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SCIENTIFIC AMERICAN SUPPLEMENT

No. 1076.

For the Week Ending August 15, 1896.

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THE METRIC SYSTEM OF WEIGHTS AND MEASURES.

There is a question being agitated just now in England which is of great commercial importance to that country, and may become so, at an early day, to the United States. We refer to the movement in favor of adopting the metric system of weights and measures in place of the cumbersome and confusing tables at present in use. The agitation has progressed as far as the introduction of a bill before Parliament, making the use of the system compulsory after a specified length of time. It has met the opposition which was to be expected from a people who have a strong sentimental attachment to the usages and traditions of the past, and, in spite of the many economies of time and labor which would be realized by the introduction of a decimal system, it will probably be a long while before the Englishman exchanges yards for meters and pounds for kilogrammes.

The arguments in favor of the metric or decimal system are too well known for repetition, and the inconvenience of the English system of reckoning money is forcibly impressed upon the American tourist when, upon landing at Liverpool or Southampton, he has to forego cents and dollars in favor of pounds, shillings and pence.

If the question were simply one of sentiment, or even of convenience, it is likely that the foot and the yard, the pound and the hundred weight, would continue to impose themselves upon the workshop and the mart indefinitely; but fortunately for England, the United States and the world at large, there are questions relating to the foreign trade of Great Britain which are likely to be the controlling factor in the case, and lead to her adoption of the modern and more convenient system.

It seems that many of the foreign countries with which England carries on an extensive trade are using the French system. As matters now stand, the dimensions, weights, etc., of the machinery which is purchased by the South American states, for instance, is expressed in terms of measurement with which they are not familiar. It would seem at first thought that this difference of measurements was a small matter, requiring only a few minutes' calculation; but it appears to have proved the decisive factor in German and English competition, these foreign countries in many cases preferring to purchase their machinery from a country which expressed its dimensions and value in familiar terms. Of course, the German manufacturers have not been slow to make the most of this slight difference in their favor; and a large part of the decrease in English foreign trade with certain countries is attributed by the manufacturers directly to this cause.

If this be true, and there is no reason to doubt it, we may look for an early adoption of the metric system in Great Britain; for sentimental and conservative as they may be, they are too practical a people, especially in all matters affecting their supremacy in trade, to allow a long established but cumbersome custom to prove a stumbling block to the continued advancement of their commercial interests.

Side by side with the many admirable institutions which our forefathers brought over from the mother country, there are some that] had better have been left behind; and conspicuous among these is our present system of weights and measures, which is practically the same as that of Great Britain. We are keenly alive to the disadvantages of the system, because side by side with it we are using a decimal system of coinage, and the defects of the one are emphasized by the speed and convenience of the other.

The arguments in favor of the metric system for England are equally strong, or soon will be, as applied to the United States; for although our foreign trade does not approach the volume of British foreign trade, it is likely that in the course of time it will do so, and even exceed it. Prudence would suggest that we should avoid the dilemma in which the English manufacturers find themselves, by making an early change to the metric system. Our present weights and measures have no special claim upon our regard. They are ours by inheritance, not by choice, and any temporary inconvenience which might be experienced in making the change would be amply compensated by the subsequent saving in time and trouble, and the avoidance of the serious handicap to which we shall otherwise be subjected in the markets of the world.

New York Rapid Transit.

Rapid transit in New York City has taken an important step forward in the decision of the commission to reject the plan of Messrs. Gould and Sage for the extension of the elevated railway system by a system of surface roads. The commission announces that it has no power to authorize the Manhattan Elevated Railroad Company to build a surface road north of the Harlem River, as they proposed to do at a recent meeting of the Commission. At the same time the engineer of the board was instructed to draw up plans, at as early a date as possible, for a system which will be practically the same as that recently suggested by him to the board, the details of which will be found in our issue of August 1; the chief difference being that the limit of cost is put at $30,000,000 in place of the $26,000,000 mentioned in the engineer's report. As the figure represents only 60 per cent of the limit imposed by the law, there can be no objection to the scheme on the ground of cost; and the fact that the elevated road's proposal is rejected very much simplifies a question which ought to secure the support of all who have the welfare of the metropolis at heart.

Palladium Toning.

