the six guns fore and aft respectively.

A new type of cruiser has been designed. This new vessel, of which six are to be laid down, will be of 9,800 tons, 22,000 I. H. P., developing a speed of 23 knots. Instead of carrying two 6-inch guns, both fore and aft, which comprises the armament for these vessels already on service, one 7.5-inch gun will be placed fore and aft. There is a great material increase in the power of this larger caliber gun which will render the armament of a very superior character.

With regard to the destroyers, ten are to be built which at full draught will have a speed of 30 knots. One important improvement in this type of vessel will be the increase in the coal-carrying capacity.

Several vessels have been struck off the effective list and will be used simply as depots. Eight vessels which the Admiralty decided to refit have been abandoned in lieu of new ships. The present programme for building comprises 18 first-class battleships, 25 armored cruisers, 25 torpedo boats, making in all, with several other vessels for different purposes, a total of 84 new ships.

Building in the various shipyards, both governmental and private, is in full swing, and rapid headway is being made to make up for the delay in building in past years. Many of the larger private yards have carried out extensive improvements and alterations and have installed new plants in order that they may cope with the work.

The fittings of the new vessels are to be of a most up-to date and modern description. They will be provided with the most approved ammunition, the guns will have cordite charges and telescopic sights, electric hoists, and the latest types of torpedoes.

Owing to the importance of specially equipped coaling vessels the Admiralty proposes devoting $400,000 for this type of ship, and at present there are seven fast steamers plying at home and abroad for supplying the vessels of the fleet with coal. Coal barges to be used as temporary transmitters are to be fitted in order to be available for getting coal on board ships not lying at the wharves. A new distilling ship has been provided, and large distilling apparatus is being installed at all the stations, so that an abundant supply of fresh water is always available. The construction of an ammunition ship is also under consideration, but, owing to the difference of opinion among experts concerning the advisability of such a vessel, it has not been definitely settled.

The trials respecting the boilers are also being pushed forward. Experiments are being made in all directions to ascertain which type of boiler is the best suited for naval requirements. The installation of the Belleville boiler has been stopped, pending the decision of the investigating committee, and orders have been placed for one or two of the Babcock & Wilcox water-tube boilers. The German naval authorities are also conducting similar boiler tests, and they are also experimenting with a combined installation of water-tube and cylindrical boilers upon some of the battleships. If this scheme is feasible and proves successful, it will probably be adopted in the English battleships.

It has also been decided to decrease the height of the masts of the new battleships. Owing to the fact that signaling has been revolutionized by Marconi's wireless telegraphy, it is considered unnecessary to have lengthy masts, as nearly all the vessels in the English navy are being provided with Marconi's apparatus. Probably as much as 60 feet will be cut off from the masts. Hardly any wood is to be employed in construction, and that utilized in the shape of furniture and fittings will be arranged so that it can be thrown overboard within a few minutes, owing to the great danger of ignition that arises from its presence.

The system of building fore-and-aft bridges at present in vogue will be discontinued. Small unobtrusive structures will be provided in their stead, and although made of steel they will be rendered easily removable so that they can also be quickly thrown overboard. These improvements will somewhat detract from the beauty and symmetry which has hitherto characterized the British ships; but a great deal of conspicuous superstructure will be removed, so that when cleared for action the vessel will not offer so conspicuous a target.

ELECTRICAL METHOD FOR DETERMINING THE VARIATIONS OF MINERAL WATERS.

