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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.

A CANAL BY LAKE AND LOCKS.

There is a growing recognition, in the discussion of the Panama problem, of the advantages to be gained by impounding the rivers that intersect the line of the canal, and turning the valleys through which they flow into large inland lakes. If the line of the canal be flooded in this way, it is evident that every foot of water represents a foot less of excavation. This being the case, one might reasonably ask why the impounding dams should not be raised sufficiently high to give everywhere the required depth of 35 or 40 feet, and thus get rid of excavation altogether. Theoretically, this would be the cheapest and probably the most expeditious way; but, as every one knows, the Panama Canal is located through the lofty Culebra divide, which projects far above any possible canal-lake level, and will call for an enormous amount of excavation, even if a high-level canal be determined upon.

Admitting, then, that the Culebra excavation must ever remain the dominating element both as to time and cost of construction, and that the portion of the canal which passes through Culebra must be of the minimum width compatible with the needs of navigation, the question arises as to how far the remainder of the canal, both on the Pacific and Atlantic slopes, can be formed by the canalization of the rivers. The question is not a new one; for when De Lesseps found that, for financial reasons, he was unequal to the task of cutting through a canal at sea level, and called upon his engineers to devise an easy and economical method of getting a canal of any kind across the Isthmus, the use of impounded lakes was suggested, and plans were drawn up embodying this feature. In all the long discussion and investigation of the Panama project, the canalization of the rivers has been made the subject of occasional suggestion; but it was not until the carefully-worked-out plans which form the subject of illustration elsewhere in this issue were presented, that canalization, or the "lake-and-lock" method, was incorporated as the dominant feature.

As compared with other types of canal, whether high level with many locks, or sea level with one tidal lock, the canalization method has the great advantage that it combines economy and speed of construction with rapidity of transit for shipping when the canal is opened. The author claims that, in the present case, the time of transit would be but 8.8 hours, as compared with the 12.4 hours, which is the estimated time of transit through a sea-level canal, the saving in time being due to the greater speed that can be made by shipping in passing through the artificial lakes.

DOES A WATER FAMINE THREATEN NEW YORK CITY?

New York city possesses a population of 4,000,000 people. Of this number, 2,400,000, representing the inhabitants of Manhattan and the Bronx, are absolutely dependent upon the water that flows in a river of very modest proportions situated about forty miles to the north of the city. Every drop of water that we draw from our faucets has to be taken from the natural flow of this river. The amount of this flow varies greatly in different months of the year, and there is also a great variation in the average annual flow. It has fallen as low as 30,000,000 gallons per day, which it did in the month of October, 1880, and it has risen as high as 956,000,000 gallons per day, which happened in February, 1881. At the present time, the city is consuming on an average 300,000,000 gallons per day.

If the point of intake of the aqueduct which conveys the water to the city were located immediately in the bed of the river, and were so placed that, when the aqueduct was running full, the surplus water of the river would flow past it and empty into the Hudson, it is evident that the city would have all the water it needed just as long as the flow of the river was 300,000,000 gallons per day. If that flow were to fall below this amount, say to 250,000,000 gallons per day, then that would be the amount of water that the city would receive, and there would be a shortage of exactly 50,000,000 gallons per day. Now, in the four months of October, November, December, and January of 1880 to 1881, the average daily flow was respectively 30,000,000 gallons, 94,000,000 gallons, 72,000,000 gallons, and 100,000,000 gallons; so that if a similar dry season were to visit this section of the country, and if there were no storage reservoirs, and the intake of the Croton aqueduct were simply placed in the bed of the river, there would be in those four months an average daily shortage respectively of 270,000,000 gallons, 206,000,000 gallons, 228,000,000 gallons, and 150,000,000 gallons.

The object of the great and costly dams, which have been built across the various valleys of the Croton watershed, is to catch all the surplus water, which flows in the river during the heavy rainstorms and during months of large precipitation, and hold it back for use in the dry months, when the flow of the river is small. At the time of the building of the Croton reservoir, it was sufficient to store only a moderate amount of the surplus water; but with the steady and rapid growth of the city, it has been necessary to build successive dams throughout the watershed, until finally the great Croton dam, which has just been completed, was put in service, thereby adding about 30 billion gallons to the total storage capacity.

