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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 LESSON FROM THE LEWIS AND CLARK FAIR.

The city of Portland, Ore., is to be congratulated on the fact that in the highly successful Lewis and Clark Fair, recently closed, it has proved that by the exercise of careful forethought and good management it is possible to carry through one of these national expositions as a paying proposition, and turn over a cash dividend to the stockholders at its close. No doubt one secret of its success is to be found in the fact that the Fair was planned on a scale commensurate with the present stage of development of the Pacific Coast, and that a conservative estimate was made of the probable number of visitors. That the gate returns should have shown a total admission of 2,500,000 is a highly creditable result, and particularly so when we bear in mind that the total population of the State in which the Fair was held is less than one-fifth that number.

We have long been of the opinion that these national expositions have grown altogether too big and cumbersome. The two elements of bulk and acreage, which have been blazoned as their chief glory, are really their chief defect, and the bane of every weary pilgrim that has toiled through their miles of boulevards and plazas, or plodded through aisles of interminable length and oppressive monotony. When such Brobdingnagian buildings as those of the St. Louis Fair are scattered over two square miles of territory, it is clear evidence that the builders have lost all sense of proportion; for only a race of giants, striding ten feet to our one, could cover such an exposition with any degree of comfort, or in any reasonable time.

If we make our future expositions smaller, we can fill them with more select exhibits. The commissioners will be more concerned about the quality and less about the quantity. Where such an enormous building, for instance, as the Agricultural Palace at St. Louis is put up, it becomes a problem how to fill it; for on a floor space measuring 500 feet by 2,000 feet, there are bound to be whole acres of stock exhibits which are simply repetitions of other acres similarly filled.

Nor are such vast proportions necessary to produce the desired architectural results. If the St. Louis buildings and grounds had been scaled down nearer to the proportions of those at Portland, the effects (landscape, architectural and illuminative) would have been scarcely less striking, and the proper acquaintance and appreciation of them would not have entailed such mental and physical exhaustion. Furthermore, a reduction in the scale of future world's fairs would not only serve to get rid of many miles of stock exhibits, such as may be seen in a day's walk through any large city's business center, but it would bring the first cost and operating expenses down to a point at which, as in the Lewis and Clark Fair, the customary deficit would give place to a cash dividend.

LONG-SPAN BRIDGES OF THE WORLD.

It is surely a sign of the great magnitude of the engineering works of the present day, and the multiplicity of such works, that the magnificent bridge which is being thrown across the St. Lawrence at Quebec should have attracted so little public attention. Time was, and not so very long ago, when the spanning of a broad river or estuary like the St. Lawrence or the Firth of Forth, held the attention and commanded the admiration of the whole world. It was thus when the Roeblings spun that seemingly delicate cobweb of wires across the East River, New York, which is now world-famous as the Brooklyn Bridge. It was so when, a few years later, Sir Benjamin Baker and his associates boldly set out to build a double-track steel highway across the stormy Firth of Forth, a few miles above Edinburgh, announcing that they intended to cross the channel in two bold leaps each of 1,710 feet, with the historic Inchgarvie Island as a single intermediate stepping-stone. In each case, the work of building these monumental engineering structures was followed in its successive details with absorbing interest, from the sinking of the huge caissons and rooting them to the solid rock far below the river bed, to the erection of the giant towers and the stringing of the airy cables, or flinging out the giant cantilever arms to join hands in midstream, nigh upon a thousand feet from the points of support.

Bridge building upon a Titanic scale was a novelty in those days, and comparatively novel also were the sinking of wooden or steel caissons through water and underlying mud and sand to a rocky bed, and the outbuilding of gigantic trusses, hundreds of feet beyond their point of support without the aid of temporary falsework or scaffolding. Familiarity, however, even in engineering works of great audacity and difficulty, breeds the inevitable contempt, and hence it is that the spanning of the St. Lawrence has awakened an interest that is almost purely academic and confined largely to the technical press and to the limited circles of our engineering societies.

