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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.

PRODUCTION AND POPULATION.

We could not ask for stronger evidence of the increasing prosperity of the country than is afforded by the last publication of the Bureau of Statistics, embodying the annual review of the foreign commerce of the United States. It contains figures which show the progress in production and consumption, in the United States, of coal, iron, and petroleum. The increase is really astonishing, particularly when it is borne in mind that it has been far more rapid—five times more rapid, in fact—than the increase of population. Thus, in 1894, the production of coal was 152,447,791 tons; in 1903, it was 319,068,229 tons, an increase of over 100 per cent. In 1894, the production of pig iron was 7,000,000 tons; in 1903, it had risen to 18,000,000 tons, an increase of over 150 per cent. The production of petroleum rose from 2,072,469,672 gallons in 1894 to 4,219,374,154 gallons in 1903, an increase of over 100 per cent. Now, the increase of population in the United States is estimated as not more between the years 1894 and 1903, than 21 per cent, so that the production of these important materials of industry has increased from five to seven times faster than would naturally be called for by the growth of population. It should be noted, moreover, that during this increase, the exports of coal have been nominal, while the exports of petroleum have slightly decreased; showing that the home consumption is growing in a ratio proportionate to the increased production.

GAS TURBINES.

It was inevitable that the success of the steam turbine should lead to an investigation of the problem of the gas turbine; for it is natural to argue broadly that the results obtained with one gas will be obtained with any other, unless indeed some radical difficulties inherent in the gas or in the mechanism employed for its expansion should be found to stand in the way. The prospects for the early development of the gas turbine were discussed recently in a paper read before the British Institute of Mechanical Engineers, and, according to the author, those prospects are not very bright. Of course, one of the chief difficulties is the high temperature of the gas, which necessitates, if the temperature is to be reduced to a degree that is not injurious to the cylinder, the carrying away of a large amount of heat by the cooling water. If it were attempted to dispense with cooling water, or to use only as much as would cause a moderate reduction of the temperature, the rotating parts of the turbine would have to run red hot, and there is no material known to the engineering art to-day that would hold together at such high temperature, if subjected to the great centrifugal forces that would be developed.

POWER OF OCEAN WAVES.

At the International Engineering Congress, recently held at St. Louis, some unusual figures were given on the subject of the height and power of ocean waves, particularly as regards their effect upon harbor works. In the course of a paper dealing with the new Dover harbor, it was stated that since these works have been in progress, no wave of a greater height than 15 feet has been recorded—a fact which will be very surprising to those who have experienced the miseries of the Dover-Calais passage. The fact is the more remarkable because at the entrance to the Tyne, waves from 35 feet to 40 feet high have been measured, and the last-named height has also been observed at Peterhead. In dwelling upon the necessity for what are known as spending-beaches and wave-traps, for dissipating and controlling wave action, it was stated that the depth to which the latter extends is now known to be much greater than was once commonly supposed. Proof of this is shown by the fact that lobster pots placed in from 120 to 180 feet of water, have been found to be filled with sand and shingle after a heavy gale; moreover, sand had been found deposited after a heavy gale in the gallery of the Bishop Rock lighthouse, the latter being 120 feet above the water, and the depth of the water at that point 150 feet. That the water, even at considerable depths, must be moving during a gale with great momentum, is shown by the fact that at the Peterhead breakwater blocks weighing 41 tons and located over 36 feet below spring tide low-water, were displaced during a storm, while a section of the breakwater weighing 3,300 tons was moved bodily for a few inches without the brickwork being dislocated.

ELECTRIC TRACTION FOR TRUNK ROADS.