A careful record of the river's flow has been kept for the past thirty-eight years. The records show that four times during one or other of the two months of December and January the natural flow of the river has fallen below 100,000,000 gallons per day, and that in December, 1876, it fell to 71,000,000 gallons per day.

Diagrams which have been prepared in the Aqueduct Commission's office give startling evidence of the way in which the city has been skating on thin ice with regard to its water supply. At times the surplus in the reservoirs has been drawn down to a point which, taken in conjunction with the limited flow of the river, has brought the city face to face with water-famine conditions. Thus, in November, 1891, a point was reached in which the supply of water behind the dams had been entirely drawn off, and the only reserve that the city had to fall back upon was that contained in the small distributing reservoirs within the city, in which was contained at the time only about one day's supply. Within twenty-four hours the city would have found itself depending entirely on the natural flow of the river which, at that time, was only 50,000,000 gallons per day; although the rate of consumption was 140,000,000 gallons per day. Nature dealt mercifully with New York city in this crisis, and withheld the castigation which its improvidence so richly deserved. There was a fall of rain, which tided the city over until other following rains served to fill the reservoirs.

Regarding the present conditions, we are informed that had not the gates of the Croton dam been filled last spring before the structure had been completed to full height, and over a month's supply thus preserved for city use, New York would now be perilously near to a grave shortage of water. As it is, the extremely small snowfall of this year, and the possibility of a continuance of the present open weather, render it unlikely that the reservoirs will be rapidly filled by melting snows, as they were in the spring of last year. If we do have a season of light rainfall, there will be a feeling of decided apprehension in the Aqueduct Department. The two additional reservoirs with a combined capacity of 25 billion gallons, which are now being built in the Croton watershed, will not be available until 1908-9, and even they will merely serve to give a temporary relief. It is not necessary to point out the moral of the above facts, and the extreme urgency of pushing forward the completion of the Esopus water supply with all possible dispatch.

NEW CONCEPTIONS IN ASTRONOMY.

After three centuries of what may be called accurate, or instrumental astronomy, three centuries filled with difficulties and discouragements, astronomers have finally arrived at conclusions given in this note. The conception is, that all that part of the sidereal structure visible in the most powerful telescopes, is made of space, suns, planets, moons, nebulæ, comets, meteors, and cosmical dust. The word "star" should be omitted from astronomical literature. It has no astronomic meaning. Every star visible in the most penetrating telescope is a hot sun. They are at all degrees of heat, from dull red to the most terrific white heat to which matter can be subjected. Leaves in a forest, from swelling bud to the "sere and yellow," do not present more stages of evolution. A few suns that have been weighed, contain less matter than our own; some of equal mass; others are from ten to twenty and thirty times more massive, while a few are so immensely more massive that all hopes of comparison fail.

Every sun is in motion at great speed, due to the attraction and counter attraction of all the others. They go in every direction. Imagine the space occupied by a swarm of bees to be magnified so that the distance between each bee and its neighbor should equal one hundred miles. The insects would fly in every possible direction of their own volition. Suns move in every conceivable direction, not as they will, but in abject servitude to gravitation. They must obey the omnipresent force, and do so with mathematical accuracy.

The first fact that strikes the beginner in astronomy is the amazing magnitude of space. The last that overwhelms the mind of a mature astronomer is this never-ending space. It is now known to modern mentalists, lately newly discovered—the ancient students of mind knew it—that our minds are unable to think of the following six words: Space, infinity, eternity, creation, beginning, and end. They are all unknowable, and the chief mathematicians of the world do not try to think of them—a sheer waste of time.