The great cantilever bridge which is now being built across the St. Lawrence River at Quebec will include the largest single span ever erected in the history of the world. It is well understood among engineers that the true test of the magnitude of a bridge is not its total length as made up of many individual spans, but the length of the individual span itself, and in this respect the Quebec Bridge is preeminent. It reaches across the St. Lawrence River in a single span of 1,800 feet. This is nearly 100 feet greater than the spans of the Forth Bridge cantilevers, which measure 1,710 feet in the clear. Next in length is the Williamsburg suspension bridge, which is 1,600 feet in the clear, and then follow the Brooklyn Bridge, 1,595 feet, and the new Manhattan Bridge adjoining it, which will be 1,470 feet in the clear. Had the various railroads which have their terminals in Jersey City shown the same liberality and zeal displayed by the Pennsylvania Railroad Company a few years ago, there would now have been under construction, across the North River, a colossal suspension bridge, which would have far exceeded in size and importance the great bridges above mentioned. We refer to the North River suspension bridge, designed by Gustav Lindenthal, which would have crossed the North River with a single span 3,100 feet in length between the towers, and would have measured 7,340 feet over the anchorages. The cables, each 8 feet in diameter over the outer covering, would have carried a triple-deck suspended structure, with a promenade on the upper deck, six railroad tracks on the middle deck, and eight railroad tracks on the lower deck; and over this single structure it was intended to have brought in all the traffic of the Jersey roads to a single station in the heart of Manhattan. The four towers carrying the cables would have been 550 feet in height, the same as that of the Washington monument. This wonderful structure came very near to being built, and had the work been put through it would have constituted the noblest work of engineering in this or any other country in the world.

Although the new St. Lawrence Bridge will exceed our East River bridges in total length of span, it will not compare with them in the magnitude of the traffic that it can carry. Its total width of 75 feet is not much more than half that of the Williamsburg Bridge, which measures 120 feet over all and provides two 18-foot roadways, four trolley tracks, two elevated tracks, two passenger footways, and two bicycle tracks. Even greater than this is the capacity of the new Manhattan Bridge which, on the lower deck, provides for four lines of street cars, two passenger promenades, and a broad carriageway 35½ feet in width, and also carries on the upper deck four elevated railway tracks. The total width of the floor of this bridge will be 122 feet.

As the St. Lawrence Bridge is the first cantilever structure that compares in magnitude and length of span with the Forth Bridge, the latter forms the proper basis of comparison. At the time that it was constructed the engineers, who were responsible for its design, had absolutely nothing to guide them in the way of long-span railroad bridges, since nothing approaching the proposed bridge in magnitude had hitherto been constructed. In determining what section to use for the members of the cantilevers, it was decided to use the tubular section, for the reason that it presented the stiffest and strongest form for a given weight of material. It was also decided, in view of the fact that abnormally high wind stresses had to be provided for (56 pounds to the square foot), to give a very pronounced batter or inclination to the towers and cantilevers. Both of these features added greatly to the labor and cost of construction. In the interim since the building of the Forth Bridge, we have learned that wind-pressures on long-span bridges are much less than was supposed, being, indeed, scarcely half as great. Moreover, steel mills can now furnish rolled rectangular steel in sizes which were not obtainable when the Forth Bridge was built. Consequently, the St. Lawrence bridge is being built with its cantilevers and towers in vertical planes, and the materials used are entirely of standard shapes, such as can be rolled in the mills. Instead of the 12-foot tubes of the Forth Bridge, we have built-up lattice chords and posts and 18-inch eye-bars in the Quebec Bridge, and the combined result will be a structure relatively lighter and cheaper to build, and of unquestionably more graceful appearance than the far-famed bridge across the Firth of Forth.

LIFE ON OTHER WORLDS.

The recent utterances of the venerable Dr. A. R. Wallace, fellow-discoverer with Darwin of the origin of species, tending to show that our earth is the only body in the known creation suited for life such as we find it here upon the globe, has awakened a wide interest among progressive scientists. It is recognized by all who keep up with the thought of the age that evolutionists are not so sweeping in their claims now as they were a quarter of a century ago, when the Darwinian theory was new.

Dr. Wallace is now a very old man, and like Lord Kelvin, he seems to find a Providential design in the arrangement of the material universe. It is perhaps true that the very greatest and best-balanced minds of all ages have inclined to such beliefs, and yet in recent years the progress of applied science has been so sweeping and her voice so omnipotent that many persons have shared Tyndall's views of testing the efficacy of progress by experiment. The difficulty is that such tests could never be carried out satisfactorily.

Now, when Dr. Wallace asserts that our earth is the sole abode of life in the universe, a renewed interest springs up among scientists. One school claims that he is old and in his dotage; the other, that he has become wise in his old age.

Astronomers can see with a great modern telescope at least 100,000,000 stars in the entire universe. The question arises, "How many other bodies like our earth exist in space?" Prof. T. J. J. See, of the United States navy, claims that the study of the double stars rather supports Dr. Wallace's contention. In 1896, Dr. See published a work on the orbits of all the double stars which could be determined at that time, and he found the double stars so different from the solar system that he says no other system like that to which the earth belongs is known to exist in the heavens. The double stars revolve in orbits of high eccentricity, and the two members of a system are usually equal or comparable in mass; while our planets move in very circular orbits, and have masses which are infinitely small compared to that of the sun, about which they revolve. The result is that our planetary system affords equable conditions of heat and light, such as organic life requires, while the system of the double stars would furnish such great changes of light and heat that life could not survive on a planet attached to a member of a double, such as Sirius or Procyon.

