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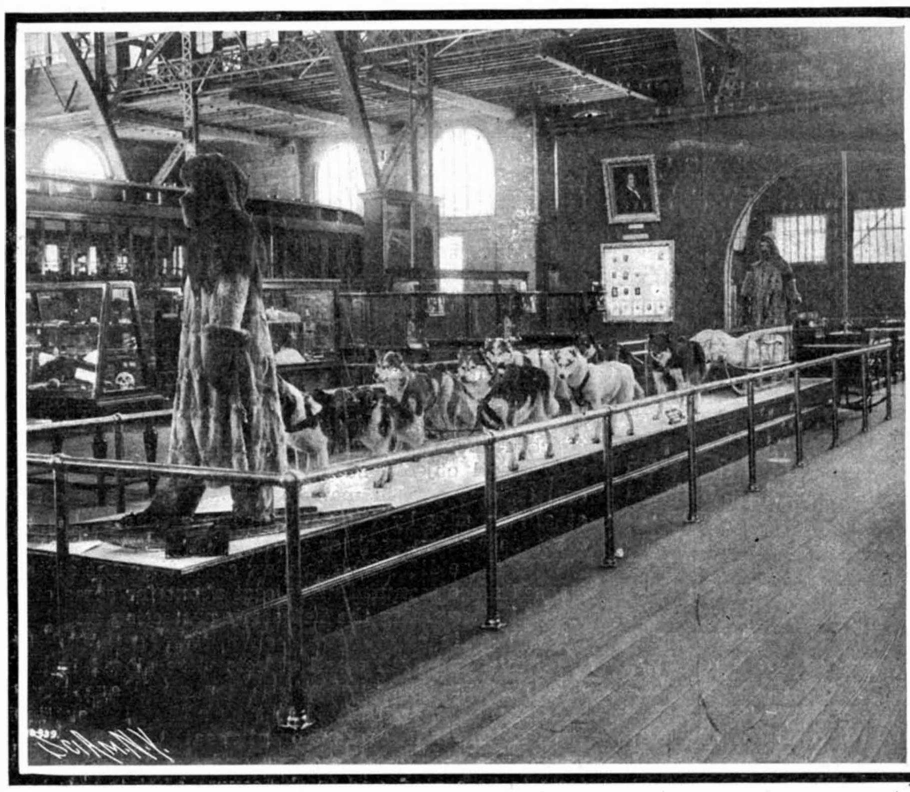
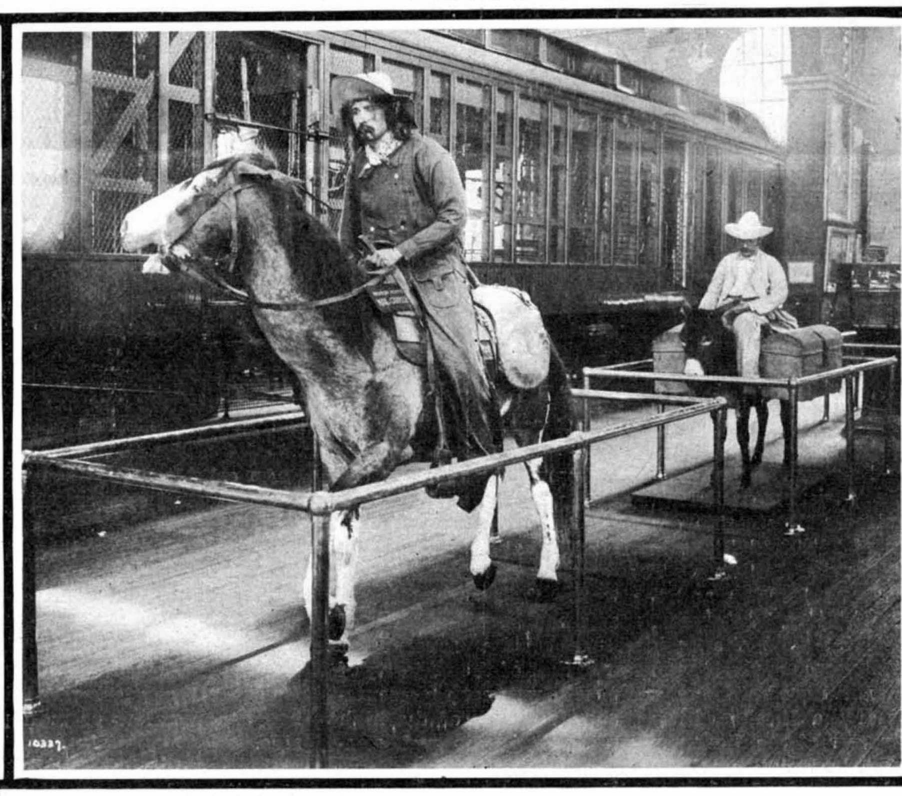


