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FINALITY IN INVENTION.

Invention is essentially continuous and progressive. It grows partly by development from within of the original idea, partly by the incorporation of various modifications and improvements from without. There is practically no such thing as finality in invention—no stage at which the inventor may fold his hands and say, with absolute certainty, "it is finished."

The recognition of this truth has been the foundation rock upon which the majority of the epoch-making inventions of history have been built up. Few, indeed, even of the common devices and implements of life have more than a faint resemblance to the form in which they were originally conceived and fashioned. More often than not the history of their development is a story in many chapters—a record of patient experiment, careful reasoning, countless trials, many failures, a few successes, and a triumph that came with double certainty because it came by slow degrees.

Invention as a science and art (for it involves both knowledge and practice) is better understood both as to its meaning and scope than it was. Thanks to the spread of education and the more practical spirit of the age, the popular ideas on the subject are changing for the better. The field of invention is ceasing to be regarded as a kind of idealized Klondike or Cape Nome, where the happy adventurer turns up the miner's nugget without the hardship and the heartbreak of the miner's life. This mistaken view was, and for that matter is yet, answerable for a number of half-finished but inherently valuable inventions, which, for want of a little persistence, have nothing to show but a pigeonholed patent and a machine that lies neglected in the cellar. In thousands of such cases, the inventor has thrown down his tools, if not at its very threshold, at least within measurable distance of success.

Proof of the truth of what we say is to be found in the fact that no sooner has some successful invention demonstrated its commercial value, than a certain number of inventors—and sometimes their name is legion—announce that the device is old, and that ten, twenty, aye fifty years ago they "invented" that identical thing, and should, therefore, be the recipients of its profits. We venture to say that, in nine cases out of ten, these claimants are sincere, and that, if asked to, they could produce the patent from the pigeonhole, and gather up the decaying fragments of the machine from the cellar. We also venture the statement that a like proportion of them differ from the successful inventor in this, that whereas they believed that they had reached finality, he did not; and by continuing his efforts upon the lines of experiment, invention and design, he carried their crude or incomplete investigations to a successful issue.

The records of the Patent Office contain thousands of half-finished inventions which are so far valuable that, if the owners would only develop them with a fraction of the zeal and intelligence with which they conduct the ordinary affairs of life, they would richly benefit both themselves and the general public. This is proved by the fact that there are not a few inventors who find it exceedingly profitable to take up the principles of discarded inventions, and by developing a practical embodiment of the same, give them that commercial value, which, by a little patience and industry might have been secured by the original inventor.

An instructive case in point is found in the hydraulic system of air compression which is illustrated elsewhere in this issue. It is possible that some of our readers will recognize in this plant a development of the ancient method of producing a furnace blast by means of falling water. The theory upon which this system is operated is by no means new, and some of the finest steel in the world has been made in the catalin furnace with the assistance of the water-blast. Yet, in spite of the fact that many attempts have been made to render the *trompe*, as it is called, amenable to modern requirements, and that a most careful scientific investigation was made some twenty years ago in Philadelphia of its theoretical possibilities, it is only within the last few years that the *trompe*, with its low efficiency, has been developed into the present highly efficient air compressor. We quote this as one among many similar illustrations of the fact that inventions with great inherent possibilities may lie dormant in a crude and impractical form for centuries, awaiting only the attention of a scientific and practical mind to make them permanently and adequately useful.

PROGRESS AND PROSPECTS OF THE TRANS-SIBERIAN RAILWAY.

In point of magnitude and cost the Trans-Siberian Railroad is certainly the greatest engineering work of the age. According to figures furnished by the Russian Imperial Ministry of Ways of Communication, the total cost of the railway will be $500,000,000, of which about $295,000,000 has been already expended. It is considered that this lavish outlay is justified by the fact that the work, when completed, will make available the resources of a country whose wealth has never been told. The day has gone by when the word Siberia was suggestive only of barren wastes and an outlawed population. Such opening up of the country as has already been accomplished, and the reliable testimony of various explorers, have dispelled this illusion and raised a reasonable expectation that Siberia will have a future comparable only to the development which followed the completion of the railroad system of the United States to the Pacific seaboard.

