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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.

"FESTINA LENTE."

If we were a people much given to the use of heraldic forms and phrases, the SCIENTIFIC AMERICAN would suggest that the classic saying of Augustus Cæsar, "Festina lente" (Make haste slowly) should be adopted as the motto for the Panama Canal. Never, surely, did the early history of a great undertaking illustrate, in the sequence of its events, the necessity for the exercise of patient investigation and the avoidance of precipitate haste, so clearly as have the past few months of the history of the Panama Canal.

Particularly is this true of the present premature discussion of the forthcoming report of the Board of Consulting Engineers, appointed by the President to determine what is the best type of canal to construct at the Isthmus. This Board is composed of the world's most eminent authoritie in the particular class of engineering problems that will be involved in the construction of the canal, and they represent the full knowledge and ripe wisdom of America and Europe in work of this character. The professional reputation of these gentlemen is such as to make it certain that their opinion, as thus rendered, will be given absolutely without personal prejudice, and entirely upon the facts. We take it, therefore, that whatever the Board of Consulting Engineers may recommend as the best type of canal to be built, judged from the standpoint of the engineer, must be accepted by Congress as the best—unless, indeed, the nation is to stultify itself in the eyes of the engineering world. The report has not yet been made public, and cannot be for some time to come, at least in its entirety; and at the present writing nothing is certainly known beyond the bare fact that the decision, by a majority of eight to five, will be given in favor of a sea-level canal.

In view of these facts, we think that it is extremely unfortunate that the press of the country should have been fairly inundated with dispatches from Washington, which not only claim to represent the attitude of individual members of the Board of Consulting Engineers, but also have gone so far as to state that the President himself views the results that have been reached, or are likely to be reached, by the Board, with "great disappointment."

The SCIENTIFIC AMERICAN has the very best authority for stating that, outside of the simple fact that the Board voted eight to five in favor of a sea-level canal, the whole of these dispatches, with their professed statements of facts and opinions, and representations of the attitude of government officials, from the President down, are absolutely and of necessity without a basis of fact. Surely the least that the press and the public can do at the present juncture is to await with some measure of dignified restraint the announcement by the President himself of the findings of his Board. When these are given out, and not until then, will it be possible intelligently to criticise the arguments that are set forth in favor of a sea-level canal.

Speaking broadly, however, and without any reference to the pending report, we would suggest that in all the long discussion which will follow its publication, whether in Congress, by the daily press, by the technical journals, or even upon the lecture platform, it would be well to bear in mind the motto that is written at the head of this article. Let the nation remember that, although the extra one hundred millions of dollars and the few extra years of time that a sea-level canal may cost, may seem large in our day and generation—ten, fifty, one hundred years hence, this little question of time and cost will be forgotten by a posterity that is reaping the inestimable benefits of an unhindered waterway from ocean to ocean.

We are committed to a task, so stupendous both in itself and in its future commercial and political significance, that if we are to judge it rightly, we need to readjust our sense of proportion. To obtain a true point of view, we must take our stand among the future "forty centuries" that will "look down upon" our completed work. We must build for all time.

To a nation that can scatter an annual largess of one hundred and forty million dollars in pensions for a war fought out nearly half a century ago, the question of time and cost in the construction of an Isthmian canal should seem—so we get the best—to be the last consideration.

ADMIRAL PRINCE LOUIS OF BATTENBERG ON SPEED IN WARSHIPS.

In the course of an interview of the Naval Editor of this journal with Prince Louis of Battenberg, Admiral in command of the visiting British squadron, the conversation turned naturally to the subject of speed in warships—for the distinguishing characteristic of this squadron is the unprecedentedly high average speed of over 24 knots an hour, with which every one of the six ships is ready to respond, should the Admiral call for it. Twenty-four knots an hour is a speed which hitherto has been attained only by cruisers of the protected or unprotected type, and the number of these could be counted on the fingers of one hand. That these cruisers of the armored type should be capable of responding to a call for 24 knots is due to the fact that every effort is made to maintain the motive power in such a high state of efficiency, as to enable the ships, when the forced draft is turned on, to develop the same horse-power and show the same speed as were secured on the contract trial. In accordance with a regulation of the British navy, the ships in commission are required, once every quarter, to undergo a 24-hour speed trial, the first eight hours of which is done with the full power, and the remaining sixteen hours at three-fifths power.

Such a regulation naturally begets a desire on the part of the engine room and boiler room staff to equal, and, if possible, surpass the original contract performance; and that this can be done has been proved in the case of this armored squadron, and particularly of the Admiral's flagship, the "Drake."

