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NEW YORK, SATURDAY, NOVEMBER 29, 1902.

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.

REPORT OF THE CHIEF OF THE BUREAU OF ORDNANCE.

It is always with pleasure that we take up the Annual Report of the Chief of the Bureau of Ordnance, for there is no branch of the navy that is able to show at the end of each twelvemonth more uniformly satisfactory results. From the very inception of our new navy, the work of this Bureau has been marked by almost uniform success. Although at the time of the Spanish war we had dropped considerably behind the rest of the world in the matter of smokeless powder and high-velocity guns, the lost ground has been more than made up, and to-day our guns, gun mounts, powder and shells are among the best in the world; while the prestige that accrued to us from our invention and manufacture of Harveyized armor will remain to our credit as long as armor-plate manufacture endures.

Although, as the Report suggests, no striking developments have occurred in the improvement of guns and armor, there has been satisfactory progress all along the line, and the manufacture of material has fully kept pace with the demand for it. The most interesting of the new guns just now is the 7-inch, 45-caliber piece, twelve of which are to form the secondary battery of each of our two great battleships "Louisiana" and "Connecticut." This gun, designed for a muzzle velocity of 2,900 foot-seconds within a limit of chamber pressure of 17 tons per square inch, has developed a muzzle velocity of 3,035 foot-seconds with a chamber pressure of only 16 1-3 tons, a most creditable result, not equaled or excelled by any gun of the same class. It is interesting to learn that the Bureau has recently ordered the manufacture of a 6-inch, 50-caliber gun to weigh about 8 tons, from which a muzzle velocity of 3,400 to 3,500 foot-seconds is expected with a 100-pound projectile. It is gratifying to know that the work of converting the old gravity-return mounts of the 6-inch guns of our earlier cruisers is being carried on, and that, shortly, practically all of the guns of this class will have the increased rate of fire and additional handiness due to reconversion. The "Baltimore," which has been undergoing reconstruction and refitting at the New York Navy Yard, is being rearmed with 6-inch, 45-caliber guns, and a similar change is to be made on the "Newark." The British-built cruisers "New Orleans" and "Albany" are to have their Armstrong guns replaced by 5-inch, 50-caliber, rapid-fire guns of American make, chiefly for the purpose of securing uniformity of guns and ammunition.

During the past year 7,612 tons of armor have been delivered at the various shipyards. The Report states that no improvement worth speaking of seems to have been made of late in the quality of the armor; a matter of regret, since guns, powder and projectiles have each made a decided advance. Rear-Admiral O'Neil draws attention at considerable length to the fact that the charge of delay in warship construction, due to the non-delivery of armor, has been pressed too far, and he shows that in the case of several of our ships the contract for armor was let many months after the contract for the ships, while in several cases the armor was delivered a year or so before the final completion of the vessel. Thus the "Illinois" was completed in September, 1901, her last armor plate having been delivered August 31, 1900, that is, a year before the final completion of the vessel; moreover, it was placed on the ship October 31, 1900, ten months before the vessel was in all respects completed. In the matter of powder, we learn that with the exception of ignition and shell powder, no black or other than smokeless powder has been purchased or manufactured for the Navy since the Spanish war. As regards the quality of our smokeless powder, we are told that so far as stability is concerned, the results have been most satisfactory.

The public will be greatly interested to learn that the question of improving the warships "Oregon," "Indiana" and "Massachusetts" by taking out their heavy and cumbersome 13-inch gun turrets and substituting electrically-operated balanced 13-inch turrets, and of otherwise improving them, has been under consideration on several occasions. We are of the opinion that this change could be made to very great advantage, for as coast defense vessels these ships will doubtless remain for several decades upon the active list of our Navy. Reference is made in the Report to the new armored cruisers of the "Tennessee" class, of 15,400 tons displacement, over which an earnest controversy was waged on the question of whether to give them 22 or 23 knots speed. Admiral O'Neil states that to give them a knot more speed, or the same speed as that of the British cruisers "Good Hope," "King Alfred" class, would call for machinery which would weigh 379 tons, or the weight of four 10-inch guns, mounts and turrets; even a quarter of a knot would represent the weight of an additional 2 inches of armor over the whole protective deck. As to artillery, the Chief of the Bureau considers that a higher stage of efficiency will be reached in the future than we have gained to-day. Stronger guns of better material, admitting of higher pressures, these pressures obtained probably with smaller charges and quicker powders, are among the possibilities that offer an interesting field of investigation. While a chamber pressure of 15 tons per square inch was until recently considered the maximum pressure that could be safely allowed, we have now a pressure of 17 and 18 tons, and guns designed for working pressures of 20 tons per square inch will soon follow.

