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## LANDS BELOW THE OCEAN LEVEL.

In an article treating on some remarkable results of evaporation and rainfall, published on page 257 of our issue of April 28, this year, we described one of the instances of the great excesses of evaporation over rainfall, namely, the Caspian Sea, on which the surface is as much below the ocean level as our Lake Champlain is above the same, namely, more than 80 feet. There are, however, two still more remarkable cases of the same sort, the Dead Sea in Palestine and the Great Desert or Sahara in Africa. The former is remarkable for the great amount of the depression, and the latter for the immense surface depressed, being in fact the bottom of an extensive inland lake, totally dried up by the heat of a tropical climate, aided by the absence of feeding streams, and by the rainless area which covers its greatest portion. It is, on an average, 80 feet below the ocean, about as much as the Caspian Sea; but it is remarkable for its extent, being nearly 2,000 miles square, or nearly 4,000,000 square miles.

The French government, having an eye to the colonization of Northern Africa, with Algiers as a starting point, has for some time favored a project for restoring this sandy waste to its primeval condition by cutting a communication with the ocean, and so transforming it into a salt water inland lake. The effect of this on the climate of the surrounding country, and especially on the colony of Algiers, would undoubtedly be most beneficial, because the south wind, instead of blowing, as it does now, over a sandy desert, would become a sea breeze; this would increase the rainfall, and change a rainless district into a fruitful region. In a commercial point of view, moreover, the benefits of such a change could not be overestimated. The introduction of water transportation is especially advisable in this tropical region, where the miserable and utterly inefficient caravan is now the only mode of carrying goods; and without doubt commercial cities would soon spring up around the shores of the proposed inland sea, which would become the scene of a mighty travel and traffic, as the lake would give easy access to the surrounding countries, and develop this part of Africa to an extent thus far utterly undreamed of.

But it is well to look also at the disadvantages of this gigantic scheme. In the first place, it will rob the ocean of such an enormous amount of water that its general surface will be lowered to an appreciable extent. In order to realize how much this lowering will amount to, let us consider that the total terrestrial surface is, in round numbers, 200,000,000 square miles, of which the ocean occupies three quarters, or 150,000,000. If the estimate given of the Desert of Sahara, 4,000,000 square miles, is correct, it occupies $\frac{1}{38}$ part of the ocean's surface, and, therefore, every foot of depth of water abstracted for the Desert will diminish the ocean $\frac{1}{38}$ part of a foot; and the withdrawal of water for a lake 80 feet deep would leave the ocean level $80 \times \frac{1}{38}$, or more than two feet lower, which would be plainly perceptible in the many harbors where careful tidal observations are made, and in some cases changes may influence the shipping, robbing as it would do all parts of the world of over two feet depth of water, which would be very bad in those localities where the harbors are shallow.

This much as to an immediate result; but the ultimate consequences would be much more serious. It should be considered that this large inland lake, if once established, would have no fresh water supply, by rivers; but the sea water would certainly rush in through the channel, to make up for the large evaporation, which we may safely set down at 1,200 lbs. of water per year for every square foot. This would lower the level 20 feet per year, which is one quarter of the whole quantity of the lake. This, for a surface of 4,000,000 square miles, or 100,000,000,000,000 square feet, gives 2,000,000,000,000,000 cubic feet of water to be replaced annually from the ocean, or nearly 6,000,000,000,000 cubic feet per day, or 250,000,000,000 cubic feet per hour, or 4,166,666,666 cubic feet per minute, or 69,444,444 cubic feet or 525,000,000 gallons per second. As the German Rhine carries only 1,000,000 gallons of water per second, on an average, the channel bringing the supply to the Desert of Sahara from the ocean would have to carry as much water as is carried by 525 rivers like the Rhine; and from the salt water only pure water would be evaporated, leaving the salt behind. As this amounts to 4 per cent, or $\frac{1}{25}$ of the sea water, and as nearly 20 feet deep, or $\frac{1}{4}$ of the water in this new lake, would annually evaporate, it would only take $4 \times 25$, or 100 years, one single century, for all the water to disappear, and a deposit of salt take its place. Then the now sandy desert would be changed into a desert of salt: which salt would fill the whole basin, and would certainly be a more serious affliction to Algeria than the present sand plain can possibly be.

