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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.

ELECTRIC TRACTION TESTS AT THE WORLD'S FAIR.

One of the most valuable features of such great industrial exhibits as that now being held at St. Louis is the series of elaborate tests of machinery and general industrial appliances. These are carried out by boards consisting of some of the best-known experts in their respective departments; and the special facilities afforded, the magnitude of the plants upon which the tests are made, and the abundance of time available, render the results of the highest scientific and commercial value. Among the most elaborate of these tests are those that have been projected by the Louisiana Exposition Commission in connection with electric traction. These are to be divided into three classes. First, those which will be made in the Electricity Building; secondly, those made on special tracks laid for the purpose within the Exposition grounds; and lastly, a series of trials which will be carried out on a lengthy stretch of line outside of the grounds, to throw further light upon the question of high-speed traction. The experiments are intended to cover in a very complete way the equipment and operation of city and suburban railroads, of interurban roads, and the operation of heavy standard trains, such as run on the trunk railroads of the country. The tests that are made within the Electricity Building will be, to all intents and purposes, shop tests, the various materials and plant selected being subjected to the same inspectors and controlled by the same rules—an arrangement which will make it possible to co-ordinate and compare results in a thoroughly scientific and satisfactory manner. The tests carried on outside the building are to be made under actual operative conditions. It is expected that all the great electrical manufacturing companies will be represented, and a more complete collection of electrical plants and apparatus will be gathered together than was ever before assembled. It is hoped to supplement and carry to an even more advanced point, the valuable high-speed electrical tests made last year on the Berlin-Zossen line, when, it will be remembered, a speed of over 130 miles an hour was recorded.

TURBINE OCEAN STEAMERS.

Although the construction of the great turbine-propelled liners for the Cunard Company overshadows in public interest every other marine turbine development just now, it is a fact that there will be some splendid specimens of turbine ocean liners in service on the high seas long before the Cunard vessels are in the water. Mention should be made incidentally of the "Turbinia," which was launched not very long ago in Great Britain, and will soon cross the Atlantic for service on Lake Ontario. Before many weeks a large ocean steamer, the "Tasmania," will be dispatched to Australia, and the Allan Line will place two turbine-driven liners in the Atlantic service of the company. Next year, moreover, a turbine-driven Cunard steamer of about half the tonnage of the 25-knot 40,000-ton turbine ships will be plying between Liverpool and the United States. Considering that the practical turbine is but a decade and a half old, this must be considered a remarkably rapid development of what is commercially considered an entirely new type of steam engine.

NEW SYSTEM OF TUNNEL CONSTRUCTION.

Probably the most original piece of engineering work along the whole route of the Rapid Transit Subway is the tunnel which is being built beneath the Harlem River. The method adopted is, as far as we know, entirely new in a work of this character, and, like many another development in engineering, it is the outcome of local conditions of extreme difficulty which demanded some other methods of construction than those commonly adopted. These conditions arose from the comparatively shallow depth at which it was necessary to build the tunnel in order to avoid excessive grades at the approaches, and the extremely treacherous nature of the material encountered at this depth. The silt is so loose that tunneling by the Beach shield system would have been very hazardous, if not, indeed, altogether out of the question, and accordingly the contractor, Mr. D. D. McBean, hit upon the plan of driving two parallel lines of sheet piling, spaced a little wider apart than the width of the completed tunnel; bulkheading each end of the structure; and covering it with a heavy water-tight timber roof, the interior being then pumped dry of water, and the inclosed mud excavated down to grade under the pneumatic system. This was the method adopted in crossing the first half of the river on the Manhattan shore. For the second half the contractor followed the same principles of construction, but made a considerable advance in point of rapidity and cheapness of erection, by driving the two parallel walls of sheet piling, cutting them off at the level of the longitudinal axis of the tunnel, building the upper segmental half of the cast-iron lining in lengths of 70 to 80 feet upon pontoons, floating it over the sheet piling, lowering it until its flanges rested upon the piling, with which it made a water-tight joint, and letting this finished half of the tunnel serve as the roof of the temporary cofferdam. When the water is pumped out the mud is excavated to grade, the lower half of the cast-iron shell is built in place, bolted to the upper half and calked, and the tunnel is completed.