The successful test of the first of the electric locomotives that are being built for the main line of the New York Central Railroad, marks a definite step toward the day when trunk-line passenger service will be worked by electrical traction. The locomotive did everything that had been expected of it, hauling its test loads with that rate of acceleration which is one of the chief advantages of the electric motor, whether applied to the locomotive or directly to the cars. The success of the New York Central installation, of which no reasonable doubt can be entertained, will be followed by the electrifying of similar stretches of steam roads, on which the traffic is sufficiently dense and heavy to warrant the change. There were special conditions connected with the New York Central service which rendered the use of the electric locomotive desirable; but when such systems as those of the Pennsylvania between New York and Washington or Pittsburg, or of the New Haven road between New York and Boston, come to be electrically equipped, we think it is altogether probable that the Sprague system of multiple control will be adopted, the electric locomotive being dispensed with. This implies a better distribution of the weight and power throughout the train, greater smoothness of running, and, of course, less wear and tear upon the track and bridges.

SUBWAY RESULTS.

The New York Subway has been in operation for a sufficient time to enable the public to realize how far its performance comes up to its high promise. In spite of a pretty liberal bombardment by the crank and the faddist, carried on from the vantage ground of the correspondence columns of the local press, there is little doubt that New York city is greatly pleased with its new system of transportation. The feature that appeals most strongly to the downtown business man and the theater-goer is the system of express trains, in which the operating company has fully redeemed its promise of a fifteen-minute service to Harlem. These trains have hitherto been run under a four-minute headway, but now that the east side branch of the road has been opened, the expresses will be run under a two-minute headway as far as the junction at Ninety-sixth Street, and a four-minute headway upon the two branches of the road from that point to their respective termini. There are two features in particular that mark the road as constructed on the most up-to-date practice in electrical traction. One is the remarkably rapid acceleration, which amounts to 1.25 miles per second, and the other is the splendid condition of the track. The combination of 100-pound rails with a tie-plate on every tie, and broken stone ballast laid on a concrete foundation, provides a remarkably smooth track, in which both surface and alignment are all that could be asked. Another feature that contributes to comfortable riding is that the curves are "spiraled," that is to say, the track runs from the tangent to the maximum curvature in a parabola, the change of direction being so gradual that the jolt which usually accompanies the entrance of a train upon a curve is entirely removed. The express train service is undoubtedly the most valuable feature of the new Subway; and it augurs well for the future service of the system that Mr. Belmont has expressed the conviction that the Subway was intended primarily to provide service of this nature, and that the more completely it is given up to express trains, the more fully will it meet the needs of this great and populous city.

A UNITED STATES WARSHIP ON TRIAL.

In the life of a warship there is no event—always excepting, of course, the day of battle—around which so great interest, both sentimental and practical, centers as her trial trip; for rightly or wrongly, the world has fallen into the habit of placing the speed of a warship as first in value of the many separate elements that go to make up the sum total of her efficiency.

It was, therefore, with no small amount of interest that the editor recently boarded the United States armored cruiser "Pennsylvania" as the guest of her builders, the Cramps, of Philadelphia, to witness the government speed trial on the well-known Cape Ann course off the coast of Massachusetts. Outside of the small party of invited guests and the ship's trial crew of 450 officers and men, the persons on the ship most immediately interested in the trial were the Government Trial Board, composed of eminent officers of the navy, and the officers and representatives of the company that built the ship. To the first named, a speed trial is an event of profound importance, since upon it depends the acceptance by the government of the United States of a vast and complicated machine which, in the completed condition, will represent the expenditure of between five and six million dollars from the national treasury. To the representatives of the firm, the issue is of even more vital importance, since it involves the payment to them of a sum of nearly four million dollars, and what is of even more importance, the prestige of the firm is greatly at stake; for of all misfortunes that may happen to a big shipbuilding firm, there is none that can give more positive chagrin than to know that such and such a great warship constructed by themselves, and designed for 20 or 22 knots an hour, must go down on the official register as having done no better than 19 plus or 21 plus, as the case may be. On the other hand, it is always an object of laudable ambition and keen competition among the respective builders of a class of sister ships to be able, as in the case of the "Pennsylvania," to say that she heads her class in speed and economy of coal consumption.