BY A. A. KELLY AND H. HUMLY.

We have recently been making a few experiments as to the suitability of this member of the platinum group for toning silver prints. The salt that we found to be most useful for this purpose was the chloro-palladinite of potassium, represented by the formula K_2PDCl_4. This salt, when combined with citric acid and sodium chloride in the following proportions:

Potassium chloro-palladinite	5 grains
Sodium chloride	50 "
Citric acid	50 "
Distilled water	25 ounces

yields a series of tones ranging from sepia to black, which are far softer in effect than anything of the kind that can be obtained from a platinum or gold toning bath. When ammonium molybdate is substituted for the sodium chloride in the above mentioned bath a fine chestnut brown color will be obtained.

Prints toned in the above bath are to be fixed in the usual hypo bath, the only extra precaution necessary to observe being that the prints should be thoroughly washed for at least fifteen minutes between toning and fixing. If this be omitted, they will be hopelessly stained by a deep yellow compound of palladium, which is formed when a salt of this metal comes into contact with hypo. To insure even toning the prints should always be washed for a few minutes prior to being immersed in the toning bath.

An objection that will probably be raised against this process is the comparatively great expense of palladium as compared to gold; and another, perhaps, that the particular salt of palladium mentioned is difficult to obtain commercially. The first objection will disappear when we remember that a bath made up with the palladium salt will tone at least twice as many prints as a bath containing an equivalent amount of gold, and, at the same time, that while gold chloride costs 1s. 9d. per tube of 15 grains, the same quantity of chloro-palladinite will only cost a penny more.

As to the difficulty of obtaining the chloro-palladinite, this should not be a serious obstacle to any amateur who possesses a slight knowledge of chemistry.

In brief, the process of preparing it is this: Take 1 drachm of palladium chloride and dissolve it in half an ounce of pure hydrochloric acid, then 50 grains of chloride of potassium is taken and dissolved in half an ounce of distilled water. The two solutions are then mixed together and evaporated to dryness on a water bath—a piece of apparatus that may be easily extemporized by taking a 4 pound golden sirup tin, half filling it with water, and placing an ordinary saucer on top in place of the lid. The solution to be evaporated is then placed in the saucer and the whole apparatus is stood either on a spirit stove or on a tripod above a Bunsen burner, and the water allowed to boil until the solution in the saucer dries up. The residue on the saucer will be the chloro-palladinite of potassium, and is in the form of a brown crystalline powder.

The palladium chloride may be purchased in quantities of 15 grains and upward at most of the big dealers in apparatus and chemicals at about 13s. per drachm, from which the cost of the finished chloro-palladinite works out at about 1s. 10d. per 15 grains.

In conclusion, we think that anyone who follows out carefully our directions in trying this process will obtain very satisfactory results.—Photographic News.

Testing Quicksand.

Suppose we take a certain quantity of quicksand, dry it artificially, and then try to make it into quicksand again. Put it into a box and pour water on it carefully. Instantly the water is soaked up, and if we measure the volume, or better, the weight, of the sand, we shall see that it takes up a quantity of water that measures 30 per cent of its own volume, or 20 per cent by weight. The rest stays above the layer of sand. If we now pierce a little hole in the bottom of the box, we shall see pure water run out; the sand forms a kind of immovable filter. Also by turning the box upside down we see the sand keep its form like a stopper. It follows from this experiment that we cannot obtain quicksand in this way. We must reverse the condition of the experiment. Let us put the water into a vessel and sift in the dry sand in a thin stream, while shaking the vessel lightly. Then we shall get the thick but easily flowing compound known as quicksand. That the mixture may keep its mobility two conditions are necessary: 1. The quantity of water contained must not be less than 21 per cent by weight. 2. The whole must be continually though lightly shaken. If we increase the proportion or interrupt the agitation for an instant, the mass settles down, retaining about 20 per cent of water, while the surplus, if it exists, rises to the top.—La Nature, Paris.

The Making of Mammoth Cave.

BY HORACE C. HOVEY.