The distance from our "star," the sun, to its nearest known neighboring sun is twenty-five trillion miles. A trillion is a million million. An object moving on a straight line without stopping, at a constant rate of one mile per minute (we think that a train running at the mile-per-minute rate is moving rapidly) would require more than 48,500,000, nearly forty-nine million, years to traverse this appalling distance. Yet this is a mere yard-stick used to measure the distances of remoter suns. The next brain-stupefying mystery met with is the velocity of light. It is known to be in motion always with the tremendous speed of 186,000 miles per second. There are in one sidereal year 31,558,149 seconds, and the time required for light to traverse the mighty void between our own and its nearest sister sun is 4.3572 years. The distance from the earth to the sun is 93 million miles, and to the nearest neighboring sun is 275,000 times 93 million miles. The next nearest neighbor our sun has is another, 590,000 times 93 million miles away. The distance from the earth to the sun is merely a foot-rule. The star Sirius is roughly of the same distance. But these are "near-by" suns. Estimates based on luminosity, light-giving power, and other complex considerations, have been made regarding the diameter of the visible universe. These range all the way from 10,000, 15,000, 20,000, and even up to 30,000 "light years." A light year is the space traversed by light in one sidereal year and equals 31,558,149 multiplied by 186,000. To find the diameter of the universe, multiply the product by 10, 15, 20, or 30 thousand, as you please. The opinion of the writer inclines toward the thirty thousand. Now the words finite and infinite in this case are equally unknowable, for the ablest human mind is totally unable to think of either. Mathematicians have tried their hands, as a recreation, at weighing all the stars. That is, finding the quantity of matter they all contain. They discovered a mighty fact: the mass of all visible stars in the greatest telescope is so small in comparison with the quantity of matter that mathematicians can feel, not see, that it may be almost neglected. Therefore the main quantity of matter does not emit light. The universe is nearly dead. Photographs of the entire celestial vault reveal about one hundred million suns. These may be ignored. It is known to mathematicians that there is matter enough in existence to make thirty-two billion suns equally as massive as our own. Proof is had from velocities of rapid suns. The quantity of matter exists. A minute fraction appears in the form of visible suns. But what of the rest? Is it in dead suns, planets, and moons? Suppose that matter has been divided into 32 billion suns, each having eight minute planets revolving around as in the case of our own. Then the number of worlds would be 256 billion. As the combined mass of all the planets in our solar system is but the 1-745th that of the sun, it has made no perceptible difference whether planets, habitable worlds, ever existed, or exist now. Planets and moons may come or go, without making more than miscroscopic differences in the stupendous universe. Is it possible that billions of exhausted suns are now wandering in waste places of space? And are they all surrounded by dead planets, still in revolution, counting off lifeless and useless years? This is the result obtained by late mathematical research. Many suns are known to contain several thousand times more matter than is now in our sun, such as Antares and Canopus. Sirius contains three and one-half times as much, and Arcturus perhaps ten times the solar mass. Our sun contains 333,000 times more matter than the earth. The heat conditions of suns and also their motions toward and from the earth, have been discovered by that standing marvel of the nineteenth century, and more marvelous in the twentieth, that all-powerful work of human hands, the telespectroscope. Could Newton, Kepler, La Place, La Grange, rise from their sleep of death and see what this marvelous instrument has accomplished, they would be amazed and wonder if they were really on earth again. No attempt can be made to describe it here for lack of space. Only one more powerful entity exists—mathematics. Many thousands of cases of binary suns are catalogued. These are where two suns revolve around their common center of gravity, usually in greatly elongated orbits. Planets with organic life could not exist in revolution around either. The ani-

mals would be burned to a crisp when the two suns were near each other, or frozen solid when far apart. The nebulæ are enormous masses of gas seen in all parts of space. It is supposed that suns are condensed from them during vast periods of condensation. Many thousands are known. Meteors are primitive masses, each as "ancient as the sun." Suns and planets constantly receive them from space; in fact, it is thought that primeval gas first condensed into meteors, and that they then, flowing into many billions of centers, builded suns, planets, and moons. Comets are merely large meteors, or collections of millions of much smaller bodies, as bolides, uranoliths, chunks of meteoric iron, small granular particles no larger than grains of sand, and other debris, all assembled and in flight around suns. And such is the modern concept, in dim outline, of modern astronomy. One hundred million worlds like the earth could come to an end at once and make less difference in the cosmical structure than a pebble dropped into a river. The inscrutable mystery is, how beings so minute as men can possibly find out these simply wonderful facts.

