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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-