The performance of the "Pennsylvania" in exceeding the contract speed by 0.43 of a knot, and the contract horse-power by 5,000, is a result that is gratifying both to the government and to the builder. It has always been the policy and tradition of our Bureaus of Construction and Engineering to encourage the hearty co-operation of the leading shipbuilding firms of the country; and in this particular case, the excellent results are directly attributable to certain modifications in the boiler room and engine room, which, as the trials have shown, resulted in greatly improving the speed and efficiency of the ship. The contract for the six vessels of the "Pennsylvania" class called for the development of a speed of 22 knots an hour, with an indicated horse-power of 23,000. The builders of the "Pennsylvania" decided that, by using a different type of water-tube boiler, and making certain modifications in the triple-expansion engines, they could secure a larger indicated horse-power, and thus serve the double purpose of safeguarding their own interests and giving the United States government a better ship. The suggested changes which were allowed by the government were as follows: The battery of thirty Babcock & Wilcox boilers was replaced by a battery of thirty-two modified Niclausse boilers, the modifications being in the direction of larger tubes and drum, and a general simplification of details. The main steam pipe was increased from 13 inches to 15 inches diameter, because it was considered that for a piston speed of nearly 1,100 feet a minute, a pipe of the larger diameter would be a necessity. The boiler pressure was raised from 265 pounds to 300 pounds, and the arrangement of the cylinders was modified, so as to give a more direct flow to the steam; the order in the departmental design being low pressure, high pressure, intermediate, and low pressure, which was changed in the Cramps' design to high pressure, intermediate, low pressure and low pressure. Another radical change was that, instead of the low-pressure cylinders being assisted by introducing live steam from the boilers, this connection was dispensed with, and, instead, the exhaust from the auxiliaries was fed direct to the low-pressure cylinders. It will thus be seen that the changes were thoroughly in touch with the latest marine practice, involving high boiler pressure, ample steam-pipe connections to convey an abundance of steam to the cylinders, and a literal adherence to the principles of triple-compound expansion, by using live steam only in the high-pressure cylinders, and allowing it to develop its full expansive efficiency from throttle to condenser.

The value of these changes is seen in a comparison of the trials of the "West Virginia" with those of the "Pennsylvania," the first-named ship being built strictly to the original designs. On her trial trip the average speed of the "West Virginia" was 22.12 knots with 25,750 horse-power, on a coal consumption of 3.2 pounds per indicated horse-power per hour. The "Pennsylvania" averaged 22.43 knots with an average indication of 27,750 horse-power, on an average coal consumption of 2.2 pounds per horse-power per hour, the temperature in the uptake in the first case being over 1,000 degrees, and in the case of the "Pennsylvania" 650 degrees. We quote these figures not only for their intrinsic interest, but as showing the wisdom of the departmental policy of encouraging the private builders to offer and put in practice their own amendments to departmental designs. The low coal consumption is, perhaps, an even more valuable feature than the higher speed, for it means that if the "West Virginia" and the "Pennsylvania" were both using their forced draft in chase of a fast cruiser of the enemy, the "Pennsylvania" would be able to follow the chase for 50 per cent longer time than her consort. In other words, by virtue of her higher economy, her radius of action, on the same amount of coal, when using forced draft, is just 50 per cent greater than that of the sister ship.

In the popular mind, the speed trials of a United States warship are associated with much that is spectacular, both in the event and in the preparations for it. Although the editor boarded the ship at the New York navy yard, under the impression that the reality would prove considerably less lurid than its oft-repeated descriptions might lead the layman to expect, he was not altogether prepared to find such a cool, matter-of-fact, everyday air prevailing both above decks and below. There were no chunks of unburned coal, "big as a man's fist," being thrown crater-like from the "belching" smokestacks, nor were there any exhausted firemen brought up and laid on deck to be revived before plunging again into that "inferno" below. Everything was orderly, methodical, and highly scientific. The trial was simply the accomplishment of results that had been carefully planned and confidently predicted months and years before they happened. Indeed, just as the vessel swept over the line at the start, her builder predicted her speed to the writer, with an accuracy which proved, when the trial was over, to be only one-tenth of a knot too low.