ALASKAN MAIL CARRIER. THE DOGS WERE THOSE USED BY PEARY IN THE ARCTICS.



MAIL CARRIERS OF THE WESTERN PLAINS AND OF PUERTO RICO BEFORE THE WAR.

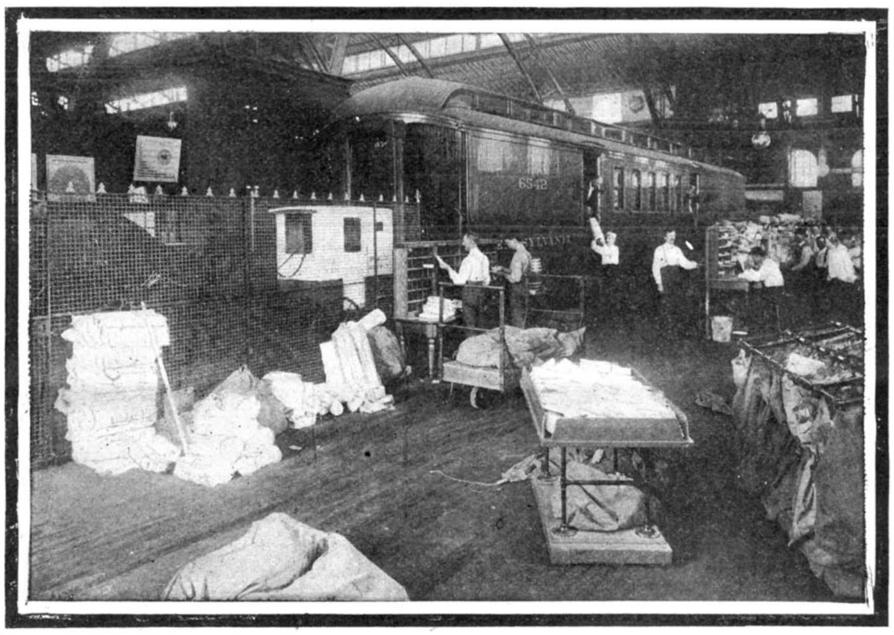
THE UNITED STATES GOVERNMENT BUILDING.

THE POST OFFICE EXHIBIT AT THE ST. LOUIS EXPOSITION.

THE GOVERNMENT BUILDING AND POST OFFICE EXHIBIT AT THE WORLD'S FAIR, ST. LOUIS.

By the St. Louis Correspondent of the SCIENTIFIC AMERICAN.

THE very fine government exhibit at the St. Louis Exposition is housed in three buildings, which were erected from designs prepared by the Supervising Architect of the Treasury Department. These are the main Government Building, of which we present a handsome illustration on our front page, the Commission of Fish and Fisheries Building, and the Life-Saving Service Building. The cost of the first two of these was $450,000, and the cost of the last $8,000.



POST OFFICE EXHIBIT. SORTING THE EXPOSITION MAIL.