The sun has a mass 746 times greater than all the planets combined, and this makes him an autocrat over the planets, whose motions he dominates absolutely. The double stars are in reality systems of double suns, and mathematicians claim that a planet could not move safely and quietly in such a system—that it would sooner or later come into collision with one of the stars, or be driven from the system never to return, in either case destroying the chances of organic life. The number of dark bodies in the heavens is immense, and, of course, it is possible that some of these may afford conditions suitable for organic life; but up to this time, astronomers are unable to point to a single body of this kind outside of our solar system. This in a measure supports the contention of Dr. Wallace.

Speaking of dark planets attending the stars, Dr. See writes in a recent publication as follows: "If such inconsiderable companions as our sun possesses attend the fixed stars, they would neither be visible nor could they be discovered by any perturbations which they might produce. It is, therefore, impossible to determine whether the stellar system includes such bodies as the planets, and we are thus unaware of the existence of any other system like our own. On the other hand, the heavens present to our consideration an infinite number of double systems, each of which is divided into comparable masses. These double systems stand in direct contrast to the planetary system, where the central body has 746 times the mass of all the other bodies combined.

In binary stars, the mass distribution is essentially double, while in the solar system it is essentially single; whether observation will ever disclose any other system of such complexity, regularity, and harmony as our own is an interesting question for the future of astronomy.

It thus appears that so far as telescopic research has yet extended, we know of no other world suited for life outside the solar system. For some reason, our system appears to be absolutely unique in the known creation; but of course astronomers are too conservative to say that no other like it will ever be discovered.

But they seem to think that our earth is very much the best abode for life ever discovered by astronomers. Mars is the only other heavenly body yet known, with conditions approximately adapted to the maintenance of life such as we know it upon the earth; and it is probable that if a strong, healthy man could be suddenly transported to our sister planet, he would be able to breathe and live there for a time. It has a rare atmosphere, water, snow, and ice, day and night, and seasons very much like those upon the earth. But, of course, it is not possible to say that man could flourish on a planet like Mars any more than he can flourish on the tops of the highest peaks of the Andes or Himalayas.

THE FIRST TOOLMAKERS AND THEIR METHODS.

Of man's existence during the geological period known as the Quaternary, or diluvial, we have evidence in his exhumed bones as well as in his flint implements. The latter bear obvious and unquestionable marks of human workmanship and, in most instances, are specialized, or made for certain definite uses. From their varying character this long period has been divided into the palaeolithic or earlier stone age (*époque de la pierre taillée*) in which the tools are merely rough chips or splinters of flint, and the neolithic or later stone age (*époque de la pierre polie*), in which the flint implements are well finished and smooth. In recent years there have been found in still older or Tertiary strata objects of flint in which the evidence of human workmanship is so slight that when Bourgeois, in 1867, first exhibited them as proof of the existence of man in the Tertiary period, he was simply laughed at.

Therefore, as Virchow has said, the question of the existence of the Tertiary man resolves itself into the problem of discriminating between natural and artificial forms of flint. The methods employed by these primitive toolmakers are also of general interest because, to the uninitiated, their selection of so hard a material as flint, and the possibility of working it at all with their crude appliances, must appear incomprehensible.

But, though flint is very hard, it is also very brittle. It is easily broken by striking or pressing, even with a much softer substance, and the resulting fragments possess sharp points and edges which make them suitable for use as spear heads and cutting tools in general. Glass, and the comparatively rare mineral obsidian, have properties much like those of the widely-distributed flint, and both, as we shall see, have been put to the same uses. In this way gunflints were made in quite modern times. A good workman, armed with an iron hammer, could turn out several hundred in a day.

But the diluvial and Tertiary men did not possess iron hammers. Their probable methods of working flint may be inferred from those of races whose stone age has continued to the present day. Such are the natives of Australia, Papua, Alaska, and Tierra del Fuego.

The Australian holds the flint between his feet and strikes it repeatedly in the same direction, but not violently, with another stone, obtaining sharp and slightly-curved splinters of various lengths, suitable for knives and arrow heads. Edward Krause, probably the highest authority on the subject, has seen and described the methods of both Alaskan and Fuegan toolmakers. The Fuegans preferred broken bottles as material, employing flint only on request and reluctantly, because it is harder to work than glass. The piece of glass was first rough-hewn to shape—with the assistance of the teeth in some cases—and then finished with the aid of a tool made of walrus bone. The Alaskan Eskimos use a tool made of reindeer horn, with a handle of fossil ivory, which abounds in Alaska. When great pressure is required the end of the handle is put to the shoulder.