The Cape Ann course is selected mainly because it affords deep water—an important element in obtaining estimated speeds—and because the course is sufficiently near to the shore to admit of the buoys by which it is marked off being accurately located by triangulation from the shore. The total length of 44 knots is divided into seven approximately equal lengths of about 6 knots each. Near each buoy, and on the landward side of it, is anchored a United States warship, which does the double duty of affording a large, conspicuous object to assist the captain of the vessel on trial in steering a true course, and also affording a means of gaging the speed of the tide at each particular mark at the time when the ship passes. The vessel runs the full length of the course, then makes a wide turn, and steams back over the same course. In estimating her average speed over each leg of the course, the speeds of the tide at the two buoys are taken, and their mean is added or deducted, according as the tide is adverse or favorable, to the speed of the vessel over that leg. The average of the fourteen speeds thus arrived at gives the average speed of the ship for the whole 88 knots.

In a case where deductions at the rate of $25,000 for every quarter of a knot that the vessel falls below contract speed, are involved, great accuracy is necessary. The time is taken by means of two vertical sighting rods placed transversely to the axis of the ship on the upper, forward bridge. At the instant that the particular buoy is in line with these two sights, the timing officer calls out "Mark," and the time is accurately taken with a chronometer. It is not generally understood how greatly the speed of the ship depends upon the steersman; for if she veers ever so little from her course, it means not only that she travels a proportionately greater distance, but that the retarding effect of the helm in bringing her back to her course pulls down the speed very materially.

Upon entering the engine room, the conditions did not strike the writer as varying greatly from those that obtained when he made a chance visit to the engine room of the "Deutschland," during a passage across the Atlantic. Each engineer and oiler was at his particular post and, of course, was closely attentive to his duties. Perhaps the only difference that one could note was the large amount of saponified lubricating oil (looking for all the world like soapsuds) that was spattered over the moving parts, frames, and bed plate. This was inevitable in a case like the present, where the engines, although they were fresh from the builders' yard, were being pushed to their maximum power. Passing through the airlock that leads into the boiler rooms, one was struck with the same quiet orderliness and utter absence of excitement or nervous tension. The coal was being brought by a couple of men from the bunker door at the end of the foot plate, a sack at a time, and emptied into a long heap athwartships, and midway between the twelve fire doors of the four boilers in the compartment. The fire doors were numbered in pairs, the doors having the same number being on opposite boilers and diagonal to each other. At one end of the foot plate stood a group of firemen, with a boy in their midst who was holding a watch. At two-minute intervals he would call out a number, and instantly two firemen would come out upon the floor plate, coal the fires corresponding to the numbers called, throwing on a half dozen shovelfuls, and then step back to join the quiet little group at the end of the floor plate. This method was followed in all the compartments, and it meant that each furnace received a thin layer of coal once in every twelve minutes. Previous experience had shown that this rate of firing would provide the thin, evenly-spread bed of coal necessary to maintain a full head of steam at 300 pounds boiler pressure.

With a view to determining the actual coal consumption, the coal, before the trial, was sacked and weighed; and many of our readers will be astonished to learn that the coal used was the straight run of the mine, and cost only $2.75 a ton—thus disposing of another of the little fictions that have grown up around warship speed trials, to the effect that the coal was picked by hand and cost something over $10 per ton.

Our observations of the whole trial confirm the statement that there is no reason why such a ship as the "Pennsylvania," after being turned over to the navy, should not for years to come, repeat, or even exceed, her trial performance. It is true the trial crew was a special one, well trained to its work; but the navy is also paying special attention to its fire-room staff, and it has some very efficient crews in the service. Moreover, the engines on this trial were perfectly new, and no doubt after several months of service they will limber up and show as good, or better results.