Prince Louis informs us that the last 24-hour trial was carried out on the recent run of his squadron from Halifax to Annapolis. On the trial with full power, the "Drake" maintained for the first eight hours an average speed of 24.25 knots an hour, with an average indicated horse-power of 31,061, and a consumption of coal (of indifferent quality) of 2.2 pounds per horse-power per hour. The forced draft was then shut off, and for the following sixteen hours the "Drake" maintained an average speed at three-fifths power of slightly over 21 knots an hour. The full significance of this performance will be appreciated by naval men, when it is borne in mind that the "Drake," with full coal bunkers, was drawing 27½ feet, or 1½ feet more than her normal draft of 26 feet, on which her original contract trial took place. Moreover, it is six months since she was last in drydock for cleaning.

The great speed of the "Drake" naturally led to the question being asked as to whether, in the supposititious and altogether unlikely event of hostilities, if the "Drake" were to sight one of the fastest merchant liners, such as the "Deutschland" or the "Kaiser Wilhelm II.," both of 23½ knots speed, she would be capable of overtaking and capturing her. Prince Louis considers that this would be largely a question of the relative ability of the boiler room force on the warship and the converted cruiser to endure for a lengthy period the intense strain incidental to driving the vessels at the highest possible speed. If she had a sufficiently long start, the merchant vessel, because of her large reserve of firemen, and her superior staying powers, might be able eventually to draw away. The result, however, would be determined somewhat by conditions of sea and weather, and on a clear day the "Drake," with her advantage of three-quarters of a knot of speed, should be able, in a calm to moderate sea, to draw up within range, and wing her quarry with her 9.2-inch forward rifle.

Although Prince Louis believes in the great advantage conferred on an armored cruiser squadron by the possession of superior speed, he is of the opinion that the speed given to a battleship should under no circumstances be raised above that critical point at which, on a given displacement, it would become necessary to sacrifice either the armament or the armor, in order to accommodate the great engine and boiler weights that would be necessary to secure that speed. The battleship, heavily gunned and heavily armored, is the central fact about which the other elements that go to make up a navy are grouped; and to which they are, after all, merely accessory and subordinate. The outer screen of scouts and the inner screen of armored cruisers may be considered as having fulfilled their primary function, if they succeed in locating each other's battleship squadrons and bringing them together to fight out the battle of big gun against heavy armor. When the battleships are once engaged, it will be found (always supposing, of course, that the personnel is of equal efficiency) that the ships which carry the most powerful guns and the heaviest armor will survive as victors. Prince Louis considers that in the present day, when the speed of battleships has risen to the high average of 18 knots, the possession of one or two knots higher speed by one of two contending fleets will not offer such a great tactical advantage as is commonly supposed. This is particularly true in these days of long-range fighting, when, as in the late war, engagements may open at a range of as great as seven miles, and be carried on for hours, at ranges of four and five miles. For at such distances it would take a considerable time for a difference of a knot in speed to have any material effect upon the tactical movements of the two fleets.

And after all is said and done, it must be admitted that recent events seem to show that the possession of the "speed gage" is determined, not so much in the designer's office, as it is by the efficiency of the personnel when the ship has been placed in commission. A highly-trained boiler and engine room force, controlled by a staff of ambitious and painstaking engineers, on the one hand, as contrasted with careless and indifferent methods on the other, may easily transpose the "paper" speeds of two contending warships. So that after Admiralty Boards and Boards on Construction have determined what speed a ship shall have credited to her, her actual speed on the high seas will depend upon the day-by-day efficiency of the engineer force.

ELECTRIC MINING IN CALIFORNIA.

Electricity for operating mining machinery has reached a high stage of development in Nevada County, and it is natural that it should typify the progress that California is making in harnessing its mountain streams and utilizing this power for industrial and commercial purposes. It is not that electricity is displacing hydraulic and steam power in the old mines so much as it is that it is opening up new mines that were considered inaccessible and reawakening abandoned mines that could not be operated profitably with steam power. The cost of getting coal up to the mines was in some cases so great that nothing but the richest returns in minerals could make any profits for the company. Before the advent of electricity in the California mining fields there had been developed ideal systems of water and pipe lines and in Nevada County many of these systems are in use to-day. In spite of this, electricity has achieved remarkable results.

The reasons are not far to seek. The mines located above what is called the water line could not be worked, nor could many abandoned mines, which were known to be moderately rich in ore, but that cost too much to work with steam generated from coal. The fuel had to be transported many miles over rough, mountainous country, and its cost at the mouth of the mines often averaged ten and more dollars per ton.