There can be no question of the economy of this method of construction over that which it supersedes; and it has the great advantage that the tunnel may be built with its upper surface practically at the highest line allowed by the War Office in navigable waterways. The vertical stability of the tunnel, a question which is causing much anxious thought on the Pennsylvania tunnel, is assured by driving along the line of the tunnel as much piling as is necessary to support the structure, this work being carried out before the lateral walls of sheet piling are put down. The question of the applicability of this system in the construction of tunnels across the East and Harlem Rivers would hinge upon the amount of interference to navigation that would be caused by the temporary staging platforms that would be necessary during the construction of the various sections of the tunnel; but it would seem that these stagings might be so widely separated as to cause but little interference with navigation.

OUR AVAILABLE IRON-ORE SUPPLY.

The falling off in demand for iron ore and iron-ore properties last fall, incident to the slackening of general business and the curtailments by the iron manufacturers, principally the United States Steel Corporation, has in a measure obscured the real facts as to the relation of consumption to available iron-ore supply and put a damper on the wild rush for iron properties which prevailed in 1901 and 1902. The sagging in the iron trade has not changed the facts, nor have there been made within recent years any discoveries of available iron ore that will materially postpone the day when the great iron industry of the country is to be brought face to face with the problem of supplying the vast and increasing amount of ore annually consumed. About five years ago, U. S. Geologist C. R. Van Hise predicted that inside of a decade the standard of marketable ore from the Lake Superior district would be between 50 and 60 per cent of iron content, instead of over 60 per cent, the then prevailing limit. The condition has been realized in less than half a decade, and there is a prevailing opinion that an even lower standard for merchantable ore in the Lake Superior country is even now at hand. Considerable ore between 40 and 50 per cent in iron was mined at Ishpeming (Michigan) last year, and iron men no longer look away from the "low-grade" properties as formerly. This lowering of the standard has increased the available supply considerably. It has been due partly to the advantages of cheaper mining and transportation and improvement in furnace practice, but it is a certain indication of the realization by the iron consumers that there is a limit to the amount of high-grade ore in the Lake Superior district. The chief consideration in the situation is the Lake Superior supply, since from that district in 1902, 79 per cent of the iron ore production of the United States came, and in 1903 an increasing proportion. The older eastern and southern districts do not hold any large ore reserves, and the newer districts are as yet all uncertain or unavailable.

From the standpoint of the Lake Superior supply, an interesting estimation as to the available iron ore of the whole country can therefore be drawn. Estimates made by the United States Geological Survey in 1902 of the amount of merchantable ore in sight, that is ore above 59 per cent in iron, give the ore reserve in the Mesabi district as 500,000,000 to 700,000,000 tons. The aggregate of ore in sight in all the other Lake Superior districts is placed at 350,000,000 tons. Explorations since this estimate was made have not materially increased these reserves. It is fair then in the light of the present known facts about the iron-ore supply in the Lake Superior districts to place the available reserve at 1,000,000,000 tons of 59 per cent ore. With this as a basis and the figures of annual consumption as a measure, the time of the exhaustion of these iron-ore reserves can be estimated. The production of the Lake Superior mines in 1890, 1901, 1902 averaged about 8,000,000 tons; in 1893 it fell to 6,000,000. Since that time it has increased at about 2,500,000 tons a year. The production in 1902 was 27,869,000 tons, and in 1903 24,300,000 tons, to use round figures. Take this as indicating a present yearly demand for 25,000,000 tons, and allowing for no increase, the visible ore would be exhausted in forty years. Allowing for an average annual increase of five per cent, which is a fair increase deduced from the years since 1899, and is within the estimated general increase of business for the country, not allowing for the yearly enlargement of the uses of iron in all lines, it can be arithmetically computed that the available ore estimated will be all exhausted in twenty-three years!

On the other side of the question is the possibility and probability that iron ores below 59 per cent will be utilized in the near future. This will largely increase the available supply, but how much cannot be estimated, as these "low-grade" ore bodies have not ordinarily been explored. Then there is a fair certainty that new ore bodies will be located within the districts now worked for ore. These new bodies cannot be very large, nor can they affect the supply in any such manner as the finding of the Mesabi, for instance, did; but these undiscovered ore bodies are to be considered as a factor in the problem of ore supply. There is also a chance that new iron districts will be opened in this region. The new Baraboo district in Wisconsin, though not up to predictions, has added perhaps 7,000,000 tons to the available ore. Explorations in Canada on the Anticoken range and on the western extension of the Mesabi give some promise of new sources of supply. The recent discovery of a new iron district in Aitkin and Crow Wing counties in Minnesota may be of importance. These new districts, however, have not, since the discovery of the Mesabi in 1893, come up to the expectations. Notably has the Michipicoten district in Ontario failed to realize the hopes of its discoverers. The other iron ore deposits in eastern Ontario are uncertain as to extent also.