THE HEAVENS IN DECEMBER.

BY PROF. W. M. REED.

On December 31, at midnight, the earth is at perihelion, and therefore nearest to the sun of any time during the year. But how far we are at this time from our source of heat is still doubtful by perhaps 100,000 miles. Since B. C. 270 many attempts have been made to determine this most important of all distances in the solar system. By other means the relative distances of all the heavenly bodies can be found. But to ascertain the dimensions of the solar system in miles, we must know the distance from the earth to the sun. Mr. Arthur R. Hinks has just made a discussion in the Monthly Notices of the Royal Astronomical Society, of the parallax of the sun, as deduced from photographs of Eros, taken during the last opposition of November 7 to 15, 1900; 295 plates were exposed at observatories in the following places: Algiers, Lick Observatory, Cal., Northfield, Minn., Tacubaya, Mexico, Cambridge, Minneapolis, Oxford, and Paris.

The measurement of these plates gives a value of the parallax of 8.7966 sec. ± 0.0047 sec., which corresponds to a distance of about 92,861,000 miles ± 50,000 miles, which places the sun about 36,000 miles further away than it was formerly supposed to be. Aristarchus in B. C. 270 obtained a parallax of 180 sec. by observations on the moon when its elongation was 90 deg. from the sun, or one-half phase. In 136 A. D. Ptolemy, from observations on the earth's shadow, made the parallax 170 sec. The Hindoos about 1100 A. D. got 240 sec. Corpernicus in 1543, also from observations of the earth's shadow, got 240 sec. Kepler, from the diurnal parallax of Mars, obtained 60 sec. in 1620. By the same kind of observations, Flamsteed, in 1672, reduced the parallax to 10 sec. Since 1850 over fifty determinations of the solar parallax have been made. They all lie between 8 sec. and 9 sec. Until quite recently the accepted parallax was 8.80 sec.

On December 20 Aldebaran is occulted by the moon. As seen from Washington, the star disappears behind the moon at 8h. 25m. Eastern standard time, and reappears at 9h. 46m. But on account of the parallax of the moon, this time must be considerably altered to suit conditions at other places. On December 2 Mars is also occulted. The Washington time of disappearance is 2h. 15m. A. M. Eastern standard time, and 3h. 16m. A. M. for reappearance.

The disappearance of a bright star behind the moon is an extremely interesting phenomenon to watch. It gives many people their first impression of how rapidly the moon is moving among the stars. Then the very sudden extinction of the star is an impressive sight. At first the moon will appear to gain rapidly on Aldebaran. Finally this speck of light will seem to be fastened to the edge of the moon, and to stay in this position longer than the observer expects. But suddenly the star will be gone. Its reappearance from the other side will be equally startling. This phenomenon is one of our strongest arguments that the moon has either no atmosphere or an extremely trifling one. Even in a small telescope it is obvious that there can be no very great gaseous envelop to our satellite. For the mountains are just as distinctly seen at the edge of the disk as they are at the center. In 1792 Schröter thought he perceived a twilight band on the moon, and argued from that, that the moon must have an atmosphere about one-thirtieth as dense as ours. But such an atmosphere should so bend the light of occulted stars as to make the time from disappearance to reappearance much less than we should expect from the measured diameter of the moon. Sir George Airy found only 4 sec. for the difference in the diameter of the moon as deduced from direct measurement and from occultations of stars. Also from this 4 sec. must be subtracted the effect of irradiation, which is far from a negligible quantity. From these observations he concluded that the moon's atmosphere, if it has any, must be at least two thousand times less dense than our own at sea level. Furthermore, as the star approaches the lunar disk, certain rays of its light should first be absorbed by the lunar atmosphere. Such an example of selective absorption is noticed on every clear day when the sun sets. The absorption in this case is so great, on account of the greater mass of air through which the sunlight must travel, that its color is perceptibly changed. To test this effect of a possible lunar atmosphere, Sir William Huggins watched the spectrum of the star Epsilon Piscium during occultation, but found that the whole spectrum disappeared as quickly as the star itself. Prof. Comstock has recently come to the conclusion from occultation of stars that the lunar atmosphere cannot have a density exceeding one five-thousandth that of the earth's. Prof. W. H. Pickering took photographs of Jupiter during an occultation in 1892. He concluded that the disk was slightly flattened as it approached the moon's limb, on account of the effect of the lunar atmosphere. These measurements gave a maximum density of the refracting medium of one four-thousandth of our atmosphere. It is interesting that during this month both kinds of occultations can be observed.