## THE THORNEYCROFT FAST LAUNCHES.

In a recent description of the French torpedo experiments at Cherbourg, we noted the wonderful speed of nearly 19 knots per hour attained by a steel torpedo launch built by Messrs. Thorneycroft. In such small craft, displacing at most but about 15 tons, this extreme velocity appears to be obtainable only over short periods; but a speed of 18 knots has been maintained over measured distances for more than two consecutive hours, the engine then developing 220 horse power. The dimensions of a launch which attained this speed are as follows: Length 63·04 feet, beam 8·53 feet, draught of water (average) 2 feet, displacement (that is to say, the total weight of the vessel and all its contents) 15 tons.

While there can be no question but that these vessels demonstrate remarkable progress in navigation, on the other hand this achievement cannot be attributed to any new discovery, but results from improved application of known principles, and especially from the rare perfection of the construction of the motive apparatus, which develops great power, while its weight is reduced to the narrowest limits. This, however, it not the only element of success. The model of the hull is such as to diminish to the utmost the liquid resistance opposed to its onward movement. Again, the material of which the hull is built is such as not to absorb by its weight a fraction of the total displacement which may be usefully devoted to the motive machinery. To this end it is built of steel plates, and weighs but 9,900 lbs., or less than a third of the total displacement. In order that the propeller should afford the maximum effect, it is necessary that the liquid vein upon which it acts should be as large as possible in comparison with the resistant section of the vessel. Ordinarily the section of vein acted upon is less than the latter. In the Thorneycroft launch, the screw shaft is placed on a level with the keel, instead of being located at a point half way between the keel and the water line, as is usually the case. The screw then projects below the keel for nearly half its diameter, and consequently it acts upon a section of vein greater in area than the greatest section of the vessel. This arrangement doubtless contributes materially to the speed; while a sharp bend of the keel protects the propeller from damage.

As already noted, Messrs. Thorneycroft's success in producing a motor both light and powerful has been remarkable. The complete machine—that is, including boilers and the water contained—weighs in all 16,060 lbs. The power at the speed of 18½ knots having been 220 horse, the weight is therefore but 72·6 lbs. per horse power. The machinery is therefore probably the lightest ever produced for purposes of navigation. Large marine engines for a long time rarely weighed less than 440 lbs. per horse power; and it is only through recent improvements that this has been reduced to 330 lbs. For ordinary launches, with non-condensing engines running at high velocities, the usual weight per horse power is about 220 lbs. It is therefore interesting to note under what conditions Messrs. Thorneycroft's engines are produced. They are condensing machines, twocylinder, on the compound system. The boilers are of the locomotive type, with the difference that the tubular surface is reduced about one half. This is the only sacrifice which has been made for the economic production of power; and it was necessary in order to reduce the weight of the apparatus. The safety valves are loaded to 13·2 lbs. The engine makes 430 revolutions per minute, which requires great mechanical excellence of the mechanism, and especially of the air pump. The consumption of coal per horse power per hour is 3·52 lbs. The grate surface is 11·19 square feet. An artificial blast is conducted directly to the fire chamber instead of to the ashpit.

## THE PERMANENT SUPPLY WATER WORKS OF BALTIMORE.

One of the greatest engineering works now in progress is that to supply the city of Baltimore with water, and the gentlemen in charge of it have been so busy pushing it forward that they have had very little time to talk about it: in consequence of which not many people outside of the city know anything of it, and comparatively few have any idea of the immensity and difficulty of the works that are now so quietly progressing to supply them with an almost unlimited supply of the necessary article of water. One of our correspondents lately called on Mr. Robert K. Martin, the engineer in charge, who was so obliging as to show him over the line of works, and we are thus enabled to lay the following particulars before our readers.