So we have a possibility that within a quarter of a century the Lake Superior mines will be unable to meet the demands for a high-grade ore.

The western deposits are a factor in the future, but most of these are at a disadvantage as to transportation. In fact, they are all cut off from the eastern consumption by the necessarily high freight costs. The consumption of iron produced in the western furnaces may supply the local demands, and relieve the demand on eastern furnaces to this extent. It is generally believed that these western deposits are not generally so extensive as claimed, and further that with depth the ore will become valueless, by reason of the increasing sulphur content from the sulphides from which all of these ore bodies, except perhaps those in Wyoming, are derived. The iron ore in Mexico may be an important factor at no distant date. The deposits available to the Pacific Ocean are now being secured by American capital as a supply for proposed furnaces at American Pacific ports, and an iron property near Vera Cruz is preparing to ship ore to the Atlantic ports, to be consumed with the relatively small amount of Cuban ore now imported for this market.

But the fact is, that but for the bountiful supply of cheaply mined and transported ore from the Lake Superior districts, the wonderful progress of the country in industrial lines would not have been possible, and it will be necessary to figure on the day when the Lake Superior supply will be exhausted or be of a lower grade, except as to reserves held by special interests. Since the United States Steel Corporation controls more than 70 per cent of the visible ore in the Mesabi district, all of the developed mines in the Vermilion district, 60 per cent of the Penokee-Gogebic district, and 50 per cent of the Marquette and Menominee districts, the problem for the independent consumer of ore is made more imminent than the general considerations indicate.

ON SOME NOVEL N-RAY PHENOMENA.

Prof. Blondlot actively continues his investigations of N-rays, and in a paper recently read before the French Academy of Sciences, we note some interesting facts. The author some time ago observed that sources of light under the action of N-rays would show an increase in brilliancy. Now, Blondlot thought it interesting to ascertain whether the same phenomenon occurs in the case of a body reflecting the light from an external source or from an illuminant proper. The following experiment was accordingly made: A ribbon of white paper, 15 millimeters in length and 2 millimeters in breadth, was fixed vertically to an iron-wire support. The room being darkened, the paper ribbon was feebly illuminated by a lateral beam of light emerging from a vertical slit in a box inclosing a flame. The N-rays from an Auer burner, traversing a rectangular slit in front of this slit, would strike the paper ribbon. Now, if the rays were intercepted by interposing either the hand or a lead plate, the small paper rectangle would be darkened, and its outline lose in distinctness. As soon as the screen was removed, both the brilliancy and distinctness would reappear, thus proving that the light diffused by the paper ribbon was increased by the action of N-rays.

Now, the diffusion of light is a complex phenomenon where regular reflection plays the part of an elementary fact. The author therefore thought of investigating whether the reflection of light is also modified under the action of N-rays. For this purpose a polished knitting needle of steel was placed vertically in the position previously occupied by the paper ribbon. In a box completely closed but for a vertical slit at the height of an Auer lamp (shut by a screen of transparent paper), a flame was placed so as to illuminate the slit. By placing the eye at the slit, the image of the latter formed by reflection on the steel cylinder was distinctly seen, while the reflecting surface was struck by N-rays, the action of the ray seeming to strengthen the image. Similar results were obtained when the needle was replaced either by a plane bronze mirror or a polished quartz surface. All these effects of N-rays require an appreciable time both to be produced and to disappear. On the other hand, no action of N-rays on refracted light could be observed, though various experiments in this direction were undertaken under many different conditions.

As the capacity of seeing small variations in candle power varies for different persons, these phenomena are nearly at the limit of perceptibility to some persons, who only after a certain practice will be able to observe them regularly and safely, whereas others will at once and without the least difficulty note the strengthening effect of N-rays on the candle power of a small illuminant. Now, as the author has recently observed the same phenomena with considerably increased intensity when replacing the Auer burner by a Nernst lamp, these phenomena may now be produced with such intensity as to be visible to anybody.

INDUCED RADIO-ACTIVITY AND ALUMINIUM.

BY DR. M. METZENBAUM.