On December 16, at midnight, Jupiter is in conjunction with the moon. The sun is at the winter solstice, which marks the beginning of winter, on December 22 at 1 A. M.

On December 20 at 6 P. M. Venus is in the southwest at an altitude of 15 deg. The planet will continue to grow more brilliant throughout the month. At the same time Saturn will be in the same quarter of the heavens at an altitude of 22 deg. At 6 A. M. Mars will be seen in the S. S. E. at an altitude of 40 deg. It will be a short distance above the bright star Spica, in the constellation of Virgo.

During the evening Jupiter will be a very prominent object. At about 8 P. M. it will be in the direction S. S. W. at an altitude of 57 deg. It will be easily distinguished by its great brilliancy.

Mercury is at greatest elongation on December 13, when it is 20 deg. from the sun. It will then be close to the horizon just after sunset. But at this season of the year the ecliptic makes such an acute angle with the horizon at sunset that it is very difficult to see Mercury unless the weather is exceptionally clear.

At 8 P. M. on December 20, Orion is S. S. E. at an altitude of about 30 deg. The three stars that form the belt are almost vertical to the horizon.

Farther to the north, in a direction about E. N. E., are the Twins—Castor and Pollux. They will be about the same distance above the horizon as Orion's Belt. A line connecting these two stars is also nearly vertical to the horizon. Directly above Orion's Belt is the red star Aldebaran, and around it the group of faint stars known as the Hyades. Still further toward the zenith, 65 deg. from the horizon, is the famous group of the Pleiades, consisting of six stars easily seen and six others that are seen with difficulty. Below Orion's Belt and close to the horizon is the dog star Sirius—the brightest of the fixed stars.

Princeton University Observatory.

SCIENCE NOTES.

Only 14,995,272 acres, or 15.7 per cent of the whole area of Japan, exclusive of Formosa, consists of arable land, and 55 per cent of the agricultural families cultivate less than two acres each; 30 per cent cultivate 2 acres or more up to 1½ cho, or a little less than 3¾ acres, leaving 15 per cent of the farmers who cultivate the farms of 3¾ acres or more.

An important and valuable discovery relative to the deadly sleeping sickness has been made by the Liverpool School of Tropical Medicine. The cause of this disease, according to the results of elaborate diagnoses that have been made, is attributable to "trypanosomiasis," i. e., the presence in the blood, and in the fluids of the brain and spinal cord, of some form of the microscopic parasite known as "trypanosoma," which is propagated by the tsetse fly in South Africa. From the close observations that have been made upon the afflicted patients, the symptoms and the danger bear some relation to the greater or less abundance of the parasites, and develop seriously when they have entered the cerebro-spinal fluid. The parasites may be present in the blood of deeply-seated organs, when they are not to be found in that which is drawn from a skin puncture, and their frequent temporary disappearances from this surface blood renders it difficult sometimes to be certain of their presence in the system. The expedition organized by the school also discovered a blood-sucking larva, which thrives in many parts of the Congo. During the daytime this larva conceals itself in the cracks of the native floors, and only attacks its victims during the night. When dug up they are found to be full of bright red blood, thereby testifying to the severity of their attack during the previous night. It is the larva of the Glossina fly which is apparently harmless in the imago state. This discovery is of great value, and systematic measures to combat its injurious nature will at once be inaugurated.