CRITICISM OF THE NEW EAST RIVER BRIDGE.

In a recent issue of the New York Sun there appeared a letter from an engineer who was on the staff of the Forth Bridge during the erection of that famous structure, in which the writer, after paying a well-deserved compliment to the bravery of the city Fire Department at the East River Bridge fire, passes on to a general criticism of the careless management which rendered a fire possible, and of the great delay in the completion of the bridge, and closes with an attack upon the general design of the East River Bridge as such, alleging that it is erected on "antiquated and discarded engineering practice." The writer of the letter in question announces himself in his opening sentence as having been one of the staff of engineers that built the Forth Bridge, and he would have us believe that New York city is engaged in the construction of a great municipal work which is wrong in theory, poor in construction, and doomed to early decay. The somber hue of his reflections is evidently deepened by the fact that he was associated with the construction of a bridge which, according to his convictions, is the only type that is recognized by good engineering practice, or that the all-destroying hand of time will spare.

The SCIENTIFIC AMERICAN would scarcely have given attention to the letter, were it not that the writer of the letter admits that he was driven to utter his word of warning by an article which appeared in our journal so far back as August, 1897. The article in question contained a detailed description of the bridge, in which, by way of emphasizing its vast proportions, a comparison was made with the great Forth Bridge, which, while greater in its total length and longer in each of its main spans by 110 feet, does not possess any single span that is comparable in its width of suspended roadway or in its vast carrying capacity with the main span of the new East River Bridge. The Forth Bridge was built to carry two lines of railroad track, and permit the running of heavy express trains at their highest speed. This it has proved well able to do, and so far as its proving a link in a great railroad system, over which express trains may run at high speed, is concerned, the Forth Bridge is an admirable piece of engineering. But the carrying of two tracks of railroad is a very simple matter compared with the carrying of six railroad tracks, two of them for the steam cars of the elevated railroad system, and four of them for our heavy, modern electric cars, to say nothing of two 20-foot roadways for heavy city traffic, two footways for passengers, and two bicycle tracks, the whole suspended floor system having a total width of 120 feet. Any single span of the Forth Bridge, compared as to width of floor and carrying capacity with the single span of the East River Bridge, is of very modest capacity.

Our critic next proceeds unwittingly to censure the work of himself and his *confrères* on the Forth Bridge, by saying that, given the necessary platforms and floors, the Forth Bridge could carry, in addition to its present work, the whole traffic of the Brooklyn Bridge without appreciable fatigue. If this is the case, there must have been built into the Forth Bridge some thousands of tons of material which was absolutely unnecessary. We had heard it stated that after completing their calculations for a bridge, English engineers were in the habit of throwing in a whole lot of additional material, merely to be sure that it was "perfectly strong enough;" but not until the fact was so frankly admitted by this correspondent, did we believe that this was anything more than one of the stock jokes of the profession. Now, the American engineer believes that in designing a bridge the first thing to ascertain is the exact amount of duty required of it; and secondly, to select the materials and so dispose them that this duty shall be performed with the use of the least possible amount of steel, disposed in the best possible way for utilizing its compressive and tensile strength. It was in accordance with these principles that the East River Bridge engineers decided to use the suspension in preference to the cantilever principles of construction. For the suspension bridge permits the use of steel wire, the very strongest form of steel known to our modern industries; whereas the cantilever form necessitates the use of a mild steel, whose strength is only about 30 per cent of that of steel wire. Strange to say, the Sun's correspondent is so wrapped up in the conservatism which is so frequently charged against English engineers, that he does not hesitate to commit himself in his letter to the following extraordinary statement: "It is a remarkable fact that . . . a new bridge should have been designed and partly erected on antiquated and discarded engineering practice;" referring, of course, to the use of the steel wire suspension bridge in preference to the cantilever adopted in the Forth Bridge. Now, as a matter of fact, before it was decided to build a suspension bridge, the whole question was very carefully thrashed out by our engineers, and the cantilever form was rejected at once as being altogether too heavy and costly for a span of this magnitude. Our practice, in this country, is to use plate-steel, riveted girders on bridges up to 175-foot spans; riveted or pin-connected trusses for from 175 up to 500-foot spans, cantilevers for from 500 to 1,000 or 1,200-foot spans, and steel wire suspension bridges for everything above that. While it is true that in the smaller suspension railroad bridges the problem of rigidity of floor system is a difficult one to satisfactorily solve, in spans of over 1,200 feet the great mass of the floor system as compared with the moving loads, and the depth of the stiffening trusses, are such that the rigidity of the floor system can be completely assured; and with a perfectly rigid floor system the steel-wire suspension bridge is from every point of view the ideal, and in fact is the only practicable form of bridge that can be used.