A simple and rapid method of finding out the variations in composition of mineral waters has been brought out by M. P. Muller, who uses the variations in electric conductivity for the purpose. To make a complete study of a given mineral water and establish its qualitative and quantitative composition, chemical analysis is indispensable, and of course cannot be replaced; but the composition of a water is not necessarily invariable, and one cannot be sure whether a certain spring of mineral or ordinary drinking water, when analyzed in the month of January, will have the same composition in the month of June, or in the following year. The chemical analyses would be long and costly, nevertheless it would be interesting to be able to follow the variations of a spring from the time when an analysis had been made, and to know the influence of the seasons or of a change of flow due to rains or dry weather; also the modifications due to an infiltration which may be unknown. A method of indicating such variations should be simple, rapid and easy to carry out, and besides, the property which it is proposed to measure should depend as much as possible upon the dissolved matter and not upon the water itself. The method of electric conductibility fulfills these conditions very well. The experiment is made promptly by the method of alternating currents and telephone (a greater or less sound indicating greater or less conductivity), but care should be taken to operate always at the same temperature, say, 25 deg. C. The conductivity of a water defines this liquid in the same way as a fusing point defines a chemical substance; it depends upon the nature and quantity of the substances dissolved, which in a potable water are almost exclusively composed of electrolytes. It is natural that two different waters which have the same conductibility may not have the same composition, any more than two bodies with an identical fusing point would be alike, but to follow the variations of a determined source the value method cannot be questioned, One may even go farther; if two neighboring springs flowing from the same geologic earth, seemingly independent, show the same conductibility, it may be safe to affirm that they are identical. The author, after two experiments requiring half an hour, predicted the identity of two such springs which passed for distinct, and a subsequent chemical analysis showed an almost complete identity, the only divergence being that for the silica and oxide of iron (present only in minute quantity), and it is known that these substances exist in the waters almost entirely in the colloidal state and non conductor. In another case he showed considerable variations in the composition of a mineral spring of which an analysis was about to be commenced, and made it evident that such an analysis would have no value.

NATIONAL PHYSICO-TECHNICAL LABORATORIES.*

BY H. PELLAT, PROFESSOR AT THE UNIVERSITY OF PARIS.

Industry is making an increasing demand on science, not only for its discoveries, but for the exactness of its measuring processes; it depends upon the precise data found in the laboratories. If the largest companies can support the expense of testing or research laboratories and have a personnel of engineers and scientists, the greater part of the manufacturers cannot go to this expense, especially for the tests relating to physical measures, which most often demand very costly apparatus. Even the scientists cannot have in their laboratories all the apparatus necessary for the verification of measuring instruments, as many of these are cumbersome and of a very great cost. For this reason, some of the governments have aided their manufacturers and scientists by establishing national physico-technical laboratories provided with the most improved measuring instruments where verifications of great precision and useful researches are carried on, these being of benefit to science and industry. Germany has commenced this movement, and possesses now in the Physikalisch-technische Reichsanstalt, founded about 1890, the most important of the national physico-technical laboratories. This establishment, situated at Charlottenburg, near Berlin, occupies an immense edifice which has been especially built for the purpose, in the middle of a park, which is an excellent position to guard the instruments from trepidations. The director has under his orders a corps of eighty persons. The Reichsanstalt is divided into two sections. The first has for its object the solution of problems of metrology proper; it is occupied with problems of a high interest and has especially rendered service to pure science. For instance, its researches have related to the normal thermometric scale, the rotative power of quartz for the light of sodium, the standard of resistance, etc. It also makes determinations of the unknown or ill-defined physical constants of bodies presenting a scientific or industrial interest. It is thus that during 1898 this section took up the study relative to the density of water vapor between 1 and 20 atmospheres to the maximum pressure of water vapor at low temperatures, the comparison of thermometric bodies with the normal thermometer at high temperatures, the heat conductibility of several metals, the luminous radiations emitted by certain substances, etc.

The second section, the most important of the two as far as the personnel is concerned, is charged with verifying the instruments of precision and the measurement of certain physical properties which have a less scientific character than those of the first section. The section is subdivided into six sub-sections, whose names indicate their field of work: 1. Mechanics of precision. 2. Electric measurements. 3. Optical measurements. 4. Thermometric measurements. 5. Chemical work. 6. Workshop. An example may be given by a resumé of the work done in the space of one year by the first and fourth sub-sections. The first, with three workers, has made about 200 researches relative to the determination of the errors of division of various scales, to the measurement of exterior dimensions of calibrated pieces, to the evaluation of the dilatation coefficient of metallic rods, the verification of tuning-forks, etc. The fourth sub-section, with seven workers, has verified 16,329 thermometers, including 14,910 medical, 81 apparatus for determining the inflammability of petroleum, 116 viscosimeters, 4 pressure gages, 35 barometers, 116 thermo-elements of the Lechatelier type and 400 feet of wire for the same, 50 fusible safety-plates for boilers, and has made besides a number of different tests. The verification of alcohol and density gages, etc., has remained in charge of an older institution known as the Normal Aichungs Kommission, and which verifies also the secondary standards for weights and measures.