In some earlier expositions it has been a matter of complaint that the architecture of the Government Building was decidedly inferior to that of the majority of the exhibition buildings, and that it was not representative of the dignity of the government nor of the high character of the display which it housed. No such complaint, however, can be made against the Government Building at St. Louis, to which many competent critics have given the first choice in point of architectural beauty and general fitness for its work. It stands on a slight eminence about twenty-five feet above the level of the main exhibition buildings, closing the vista of one of the principal plazas. The building is 800 feet long and 180 feet wide. There are no interior posts, the roof being supported by elliptical steel trusses. The architectural style of the building is classic or psuedo-Roman. The main entrance consists of a portico of eight Ionic columns, 5 feet in diameter and 45 feet high. It is connected with the end porticoes by colonnades of Ionic columns of the same height and diameter. The central dome is 90 feet in diameter, and the top of the Quadriga which surmounts the dome is 160 feet above the floor of the building.

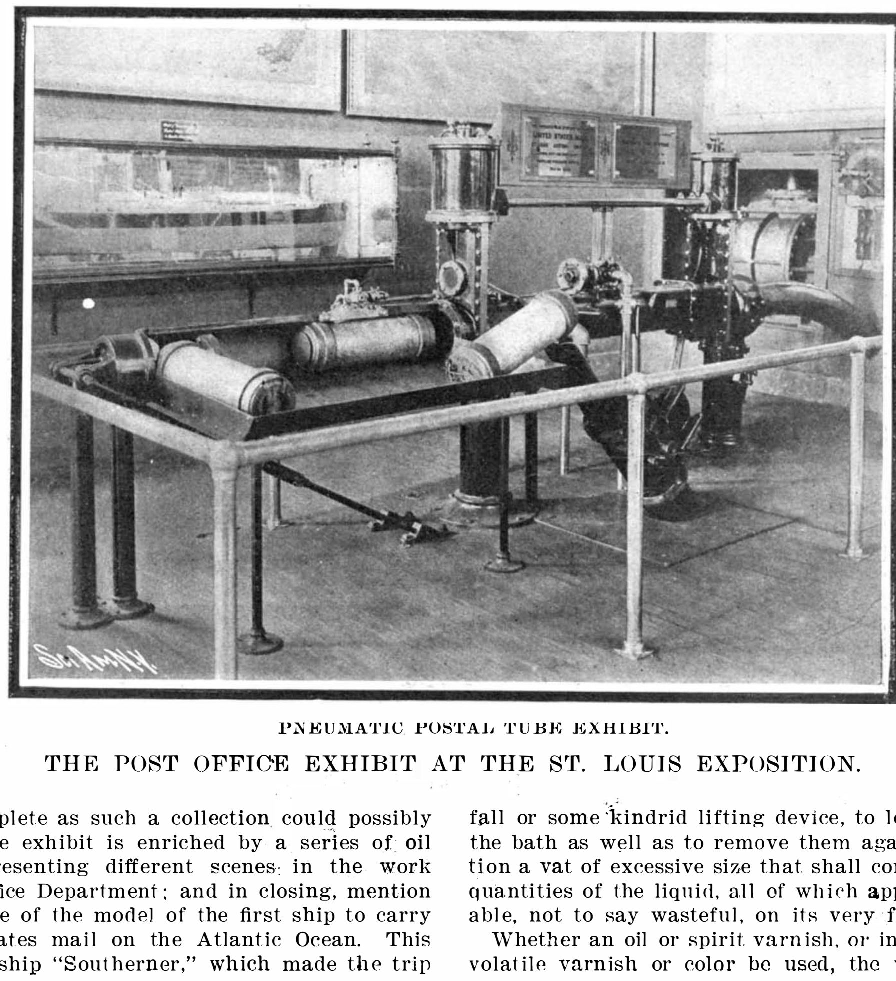
The Ionic order referred to is 56 feet high, and carries an attic 12 feet in height. The whole building is enriched with colossal statuary, and the roof and various portions of the architecture have been emphasized by a judicious use of bronze tinting. Altogether, we have never seen an exhibition building that pleased us better than this very successful effort of the United States government.