Hardly any other cavern has been so repeatedly described as the Mammoth Cave of Kentucky. Its bibliography includes more than 400 recorded titles of books, pamphlets, magazine articles and excerpts from scientific proceedings. Among this mass of literary material there is a guide manual and map, published about fifteen years ago by the writer of this article, and recognized as of standard authority by the managers of the cave. The time has come for a new manual, and in preparing it I have gone over the ground again, with the expert co-operation of Dr. R. Ellsworth Call. Between us every avenue, room, pit and dome of the vast cavern has been re-explored (with one or two exceptions), there being more than 200 in all. Among the many things to which our attention was directed was the vexed problem of cave making. Almost every writer, popular or scientific, mentions two causes as particularly active; namely, the disturbance of strata by earthquakes and the grinding force of pebbles and sand by whirling water. Our conclusion is that neither of these agencies had much to do with making the Mammoth Cave.

Limestone caves form a class by themselves, unlike those in lava, basalt, granite or sandstone. But they also differ greatly among themselves. Some of them have undoubtedly been subjected to repeated seismic action, like the fractured and cemented rocks of Virginia; whereas the limestones of Kentucky are remarkably homogeneous, and show hardly any signs of disturbance from their primitive condition. The entire region has been carved into its present shape by simple erosion. Imagine a vast plain covering fully 8,000 square miles, slowly and gently uplifted, and meanwhile subjected to the chemical and mechanical action of air and water; and the result would be such an area as that in the heart of which Mammoth Cave and many similar caverns are found. The surface now is undulating, with thousands of "knobs" and "sink holes;" the former being eminences, some of them several hundred feet high, often in the shape of symmetrical cones, left by the wearing away of the weaker rocks, the original strata being undisturbed even to the very apex; and the latter being oval depressions of various sizes, without inlet or outlet, except through funnels communicating with underlying caverns.

On leaving the Louisville & Nashville Railroad, at Glasgow Junction, we are in Edmondson County, with its 4,000 sink holes and 500 open caverns—a cave hunter's paradise, only imperfectly explored and inviting further research. Following the spur track that runs to Mammoth Cave, and passing several rival attractions, we skirt the margin of Eden Valley, adorned by fertile farms that are flanked by the virgin forest. This, instead of being a true valley, is really an enormous sink hole, probably due to the falling in of some immense cavern. Beyond it we soon approach Mammoth Cave and its associated group of grottoes, all drained into Green River, which is the only openly running stream in all that region.

In general terms, the Mammoth Cave may be described as a congeries of caves and grottoes of various sizes and levels, whose walls and floors have been worn thin and finally broken down, thus making one vast labyrinth. The explorer cannot tell to what huge chambers he may be admitted by some small aperture. And this is one thing that makes even a tentative survey difficult and unsatisfactory, as compared with a similar survey of a surface area.

The occlusion of some of the large avenues is interesting and instructive. Wherever this occurs it shows a falling in of the roof, with a strong presumption that the passageway extends beyond the mass of debris. The original entrance to Mammoth Cave was through what is known as Dixon's Cave, which proceeds with dimensions of surprising magnitude for 1,500 feet, and then abruptly ends in a pile of rocky fragments mixed with clay, making a hill about a hundred feet high. Shortly beyond this is the present entrance, which is plainly due to a breaking down of the cavern roof. Following the main cave for perhaps two miles we reach the cataracts, where, at times, the water descends in great volume and force. Just beyond them the roof has been crushed downward by the superincumbent weight, showing the strata in sweeping reversed arches—the only place in this cave where such a phenomenon is observed. Going on through several grand enlargements, one of which as measured is 500 feet long, 300 feet wide and estimated to be 130 feet high, we see myriads of rocky fragments, by many supposed to have been due to the action of earthquakes. But as the strata overhead show no signs of fracture, even where the rocky canopy covers two acres by one block of limestone, as in the great hall just mentioned, we explain the fallen fragments wholly by aqueous agency. The main cave ends in an occlusion of debris. A similar mass is found at the end of the Audubon Avenue, and others appear elsewhere. The fact that the limestone from which the cave is excavated is overlaid by sandstone accounts for the paucity of stalagmites, as compared with the neighboring White Cave, and many other smaller grottoes. And this, indeed, helps to explain the bigness of Mammoth Cave. It is big because never obliterated by the causes that commonly work to destroy subterranean passages.