It has been stated that if a sealed tube containing radium of high activity be suspended in a normal salt solution, and solutions containing various drugs, these solutions become radio-active and are capable of affecting photographic plates. It has further been intimated that if radium has a therapeutic value, then these solutions, which have been rendered radio-active, might likewise have a therapeutic action; and that since solutions can be taken internally, the possibilities of these radio-active solutions might be of considerable value. In view of these statements, I conducted a very large series of experiments, from which the following negative results have been obtained:

Two tubes of radium of 1,000,000 activity, each containing 5 milligrammes, and two other tubes of lesser activity, each containing 50 milligrammes, were placed in a normal salt solution and remained there for ten days. This solution was placed in test tubes of very thin glass and in the small vials in which hypodermic tablets are contained. These were then strapped with adhesive plaster to the film side of photographic plates. Some of the plates had first been covered with black paper. The tubes were thus maintained from a period of twenty-four hours up to twenty-one days, and in no case was there the faintest sign that the photographic plates had been affected.

It has been known for a long time that aluminium offers very little resistance to the rays of radium and radio-active substances. I therefore took many boxes made of very thin aluminium, filled these with so-called radio-active solutions, and placed them on photographic plates covered with black paper. But in no instance, even after ten days, was any image obtained.

Then aluminium boxes were filled with these solutions and placed on the bare photographic plates, and after forty to forty-eight hours a very definite outline of the boxes was obtained. Stimulated by this last observation, which I then considered a correct one, as indicating a result due to the so-called radio-active solutions, I practically completed a series of ninety-six experiments, from which I made the following inferences, which would be very gratifying if true, but as I will soon show, are incorrect:

First.—A normal salt solution becomes radio-active, as proven by the outline of an aluminium box containing this solution, when this box is placed on a bare photographic plate for forty to forty-eight hours.

Second.—A saturated salt solution becomes more radio-active than a normal salt solution.

Third.—As the amount of salt in the solution is increased, so is the induced radio-activity.

Fourth.—A tube of 10 milligrammes of 1,000,000 activity does not induce a greater amount of radio-activity into a salt solution, than does a tube of 20 milligrammes of 7,000 activity, or a tube of 15 grains of 40 activity. From this it seemed as though a salt solution could be rendered radio-active to a certain degree only.

Fifth.—The radio-activity seemed to be just as great after a tube of radium was suspended in a salt solution for ten hours, as it was after the tube of radium had been kept in the salt solution continuously for three weeks.

Sixth.—That a tube of radium could be placed in some salt, and if this salt were made into solution, it would retain its radio-activity.

Seventh.—That this radio-activity is not lost after several weeks.

If all of these inferences had not been overthrown, and if these radio-active solutions had any therapeutic action, then surely these results would have been of great value, for it would be possible to transport these solutions, or to render substances radio-active, and to apply them. A tube of radium costing a few dollars would accomplish the same result as a tube costing $250.

When these aluminium boxes were placed on the photographic plate, they produced only an outline of their rim. This I explained by the fact that they were slightly concave, and affected the plate only at the points of contact. It was also noticed, no matter what solutions the boxes contained, that there was always about the same amount of print for the same length of time. I had also noticed that distilled water, when submitted to the tubes of radium, produced the same amount of print. This caused me some doubt; for I believed it to be the solids in the solution which became radio-active. Then aluminium boxes filled with these salt solutions and empty ones were placed on the reverse side of the photographic plates. They did not affect the plates after a period of ten days.

During the entire series no aluminium box had been used more than once, for I soon observed, if a box had contained any of these solutions or any radio-active substance, no matter how much I cleaned it or boiled it, the box still affected the photographic plate, while the steel keys, which had been covered with the various uranium salts, and thorium, if they were cleaned thoroughly, would not affect the photographic plate. These boxes were always kept in a place where I considered them out of the influence of all radio-active substances.

These observations forced me to seek for an error. This action of metallic aluminium on the photographic plates I concluded must be sought for in the boxes themselves. Several empty boxes were placed on bare photographic plates, and after forty-eight hours they gave as good prints as if they had been filled with the solutions. I thought that somehow they might have been rendered radio-active. Some new boxes were then obtained and placed on bare photographic plates. After forty-eight hours these also affected the plate, as well as many other new boxes.

The next questions which presented themselves were:

First.—Is the particular product of aluminium, from which these boxes are made, radio-active?

Second.—Is all aluminium radio-active?

Third.—Is the action of aluminium on photographic plates due to radio-activity, or some other cause?

Fourth.—If this action of aluminium on photographic plates is not due to radio-activity, to what, then, is it due?

Fifth.—What action will aluminium salts have on photographic plates?

Summary: Many aluminium articles were placed on bare photographic plates, and in every instance they produced their own image in forty-eight to ninety-six hours.

The same aluminium articles, when placed on photographic plates covered with black paper, did not produce an effect on the plate in ten days. The same aluminium articles, when placed on the reverse side of the photographic plate, or when separated from the film by a plate of glass, did not affect the plate in ten days.