England has already three standardizing establishments. Two of these are under the direction of the Board of Trade. The first, the Standards Department, has had the keeping of the standards (length, weight, money, gas meters, petroleum inflammation apparatus, etc.) and makes comparisons with these standards. It is besides at the disposition of the Board of Trade for all the scientific researches which it may require. The second, the Electrical Standardizing Laboratory, founded according to the law of 1889, is devoted to standardizing and verifying all the electrical measuring instruments and the keeping of the standards for these. Besides these two official laboratories there is a semi-official laboratory, the Kew Observatory. Besides the meteorological service, this establishment has, in fact, a standardizing laboratory, where each year are verified about 30,000 instruments of different kinds, such as thermometers, barometers, theodolites, sextants, compasses, telescopes, watches and chronometers, photographic lenses, etc. Not content with these three establishments, the government is now founding a national physical laboratory upon the plan of the German institution. Parliament has voted the necessary funds for its construction and maintenance; into it will be absorbed the Kew Observatory.

In Belgium, the founding of a Meteorological Bureau, distinct from the Bureau of Standard of Weights and Measures, and closely resembling the Reichsanstalt in character, was decided eight years ago; various circumstances have retarded up to the present the voting of the necessary funds, but it is expected that this vote will take place before the end of this year. In Russia, the Central Chamber of Weights and Measures possesses vast laboratories very well fitted up, and its extensive functions permit it to render in part the same services as a physico-technical laboratory. This chamber has, in fact, the following functions: 1. The keeping of the prototype of the Russian standards of weights and measures. 2. The making and verification of the copies of these standards made for the use of local standardizing bureaus or for the government bureau. 3. The verification of all special instruments serving to measure the temperature, light intensity, consumption of gas or electric energy, etc., and in general it verifies upon demand all the measuring instruments in use in commerce, industry, arts or sciences. 4. The fixing of the limits of error admissible for the weights and measures, in standardizing and in practical use. 5. The examination of all questions relating to weights and measures. 6. The direction of the local bureaus, etc. The chamber occupies at St. Petersburg a solid building of three stories, situated in the middle of a large space; a pavilion for electrical measures is shortly to be added. The establishment is provided with a complete assortment of the best meteorological apparatus existing. An idea of its importance will be given when it is stated that its personnel consists of fourteen persons, not including laboratory assistants, etc., and that its annual budget is about $46,000. It is under the control of the Department of Commerce and Manufactures of the Minister of Finance. The chamber is not the only standardizing establishment which Russia possesses; the instruments which serve for determining the tax upon certain substances are verified by the Technical Committee, which has this in charge; it is also under the Minister of Finance. In consequence, the Technical Committee is required to verify the alcohol and density instruments, thermometers, saccharimeters, etc. For the alcohol measures a special section is devoted, and it is provided with standards of length and weight verified at the International Bureau of Weights and Measures and the most improved apparatus. This section occupies a separate building at St. Petersburg. Again, the Central Physical Observatory of the Imperial Academy of Sciences also verifies metrological instruments.

In other European countries there are no national physico-technical laboratories and the functions of the service of weights and measures are in general much too limited to supply their absence. Nevertheless, in Austria the Normal Aichungs Kommission has about the same functions as in Germany, being devoted to verifying measures and weights, thermometers, etc. In the United States the principal cities possess, in their universities and colleges, splendidly organized laboratories where are carried out the tests and standardizing needed in the sciences and industry.

In concluding his address, M. Pellat points out the immense advantages of such institutions and the desirability of founding them in countries which, like France, do not yet possess them. As in the case of Germany and England, such a laboratory should be independent of the Bureau of Weights and Measures, as each responds to a different need. The buildings should be away from the centers of cities to avoid trepidations.

* Lecture delivered before the Congrès de Physique. Reported by special Paris Correspondent of the SCIENTIFIC AMERICAN.

THE WORK OF THE EGYPTIAN EXPLORATION FUND.

BY OUR ENGLISH CORRESPONDENT.