The cantilever which our Forth Bridge engineer would have us substitute is so enormously costly and clumsy that the engineer who would use it in America to-day would be, to borrow the phrase of our critic, guilty of "antiquated and discarded engineering practice." To give a few concrete figures as evidence, we quote the results arrived at by a board of engineers appointed a few years ago to make an estimate for a bridge of 3,100-foot span across the Hudson River. This board, which included such eminent men as Messrs. Burr, Cooper and Morison, found that while a suspension bridge would cost $35,367,000, a cantilever bridge of the same capacity would cost not less than $51,128,000, a cost which the Commission very promptly set down as prohibitive.

The great Forth Bridge, with its two spans of 1,710 feet, is a monumental structure which, when we bear in mind the absence of any precedent at the time of its design, some twenty years ago, for a work of such magnitude, reflects the greatest credit upon the courage and resourcefulness of its engineers. At the same time, the "boilershop methods" adopted in its construction would never be used in American practice; for the tubular sections adopted for the compression members involved an enormous amount of labor which could have been avoided by the use of rectangular sections, with which the same strength of structure and a more harmonious effect could have been secured. Of course, at the time of its erection, the Forth Bridge engineers did not have at their command steel with a tensile strength of 223,000 pounds to the square inch, which was the load under which the test wires used in the Brooklyn Bridge cables broke when tested. With such wires in the cable, and with these cables thoroughly saturated with a waterproof composition, wrapped with a triple layer of canvas and an outer covering of steel plate, and the whole carefully painted from year to year, there is no reason why the Brooklyn Bridge cables should not live as long as the Pyramids themselves.

A 200 HORSE POWER MOTOR-PROPELLED BOAT.

M. Emile Altazin is constructing a boat which is to use a 200 horse power gasoline motor. The vessel, which is a fishing boat, will also be provided with sails; it is being built at Boulogne, France, and will be tried next year. Up to the present gasoline motors of over 80 horse power have not been used on boats, and the experiment will therefore be of interest. The boat is 90 feet long, 26 feet wide, and the maximum draft is 14 feet. It is to be used for herring and mackerel fishing with nets, and can carry a load of 250 to 300 tons. On the fishing trip it is to take on board 330 nets, 900 barrels for receiving the fish, 800 boxes for placing the fish on ice, etc. It will also carry 65,000 pounds of ice and the same quantity of salt. Tanks are to be provided having a capacity of 8,000 gallons of gasoline or alcohol for the motor. Besides the 200 horse power motor for driving the propeller, there will be a small 25 horse power motor to operate the capstan and for raising and lowering the nets. The large motor has four cylinders of 50 horse power each, and the smaller one two cylinders. The mechanism is arranged so that the small motor can be coupled to the larger, and thus add its power if need be. Both motors work at 300 revolutions per minute and have governors which may be controlled either from the engine room or the deck so as to vary the speed at will. The combustible to be used is either ordinary gasoline or pure alcohol without the usual mixture with gasoline. The carbureter is designed to work equally well with either. As the nets, when they are lowered, might become caught in the propeller, the latter is provided with a sliding covering which may be run down along a guide support and thus be partly inclosed.

