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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.

## PIPE GALLERIES IN THE NEW SUBWAY.

Now that rapid transit subways in this city have acquired all the prestige which comes from twelve months of remarkably successful operation, it is to be hoped that the Rapid Transit Commission will be emboldened to take an unyielding stand on the important question of the construction of pipe galleries. It is a most regrettable fact that the present subways have been built without any pipe galleries, and that the various gas and water mains lie spread out over the roof of the Subway, under conditions which will mean the ripping up of the streets whenever a break occurs, or a new system of pipes has to be laid down. In justice to the Rapid Transit engineers, it should be stated that originally they drew up complete plans for pipe galleries extending on each side of the Subway. The Rapid Transit Commission, moreover, approved of these plans, and was anxious to have them carried out. That they were not built was due to interference from the department which is responsible for the major part of the street mains. The grounds of this interference were apparently of the most trivial and unreasonable character; and there is no doubt that had the Rapid Transit Commission carried the question into the courts, they could have secured the necessary legal indorsement for the construction of the galleries. At that time, however, the Subway scheme was opposed by many powerful interests, and the Commission decided that rather than run the risk of legal delays, it would be better to forego the pipe-gallery plans for the time being, and push the Subway itself through to completion.

To-day, however, the Rapid Transit proposition in New York city needs no such delicate handling. It has established itself as one of the most attractive ventures for the investment of capital. It is safe to say that the very interests which did their utmost to kill the Rapid Transit scheme when it was advocated on the high grounds of public utility, are now falling over each other to secure Rapid Transit franchises, because of their proved commercial value. It is not likely that there will be any opposition to the construction of pipe galleries as a part of future extensions of the Subway. The objections that were raised against them originally were altogether trivial, and were strongly suspected of being prompted more by political considerations than they were by considerations of a constructional or operative character. The only plausible objection on technical grounds was that offered by the gas companies, namely, that the presence of electric mains and gas mains in the same galleries might, under certain conceivable conditions, lead to serious explosions. We consider this danger to be exceedingly remote. The gas mains would be so placed in the galleries that every part of them would be open to daily inspection; and it would be possible to detect a leak long before sufficient gas could accumulate to form explosive mixtures with the air. A further safeguard would be afforded by utilizing the system of ventilation, which should be installed as part of all future subways, to effect a continual renewal of air in the galleries.

## WE SHOULD USE THE METRIC SYSTEM.

It is gratifying to note that the agitation for the introduction of the metric system of measurement is growing in strength, and seems not unlikely to be pushed to a successful issue. Judging the question from the purely practical standpoint, and in a broad-minded spirit, there is everything to be said in favor of, and nothing against, this most rational and convenient system. It is really surprising that a nation which is as eminently practical as we are, and which

has proved by over a century of use that as a system of coinage and for all monetary transactions, the metrical is ideally perfect, should for so many generations have been content to subject its arts and industries to the burdensome inconvenience of the old system of measurement.

At the same time, it would be a mistake for the advocates of the metric system to shut their eyes to the fact that its introduction could not be brought about without incurring in some quarters a certain amount of inconvenience and some pecuniary loss. To those whose hostility is based upon the fact that their interest would, for the time being, be temporarily affected, the argument should be presented on the high ground, that great improvements of a broad and sweeping character have usually been attended with a certain amount of inconvenience to the small minority. This minority must take such comfort as it can from the reflection that its temporary loss or inconvenience is absolutely insignificant compared with the vast national benefit that would be conferred, not merely in the present hour, but for all time. The question of the relative merits of the decimal and duodecimal systems has been well threshed out, and we believe there is practically a universal agreement that, except for the minor and temporary drawbacks attending its introduction, there is everything to be said in favor of the more modern and rational method.

## ALTERNATIVE SCHEMES FOR THE PANAMA CANAL.

The average citizen of the United States may well be excused if the subject of the Panama Canal appears to him to be just now something of a Chinese puzzle. What with reports of committees and advisory boards, plans for high-level canals and plans for low-level canals, plans for canals with locks and plans for canals without, to say nothing of the 500-foot "Straits of Panama," it is certainly difficult for the average work-a-day citizen to distinguish fact from fiction, and find in the flood of printer's ink with which the subject has been deluged a few solid verities, on which he may plant his feet and say, "This at least I know to be true."