Baltimore is at present supplied with works having a capacity of about 15,000,000 gallons a day, which comes from Jones' Falls to Lake Roland, whence it is brought by a conduit 3½ miles long to Hampden reservoir and Druid Lake. From the latter, which is 53 acres in extent and 217 feet above tide, one portion of the water is raised by powerful steam pumps to a high service reservoir 350 feet above tide, for supplying the highest region of the city; a second part is supplied direct to the mains; and still another portion is allowed to pass to Mount Royal reservoir, which is only 150 feet above tide, so as not to give too high a pressure to the lowest portion of the city.

This supply having been found to be insufficient in the summer season, it was resolved to increase it temporarily by erecting, near the Gunpowder River, a pair of Worthington's duplex compound pumping engines, capable of raising 10,000,000 gallons a day from that river, over a hill 265 feet high, to Roland Run, a tributary of Jones' Falls above mentioned. This arrangement, however, was not sufficient for some of the more enterprising of the Baltimoreans, and a new plan was devised; and it is now being carried out, notwithstanding considerable opposition by interested parties, by the capable and energetic civil engineer of the Water Commission, Mr. R. K. Martin, who had charge of the previous works, erected in 1858. The source of the new supply is the Gunpowder River, which at about nine miles from Baltimore makes its nearest approach to the city, as at this point it takes a bend in another direction Advantage is taken of this turn to form a dam across the stream, and so form a storage lake which will, it is believed, be capable of supplying the city with 175,000,000 gallons of water every twenty-four hours. This lake will be from 500 to 1,000 feet wide, about 20 feet deep on the average, and will extend up the Gunpowder a distance of about 5 miles through the most picturesque scenery, which is constantly changing, as the river and the valley through which it runs pursue a very devious course between ranges of precipitous, wooded hills, from where it leaves the open country near Meredith's Ford bridge, which forms the head of the lake. To facilitate operations, a road 10 miles long, about 30 feet wide, and about 10 above the intended level of the lake, has been cut in the sides of the hills on each side, which will no doubt be utilized hereafter as a pleasure drive by the lovers of beautiful scenery.

At the lower end of the site chosen for the lake, two hills jut out into the valley, leaving but a comparatively narrow place, of which advantage is taken to form a dam which will raise the water about twenty feet above the natural level of the river. In one of these hills is the mouth of the tunnel, hereafter referred to, from the side of which a dam will be built having an overfall of 300 feet and a wing of 190 feet, that will extend into the opposite hill. This dam will be of the most substantial character, of heavy stone laid in hydraulic cement. The stone work will be 31 feet high and about 65 at the base, having its foundation on the solid rock; and it is estimated that about 20,000 perches of stone will be required for this part alone. The face of the overfall will be built of large blocks from three to four feet in depth; and to prevent any undermining, an apron is to be cut below the overfall resting four feet below any of the other foundations. The other side of the dam will be protected by a backing of 165 feet of puddle clay, gravel, and riprapping. The parapet walls will rise 12 feet above the overfall, and will be level with the floor of a gate house that is to be erected at the tunnel end of the dam. At the gate house begins the tunnel, which is to carry the water to Lake Montebello. This tunnel is nearly seven miles long—36,510 feet—and is therefore the longest in the country. The bore is circular in shape and is 12 feet in diameter. Over five miles of it will be through hard gneiss, which is being cut with drills driven by manual labor, as the contractors think that, owing to the comparatively small area of the tunnel, the power drills are not economical enough to pay them for the cost of the necessary machinery. A portion of the tunnel is being cut through softer material—a kind of limestone, that crumbles into powder by the force of the explosion when blasted. This part of the tunnel will have to be bricked; but where the gneiss occurs, the brickwork will be dispensed with, except in some localities where there are bad breaks and crevices in the rock, and at the bottoms of the shafts which will, when the tunnel is completed, be arched over with masonry 6 feet thick, to withstand the immense pressure of the loose earth filled in above.