The two most important sections of the Trans-Siberian road are practically completed and ready for the cars. One of these extends from Cheliabinsk in the west of Siberia to a point which is only 120 miles from the northwestern frontier of Manchuria; the other section extends from Khabarovsk to Vladivostock. These two sections have a combined length of about 3,250 miles. If to this be added the aggregate length of various branch lines which are completed, or nearly so, there is a grand total of 4,300 miles of road which will soon be placed in operation. According to the official report above mentioned, it was determined that for the present the stations and various yard buildings, and in fact, the general construction of the line above sub-grade, should be built as cheaply as was consistent with safety and the strict necessities of traffic. Light rails were put down and wooden bridges of the Howe truss type, so well known in our Western railroads, were built, the intention being to replace them with more solid construction as soon as the increase of traffic would justify it.

It seems, however, that this policy has not been as successful in Siberia as it was on our pioneer railroads in this country, for during the last year large sums of money were spent in replacing the rails with heavier steel and erecting steel bridges in place of the wooden trusses referred to. It may be that this sudden reversal of policy is due to the remarkable increase in the traffic which has taken place thus early after the opening of the line, an increase which, according to reports, has been altogether beyond expectations. According to figures published in the official guide to the Siberian Railway, the total number of passengers carried in 1896 was 160,000, and this increased to 236,000 in 1897, and to 379,000 in 1898, while the amount of freight carried had increased in two years from 169,000 tons to 484,000 tons. This increase refers only to traffic upon the West Siberian Railway. Upon the Central Siberia Railway, the number of passengers increased from 177,000 in 1897, to 476,000 in 1898, while the amount of freight carried rose from 87,000 to 177,000.

To the Russian official mind there is no doubt, whatever, that the traffic will increase at an equally rapid rate in the future. As regards passenger through traffic, the new overland route to the Far East from Europe will occupy much less time and be considerably cheaper than the sea route. The voyage from London to Shanghai, for instance, now takes from thirty-four to thirty-six days to complete and costs from $350 to $500, whereas the journey by rail between these two cities, if made at the present rate of speed, which is between twenty-three and twenty-four miles an hour on the Siberian Railway, can be made in sixteen days, or less than half the time, at a cost of $175. It is not by any means upon through passenger traffic, however, that the Siberian Railway will depend for its revenue, for it is the enormous anticipated shipments of freight from which the promoters of this road expect to realize its profits. It is expected that the freight traffic will be heavy in both directions, for not only will the opening up of railway communications between China, Japan, and Corea and the European markets lead to a large importation of European goods, but there is a considerable export trade which only awaits the completion of the railway to enable it to escape from the heavy shipping rates which at present are obtained.

The net yearly receipts from the working of the road when it is completed are estimated at a little over $4,000,000, and while this looks to be a very small return on such an enormous outlay, it is to be borne in mind that the construction of this great work was not undertaken so much with a view to commercial profits as from a desire to develop a vast region which is rich in natural resources, and to secure the military and naval advantages which rail communication will confer. In connection with the construction of the railway, systematic explorations have been made of the various great river systems which it intersects, and which form its natural feeders. Hydrographic parties have been sent out which are surveying both the rivers and that great inland sea, Lake Baikal, whose shores are reputed to be rich in mineral wealth. The government is facing the serious problem of building a railroad around the southern shore of the lake, a work which, while both difficult and costly, is absolutely indispensable to the future success of such a trans-continental line as this. The uncertainty of the winter weather on the lake would always be a serious menace to communication during the winter months.