Krause's explanation of the action, in both cases, is that the soft tool is first indented by the sharp edge of the flint or glass. Then, as the tool is moved along the edge with a constant outward pressure, a splinter is forced off. Krause himself succeeded in splitting glass with a tool of hard wood.

At the time of the Spanish conquest of Mexico, the Aztecs, who were still in their stone age, worked obsidian in a similar manner. Torquemada describes the process as follows: "The Indian cutler holds a piece of obsidian, about eight inches long and as thick as a man's leg, on the ground between his feet, or in tongs or a vise, and with hands and breast forces against it a stick of wood with a rounded end. The great pressure breaks the stone, yielding a sharp, pointed knife, the edge of which is the original edge of the stone."

We may assume that the men of the European stone age made their flint implements by methods similar to these. The implements bear characteristic marks of blows or pressure. On the inner surface of the splinter appears a slight, rounded elevation, the *bulbe de percussion*, and the surface of the flint nucleus, or remnant, shows a corresponding depression. The little nicks, or *retouches*, made by blows or pressure on the edges of the fragments are still more characteristic. The recent researches of Rutot, Krause, and Klaatsch have proved that these marks cannot be simulated by simple fractures or by the effects of heat, cold, or water.

Many exceedingly crude flint implements, called "eoliths," have been found in the oldest diluvial strata in Belgium, France, Germany, and Egypt. Rutot, Klaatsch, and Capitan have found numerous eoliths, also, in Tertiary strata in France and England.

In order to put the existence of the Tertiary man beyond all doubt Dr. Max Verworn has been making extensive explorations near Aurillac, in Auvergne, where Capitan and Klaatsch have recently worked with success. In a paper read before the Anthropological Society of Göttingen, on June 30, 1905, Dr. Verworn gave an account of his investigations, the complete report of which will shortly be published by the Royal Scientific Society of Göttingen, which financed the undertaking. The strata explored are defined as belonging to the upper Miocene, or lower Pliocene, by the occurrence in them of bones of the dinotherium and the hipparion (a progenitor of the horse). Of the many flints exhumed, from 16 to 30 per cent (in various localities) showed unquestionable marks of human workmanship, and only from 15 to 20 per cent were as certainly not worked.

The large proportion which remains as doubtful is explained by the fact that Verworn accepts only the combination of the face marks with the edge marks already mentioned as incontestable evidence of human workmanship.

Many of the pieces show the typical elevations on one face and depressions, or "negatives," on the other, with very numerous marks, parallel and made by blows in the same direction, on one edge or side, while the remaining edges are very sharp. Nuclei, or flints from which chips had been taken, were also found.

It appears, therefore, that there lived in Auvergne, at the end of the Miocene, a race of beings whose skill in toolmaking implies a period of development which carries the first approximation to humanity back to a far remote antiquity. No remains of these creatures have come down to us. We do not know whether they made use of clothing, fire, or articulate speech, whether they may fairly be regarded as men or only as the ancestors of men.

LITERATURE FOR CONVALESCENTS.

For reading during convalescence the British Medical Journal would prescribe literature that cheers but does not inebriate, and would contraindicate writers "whose style, like that of George Meredith, puts a constant strain on the understanding of the reader, or, like that of Mr. Maurice Hewlett, irritates by its artificial glitter, or, like that of Marie Corelli, annoys by its frothy impertinence." Dickens should go well during convalescence—except "Pickwick," at least in surgical cases, because of the many side-splitting episodes which would play havoc with the union of parts. And for the same reason, in order that healing granulations may not be interfered with, we would absolutely interdict Mark Twain. Smiles's "Self Help" is quite innocuous; but we should be cautious in recommending it, in order that the patient may not thereby be led to meditate over a misspent career, and to have suggested to him all the opportunities in life he might have grasped but did not. A despondency might thus be induced which would delay a restoration to health, and which might even prove fatal. Thackeray (except "Vanity Fair," which is a pessimistic book) should go very well; "Pendennis" and "Barry Lyndon" will certainly entertain. The magazines of the day are placid and cheering enough; and in them one will seldom come upon a story sufficiently original or vigorous to excite anybody. Punch will, of course, be always in order—for its humor is of the soothing sort, which never arouses one's risibilities, but keeps him always within the decorous limits of a smile.

TWENTY-FIVE ELECTRIC LOCOMOTIVES FOR N. Y., N. H., AND H. R. R. CO.