Pits and domes played an important part [illegible]ill do so, in the making of Mammoth Cave. It [illegible]ould be understood that these terms are identical. Vertical shafts seen from above are called pits, but domes if seen from below. Following Dawkins, Shaler and other eminent authorities, we have been accustomed to regard these as irregular tubes cut down from the highest to the lowest level, by whirling water, using pebbles and sand for teeth. But we are now convinced that this theory is untenable. Were it correct, the pits should be wider at the top than at the bottom; but in every case it is otherwise. A small crevice five feet across may expand into a dome several hundred feet in diameter. There is water in most of these shafts, but it trickles down the sides, or flows along the floor, and not a sign appears of its having ever been "whirled about with pebbles for teeth," as is stated by Prof. Shaler. The grooving is invariably vertical, with no marks of boring, drilling or grinding. We examined minutely many small domes formed on exactly the same plan as the larger ones. In every instance their arch was solid, except for the narrow aperture through which water gently flowed. On the floors of some of them were pebbly basins, but in others not a pebble or a grain of sand was visible. All the great pits extend down to the drainage level, and contain standing or running water, sometimes quite a rapid stream, but no whirlpools.

Our conclusion is that the typical domes have resulted from simple solution by the agency of acidulated water. In proof of this we found, in Gorin's Dome, Lucy's Dome, and elsewhere, masses of limestone, both fallen and in place, that seemed solid and firm, but that crumbled to fragments or yielded like putty under the hand. This, indeed, is such an element of danger that Manager Ganter had his men go to the summit of Gorin's Dome with sledge hammers, and break down the edges until they came to sufficiently solid rock to support the timbers of the new bridge he is building there, and from which one of the finest cave scenes in the world will be made visible to the tourist. On inspection, the limestone is found to be highly oolitic, hence its friability when the round, egg-like particles of which it is composed are set free by the dissolving of the cement that holds them together. These particles, rolling down with the trickling water, would naturally carve just such vertical grooves as actually exist. We may add that much of what has been mistaken for sand is really comminuted limestone. Great banks of it are sometimes found, and elsewhere true silicious sand exists, but not as an agent in cutting the domes.

Such exaggerated statements have been made as to the dimensions of the domes and pits, that we took pains to sound them all. We began with the well known Crevice Pit, in Little Bat Avenue, that opens into the Mammoth Dome. Lee's map, published in 1835, and claiming to be made by instrumental survey, makes this pit 280 feet deep, or "120 feet lower than the bed of Green River." The shelving edges of this ugly black hole make an approach dangerous. There are also projecting shelves below and out of sight, on which, unless one is careful, his plummet is liable to lodge, the weight of the line causing it to continue to be paid out, a circumstance that probably deceived Mr. Lee and others, as it did ourselves more than once. We made three measurements of the Crevice Pit; one was by ordinary line and plummet; another was by tying a large stone to the line, as a bob that would jump the ledges, and make it impossible to mistake the paying out of the line for the pull of the weight; the third way was by attaching a lard oil lamp by wires to the line, and watching the light till it reached the bottom. Finally, by going around through Spark's Avenue to the Mammoth Dome, we made sure that our weights had properly landed.

The line was then measured by a steel tape, the result being that the pit is 89 feet deep, instead of 280. Even if we add to this the estimated height of Klett's Dome, the entire vertical opening cannot exceed 150 feet. I am thus minute as to methods, because we took similar pains in measuring the other pits. There is no question as to the peril of the task. The depths of some of the pits may here be given, as determined either by Dr. Call, Mr. Ben Hains, or myself.

The so-called bottomless pit, as measured by me, is exactly 105 feet deep, although commonly said to be 173 feet in depth. The covered pit, instead of being 120 feet, as formerly stated, was found to be but 54 feet deep. Garvin's pit is 95 feet deep, with a dome above it 35 feet high. My measurement of Scylla made it 135 feet deep; but I suspect that slack line was paid out, as its twin pit, Charybdis, was proved to be but 89 feet deep. Dropping a line from the "window" of Gorin's Dome, where tourists usually look, I found it 88 feet down to the floor. From the new bridge across the summit of the dome it was 105 feet to the stream flowing at the bottom. While thus casting my lines from above, Dr. Call and his guide went down a sort of natural well and saw that my weights had touched the floor. They then distributed lamps at advantageous points, as we did from above; and the guides flung numerous fireballs, with great skill, so as to alight on different ledges. Thus we contrived to illuminate the entire dome, as it had never been done before, and the effect was splendid beyond description. The Long Route ends in a pit called the Maelstrom, stated to be 190 feet deep by W. C. Prentice, who descended into it, and 175 feet by Dr. Forwood. But as measured by Mr. Hains, by a cord knotted at every five feet, and allowing for the stretching by the plummet, it is 98 feet deep. We do not question the veracity of others, but allow for their mistakes in taking measurements where the experimenter is liable, by one careless step, to follow his plummet down into the frightful abyss.