Broadly speaking, there are, at the present writing, three leading proposals for the construction of a canal across the Isthmus, and with these three we propose to deal in separate articles in the SCIENTIFIC AMERICAN. The first is that proposed by the former Chief Engineer of the Panama Canal when it was under French control, Mr. Bunau-Varilla. It contemplates the early completion of a high-level canal, and its subsequent widening and deepening after it has been opened to navigation. The second proposal is that of a leading American hydraulic engineer, Mr. Lindon W. Bates, who proposes the formation of a large freshwater lake at each end of the canal, and the creation of a central lake by means of a dam at Bohio; the surface of this lake to constitute the summit level, which would be cut through the Culebra divide at an elevation of about 60 feet, the level of the two terminal lakes being held at about 30 feet. The third proposal is that which it is understood has been agreed upon by the International Advisory Board of Engineers, and which recommends the immediate construction of a sea-level canal provided with a tidal lock near its Pacific terminus.

The first type of canal, to which its author has given the high-sounding title "Straits of Panama," forms the subject of illustration and description in the present issue. In an early succeeding issue we shall give an illustrated description of the Lindon W. Bates lake-and-lock project; to be followed in due course by a third article on the proposal of the President's Advisory Board, the full report of which will be available at an early date.

In presenting the Bunau-Varilla and Bates proposals we offer no words of criticism one way or the other, and this for the reason that both plans will be the subject of comment in the forthcoming report of the Advisory Board to the President of the United States. The high position held by Mr. Bunau-Varilla during the operations of the French company and the wide experience and well-deserved reputation of Mr. Bates in operations involving the excavation and removal of material in works of the general character of the Panama Canal, demand for both of these engineers a thoughtful hearing. Although the plans of Bunau-Varilla for digging out 600 million cubic yards of material, and dumping it all into an artificial lake that is 200 feet above tide level, are calculated at the first hearing to stagger the conservative mind of the average engineer, it must be remembered that its author has a wider acquaintance with the actual conditions of work on the Isthmus than any living engineer.

## ELECTRO-TECHNICAL INDUSTRIES.

The complete revolutionizing of many old industries, and the creation of entirely new ones, by electricity in the last half dozen years represent some of the most marvelous achievements of the present century. In no line of scientific and experimental work are the uncertain opportunities for magnificent

possibilities so brilliant as in the practical laboratory of the electrical engineer and chemist. Electricity supplied in large and cheap current permits the experimenters to make tests in the fusing of metals, which a dozen years ago could not be performed except at enormous cost in time and money.

Electro-metallurgy has given a tremendous impetus to the manufacture and refining of many common articles of commerce, and owing to the cheapening of their manufacture, the demand for them has enormously increased. Thus in the production of aluminium the price has been so reduced in the last few years that it is employed in many new industries. The most noticeable field of usefulness is the substitution of aluminium transmission wires for copper in the electrical industries. The new transmission lines are of stranded aluminium, and they carry heavy voltage over great distances. The longest transmission line in the world, from Electra to San Francisco, a distance of 154 miles, is composed of stranded aluminium wire, and also the Colgate to Oakland line, a distance of 144 miles. The demand for aluminium is so great, that all the electrical manufacturing companies engaged in its production are extending their plants to increase the output. There are to-day upward of 70,000 electrical horse-power used in the manufacturing of aluminium in this country and Europe. Four plants are located in this country and they have available for the manufacture of aluminium upward of 24,000 horse-power, and the total output of the American plants varies from 15,000 tons upward a year. With the development of the Niagara power the extension of these aluminium manufacturing companies is being rapidly pushed, and the total capacity of the plants is likely to double within a year or two.

In copper refining electricity has achieved results no less notable than in the production of aluminium. There are upward of thirty-two electrolytic copper refineries in operation to-day, and considerably over half the world's output of copper is refined in these plants. The annual output of electrolytic copper is estimated at nearly 320,000 tons a year. In spite of the cheapening of the refining of copper by electricity, the price has steadily advanced in recent years. The employment of electricity for the extraction of copper from low-grade ores has also developed a good deal, and in this new development it may be possible to materially increase the world's annual supply. In Canada the electrical extraction has been quite successful with ores containing only from 2 to 4 per cent copper. An experimental company of French operators have more recently located a plant in Chili to handle the low-grade native ores of that country by means of an electric furnace process of concentration. The recovery and refining of scrap copper has also assumed considerable proportions in this country. By means of the electrolytic process, old copper bottoms, boilers, tubing, nails, sheet clippings, and type-shells can be utilized in a remarkable way. Scrap copper of this nature commands from 12 to 13 cents a pound, and is only a trifle less than casting copper. The scrap copper is thus recovered at little cost, and used over again in the industries. Old copper wire commands a premium to-day at prices ranging from a cent to half a cent less than that of the best casting copper.