Practically all of the departments of the government are represented within or connected with this building, and in the present connection we have selected the Post Office Department for an illustrative description. The most prominent feature is a full-size postal car, in which the whole of the postal business of the Exhibition is carried on, the mail from over one hundred boxes being brought to the car, "pouched," and sent to the Wabash Railroad Station, just outside the grounds. In order to illustrate the working of the postal car, the siding has been removed, thereby enabling the public to see the whole process as carried on in a standard postal car of any of our railroads. Near the car stands an old-time Rocky Mountain mail coach, which ran once a week from Helena to Bozeman, Montana. Over the same route there are now four mail trains a day. This coach was captured by the Indians in 1877, and recaptured after a hot pursuit by Gen. Howe. Garfield, Arthur, and Sherman traveled in it on a tour of inspection in 1877. It was during this tour that Gen. Sherman made the distance from Fort Ellis to Helena, 108 miles, in eight hours, using six horses with frequent relays. Near by stands a model of a rural free delivery wagon. The success of the free delivery has been so great—it has proved such a boon to the agricultural districts—that naturally this portion of the display attracts great attention. We might mention that the mail wagon is really a traveling rural post office. The driver has in front of him a small desk with drawers, pen, ink, etc., and he is able to do a regular post office business, including the selling of stamps, money orders, etc. A series of mutoscope pictures shows the whole work of the post office in its various phases. In one group of pictures we see the letter carriers starting on their different routes. In another machine the Star Route carrier is shown at his particular work. Some of the mail wagons are gone all day, leaving at 7 o'clock in the morning and returning at 5 in the evening. In order to facilitate the delivery of the mail, Star Route carriers meet these mail wagons at certain specified points, gather up what mail they have collected, and drive with it to the nearest railroad station. Another series of pictures depicts the work of catching the mail pouch from a mail train moving at sixty miles an hour, or delivering it to such a train.

An exhibit that is specially interesting is that of an Alaskan mail carrier. He is shown with his sled and team of eight dogs. These dogs, by the way, are the same that were used by Lieut. Peary in his attempt to reach the North Pole. There are also excellent models of mail carriers of the Western plains and of a Puerto Rico mail carrier of a time prior to the Spanish-American war. The Western mail carrier is a somewhat familiar figure; but not so the Puerto Rico mail carrier, who sits astride a burro, which has two panniers or mail pouches slung, one on each side.

One corner of the exhibit has a full-size working installation of a pneumatic postal tube of the type installed in New York and other leading cities. The operation is carried through exactly as it is in daily service, and an opportunity is given to examine the details of the carriers and of the receiving and dispatching mechanism. We have so fully described this system in the SCIENTIFIC AMERICAN, that no further description is necessary at this time.

Historically, the Post Office Department exhibit is full of interest. There is a case of relics, among which is the original book of accounts of the first Postmaster-General, Benjamin Franklin, in which one may read the annual report in Franklin's own handwriting. Another case contains a collection of objects which have been sent in disobedience of the rules, through the mails, including a rattlesnake, and a package containing an explosive, sent to Capt. Eulate of the "Viscaya," the work, of course, of some crack-brained creature. To stamp collectors, perhaps the most attractive feature of the post office exhibit will be the magnificent collection of United States stamps, which, needless to say, is as complete as such a collection could possibly be. The whole exhibit is enriched by a series of oil paintings representing different scenes in the work of the Post Office Department; and in closing, mention should be made of the model of the first ship to carry the United States mail on the Atlantic Ocean. This was the steamship "Southerner," which made the trip from Savannah to Liverpool. It was many years before the department would give a contract for carrying the United States mails, the chief objection being that steamship transportation was "slower than sailing."



PNEUMATIC POSTAL TUBE EXHIBIT.