The summary of the experiments of placing aluminium salts, of which there are many, on bare photographic plates, is that in no instance was the plate at all affected after ten days.

The inferences to be drawn are:

First.—When metallic aluminium is placed on the bare photographic plate in the dark, it will produce its own image.

Second.—That aluminium will not affect the photographic plate, when separated from the film of the plate by black paper, glass, or when placed on the reverse side of the plates. Therefore, aluminium is not radio-active.

The action of metallic aluminium on photographic plates is probably either a chemical action or an electrical action between the metal and the albuminate of silver of the plate. This observation, that metallic aluminium when placed on a bare photographic plate produces its own image, has heretofore not been pointed out. Tubes of radium were placed in various powders, as bismuth subnitrate, for several days; then these powders were placed directly on the film of the plate, and in no instance, even after ten days, did they show the slightest effect on the plate.

These conclusions give positive proof that by suspending tubes of radium of varying strength, for long periods, in various solutions and various powders, neither the solutions nor the powders are capable of affecting photographic plates. Nor was it possible to show the supposed induced radio-activity by means of an electroscope.

SCIENCE NOTES.

M. Chevalier, the eminent French explorer, has recently returned from prolonged travel in Central Africa. He has secured a valuable collection of interesting documents and photographs of the country and its people. Furthermore, he carried on his travels a phonograph, upon which he has secured records of the languages of the various natives in the region which he explored, made by the natives themselves. These records will be reproduced by Mr. Chevalier in the course of his lectures describing his travels, experiences, and discoveries.

A French inventor, M. Heit, has devised a new type of compass, which is automatic in its action. By means of this contrivance, the direction of the compass is automatically registered minute by minute, so that by consulting the chart which is thus produced the ships' officers can ascertain the exact route traversed at any time of the passage. In the Heit apparatus the compass card, instead of having at its center an agate resting on a fixed steel point, is fixed on a steel pivot which rests on a fixed agate. The latter is immersed in a drop of mercury, which serves to conduct the current of electricity that renders the registering of the movements of the compass possible. To perform this function, a small silver index, kept in constant electrical communication with the pivot by a fine and flexible wire, is attached to the card. Normally. this index does not touch the fixed basin surrounding the card, but by means of the electrical current the circuit is rapidly closed and opened, with the result that the angle of the boat with the meridian is registered. For this purpose the basin is divided into a certain number of sections, isolated from each other and corresponding in each case to a special circuit, the registration being made on a sheet of paper by means of a spark produced by a small induction coil. The apparatus also registers the speed of the boat by recording the revolutions of the screws, at each stroke of the piston a current being closed and a signal sent to the receiver.

Mr. Percival Lowell, director of the Lowell Observatory, speaking of what constitutes satisfactory or unsatisfactory vision of the celestial bodies, says, in substance: Studies directed to that end have resulted in a knowledge of the conditions which constitute good or bad seeing. . . . The basis of the matter lies in the well-known fact that systems of waves traverse the air, several of these systems being present at once at various levels above the earth's surface. The waves composing any given system are constant in size and differ for the different currents all the way from a fraction of an inch to several feet in length. If the distributing wave be less from crest to crest than the diameter of the object glass, the image is confused by unequal refraction from the different phases of the wave; if the wave be longer than this, a bodily oscillation of the whole image results. The first is fatal to good definition, the second makes accurate micrometric measurement difficult. It is easy to make these waves visible by taking out the eyepiece and putting one's eye in the focus of the instrument when the tube is pointed at a bright light. It is further possible to measure their effect by carefully noting the character of the spurious disk and diffraction rings made by a star, and the extent of the swing of the image in the field of view. By combining the amount of confusion with the degree of bodily motion of the resulting image the definition at any time and place can be accurately and absolutely recorded. The perfection of the optical image of a star testifies to the lack of damaging currents with reference to the object glass used. It records all the waves below a certain wave length. Similarly, the amount of bodily motion registers all those above that length.

The biggest carving knife ever manufactured may be seen at the World's Fair. This monster blade is 30 feet in length and has an edge as sharp as a razor. It is made out of the finest steel, and the handle is a masterpiece of the cutler's art, elaborately carved and beautifully polished. It would take a veritable giant to wield a knife like this. The blade is altogether of American manufacture, and it is expected to show for the first time that American cutlery has now reached a point of perfection where it fears no rivalry. The giant carving knife cost several thousand dollars, and special machinery had to be made before its construction could begin. No such knife was ever before manufactured.