THE HEAVENS IN DECEMBER.

BY HENRY NORRIS RUSSELL, PH.D.

The finest region in all the starry heavens now occupies the eastern sky. In one-tenth of the total area of the visible heavens it includes eight out of the sixteen brightest stars visible in our latitude. As we turn our gaze eastward at our customary hour of 9 o'clock on December 15, we find near the horizon the two dog-stars, Sirius and Procyon. The latter is nearly due east, and is somewhat higher up than the former, which, even at its present low altitude, gives evidence of its surpassing brightness. Both these stars are among our near neighbors in space, and both are attended by faint companions, visible only with the largest telescope.

Above Sirius is Orion, with the bright red star Betelgeuse on the left, and the still more brilliant Rigel lower down on the right. Gemini, which lies above Procyon, has also a pair of bright stars. The upper one is named Castor, and the lower Pollux. Still higher up are Auriga (above Gemini) and Taurus (above Orion) bearing the bright stars Capella and Aldebaran.

The long line of faint stars which begins at Rigel and can be traced westward, then southward, and then back toward the southeast, forms the constellation Eridanus. Its one bright star, Achernar, which nearly equals Rigel, can be seen at this season low on the southern horizon from places south of latitude 32 deg. The large constellation of Cetus, the Whale, occupies a great part of the southern sky. The monster's head is marked by an irregular pentagon of small stars, which is now on the meridian, about half way up to the zenith. The brightest star in the constellation, Beta Ceti, lies nearly 40 deg. to the westward, and is the only conspicuous one in the southwestern sky.

Aries is nearly on the meridian above Cetus, and Perseus is directly overhead. Observable minima of Algol will occur on the 12th at 11 P. M., on the 15th at 8 P. M., and on the 18th at 5 P. M. Andromeda and Pegasus are the most conspicuous constellations to the west of the zenith, Cygnus is still visible in the northwest and Lyra is low on the horizon. Ursa Minor and Draco are below the pole, Ursa Major coming up to the east of it, and Cassiopeia and Cepheus high on the west.

We have had some occasion in the foregoing to refer to the distances of certain stars. Nothing in all the realm of astronomy impresses the imagination more than these enormous distances. Indeed, they are so vast that it is hardly credible that they can be measured at all.

The principle used by astronomers to determine them is exactly that of the range-finder employed by modern gunners. Bearings are taken on the distant target from two points as far apart as is practicable. Knowing the distance between these points, the distance of the target can be calculated from the difference of its bearing at the two points.

When we come to apply this method to the stars, we find that the whole diameter of the earth is far too short a base-line. Fortunately, we have a longer one available, the diameter of the earth's orbit. By taking observation of a star at properly chosen dates six months apart, we have a base 186,000,000 miles long, and can proceed with some chance of success.

The next question is: How can we measure the bearing of the star with sufficient accuracy? The best way is to choose some small stars near the one to be investigated, and use them as points of reference. Such small stars are usually so far away that their change of bearing may be neglected, while the nearer star appears to be slightly displaced with reference to them. Occasionally the faint star chosen is no farther off than the other, or even nearer. This is the case with Rigel, which has a ninth magnitude star close to it. The measures showed that the faint star, far from being behind the other, was actually the nearer of the two. But by choosing several small stars and measuring from them all, this source of error can be pretty well done away with.

The whole observed change of bearing of the star is evidently equal to the angular diameter of the earth's orbit, as seen from the star. Half of this, or the radius of the earth's orbit, as seen from the star, is called its parallax. The nearer a star is the greater its parallax will be.

By the methods outlined above, the distances of a considerable number of stars have been measured. The nearest one is Alpha Centauri (invisible in our latitude) whose parallax is three-quarters of a second of arc, corresponding to a distance 275,000 times as great as the sun's.