According to the official statistics, Siberia has a total area of 5,333,333 square miles. It is liberally watered by some of the finest rivers in the world. The total area of land that is capable of agricultural development is about 20,000 square miles, and the soil of these sections consists of a deep layer of black loam. A total of about 16,500 acres of land has already been colonized, and the government is now parceling out the prairies through which the line runs, with the confident expectation that Siberia will become one of the most powerful competitors in the world's supply of wheat. For the immediate future it is expected that the new settlers will devote themselves chiefly to cattle raising, which, so far, has proved to be profitable. It seems that the virgin forests of Siberia have been cut down in the same ruthless and wasteful manner that characterized the denudation of our own forest lands; nevertheless, it is estimated that there still remains about 80,000 square miles of valuable pine and fir timber.

The official estimate of the mineral wealth of Siberia is remarkable reading, for it would indicate that this mysterious country is, minerally speaking, one of the richest in the world. North of the Aral Sea and Mountains the land is rich in lead, silver, copper, and gold. Several ranges of the Altai Mountains are known to be rich in gold, copper ore, and minor precious stones, while the varieties of porphyry and jasper, known by the name of this range, have an established reputation. Extensive deposits of coal are found in the Kusnetz region. It seems that in far Eastern Siberia the mountain ranges are equally rich in silver, copper, iron, coal, and graphite, while the gold fields of Eastern Siberia are known to be particularly promising. Elsewhere, coal and naphtha have been developed, while the coast line of Eastern Siberia has yielded good results to the gold washers.

We have been so frequently told during the progress of the Trans-Siberian Railway that the work was being undertaken mainly for military and strategic reasons, that it is with peculiar satisfaction we learn from this official guide that the resources of the country are in themselves sufficient to warrant the construction of the railway. Just how far the opening up of such a vast and apparently rich region will effect the present economic equilibrium of the world, it is difficult to foretell, but that its influence will be far-reaching and profound, can scarcely be disputed.

OPENING OF THE PARIS EXPOSITION.

The Paris Exposition opened on April 14, with imposing ceremonies which were held in the Salle des Fêtes, and nothing could have exceeded the picturesque stage setting. The uniforms of the diplomats and soldiers were gorgeous, the orchestra and chorus were superb, and the effect produced by the great staircase up which the President of the Republic passed was most imposing, being lined with picked men of the Republican Guards. At the top of the stairway was a room, the interior of which could be seen from the Salle des Fêtes, and this was hung with priceless Gobelin tapestries brought over from the Louvre for the occasion. Fourteen thousand guests formed the audience. The traffic arrangements were inadequate and many of the guests did not succeed in getting down to the grounds. The ceremonies were simple and impressive. After the speeches had been made and the Exposition was declared open, President Loubet and his party passed over the Champs de Mars and took a steamer up the river to the Alexandre III. Bridge. The President was saluted on his trip up the river at the various national pavilions. After the boats reached the Alexandre III. Bridge the party landed and admired the vista up the Esplanade of the Hôtel des Invalides and the new Avenue Nicholas II. The President then proceeded to the Champs Elysées where the party entered carriages and were escorted to the Palace of the Elysée. In the evening Paris was brilliantly illuminated. The next day the Exposition, or rather a portion of it, was opened to the public. On the whole the Exposition is in a state of great incompleteness, and probably will be until the end of May. It is expected that no motive power will be ready until that time. The United States exhibit is said to be the farthest along toward completeness of any, except as regards machinery, where Germany leads. In general readiness Russia came next to the United States.

There are 30,000 French exhibitors; 6,564 United States exhibitors; 2,500 Belgian; Germany has 2,000; Italy, 2,000; Russia, 1,500; Scandinavia 1,400; Austria, 1,000; Great Britain, 600. The United States exhibits occupy 329,052 square feet, in forty-seven distinct exhibition spaces, thirty-three in the main Exposition grounds, and fourteen in the Vincennes Annex.

NATIONAL ACADEMY OF SCIENCES.

BY MARCUS BENJAMIN, PH.D.

The spring meeting of the National Academy of Sciences was held at Columbian University in Washington on April 17-19.