With her fine system of hydraulic generation of electricity in the Sierra Mountains, California leads all other States in the cheap distribution of electric power. Gold mines all along the route of her long-distance transmission lines have been converted into active scenes of mining. Lateral lines of transmission run in all directions, and some of these extend upward of twenty and thirty miles from the main route. So great has grown the demand for electricity for mining purposes that the supply of power for the Pacific coast end of the transmission lines is seriously menaced. The application for electricity for new mines increases with each month, and several new mines call for electricity every few weeks.

The water power of California is thus its most precious heritage. So important is this considered that its distribution has been developed into a system that makes both miners and farmers dependent upon it. The location of a mine or farm is therefore the important consideration in opening and working it. Water is sold and distributed at so much per miner's inch throughout the State. This appears on the surface a very equitable system, and it was, before hydraulic power was introduced for generating electricity. The sale of the miner's inch of water has no bearing whatever upon the head of the water. One farmer or miner pays the same for the water as another who is located 100 or more feet lower down in the valley. As each inch used had to be paid for, it was not considered necessary to take into consideration the pressure of the water.

This condition of affairs has created some peculiar results. The miner or farmer who uses the water in the higher altitudes loses a power which another some hundred feet below can convert into electric power for mine purposes. There are a number of instances where one mine develops something like 0.19 horse-power for each miner's inch of water, and another 500 feet lower down secures 1.19 horse-power at the same cost for the water. We find, therefore, that the generation of electricity on a large scale in the lower valleys is more economical than in small units near the camps higher up. Most of the power-house companies can transmit electric current to the higher camps at less cost than the latter can generate it, no matter how efficient the water-wheels and motors may be.

In Nevada County there is nearly 5,000 electric horse-power used for mine operation. The power house on the South Yuba supplies most of the mines with its electricity, but individual companies and groups of mines have organized in the last year to develop their own electric current. There are a number of streams in the mountains which have a head varying from 300 to 800, and the harnessing of these assures permanent cheap power for the mines. On the South Yuba there are two 600-horse-power plants working under 800 feet head, and the current is used almost entirely for mine purposes. The original machines in this region, consisting of two 330-kilowatt motors, are still in active operation, one working at 190 feet head, and the other at 800 feet.

In Grass Valley there is one mill that is driven entirely by electric synchronous motors. There are forty stamps and sixteen concentrators operated there, and the current is transmitted from the distant power house and sold by meter. It has been found that electricity operates a quartz mill cheaper than any other power.

There are some rather anomalous conditions to be found in Nevada County where electricity has displaced steam. All the mining machinery was formerly driven by steam, and the work of displacing steam was slow. In order to save the old machinery the engineers adopted many peculiar devices. But electricity has triumphed, and steam is practically abolished owing to the high cost of fuel. The direct-current motors are used for pumping in connection with compressed air, and also in a more limited way for driving drills. It is doubtful if compressed air for driving drills, pumps, and a few other machines will be displaced by the electric motor. In drilling with compressed air it has been found that the exhaust air proves of great value in ventilation. Electric drilling cannot offer such advantages unless worked in combination with a system of electric fans. While electricity is used for driving the compressors, working the mine house hoists and operating pumps, it has so far made little progress in drilling. Electrically-driven mine pumps have proved popular and profitable in this region, and two new ones are being installed, one at the 700-foot level and another at the 1,000-foot level. The success and profits of these new large pumps will naturally influence the construction of others, for mining companies are quick to note the practical advantages of any new departure.

In the matter of ventilation by exhaust fans, the mines are still inadequately supplied, but their introduction is being steadily pushed. Estimating current at ten cents per kilowatt-hour, the cost of exhausting 1,000,000 cubic feet of air by the slow-speed blower has been found to average 44.2 cents, and by the high-speed blower only 17.2 cents. The installation of the latter in preference to the former is therefore an assured fact, and a number of 20 horse-power motors are used for driving fans from six to nine feet in diameter.

HOW MUCH DOES THE UNIVERSE WEIGH?

BY PROF. EDGAR L. LARKIN.

The laws of attraction, motion, and centrifugal tendency are known in every detail, and with great accuracy. Three centuries of mathematical investigation revealed all their mysteries. The attractions and motions in this note are those in free space, between the distant stars. When one cosmical body is seen revolving around another, as sun about sun, or planets around suns, the combined mass of both may be easily determined, if the distance of the earth from the flying bodies is known. For the quantity of matter required to exert attraction sufficient to impart any velocity to any body at any distance is known to mathematicians. Thus, suppose the sidereal structure to have a boundary, and that its distance from the earth is known. Imagine a body entirely outside, to be in motion, falling toward its center of gravity, then if the speed and distance of the falling body could be discovered, the entire universe can be "weighed," that is, the quantity of matter it contains is capable of computation. Or, if the location of the center of gravity of the stellar hosts could be detected, and a sun should happen to be flying through it, then, again, the mass of all the stars could be found, if the speed of the moving sun and its distance from us were known.