To facilitate the operations in the tunnel, fifteen shafts, from 65 to 300 feet deep, have been sunk, most of which are down to grade; and in some of them considerable work has been done on the tunnel. But owing to the hardness of the rock for the larger portion of the distance, very fast progress cannot be made—only about a running foot of tunnel per shift of 12 hours, or two feet per day, as in tunneling night and day are alike so far as work is concerned, the only light in either case being that obtained from the small lamps attached to the miners' hats. As before stated, the contractors employ manual power for drilling, which, in the hard work, is done by task work—thirteen feet per shift being the miner's task. The holes are bored 30 inches deep, and an eight ounce cartridge of giant powder (nitro-glycerin and sawdust) is used in each hole, at which rate about 7 lbs. of powder, at 40 cents per lb., is used for each running foot of hard rock tunnel, making for the five miles through the gneiss nearly $74,000 for explosives alone, to say nothing of that used in the other portions of the work.

The shafts are from 8 x 17 to 8 x 20 feet inside the timber work, which, when used, adds about 30 inches to the above figures; and as fast as they are completed they are fitted with improved safety cages to prevent accidents from the hoisting mechanism; but they have only the ordinary tipping bucket until the shaft is down to grade. The exhaust from hoisting engines is utilized to create a draught in a pipe, the mouth of which is near the heading, and by this means ventilation is secured in the tunnel.

In the limestone portion of the tunnel, between shafts 1 and 2, the stratum makes an eccentric dip, leaving a "pocket" of mud which, as the miners were working towards it, suddenly ran into the tunnel, overwhelming and suffocating one poor fellow who had been driven by it against the timbers; but the remainder of the workmen managed to escape. In this, as in some other sections, the water forms a great hindrance to operations, a spring being found here which keeps a steam pump of a capacity of 200 gallons a minute constantly at work, while about the same quantity of water percolates through other crevices in the rocky sides of this section of the tunnel and has to be removed by another pump of the same size. The same trouble occurs in other shafts, especially No. 5.

To make the necessary observations required to properly line and level the tunnel, a straight line has been made over the tops of the hills and through the woods, and three observatories have been erected for this purpose. As an instance of the great care taken by Mr. Martin in this matter, it may be stated that these structures are double, consisting of an inner tower (on which the instruments are placed) protected from atmospheric and other influences by an outer one, entirely detached from the other, on which the engineer stands when making his observations.

At the lower end of the tunnel is to be located a reservoir, to be known as Lake Montebello, which is being formed by damming up a valley admirably suited to the use to which it is being put. The upper and lower ends of the valley, forming the east and west sides of the reservoir, will be closed up with dams of stone and earth, 450 feet wide at the base and 100 feet at the top, with each end imbedded in the hills at the sides, so that the greatest possible strength may be obtained; for this is one of the most critical pieces of construction along the whole line, as these dams will have to sustain the pressure of 600,000,000 gallons of water. The north and south sides of the valley, about 3,500 feet each, will form the other sides of the reservoir, which, when completed, will have the appearance of a natural lake, and will have a superficial area of about 80 acres and a depth of at least 30 feet. The sides will be finished with riprapping, and the top will be surrounded by a fine road $1\frac{1}{2}$ miles long and from 60 to 80 feet wide, divided from the reservoir by a neat and substantial iron fence.

There being a stream running through this valley whose water is too impure to be used, a drainage tunnel, 2,870 feet long and of 9 feet diameter, had to be made to carry it away, which tunnel will also serve to take off the surface drainage, and to empty the reservoir, should it be required. From this reservoir, another tunnel, 2,600 feet in length and 12 feet in diameter, is now in course of construction. This tunnel is cut through soft material, and therefore requires strengthening with brickwork laid in hydraulic cement. Where the tunnel is of the right character, the top arch is three bricks thick and the invert below the spring line two bricks, with a proportionate backing of from 18 to 24 inches above the spring line, built in against the timbers or the rock wall of the tunnel. In the soft places, there is an additional ring of brickwork added, and the backing is proportionately increased. In all cases, the arch is packed over the top with clay well rammed in. The brickwork in this, as in the main and drainage tunnels, requires to be done with the greatest care, as it has to stand not only the outside pressure of the immense weight of material above it, as in railroad tunnels, but also the internal pressure of the water within, which is always searching for weak spots to break through, and it is therefore being done by the day. It is estimated that about 12,000,000 bricks will be used in all the tunnels.