The manufacture of artificial graphite with the electric furnace has assumed considerable importance, and to-day upward of 3,000 horse-power is used in supplying the electric furnaces with heat for this purpose. The output of artificial graphite at Niagara Falls last year was over three million pounds. The method of production is covered by patents, but the process consists of converting a large mass of coke or carbon into graphite by means of the electric furnace. At a certain temperature all carbides decompose, and the carbon separates in the form of graphite, but by the process now used only a small amount of iron or silicon is required for the purpose. The flourishing nature of this industry has led to further extensive experiments with the electric furnace in the treatment of carbides.

The use of the electric furnace in the iron and steel industry has promised for several years great transformation of smelting, but the actual reduction of iron ore for steel making by means of the electric furnace has not yet attained a large commercial success. A number of such furnaces have been in operation in different parts of the country, and new improvements are constantly being made to simplify the process. In certain parts of the world where electric current is very cheap and abundant, iron ore plentiful, and coal scarce and high priced, the electric furnace may displace the ordinary blast furnace for the production of pig iron. Or what may be nearer the truth, the use of the electric furnace in certain regions near great hydraulic works may build up electric smelting where it would be impossible to succeed with coal as a fuel.

In the specialized field of making high-class steels and steel alloys from scrap, the electric furnace has a more promising outlook, and quite remarkable achieve-

ments have already been made. Both in Germany and France such electric furnaces for steel making have been in profitable use the past year. In France at Le Praz, in Savoy, a plant for steel making utilizes the Heroult furnace, in which the electric arc is employed for heating, and at a cost of 6.5 c. per ton for electrical energy between six and ten tons of specialized steel are produced daily at a good profit. Over 5,000 tons of steel have been produced at this plant. Two other plants are in successful operation in France, one of which uses the arc for heating and the other the resistance method. In Italy the Stessam electric furnace is employed extensively, and in Germany similar attempts at steel making by the electric method are being carried on with more or less success.

In this country and Canada the electric steel furnace is in operation experimentally. At Massena a new process in which a patented electric furnace is employed has been tried, and the project promises much for the future. At Niagara Falls the Ruthenberg process is also in use, but not commercially. A number of other plants, using either the Heroult or Keller furnace, have been established, but so far most of them are making tests for future commercial exploitation.

In the manufacture of such alloys of iron as ferro-chrome, ferro-silicon, and ferro-titanium by the electric furnace, a great commercial success has been attained. At Niagara Falls ferro-titanium is made in the electric furnace from scrap iron, aluminium, and cheap titaniferous iron ore. Even discarded slag is utilized. Likewise ferro-silicon is made from scrap iron and scrap steel. A good many of the old carbide works which failed have been rebuilt for manufacturing ferro-silicon. The resistance type of furnace is employed for this work, and the scrap iron or steel is melted at a high temperature with pure quartz. A 4,000-horse-power plant generally turns out about 20 tons of this alloy a day. Ferro-chrome is an alloy used in the manufacture of face-hardened steel, especially for armor plates and tools. One plant turns out upward of 1,800 tons per year for the Carnegie and Bethlehem steel companies. The electric furnace employed for this manufacture is not materially different from those used in allied industries. Ferro-manganese is made in the electric furnace for the steel industry on a smaller scale, but it has become an important factor in modern production of high-grade steels.

The question of using the electric furnace in glass manufacture has received unusual attention the past year, and it is predicted that a complete revolution may be thus created in this industry thereby. If the electric furnace should prove as successful as promised in this field, it would probably mean the shifting of the center of manufacturing from Pittsburg to Niagara Falls or some similar place where electric current can be had cheaply and in abundance. It is not likely for some time to come that the electric furnace can displace the regenerative gas furnace for glass making except in a few favored regions. However, in Germany electric glass furnaces are being used, especially in the production of quartz glass vessels for chemical purposes. The quartz-glass manufacture has assumed a good deal of popularity in many new lines of work, for the glass is not easily fractured by sudden changes of temperature, and its melting point is very high. In regions where quartz exists in great quantities, and water power for electrical development is favorable, the manufacture of quartz-glass vessels and articles in the electrical furnace appears to have a very promising future. Experiments are now being conducted by a number of companies along this line, and only the future can determine what ultimate effect the electric current will have upon the glass trade.