The meeting of the Academy held in Washington has usually for its most important feature the business that is transacted before it. Much of this is naturally routine, and only a portion of it is given to the public. The reports from the committees in charge of the various trust funds are usually presented and the committees in charge of the award of the medals of the Academy announce their decisions.

Perhaps the most important feature of the meeting is the election of new members. The names of those who have achieved eminence in science are presented by their sponsors before the Academy, and sometime before the April meeting a full list of those proposed are sent to the members for their approval. From this list the names of the seven candidates securing the highest number of votes are selected, and from them not more than five new members can be chosen each year. Owing to the difficulty in arriving at a unanimous decision in regard to the claims of those presented for membership, there is always much anxiety as to who the fortunate persons are. This year, those who were selected included James E. Keeler, who, after serving as an assistant at the Lick Observatory, passed to the charge of the Allegheny Observatory, only to return to the Lick as its director, succeeding Edward S. Holden in that place two years ago; Henry F. Osborn, the Da Costa Professor of Biology in Columbia University, New York, whose brilliant investigations in vertebrate paleontology has marked him as the proper successor to fill the vacancies caused by the deaths of Cope and Marsh; Franz Boas, who is professor of anthropology in Columbia University and an assistant curator in the American Museum of Natural History, New York, and whose ethnological studies among the Indians of the Northwest have gained for him much reputation; and Samuel L. Penfield, professor of mineralogy in Sheffield Scientific School of Yale University, whose frequent contributions to science in the way of new minerals made him a desirable addition to the Academy.

An award of the Barnard medal was made to William Conrad Roentgen for his discovery of the X-rays. The Barnard medal is given but once in every five years, and then to the person who has made the most important contribution to physical science during that period. Its first presentation was to Lord Rayleigh and Prof. William Ramsay, for their joint discovery of argon.

Another very important piece of business was the offer of Dr. Agassiz to give the sum of $5,000 to the National Academy as the beginning of a building fund to be raised in order to erect a suitable home in Washington, for the use of the Washington Academy of Sciences and of local or affiliated societies, on condition that the land needed for such a building be either given by the government or obtained from other sources; and, furthermore, that the sum of at least $100,000 be raised for that purpose, the National Academy to have such privileges granted them as they might need in the way of use of the hall at the proper time for their meetings, and of suitable smaller rooms to be used for office purposes. Dr. Agassiz also offered to give $1,000 to serve as a beginning of a general fund, provided sufficient money was raised to make that fund $20,000 as a minimum amount. Committees were appointed to take charge of raising both of these funds and to solicit subscriptions for them.

The papers presented before the Academy were very few, and of them that which created the most interest was "The Cruise of the U. S. Fish Commission Steamer 'Albatross' in the South Seas," by Alexander Agassiz. That cruise was begun in the month of August, 1899, and continued until the end of March of this year. Doctor Agassiz, with the aid of charts, gave a graphic account of the voyage, and told of the dredging and deep soundings made by the scientists of the expedition. Dredging and soundings were made at a depth of 4,500 fathoms, which is 1,600 fathoms deeper than any previous record. He described the animal life found at those depths, and also discussed the formation of coral reefs, contending that each reef required special study in order to determine the causes of its formation. Mr. J. E. Duerden, who was introduced by Prof. William K. Brooks, of Johns Hopkins University, presented a paper on "West Indian Madreporarian Polyps," in which he discussed the methods by which those corals were formed. A brief paper on the "Secondary Enrichment of Sulphides in Ore Deposits," was read by Samuel F. Emmons of the U. S. Geological Survey. He described the oxidation of ore zones of the noted mines in this and foreign countries, giving an interesting account of the various researches he had made and of the conclusions he had reached concerning the formation of ore deposits.