PROF. EDGAR L. LARKIN.

THE VOYAGE OF THE "DISCOVERY."*

Among the recent contributions to the literature of Polar exploration and research, is the account of the English "Discovery" expedition to the Antarctic. In two large volumes Capt. Robert F. Scott, commanding this, the National Antarctic Expedition, tells of the work accomplished during the two years' sojourn within the Antarctic circle. The narrative is written with simplicity, directness, and a certain charm of style. While parts of the account go into scientific detail for the benefit of future polar voyagers, the book will be found interesting even by readers not directly concerned in Antarctic exploration.

The institution of the "Discovery" expedition was due almost entirely to the efforts of Sir Clements Markham and the Royal Geographical Society. After the usual difficulties in securing necessary funds and governmental co-operation, the sum of £47,000 was finally raised by private subscription, and this with the £45,000 contributed by the government, placed the enterprise on a sound financial basis. It was decided to build an entirely new vessel for the purpose, and in March, 1900, at Dundee, was laid the keel of the "Discovery." The ship was built in accordance with the most advanced ideas of naval architects and explorers. In June of the same year, R. F. Scott, then First Lieutenant of H.M.S. "Majestic," was appointed to command the expedition. The year following was busily occupied in completing arrangements, procuring all necessary apparatus and supplies, and selecting the other members of the party, which consisted almost exclusively of naval men.

The "Discovery" left London July 1, 1901, and arrived at Lyttleton, New Zealand, on November 29. The final leave-taking from civilization occurred on December 24, when the ship sailed from Port Chalmers, where a last supply of coal had been taken aboard. After [illegible]king through the pack-ice, Victoria Land was first sighted on January 8, 1902. A southerly direction along the coast was continued, with landings at Cape [illegible]re, Lady Newnes Bay, Granite Harbor, and othe[illegible]nts, for survey and investigation, until further progress was made impossible by the ice pack in McMurdo Sound under the volcanic Mounts Erebus and Terror. The ship was now turned eastward in an attempt to solve the problem of the great Ross Ice Barrier. This was followed along its entire length to where it joins with King Edward VII. Land, the coast of part of which was explored. The Barrier was thoroughly investigated, at one point even by means of a balloon ascension. By February 8 the "Discovery" was again in McMurdo Sound, which was then found free of pack-ice. Winter quarters for the ship were chosen on the southwest coast of Ross Island.

The first winter in the Antarctic was occupied with meteorological, magnetic, and other observations and investigations, in becoming accustomed to the unusual conditions of livelihood necessitated by the region, and in making short expeditions into the surrounding territory. As soon as the approach of warmer weather permitted, sledge journeys for wider exploration were started. The first of these was Armitage's journey from Mount Erebus westward into the continent for about a hundred miles from the coast, ascending glaciers and mountains, to a smooth, open, snow-covered plain, over which he traveled till failing provisions forced a return. Another party, under Scott and Royds, made reconnoissances to the south. Another party under Royds left communications at Cape Crozier, for the guidance of a relief ship. On November 2, Capt. Scott started on his sledge journey along the Antarctic continent for 350 miles south of the winter quarters at Ross Island. Inexperience, loss of the entire dog-team, incipient scurvy, and late bettering of weather conditions, made this achievement noteworthy. The farthest south was 82 deg. 16 min. 33 sec., a point 250 miles nearer the pole than had theretofore been attained. Meanwhile the relief ship "Morning" had arrived. This southern journey of Scott's ended on February 3, 1903, after 960 statute miles had been traveled in 93 days.