In bullion refining electricity has made great strides. Electrolytic methods of refining gold and silver are employed in all parts of the world. At Perth Amboy and Philadelphia large quantities of the two precious metals are thus refined. In Germany the electric refining of gold and silver is carried on even more extensively, and the combined outputs of the Frankfort and Hamburg refineries are valued at a good deal over ten million dollars a year. The electrolytic method of bullion refining, however, is increasing rapidly in this country, and as one of the largest producers of precious metals in the world, it seems not unlikely that we shall stand first in this industry of refining within a few years.

Electro-metallurgical industries include the manufacture of many other products of only slightly less importance than those mentioned. Such new products as silicon-copper and siloxicon are the results of the application of the electric furnace to experimental fields. Nickel, lead, tin, and zinc have all come under the power of electricity, and they are either refined or extracted from the ore by electrical methods in increasing quantity. Not the least important of these methods is the recovery of scrap. Scrap tin and zinc are recovered to-day by electrolytic processes, which make every tin can, tin roof, or tin boiler of potential

value. Electricity has made phenomenal strides in saving the waste. Metal of any kind can be recon-verted by it into useful material for new manufacture. In other words, the scrap heap and waste pile is as legitimate a field of exploitation for electricity as the mines with their rich or low-grade ores.

GEORGE E. WALSH.

#### SOME COSTLY EGGS.

BY ARTHUR H. J. KEANE.

By reason of the extinction of certain classes of birds, there are many eggs which are so scarce and costly, that they can be termed rarities without fear of exaggeration. The rarest of all the eggs of a still existent family of birds is that laid by the condor. At the present moment there is not in existence one single dozen perfect specimens, and the few there are can be seen solely in some of the wealthiest and richest collections. The condor, which is found in Southern California and the Andes, is now hopelessly doomed to die out. It is also practically impossible to collect any fresh specimens of its eggs, as these rare and extremely shy birds nest thousands of feet above the plains, in the most rugged and inaccessible fastnesses of the San Bernardino and San Jacinto Mountains. Hence finding and plundering (two very different things, by the bye) a condor's nest is regarded as a most wonderful and sensational event; in fact, a prize of \$500 would not tempt any sane man to start out on the hunt for a fresh condor egg.

Still more costly are the eggs of the great auk, or garefowl, a flightless marine bird, with large head, heavy body, and compact plumage, the last two living specimens of which were discovered and killed in Iceland in the year 1844. One of these eggs is now to be seen, carefully preserved under a glass case, in the National Museum at Washington; the original owner sold it in London for £22 (\$110) in the year 1851, whereas its present value is estimated at more than £2,000 (\$10,000). In 1853 two other auks' eggs were sold in London for £85 (\$425) apiece, while in 1869 a nobleman (Lord Caervagh) paid £74 (\$370) for a damaged specimen. A Scotchman of the name of Powell was fortunate to buy two of these eggs in Edinburgh in 1879 for a mere song, viz., 32 shillings; a few weeks afterward he sold them for £240 (\$1,200) each. In 1887 an auk's egg, which was sold for £40 (\$200) in 1867, realized \$800 in America. At the present time there are only from 70 to 80 specimens known to be still in existence; 12 of these are in the British Museum (London). This bird died out because of its inability to fly, and of the difficulty of its movements upon dry land. It used to nest in thousands on Funk Island (a rocky islet opposite the coast of Newfoundland) which at one time was used as a kind of provisioning station by whalers, who used to kill these fat and palatable birds in hundreds. The birds were knocked on the head with clubs, plucked (the feathers used to fetch a good price) and salted for future consumption.

Funk Island also used to afford shelter every year, at breeding time, to countless numbers of other natoratory birds, among them being the white booby (*Sula bassana*). These birds have also met with the same fate as the auk. In the year 1860 their nests were still to be seen in thousands, but at the time of writing it would probably be a matter of impossibility to find one solitary specimen. Ruthless slaughter, and the scaring away of the birds—due to the erection of a signal station on the island, which used to fire off a shot every minute in foggy weather—soon led to a thinning of their ranks, and the price of their eggs already began to rise in the seventies. Now they are great rarities, and would fetch large sums, but unfortunately there are no specimens in the market. Some specimens are on view at the Smithsonian Institution and at the American Museum of Natural History in New York; they range in value from \$500 to \$750 apiece.

Large sums are also paid for the eggs of the aepyornis or moa, a gigantic wingless bird of from 12 to 14 feet in height, which as long ago as two hundred years was already dying out in Madagascar. In appearance the bird much resembled the ostrich, and its egg was one foot in length. The first specimen was brought to Europe (Paris) by a French merchant in 1851, and caused quite a sensation from the amount of interest it attracted; its cubic capacity is about equal to that of one hundred goose eggs. In 1897 one of these eggs was found swimming about on the southwest coast of the island of Madagascar, in Augustine Bay. It now lies in the British Museum, and is undoubtedly one of the most extraordinary and valuable relics of its kind.