The most convenient unit for measuring these great distances is the *light-year*—the distance light travels in a year. This is about 63,000 times the sun's distance, so that if we made a map on such a scale that the earth was one inch from the sun, a light-year would be represented on the map by one *mile*.

Alpha Centauri is a little over four light-years distant. Sirius, whose parallax is half as great (0.37 sec.) is twice as far away.

If a star is over 100 light-years distant, its parallax is too small to be measured, and we must remain ignorant of its true distance. This is the case for some of the very brightest stars, and for the vast majority of the remainder. For example, all the conspicuous stars in Orion have no sensible parallax. All we can say is that they must be many times as far away as Sirius or Procyon—how many times we do not know. But it follows that they must be really much brighter than Sirius, which if transported to so great a distance would at best be inconspicuous to the naked eye.

THE PLANETS.

Mercury is morning star until the 12th, but evening star before his passage through superior conjunction on that date. He is too near the sun to be seen.

Venus is evening star, and is also very near the sun, though she may perhaps be visible at the end of the month, when she sets half an hour after sunset.

Mars is morning star in Virgo, and is now rapidly gaining brightness. On the 22d he is in quadrature with the sun, and crosses the meridian at 6 A. M. He is at his greatest phase, and appears through the telescope like the moon three days from the full.

Jupiter is evening star in Capricornus, setting about 8:30 P. M.

Saturn is evening star in Sagittarius, setting at about 7 P. M.

Uranus is in conjunction with the sun on the 14th, and is invisible.

Neptune is in opposition on the 24th. His position on the 1st is in right ascension 6 h. 12 m. 40 s., and declination 22 deg. 16 min. 25 sec. north, while on the 31st it is right ascension 6 h. 9 m. 7 s., and declination 22 deg. 17 min. 27 sec. north. He can be seen with a small telescope, though it takes a large one to show his disk. His green color will aid in finding him, though he can only be certainly identified by his motion.

THE MOON.

First quarter occurs at 1 A. M. on the 8th, full moon at 11 P. M. on the 14th, last quarter at 2 P. M. on the 21st, and new moon at 4 P. M. on the 29th. The moon is nearest us on the 15th, and farthest away on the 2d, and again on the 29th. She is in conjunction with Saturn on the 3d, Jupiter on the 5th, Neptune on the 15th, Mars on the 21st, Uranus on the 28th, and Venus and Mercury on the 30th. On the 13th she occults the fourth magnitude star Delta Tauri, and two smaller ones near it. The occultation lasts from 6:55 to 7:59 P. M., as seen from Washington, and should be interesting to watch with a glass.

At 1 P. M. on the 22d the sun reaches its greatest southern declination, and enters the sign of Capricorn, and, according to the almanacs, "Winter commences."

THE NATIONAL ACADEMY OF SCIENCES.

BY MARCUS BENJAMIN, PH.D.

The Scientific Session, as the autumn meeting is called, of the National Academy of Sciences, was held in the Physical Laboratory of the Johns Hopkins University in Baltimore, on November 11 and 12, 1902. Fifteen papers were presented before the Academy, several of which were of considerable importance, and a brief abstract of these is herewith given.

Under the title of "On Elevated Oceanic Islands in the Pacific," Dr. Alexander Agassiz continued a description of the results of his interesting researches into the character of two of the islands of the Fiji group made by him some years since while cruising on the U. S. Fish Commission steamer "Albatross."

Dr. Lewis Boss, Director of the Dudley Observatory, in Albany, N. Y., read a technical paper on "A New System of Positions for Standard Stars, with Notes Relative to its Bearing upon Sidereal Astronomy," and a short biological contribution on "The Embryology of Salpa Cordiformis" was presented by Prof. William K. Brooks, of the Johns Hopkins University.

"The Spectra of Stars of Secchi's Fourth Type," by Prof. George E. Hale, of the Yerkes Observatory and the University of Chicago, was the first paper read before the Academy. It is too technical, however, for abstraction here.