Among anthropologists there is probably no one subject on which a more decided opinion is held than on the subject of the presence of human remains in the Trenton gravels. At the Detroit meeting of the American Association a few years ago, it seemed as if those who believed that human remains in that formation were impossible, were in the ascendant, but the persistent efforts of the opposing faction may yet result in changing that opinion. Prof. Frederic W. Putnam presented a paper entitled "A Human Bone from the Glacial Deposit at Trenton, N. J.," in which he briefly described the finding of a human femur by one of his assistants, and exhibited photographs of the bone itself and a photograph of the bone in situ. Prof. Putnam has always been a firm believer in the existence of the Trenton gravel man. Prof. Theodore Gill, of the Smithsonian Institution, read a paper on "The Zoogeographical Relationships of Africa," in which he showed the relationship of the animals which recent geographical exploration of Africa has brought to light, with those on other continents. The "Report of the Watson Trustees on the Award of the Watson Medal to David Gill," was presented by Simon Newcomb, in this he described the qualifications of Prof. Gill for the Watson medal, telling how, as a comparatively young man, he had been called to the charge of the observatory at the Cape of Good Hope, where with indifferent equipment and small funds, he had been able to obtain results that had gained him a high rank among astronomers of the world. He referred to the fact that Prof. William L. Elkin, of Yale University, had been associated with him in some of his important work.

In addition to the foregoing the following papers were presented by gentlemen not members of the Academy: "The Anatomy of Nautilus Pompilius," by L. E. Griffin, who was introduced by Prof. William K. Brooks (this was read by title); "On the Use of Electric Motors, of the Shunt Type, for Solving Linear Differential Equations of any Order with Variable Coefficients," by Reginald A. Fessenden, who was introduced by Prof. Cleveland Abbe (this was also read by title); Mr. Fessenden also read a paper "On the Prediction of the Physical Properties of the Pure Metals;" and Rollin A. Harris, who was also introduced by Prof. Cleveland Abbe, read "A Partial Explanation of Some of the Principal Ocean Tides." Both of these papers were results of investigations now being carried on at the United States Weather Bureau in the first instance, and at the United States Coast and Geodetic Survey in the second instance.

The additional members of the council who are annually chosen were as follows: Dr. John S. Billings, Dr. Henry P. Bowdich, Prof. George J. Brush, Prof. Wolcott Gibbs, Mr. Arnold Hague and Prof. Simon Newcomb.

It was with considerable regret that the Academy received the announcement from Prof. Wolcott Gibbs that his advancing years compelled him to resign from the presidency of the Academy. Doctor Gibbs is one of the three surviving original members of the Academy, and the one who has fairly earned the title of the "Nestor of American Science." He was for a quarter of a century Rumford professor at the Lawrence Scientific School of Harvard University, and on his retirement, some ten years ago, he returned to his home in Newport, where he has since devoted himself to the prosecution of chemical investigations. All of the great honors that can be conferred upon an American scientist have been given to him, and his absence from the meetings in the years to come will be severely felt.

AN AMERICAN AUTOMOBILE RACE.

The first real race of modern motor carriages which has ever been held in the United States, was run on April 14, on the Merrick Road, Long Island's splendid thoroughfare. The contest was held under the auspices of the Automobile Club of America. It was a battle royal between five gasoline, three steam carriages, and one electric vehicle. The course was fifty miles, and the prize a cup, donated by M. Léon Blanchet, was won by A. L. Riker, with his electric carriage. The time was 2:03:30. S. T. Davis, Jr., with a steam carriage, came in second, the time being 2:18:27. He was followed by A. Fisher, with a gasoline carriage, the time being 2:30:01.

The other competitors was D. Wolfe Bishop, Jr., gasoline carriage, 2:37:52; A. C. Bostwick, gasoline carriage, 2:46:40; G. F. Chamberlain, gasoline carriage, 2:48:42; and C. J. Field, gasoline carriage, 3:15:30.

Two carriages failed to finish, one of them losing a tire. The various towns along the course, from Springfield to Babylon and return, have never been particularly partial to racing of any kind, but on this occasion the authorities not only did nothing to interfere with the race, but did excellent work in keeping the road clear.