The eggs of the aptornis, a recently extinct wingless bird, probably a member of the Rallidæ family, also fetch very high prices, fine colored specimens fetching as much as \$750 to \$1,000 apiece. The apteryx or New Zealand kiwi is a bird which, though still living, is becoming scarcer from day to day, and its final extinction is only a question of years. These kiwi breed very slowly, only one or two very large eggs being laid

during the season, and as yet there is no record of the successful rearing of young in captivity. Speculators might do much worse than to buy up as many eggs of this bird as they can get hold of, for, although now carefully protected, it is to be feared that the specimens now existing are the last of their kind.

Collectors also pay good prices for the eggs of the golden eagle, the East Indian swallow, the Californian parrot or "popinjay," etc., and for those of all similar birds which make their nests in such inaccessible spots that their obtaining is a matter of difficulty and danger to life.

The ordinary barn-door fowl or "breakfast table" egg has also a fancy value—sometimes, to wit, when like wine it has "improved" with age. We rudely term such eggs "rotten." In China, however, such an egg is a delicacy of the first water, and the well-to-do pay high prices for a real good old egg of the "blue-blooded" type that has had "ample time to mature."

#### SCIENCE NOTES.

Curious experiments are being carried out by Capt. Simpson of the steamship "Moravian" to test the course and speed of ocean currents. For the past fifteen years, during the passage of this liner between Plymouth, South Africa, and Australia the captain has every day thrown overboard a tightly corked beer bottle containing a scroll bearing the latitude, longitude, and date when cast adrift, together with a request to the finder to forward the bottle to him at the London offices of the steamship line. The captain, who is a member of the British Meteorological Society, keeps a careful record of his daily operations. The number of bottles returned to him, however, is very small, the average being less than one per year.

The second law of thermo-dynamics may be formulated in different ways. It limits the possibility of natural processes to the occurrence of those in which a difference of intensity is diminished. If there is a difference of pressure in two parts of a gas, a movement will occur producing equality; if there is a difference of temperature, heat will be transported so as to produce equality once more. It is curious that such simple necessities, which we all feel as such, can be converted into far-reaching sharply formulated equations, as was done by Carnot and Clausius. These principles were first applied in chemistry by Horstmann. Then, by successive application to chemical problems by Massieu, Gibbs, Helmholtz and others, was won a system of relations touching the problem of affinity.

The bacteria and other microscopic forms of plant and animal life, all of which are conveniently included under the term microbes, have so lately begun to be understood and appreciated that we must still emphasize their extreme importance. The discoveries of the botanists and zoologists and revelations of the microscopists in this domain are comparable, in their importance to public health science, with nothing less than the revelations of the telescope to astronomy. Astronomy had indeed existed long before the invention of the telescope, and public health science had its beginnings nearly a century before any considerable progress had been made in micro-biology. But it is not too much to say that the developments in micro-biology since Pasteur began his work have not only revolutionized our ideas of the nature of the infectious diseases, but have also placed in our hands the key of their complete control.

Arrangements have been completed by a British corporation for the development of the extensive Australian shale fields, which are among the largest yet discovered in the world, and the manufacture of lubricating and illuminating oils, etc. The fields are located about one hundred miles from Sydney, the capital of New South Wales, in the fertile and well-watered valleys of Wolgan and Capertee. It is estimated that the fields contain many million tons of the richest shale. Every assistance possible is being rendered by the government to promote the success of the enterprise. A railroad about twenty-seven miles in length of the existing government gage is being laid, connecting the fields with the government trunk system. Electrical ore-cutting machinery is now in operation, boring a tunnel three miles in length through the heart of a mountain, which throughout its length is rich with shale deposits. By means of this tunnel the shale will be brought into direct communication with the extensive retorts and refineries that are in course of erection, the government railroad, and the port of Sydney. The Australian government in their latest financial report describe the industry as one of the largest that has ever been established in Australia, and which will ultimately eclipse all the others in size and value. Arrangements have been concluded for the exportation annually of hundreds of thousands of tons of shale to Europe and other parts of the world in connection with the manufacture of gas. According to the leading authorities on coal gas who have examined the shale, it gives the greatest quantity of gas and the highest illuminating power yet obtained.