As the ice did not break up, the "Discovery" was obliged to spend another winter at Ross Island. The second season passed in almost the same manner as the first, and with the beginning of warmer weather, preparations for further sledge journeys were energetically pushed forward. Several short but severe trips were undertaken, either for the purpose of local exploration or to arrange depots for the later journeys. The first of these, starting on October 6, was that under Barne, to the southward toward Barne Inlet. Capt. Scott himself left on October 11, for a western journey through the Ferrar Glacier, into the great waste of Victoria Land. After a journey replete with adventure and terrible traveling, the return was accomplished late on Christmas Eve. The sledge party traveled inland for 270 miles, and found that the vast continental plateau rises to a height of over 9,000 feet above the sea, a great, monotonous, undulating plain covered by the perpetual ice-cap. In an absence of 59 days, over 725 miles had been covered. Barne's party encountered great difficulty with bad going and severe weather, and was forced to return after having barely reached the mouth of the inlet which they hoped to explore. They discovered, however, important proof of the moving of the great Ice Barrier, when it was noted that one of the supply depots established thereon had moved considerably from its original location. This party returned to the vessel on December 13, after being out 68 days. The southeasterly expedition to the interior of the Great Barrier, under Royds, returned on December 10. The party marched day after day over the same monotonous and unutterably wearisome plain of ice and snow. Extremely valuable magnetic observations were made, as here these were absolutely free from possible disturbance, either from casual iron or from land-masses.

In January, 1904, 20 miles of solid ice separated the "Discovery" from open water, and an attempt to saw a channel was seen to be impossible. On January 5 the relief ships "Morning" and "Terra Nova" appeared. As the ice gave little hope of breaking up, preparations were made to abandon the ship, and to transfer the valuable contents to the relief vessels. By February 16, however, the "Discovery" was freed with the help of explosives, the miles of intervening ice having previously been broken up by stress of weather. From McMurdo Sound the little fleet ran north along the coast, the "Morning" soon leaving for New Zealand, while the other two continued to the north. Shortly after the "Terra Nova" and the "Discovery" separated and the latter turned to the westward between latitudes 67 and 68. The Balleny Islands were found to be identical with the three Russell Islands of Ross. It was also found that the extreme eastern part of the coast line indicated by Wilkes does not exist, and this disproves the hypothesis that the coast of Wilkes Land is extended eastward in a long connected line to Victoria Land. Thus it is probable that there is an important recession of the shore to the west of Victoria Land, which may be a broad peninsula. On March 15 Ross Harbor, Auckland Island, was reached, where the other two vessels soon joined the "Discovery." On April 1 Port Lyttleton was entered, and the final return to civilization accomplished. September 10 saw the "Discovery" again at Spithead, England, after an absence of three years and one month.

The two years of strenuous work were crowned with success. The eastern edge of the Antarctic continent was traced for 350 miles south of the winter quarters, thus completing a fair survey of about 1,000 miles, including coastal irregularities, of this shore line extending mainly north and south. The explorations of the surface of the Great Barrier and the inland continental plateau were extensive, notwithstanding initial and complete ignorance of sledging and sledging methods. The complete survey of the edge of the Ice Barrier to where it joins the newly discovered King Edward VII. Land, proved that the Barrier has receded considerably since the time of Ross. It is not considered a land ice-cap, but is believed to be an ice-mass afloat on a great sea basin. The extreme southern dash was made on the surface of this Ross Barrier, a huge plain so flat that even slight objects could be seen for miles. It is bordered, on one side at least, by high mountains, some of which reach elevations of 12,000 to 15,000 feet, and these continued as far as could be seen from the farthest point south. The opinion has been advanced that possibly these mountains extend over the pole as a continuation of the mountains of Graham Land and the Andean chain. The geographical, meteorological, zoological, and magnetic and other physical investigations are of great value, and go far to show that the voyage of the "Discovery," as Capt. Scott says, "was not undertaken in a spirit of pure adventure, and that the members of the expedition strove to add, and succeeded in adding, to the sum of human knowledge."

* The Voyage of the "Discovery." By Capt. Robert F. Scott, C. V. O., R. N. In two volumes. London, 1905, Smith, Elder & Co. New York: Charles Scribner's Sons.

SCIENCE NOTES.