All suns are in motion; it is impossible for one to remain at rest. If one is coming toward the earth on a straight line, or receding, the spectroscope—that marvel of all ages, and one of the most powerful engines in the hand of man for the conquest of the universe—tells its velocity of approach or recession. If a sun is flying through waste places in space, in a direction at right angles to a line drawn to it from the earth; its motion can at once be measured with a telescope and micrometer. And if the directions of stellar motions make angles with this line, the motion can be resolved into component parts by the usual formulas.

Careful research has long been made on the star No. 1830 in the catalogue of Groombridge. It moves with an angular velocity of seven seconds of arc per annum. There are 1,296,000 seconds in every circle, which divided by 7, equals 185,000, or the number of years required to traverse the circumference of the celestial vault. The distance of this star is not known with accuracy. Some catalogues omit its parallax, others say 0.1 sec. and another 0.13 sec. If exactly 0.1 sec., its distance from the earth would come out 2,062,650 times greater than that of the sun, or 192 trillion miles. So it will be taken at 200 trillion; for calling it 190 or 210 will not make an error in the result greater than an infinitesimal of the first order. And with a distance of 200 trillion miles, and a period of revolution of 185,000 years, the terrific orbital velocity of 200 miles per second appears. This is absolutely overwhelming even to the trained minds of those accustomed to revel in great numbers. The object now sought is to find the quantity of matter within a sphere having the diameter of this mighty orbit, 400 trillion miles. Perhaps the simplest way to get at this is to find the centrifugal tendency set up by this orbital speed. If the star moves on a circular orbit, this tendency equals the attraction of all the matter within. The same is true of an ellipse with the proper modifications for eccentricity. Tie a cord to a stone, and whirl it around the hand. The pull on the string is centrifugal tendency, and is equal to the square of the velocity of the stone, divided by the length of the string from the hand to the stone. And 200 squared equals 40,000, which divided by 200 trillion gives a quotient of one-five-billionth.

That is, the centrifugal tendency is equal to an acceleration of the one-five-billionth part of a mile per second. This is cleared by saying that if the star could come to an absolute rest, then it would instantly start to fall toward the center of gravity of all the matter inside of a sphere having a diameter equal to that of its orbit. And at the exact end of the first second of its fall, it would be falling with a velocity of one five-billionth of a mile per second. The fall would be due to gravity; but as it does not approach the center, but keeps on its orbit, the centrifugal tendency exactly balances the attraction. Thus in this roundabout way, the force of gravity exerted by the matter acting on the star is found. So far, no idea is had of the quantity of matter able to impart this velocity to a falling body 200 trillion miles from its center of mass. It is possible to approach the problem by comparing this force and distance with a body whose attraction and distance are known. Suppose our sun is selected for trial. Take a stone to within one mile or so of the sun and drop it. At the end of the first second, it will be falling with a velocity of seventeen hundredths of a mile per second. This is the well-known velocity potential of the sun, and is called, for short, "solar gravity." Now it must be found how fast the stone would be falling at the end of the first second, if taken to a distance of 200 trillion miles and let fall. Gravity varies inversely as the square of the distance. So the 0.17 of a mile divided by the square of the distance to 1830 Groombridge will give the desired quantity. But it would never do to divide the 0.17 by 200 trillion squared, but by the square of its ratio to the radius of the sun, which call 400,000 miles.

This is not obscure, for a stone falling on the sun's surface is 400,000 or more miles from the center. This is equal to one (1). To find the ratio, divide 200 trillion by 400,000. The quotient is five hundred million, whose square is 25 quintillion. Now everything is ready to find the mass of matter within the orbit of the star. For 0.17 divided by 25 quintillion, equals 0.0000000000000000000068 of a mile per second velocity the mass of the sun could impart to a falling body at the end of the first second of its fall, at a distance of 200 trillion miles. But one five-billionth is enormously greater than this minute decimal. By actually dividing the greater by the less the appalling quotient of three hundred million is obtained, that is, there must be 300,000,000 times more matter acting on the star than is contained in our sun! And the sun contains 333,000 times more matter than is contained in our little world—our earth.