A series of papers by non-members introduced by Prof. Ira Remsen, President of the Johns Hopkins University, were read, and of these "The Preparation of Cells for the Measurement of Osmotic Pressure," by Prof. Harmon N. Morse, called attention to the fact that our knowledge of osmotic pressure has been very defective, because of the lack of an experimental basis for it. It has been seventeen years since Van't Hoff told us that osmotic pressure obeys the same laws as those for the pressure of gases. Since this principle was enunciated not more than half a dozen quantitative experiments in this field have been undertaken. Prof. Morse then explained the results which he had obtained from his studies, and showed cells which he had made himself, and which gave a higher osmotic pressure than has as yet been obtained by anyone in the world.

Prof. Robert W. Wood, who succeeded to the chair of physics in the Johns Hopkins University on the death of Henry A. Rowland, announced, under the title of "A Substance with Remarkable Optical Properties, and Screens Transparent only to Ultra-Violet Light," a discovery which is said to be of great value in science, and which was a notable personal triumph for Prof. Wood. He first described Tyndall's experiments with a screen that cut out all the visible rays of the spectrum, as well as the ultra-violet rays, and let through only heat rays. For the past thirty or forty years eminent physicists all over the world have been trying to find a similar screen that would cut out all the heat and all the visible rays and let through only the ultra-violet rays. Dr. Wood had for some time known that the substance called nitroso-dimethyl-aniline would keep out all the visible and heat rays, except some red and violet, and that it would also let through the ultra-violet. It has been only within the past few days that Dr. Wood has discovered the much-sought screen. He combined the known substance with cobalt glass and obtained a screen that lets through only ultra-violet. One striking peculiarity of the nitroso-dimethyl-aniline, which Dr. Wood dwelt upon and especially emphasized, is the fact that it gives a spectrum about thirty times as broad as that produced by ordinary quartz.

An exceedingly interesting communication on "The Occurrence of Reef Corals near Beaufort, North Carolina," by Dr. Caswell Grave, a non-member who was introduced by Prof. William K. Brooks, was then read. In introducing Dr. Grave, Prof. Brooks said: "Rocks are entirely absent from the coast of North Carolina. The natives use the word 'rock' to designate a bed of oysters. Notwithstanding this, however, I have observed along that coast for many years signs of animal life which seemed to indicate a rocky bottom not far away. Dr. Grave discovered last summer, twenty miles off the coast, what seems to be a coral reef." Dr. Grave then said: "The fishermen about Beaufort have long known of a spot over which, if they strike it just right, they can always fill their boats. In the ship "Fishhawk" we located this place about twenty miles off the Beaufort inlet, half way out toward the Gulf Stream. We dragged it thoroughly, and the many forms our dredges brought up resemble closely those from the coral reefs common farther south. Among other things, we found the corals themselves. Fishing with fifteen lines for the two hours it took us to drift across the reef, we caught seven hundred fish so large that they filled ten bushel baskets. No one could get a bite after we had drifted over the edge of the reef." In discussing this paper President Agassiz expressed the opinion that the bed found by Mr. Grave must be a spit or spur of the great Florida reef, which he and Prof. Shaler traced as far north as South Carolina and there lost.

A "Biographical Memoir of Henry A. Rowland" was presented before the Academy by Thomas C. Mendenhall. It will be recollected that Prof. Rowland was from the opening of the Johns Hopkins University until his death in 1901 in charge of the Physical Laboratory, and it was therefore especially fitting that this memoir should be read in the laboratory where he had so often lectured.

President Agassiz announced the deaths of the following members who had died since the last meeting: Henry Morton, President of the Stevens Institute of Technology, Hoboken, N. J.; John W. Powell, Director of the Bureau of American Ethnology, Washington, D. C., and Ogden Nicholas Rood, Professor of Physics in Columbia University, New York city.

The members were made the recipients of many social courtesies, President Gilman, of the Carnegie Institution, entertaining a number of them at dinner and at a public reception, and Profs. William H. Welch and William Osler giving the members of the Academy a dinner at the Maryland Club.

It is reported that H. W. Menke, of the Field Columbian Museum, Chicago, has discovered in Oklahoma the fossil remains of enormous amphibians. Some of the bones found are as large as those of a modern ox.