Hardly any theory is all true, and many theories are not all false. A theory may be essentially at fault and yet point the way to truth, and so justify its temporary existence. We should not, therefore, totally reject one or other of two rival theories on the ground that they seem, with our present knowledge, mutually inconsistent, for it is likely that both may contain important elements of truth.

A new industry, the making of mattresses, pillows, etc., of sponge, has been started in Florida. The sponge material is cleansed of all foreign matter by a scrubbing process in large tanks of water, then run through wringers, and the drying continued by subjecting it to a cold-air blast. It is then shredded by machinery, sterilized, and rendered odorless by chemical treatment, and subjected again to cold-air drying, when it is ready for use. It is claimed that the sponge mattresses are only about one-third of the weight, and cost only about two-thirds as much as those of the same size made of hair, that they are thoroughly springy, yet firm and durable, and that they are especially sanitary, the material being non-absorbent of moisture and emanations from the body. A pillow is made measuring 19 by 26 inches which weighs only one pound, feather pillows of the same size weighing three pounds. Other articles are a sponge cushion and a toy sponge ball as light as an inflated rubber ball.

The berries of different species of coffee generally contain from 10 to 15 grammes of caffein per kilogramme. M. Bertrand, in a recent communication to the Académie des Sciences, shows that there are exceptions to the rule. The coffee of the Great Comaro, to which Baillon has given the name of *Coffea Humblotiana*, does not contain the slightest trace of the alkaloid. This exception is the more curious, as this species much resembles the ordinary kind, the *Coffea arabica*. The absence of caffein in the coffee of the Great Comaro is not due to the influence, either of the soil or of the climate of the African island. Analysis of the *Coffea arabica*, cultivated in the same island, has yielded a normal percentage of caffein, 13.4 grammes per kilogramme of the berries. Other coffees gathered near Diego-Suarez in Madagascar, and quite distinct species, exhibit the same peculiarity, the absence of caffein. This fact is not accidental, but a distinct characteristic of certain species, previously found only in Madagascar.

Prof. Moreaux describes in a paper, read at a session of the Académie des Sciences, observations on a waterspout which passed through the communes of Saint-Maur and Champigny on the 28th of August. The direction was from west-southwest to east-northeast. It seems to have been formed to the south of Saint-Maur-ice, and passed over a space of about five kilometers in twenty-five minutes, from 10 minutes after 3 o'clock to 35 minutes after 3 o'clock in the afternoon. It was noticed at the observatory of Saint-Maur when it had completed about half of its course. Its passage was accompanied with a sound which is described as resembling that of a battery of artillery drawn on the gallop over a paved street. At the base of an extended nimbus hung the reversed cone characteristic of phenomena of this kind. The barometer, 11 millimeters lower than the day before, stood at 745 millimeters at an altitude of 50.3 meters, at 5 minutes after 3 o'clock, when the fall was increased. A strong wind was then blowing from the south-southwest. The temperature was 15 deg. C. These two conditions did not change. The waterspout passed to the north of the observatory within a distance of about one kilometer. It was preceded by a storm, and followed by a shower.

The ordinary methods for the determination of refraction, of which the influence is so considerable in all astronomical measurements, are attended with great difficulties. Observations must be accumulated during a course of years, and at the same time estimates must be made of the multiple effects of the numerous causes that may intervene in measurements taken by means of meridian and other similar instruments. M. Loewy, who has studied this subject closely, pointed out several years ago two methods by which the inconveniences might in great part be avoided. They were based on the comparison of the stellar distances by the use of a special compass, of which the opening remains constant; this consists of two mirrors cut from the same block of glass in prismatic form. With the aid of this optical apparatus before the objective of an equatorial, the distance between two stars may be determined, whatever the size, with much precision. The constant of refraction may be deduced under certain conditions. In a new communication to the Académie des Sciences, he has recently made known an improved method free from the practical imperfections of the previous theoretical solutions. By means of a single prism the refractions can be exactly measured at all zenithal distances, by taking advantage of the fact that the apparent distance between two stars is not diminished by the effect of refraction, provided the vertical circle of one of the stars is perpendicular to the arc of the great circle which joins them.