One portion of this tunnel passes beneath a well, the bottom of which is only four feet from the top of the tunnel; and yet the water of the well has not been drained, and it continues to furnish its usual quantity of water, notwithstanding that another well, 300 feet from the tunnel, was almost immediately drained and has now no water whatever.

At the end of this tunnel will be a gate house from which the water will pass into six pipes of 48 inches diameter each, by which it will be conveyed to the city limits, and there connected with the present system of mains for distribution throughout the city.

Along the line of the work have sprung into being several temporary villages for the miners and laborers, showing styles of architecture that one would hardly expect to find so near a great city, varying from the tolerably comfortable offices of the contractors to that of the squalid log huts of the negro laborers on the storage lake, with a single room that is half below ground and half above. Many drinking shops have also been built on the line, or rather as near to it as they can be built (for the engineer will not allow them on the city property), in which the men squander their hard earnings after each pay day, and so unfit themselves for their labor as to cause no small delay to the progress of the work.

Unlike the officials of some other cities that may be named, those of Baltimore appear to have a fashion of completing their public works without exceeding the appropriations for them. This was the case with their city hall, inaugurated a year or two ago, and it appears as if it would be the same with the water works. The whole amount appropriated for this purpose is $4,000,000; but the engineer in charge, who is doing his best to cut down the expenses all he can without depreciating the quality of the work, thinks the whole improvement can be completed at a cost of very little, if any, over $3,000,000. About 1,500 men are employed—common laborers getting $1.25 per day and miners $1.50. It is expected that the whole work will take about three years to finish, and Baltimore will then have a natural flow through the tunnel that will supply it for generations to come with all the water for ordinary purposes that can be used or wasted, as the river at the point tapped is 170 feet above mean tide, and consequently will give water to nearly all the houses in the city, except in the extreme northwest section, for which the water will still have to be pumped into a high service reservoir.

Mr. Martin is assisted by Mr. C. P. Manning, consulting engineer, W. L. Kenley, chief assistant, and seven resident engineers, Messrs. R. B. Hook, W. R. Warfield, C. O. Swan, C. T. Manning, O. H. Balderston, and C. A. Hook, who are named in the order of the work they have in charge, beginning at the storage lake. The contractors, also named in the same order, are Messrs. Condon and Co., Fenton and Allan, Bruce and Patterson, L. B. McCabe and Brother, J. Donohue and Brother, and J. E. Eschback.

From this cursory sketch, some idea of the magnitude of the work in which the city of Baltimore is engaged may be obtained—a work alike honorable to the public spirit of her citizens and the gentlemen engaged in its construction.

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THE most valuable part of a man's education is that which he receives from himself.

## WHAT IS A TEMPORARY STAR?

On November 24, 1876, Professor Schmidt, Director of the Observatory at Athens, Greece, noticed a new star, of the third magnitude, in the constellation *Cygnus*. The three nights immediately preceding had been cloudy, but the star had not become visible on the night of the 20th. Astronomers throughout the world were at once notified of the discovery, and the object was diligently observed both in Europe and America. Its apparent magnitude very rapidly diminished from the date of its discovery. In a few weeks it became invisible to the naked eye; and in less than three months its light was no greater than that of a star of the ninth or tenth magnitude. Other instances of such phenomena are well known in the records of astronomy. The following catalogue, with the exception of the last two, is given by Humboldt:

| No. | Date. | | Position. | Duration of visibility. |
|---|---|---|---|---|
| 1. | July, | 134 A.B., | in *Scorpio.* | Doubtful. |
| 2. | Dec., | 123 A.D., | in *Ophiucus* | " |
| 3. | Dec. 10, | 173 " | in *Centaurus* | 8 months. |
| 4. | March, | 369 " | Doubtful | 6 " |
| 5. | April, | 386 " | in *Sagittarius* | 3 " |
| 6. | | 389 " | in *Aquila* | 3 weeks. |
| 7. | March, | 393 " | in *Scorpio* | Doubtful. |
| 8. | | 827 " (?) | in *Scorpio* | 4 months. |
| 9. | | 945 " | near *Cassiopeia* | Doubtful. |
| 10. | May, | 1012 " | in *Aries* | 3 months. |
| 11. | July, | 1203 " | in *Scorpio* | Doubtful. |
| 12. | Dec., | 1230 " | in *Ophiuchus* | 3 months. |
| 13. | | 1264 " | near *Cassiopeia* | Doubtful. |
| 14. | Nov. 11, | 1572 " | in *Cassiopeia* | 17 months. |
| 15. | | 1578 " | Doubtful | Doubtful. |
| 16. | July 1, | 1584 " | in *Scorpio* | " |
| 17. | Oct. 10, | 1604 " | in *Ophiuchus* | 17 months. |
| 18. | | 1609 " | Doubtful | Doubtful. |
| 19. | June 20, | 1670 " | in *Vulpes* | 20 months. |
| 20. | April 28, | 1848 " | in *Ophiuchus* | Doubtful. |
| 21. | May 12, | 1866 " | in *Coronæ Borealis* | " |
| 22. | Nov. 24, | 1876 " | in *Cygnus* | " |

"It is worthy of especial notice," Sir John Herschel remarks, "that all the stars of this kind on record, of which the places are distinctly indicated, have occurred, without exception, in or close upon the borders of the Milky Way, and that only within the following semicircle, the preceding having offered no example of the kind." The striking fact here noticed indicates the existence of unknown physical conditions in this portion of the heavens, favorable to the production of the phenomena described.

Again, while two or three of the recent temporary stars have remained visible as small telescopic objects of somewhat variable brightness, yet in no case has an outburst occurred in precisely the same locality with a previous one. The supposed identity of the stars of 945, 1264, and 1572, cannot therefore be sustained, and the assumption that "all the temporary stars are simply variable stars" of long period is wholly destitute of support.

### CAN THE PHENOMENA BE EXPLAINED WITHOUT THE ASSUMPTION OF AN UNKNOWN CAUSE?

It is a remarkable feature of the binary systems among the fixed stars that the orbits have great eccentricity, the less component in its periastron passage coming into very close proximity to the greater. This approach, in several known instances, is within less than the earth's distance from the sun, and, in at least one case, less than that of Mercury. Among the large and increasing number of known systems whose elements have not been determined there are probably some of still greater eccentricity. If we suppose in such case that the principal star is still in a gaseous condition, and that the radius of its atmosphere is greater than the periastron distance of its companion, the latter will at each return, by plunging through this atmosphere, produce an increased degree of light and heat. Its period will become shorter at each successive return, until it shall be arrested by penetrating the denser strata of the principal star. Its orbital motion will thus be converted into heat and the phenomena of a new or temporary star may be presented to distant spectators. Such collisions as we have supposed must have occurred very frequently in the solar system when the sun's diameter was much greater than at present, as comets of small perihelion distance would be absorbed by the central mass.

"The circumstance," says Humboldt, "that almost all these new stars burst forth at once with extreme brilliancy, as stars of the first magnitude, and even with still stronger scintillation, and that they do not appear, at least to the naked eye, to increase gradually in brightness is, in my opinion, a singular peculiarity, and one well deserving of consideration."* The fact here stated is in manifest harmony with the theory above proposed. It is worthy of note, moreover, that the part of the heavens in which the outbursts have occurred is rich in double stars and sidereal clusters.

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### A Simple Fire Escape.

J. R. M. writes to suggest that a piece of stout canvas, about 20 feet square, with hand loops all around it, could be held in the hands of a few men under the windows of a burning house. Persons could then jump from the windows with safety, especially if the handles were attached to the canvas with rubber or wire springs, which would give elasticity to the canvas, and break the fall of the person jumping from the window.

* "Cosmos," vol. III., page 218.