The subterranean rivers have, of course, been an important factor in making the Mammoth Cave. One who sees them at their lowest stage in the summer months, and floats over them at leisure, awakening their wonderful echoes, has no idea of their tremendous volume and force during winter and spring. I have been in the cave when the Dead Sea, Lake Lethe, the river Styx, Echo River, and the Roaring River were all combined into a mighty stream fully two miles long, as known, and how much further it flows into inaccessible channels nobody knows. Its depth at such times is at least 100 feet in the deepest places, and it sets back into the large pits already mentioned. Moreover, this great flood has a powerful current that makes any attempt at its navigation dangerous. The guides have told me of their narrow escapes from having their craft swept under overhanging ledges, or swamped where there was no shore. What are called the upper and lower big springs, in the cliffs of Green River, are wholly insufficient to serve as the main exits for these pent-up waters. About five miles below them a mighty stream gushes from the rocks with force enough to stem the current of Green River to its opposite bank; but unfortunately it is on the wrong side of the river, unless passing through a tunnel before it gets there, of which we have no proof. These subterranean rivers are, after all, the chief cave makers. They hollow out the long horizontal passageways, swaying to and fro like liquid battering rams, hammering down the weakened walls, and undermining the arches, thus making the successive tiers, or galleries, for which the cave is noted, many of which, having been deserted by the waters long ago, like the upper gallery called Gothic Avenue, are extremely dry. And yet, even in the walls of these broad avenues, we frequently find the deep vertical grooves, proving that there were also pits and domes, of which these are the only remaining traces. Thus our conclusion is established that Mammoth Cave was made, not by earthquakes, nor by whirlpools with pebbles for teeth, but almost solely by the chemical and mechanical action of water.

Prof. Andrée's Arctic Trip.

Advices received at Hammerfest, Norway, on August 6, say that Prof. Andree has completed the inflating of his balloon, and is awaiting a favorable wind to start on his journey toward the pole.

The following letter has been received from M. Andrée by Prof. Retzius at Stockholm:

PIKE'S HOUSE, DANE'S GATE, June 27.

DEAR FRIEND: At this moment forty pens are scratching on board the Virgo, for to-day a steamer arrived bound to Frefjorden, which is to take our letters. I take this opportunity to tell you and your wife that everything is going on well here. After having searched only one day we found a good spot for our balloon house, and we are now occupied in putting it up. It lies on the northern side of the Danish Islands. We have there sufficient space, good protection against storms, and a good landing place. The hydrogen apparatus has already been put on shore, and with this the most difficult part of the landing has been finished. The barrel of sulphuric acid has held out excellently. We can now examine the balloon a little better, and it seems to be in very good condition. Capt. Nilsen, who since the middle of May has been sailing about here, says for thirty years he has not seen such favorable ice. All on board are in the best spirits. Need I add more to convince you that the whole expedition feels very comfortable, and that no apprehension or care oppresses us? If everything goes on in the same manner for the next three or four weeks to come, we shall then set out for our expedition to the North Pole, and to none of us the idea occurs that we may meet serious difficulties. Strindburg and Eckholm are occupied with magnetical and cartographical examinations, and have begun a map of the Danish Islands. The snow shoes did good service, for they prevented us from sinking in, though the snow is at several spots meters deep.

Rogers Peak Ascended.

A despatch from Glacier, British Columbia, announces the first ascent of Rogers Peak, the highest part of the Hermit Range of the Selkirk Mountains, by Prof. C. E. Fay, of Boston, and his party. This is Prof. Fay's second season among the Canadian Rockies and Selkirks.