All these results are based upon the theory that the rapid star is moving around our sun in a regular orbit, and on the further hypothesis that no other matter exists. There is an untold quantity of matter in countless suns farther away, by far, than 1830 Groombridge. And it is not known whether the wandering sun is moving on a circular, or elliptical orbit, or on a straight line. But if on a straight line, the consequence is, that the 300,000,000 suns sink and wane away into the abyss of insignificance. See my article, "Velocity Potential of the Universe," SCIENTIFIC AMERICAN, February 18, 1905. It was there shown that if this star is moving on a straight line, and if it has been falling "forever," that is, having fallen from an "infinite" distance, and is now near the center of the sidereal universe, then the quantity of matter required to impart this colossal speed is thirty-two billion times that now contained in our modest sun. And how does a mere 300,000,000 compare with 32 billion? This computation is grounded on the hypothesis that the universe has a finite diameter of such length that light moving with the known velocity of 186,000 miles per second, requires 30,000 years to traverse it. But it matters little whether the edifice of stars is larger or smaller than this, the astounding fact is here—the star is moving with this frightful speed. And this motion has a mighty cause equal to the occasion. The quantity of matter capable of exerting this intensity of attraction is so far beyond the powers of mind, that there is no use beginning to think about it. Only one hundred million suns appear on the photographs of the entire celestial vault. Therefore, the *visible* universe is so utterly insignificant in comparison with the *invisible* that mathematicians are overwhelmed.

SCIENCE NOTES.

The International Aerostatic Commission has been holding its meetings at Paris, and these were closed during October. An important part of the work of the commission has been in forming a union among all the countries which are represented on the present occasion. This union will bear the name of International Federation of Aero Clubs and will have its headquarters along with the commission. At the recent meetings a series of international rules were adopted which had been drawn up by the Aero Club of France. But the regulations concerning the airships have been reserved for a future time. The next meeting of the International Commission will take place at Berlin in 1906.

The Governor-General of Egypt has promulgated an ordinance by which the government exercises its right of possession of any archæological remains and antiquities discovered in the Soudan, comprising buildings, monuments, remains, or objects of whatever age or people, which are illustrative of arts and sciences, industries, religion, history, letters, and customs, and that were built, made, or produced in the Soudan, or brought thereto prior to the year 1873 of the Gregorian calendar. Although the law is limited to the year 1873, the Governor-General is further empowered to declare right of possession to any object whatsoever in, or attached to, the soil after that year. This decree will deal the deathblow to the Egyptian "faker" and his nefarious traffic in coins, papyri, and other spurious antiquities, in the sale of which he plies a thriving trade during the winter season among the credulous tourists.

A very convenient process of obtaining a dilute solution of hydroxyl has been described by Dr. J. F. Jaubert, an eminent chemist of Paris, who is already known for his preparation of "oxylith," by which oxygen gas is formed from water. The present process originated by observing the action of boric acid upon peroxide of sodium. If we pour a powder formed of a proper mixture of boric acid and peroxide of sodium into water; the powder begins to dissolve, but after a certain time a crystalline deposit is formed which seems to correspond to the formula $B_4O_8Na_2 + 10H_2O$. This body gives hydroxyl by simply dissolving it in water, according to the reaction $B_4O_8Na_2 + H_2O = B_4O_7Na_2 + H_2O_2$. The solution keeps well without decomposing rapidly. After a month it still keeps 56 per cent of the original active oxygen. M. Jaubert calls the crystalline substance which is thus isolated by the name of *perborax*. When recrystallized for a number of times it forms crystals which contain an increasing quantity of active oxygen, and we find thus another compound, $BO_3Na + 4H_2O$, known as *perborate*. It keeps indefinitely when dry, and gives hydroxyl by simply dissolving it in water, but this solution is alkaline, and it must be prepared just when it is needed. The perborate has antiseptic properties, and can be used in surgery.

Some interesting researches in the treatment of rabies by the rays of radium have been made by two Italian savants, Tizzoni and Bongiovanni. In some cases they act upon the virus itself, and in others upon the animals. By exposing the virus to the radium rays it is rapidly transformed into a very active vaccine. The exposure varies from four to thirty-six hours. When a drop of the vaccine is injected into the animal's eye, he is found to be protected against the inoculation with a dog's virus such as readily killed the other animals. As to animals which were already under the influence of the virus, the seances of radiotherapy (one hour each) must be commenced at least ten hours after inoculation. But by a powerful sample of radium, and a series of exposures of several hours for six days, they find that they can save animals even forty-eight or one hundred hours after inoculation, while the animals used for a check on the method all died. Especially striking are the experiments with the rabbit, where it succumbs rapidly to the virus. Under the radium treatment we see the nervous phenomena retrocede and the fever diminish, with a gain in weight. The effects thus disappear in one case, while with a second animal, untreated, they go on increasing at the same time and soon end in death. This new application of radium will no doubt prove valuable.