The annual exhibition of the year's work of the Egypt Exploration Fund was held recently in London. The investigations of Egyptologists during the years 1899 and 1900 were productive of much interesting information regarding the kings of the First Dynasty, approximately 4715 to 4514 B.C., and "the Ten Kings before Menes." Mr. Maciver, who has explored two large cemeteries at El Amrah, states as the result of his researches that one of them belongs to the first half of that remote age and the second extends from the First Dynasty. Hitherto our information concerning this period has been very vague, so that additional interest and value attaches itself to this Egyptologist's investigations in this direction. There were on exhibition models of the bracelets found on the mummy of the Queen of Zer at El Mehesna and now jealously preserved in the museum at Cairo. There are four bracelets in all, the first consisting of a row of façades with the royal hawk alternately reproduced in gold and turquoise. The second has a gold centerpiece copied from the center of a lotus flower with a group of turquoises and a large ball amethyst on each side. Skillfully woven into the back of this bracelet are strands of human hair and gold thread set with gold and turquoise. The third bracelet is of gold, lapis lazuli, and amethyst beads. The work is beautifully executed, each bead having its precise position in the scheme of decoration, while there is no excess of color. There is also the scepter of King Khasekhemui, comprising a slender copper rod with pierced cylinders of sardonyx or carnelian united by broad and heavy gold bands strung over it, bead-wise. From El Amrah were exhibited specimens of prehistoric pottery, dolls, and primitive and crude models in clay of various animals. The excavations at Abydoes and the surrounding neighborhood are now practically completed and this collection of ancient handiwork is further valuable, since this district was supposed to have been thoroughly explored some time before, but the work on that occasion was but indifferently accomplished, without the assistance of trained workmen, which has enabled the present explorations to be carried out so thoroughly and systematically.

SCIENCE NOTES

The Government is constructing a new machine for calculating the tides which, it is said, will do the work of thirty mathematicians. The most complicated problems of tidal variations are easily worked out with it.

The exhibits of agatized wood in the Mines Building of the Pan-American Exposition is very important. It is generally conceded that this agatized wood came from a tropical tree transformed in a prehistoric era from a living, growing forest to its present state. Silicified wood is found in many localities, but the coloring of this wood has never been equaled.

Prof. Koch, of Berlin, who discovered the bacilli of phthisis, stated at the Tuberculosis Congress at London that he had demonstrated that meat and milk from tuberculosis-infected cattle may be consumed with absolute impunity. He has arrived at this conclusion after most practical tests. He believes that human and bovine tuberculosis are of a totally different species, and that phthisis is not hereditary. The discovery is of the utmost importance, especially as regards milk. His views are warmly combated by other medical men.

Dr. Barton's war balloon is of cigar shape, and has a platform and machinery suspended from the balloon. The propellers are driven by a high speed motor, and there is a horizontal aeroplane for causing the balloon to ascend and descend, and at the rear there is a vertical aeroplane steering to the right and left. The difficulty which arises from moving the center of gravity is overcome by 2½-foot water tanks at each end, water being automatically pumped from one to the other as either end of the machine becomes heavier.

Alcohol is made in solid form by heating a liter of it in a vessel of double capacity over a water bath at a temperature of 60 deg. C. Twenty-eight to thirty grammes of Venetian soap, very dry and cut fine are added, as well as two grammes of gum lac. After a complete solution has been obtained, and while it is still warm, it is poured into metallic receptacles which are closed immediately and left to cool. The presence of the gum lac assures the preservation of the material and prevents too quick evaporation. The soap incorporated in the alcohol is left as a residue after burning.

John Arbuckle, of Brooklyn, has started a novel floating hotel enterprise. It consists of a small fleet of especially equipped ships which will carry people on short ocean cruises, the vessels being run as floating hotels. The vessels leave late in the afternoon, put out to sea and remain outside until early morning. The fleet consists of a thousand-ton sailing ship, a yacht, an ex-pilot boat and an ocean tug. The large sailing ship is a full-rigged three-master and has accommodations for 250 passengers. The upper deck, which is protected by a watertight awning, is fitted with bunks, and there are also bunks surrounding the dining room deck. There are a considerable number of staterooms in addition, and many of them are provided with bathtubs.