The turn at Babylon was made around two barrels at cross roads, and was successfully accomplished by all, except one steam carriage, whose driver attempted to make the turn too quickly, resulting in the loss of a tire. The winning machine carried sixty-four cells of battery, arranged in three sections, only two of which were used.

There were many wheelmen along the course, and several motor tricycles and quadricycles went over the course, one of them covering it in one hour and fifty-eight minutes.

PARIS EXPOSITION NOTES.

A model of the Brooklyn Bridge, made by the Roebling Company, which was shipped on the steamer "Pauillac," has been given up as lost, and a new model is being made. It will be sure to create general interest in Paris when it is exhibited. Miniature trolley cars will be run on the tracks.

In the two boiler annexes there is hardly a single plant actually erected, says The Iron Age, and there is also a great absence of gas and oil engines, which were in evidence in large numbers in the same locality in 1899. The United States machinery section is not well located, a considerable portion of it being below the gallery, which cuts off a great deal of the light.

The market price of admission tickets to the Exposition has fallen, and they are now selling as low as 6 cents. This is caused by the fact that when bonds were issued a few years ago to pay the expense of erecting the buildings, 65,000,000 tickets went with the bonds, and it is now estimated that the attendance will fall far below that figure, so that there will be a large quantity of the tickets which cannot be used. The authorities are requiring anywhere from two to five tickets, depending upon the hours of admission. The appearance of the grounds is much worse than on the opening day, and some of the smaller buildings are only just commenced and many of the large buildings are still incomplete. The Russian Pavilion is a notable exception.

Eleven of the valuable models of American warships have been injured during their transportation from New York to Havre on the auxiliary cruiser "Prairie." The models were inclosed in glass cases which were packed in wooden boxes and stowed in the hold. During the voyage the rolling and pitching of the ship caused them to shift, with the result that the glass was broken and this in turn broke and scratched the models, cutting their rigging and otherwise injuring them. The model of the "Olympia" suffered the greatest damage. It was thought at first that it would be necessary to have workmen sent from the Washington Navy Yard to repair the miniature vessels, but the French government offered Assistant Naval Constructor Gillmore facilities for doing this work at the shipyard at Cherbourg, which proposition was accepted. It is probable that the repairs will be of a temporary character.

CELLULITH.

In the making of paper it is known that by beating the pulp for a long time, a transparent and elastic mixture is obtained, which hardens rapidly on drying, covers the fibers and imparts great strength to the paper. An amorphous colloidal cellulose hydrate, as supposed, is produced, being set free from the cells, and acting as an agglutinating substance. This is also the theory of the fabrication of vegetable parchment.

In parchmenting paper by means of sulphuric acid, the cellulose is transformed into amyloid, which yields, with an excess of water, a gelatinous precipitate, uniting the remaining fibers, and forming a translucent sheet. The cellulith is prepared by a process exclusively mechanical—the beating of the pulp for a much longer time than is necessary for the production merely of paper. According to the properties of the pulp and the velocity of the revolving cylinder, the duration of the operation varies from 40 to 150 hours, until all the contents of the vat are transformed into a homogenous mass having no trace of fibers. In the state of extreme division the material still contains a good deal of air, which may destroy its regularity. So it is submitted to a new beating for about two hours.

If the cellulith is to be colored, the colors, soluble or otherwise, are added before the heating. The hot cellulose liquor is received into a reservoir perforated at the bottom, from which it drips. With 96 per cent of water the consistence is that of thick honey. The water is evaporated either in the open air or in a stove at 40°. The pulp hardens gradually and finally reaches the consistence of horn. Its specific weight is then about 4·5. The cellulith may be worked like horn, ebonite and other similar substances. and is, as compared with celluloid, uninflammable. In mixing the cellulith, at the moment of trituration, with sawdust and 30 per cent of lamp black, a kind of very dark ebonite is obtained, dense and susceptible of a polish.

The new material, says La Revue de Produits Chemiques, is adapted to a variety of purposes for which horn and other similar substances have been hitherto used.