An order for twenty-five electric lomotives has been placed with the Westinghouse Electric and Machine Company by the New York, New Haven & Hartford Railroad. These will be driven by alternating current, single phase. Each locomotive is to weigh 78 tons, and is to be equipped with four motors, each of 400 horse-power, making a total of 1,600 horse-power for each locomotive. This is 600 horse-power greater than steam locomotives in present use.

The motors will be able to maintain a speed of 26 miles an hour in local service, reaching a maximum speed of 45 miles an hour between stations, and hauling 200 tons. In express service a speed of 60 to 70 miles an hour can be maintained with a train weighing 250 tons.

SCIENCE NOTES.

A boiler furnace, as is known, works best when as little heat as possible escapes through the chimney. To some extent, says Technische Berichte, this escape is unavoidable, for if all the heat were utilized, the chimney would not draw, since it is the heat in the chimney which first produces the draft in the furnace necessary for burning the fuel. Nevertheless, too much heat escapes by the chimney in most cases. A patent recently granted professes to rectify this defect by bringing the flue containing the products of combustion to the place where the steam is applied before it passes into the chimney. The air, steam, or hot water and feed pipes are passed through this flue, so that the heat contained in the gases of combustion prevents radiation from the pipes in question and contributes to the heating of the air, water, and steam.

There are interesting and suggestive symptoms of a wholesome reaction against the evils of the sedentary life. Parks and open spaces are being liberally provided; public and private gymnasiums are rapidly coming into being; public playgrounds are thrown open in many of our cities, free of expense to the laboring, but, nevertheless, often sedentary, population; vacations are more than ever the fashion; sports and games are everywhere receiving increasing attention; while public baths and other devices for the promotion of personal hygiene are more and more coming into being. All this is as it should be, but all is as yet only a beginning. Here the science of education is sadly at fault, and in the direction of educational reform as regards personal hygiene lies immense opportunity for a contribution to public health science.

The growing of grapes in graperies furnishes quite a source of revenue in some countries, notably Belgium and the Channel Islands, where large quantities are annually grown and exported, the United States being a good customer for them, as high as 35 cents to 75 cents per pound wholesale, and $2 to $3 and even more per pound retail, being paid for the fruit. Grape growing in pots is much practised and in parts of Europe, and especially in France, where these are largely used for decorative purposes on festive occasions. The keeping of grapes in cool storage is deserving of more extensive practice and development. Shipping and keeping grapes in cork dust is quite an industry in some of the European grape districts, and a considerable quantity of such grapes, shipped from Spain, is annually consumed in this country.

If electric phenomena are different from gravitative or thermal or luminous phenomena it does not follow that electricity is miraculous or that it is a substance. We know pretty thoroughly what to expect from it, for it is as quantitatively related to mechanical and thermal and luminous phenomena as they are to each other; so if they are conditions of matter, the presumption would be strongly in favor of electricity being a condition or property of matter, and the question, "What is electricity?" would then be answered in a way by saying so, but such an answer would not be the answer apparently expected to the question. To say it was a property of matter would be not much more intelligible than to say the same of gravitation. At best it would add another property to the list of properties we already credit it with, as elasticity, attraction and so on. In any case the nature of electricity remains to be discovered and stated in terms common to other forms of phenomena, and it is to be hoped that long before this new century shall have been completed, mankind will be able to form as adequate an idea of electricity as it now has of heat.

THE CURRENT SUPPLEMENT.

The current Supplement, No. 1556, opens with a splendidly-illustrated article on a vertical rolling-mill 18,000-horse-power engine, the largest of its kind that has ever been built. Among the many means that contribute to the evolution and better performance of machines, and that determine their endurance and economy of construction, there is one, sometimes ignored and in all cases underrated—the phenomena of their operation, which are not computable or learned by rule. This subject has been very interestingly treated in a paper by Mr. John Richards. A protected galvanometer is described and illustrated. Mr. J. H. Morrison's history of the iron and steel hull vessels of the United States is continued, the period of 1840 to 1860 being discussed. Mr. H. Percy Ashley tells how an improved ice yacht may be constructed. His article is accompanied by elaborate working drawings. Sir William H. White's sixth paper on submarines is presented. "How Our Senses Deceive Us," is the title of an article by Dr. Horace Wilson, in which many a curious bit of information is given. Prof. Richter writes entertainingly on the inhabitants of a piece of moss. Dr. Hugo de Vries, the man who gave us the mutation theory of the origin of species, a theory which is very likely to supplant that which has been advanced by Darwin, writes on the evidence of evolution in a way that cannot but impress even the reader who is not particularly interested in biology.