THE POST OFFICE EXHIBIT AT THE ST. LOUIS EXPOSITION.

THE VARNISH-DIPPING PROCESS AND DIPPING VARNISHES.

THE ordinary process of coating objects of what material soever with films of glossy or dull colors and varnishes consists, as is well known, in applying the liquid, which is to furnish the color, color and gloss, or gloss only, to the exterior surface of the object with a brush, and, by means of the customary "spreading," that is the passing of the brush to and fro over it, covering it as evenly as possible.

We do not need to be told that this is an operation which consumes much time; it also presupposes a certain technical facility in the manipulation of the brush, particularly where large surfaces are concerned and where these surfaces are situated perpendicularly rather than horizontally, or where they are inclined at varying angles.

Nor are the difficulties less present when the objects are small, especially if they are of irregular shape, possessed of depressions, elevations, corners or niches, because the dents or corners must be dabbed with the brush, in which operation it may easily occur that too much color or varnish falls in the indentations while the higher spots appear to have been scarcely touched; or, in the effort to cover them evenly, the strokes of the brush become plainly discernible. This method of application is attended with still another inconvenience, viz., in objects of this nature, during the dabbing, when thin and quickly drying colors or varnishes are used, air bubbles are liable to form and remain on the surface, producing, instead of a smooth and glossy effect, rather a rough and disturbing aspect. Again very small objects, such as buttons, hooks and eyes, eyelets, etc., can, in many cases, either not be coated at all, or only by the aid of some means of holding them, as wooden pegs, or wire.

With these difficulties in view some time has already elapsed since manufacturers cast about for some other method of applying the necessary protecting and beautifying coatings.

Buttons and such small objects were placed in a revolving drum or "tumbler" with a small quantity of the varnish and permitted to turn and roll about in it until all the buttons were evenly coated. The methods varied according to the shape and the size of the objects to be coated, and in the course of time was built up the process known as the "Varnish dipping process" now so extensively employed for metals and glass, though less used in connection with wood. Such progress in the application of the method has been made that it is no longer confined to the smallest or even the small objects, but articles of considerable size, such as parts of lamps, parts of vehicle wheels, sewing machine parts, and stands of all sorts may at present be faultlessly coated with smooth, glossy colors, or mirror-like varnishes. There is, of course, a limit to the size of the objects which may be profitably dipped, not only on account of the difficulties in the way of coating them, of which we shall speak anon, but chiefly on account of the corresponding increase in the size of the vessel, not to mention the necessary quantity of the liquid which increases out of all proportion to the amount virtually consumed. For this reason it is technically impossible to dip objects weighing several hundreds of pounds, or even large parts of machines or engines. Such weighty pieces require a block and fall or some kindrid lifting device, to lower them into the bath as well as to remove them again, not to mention a vat of excessive size that shall contain enormous quantities of the liquid, all of which appears unreasonable, not to say wasteful, on its very face.

Whether an oil or spirit varnish, or in fact any other volatile varnish or color be used, the varnish-dipping

process reaches its highest degree of utility when the object to be treated may be suitably fastened either on wires or with clamps, etc., and lowered into a vessel corresponding to its size, containing a sufficiency of the liquid to permit of its complete immersion and disappearance for a short interval, after which it is slowly raised again. Taking for granted that the article has been previously subjected to a careful cleansing, during its short period of immersion, the dipping liquid will attach itself to the outer surface, entirely and even excessively covering it, in proportion to the thickness of the original liquid. This excess, as long as it remains in its prime fluid condition, tends to run down along the surface of the object; it gets thicker, however, as it passes on, by virtue of the evaporation of its volatile solvent, its density ever increasing in a direct ratio with its path of travel, or in other words, the size of the object. Without further demonstration, then, we may conclude from this, that small objects are easily handled after this fashion; that films of varying thickness are not formed, because of the short path of travel of the excess of liquid; and, moreover, that rims or ridges of color or varnish are not likely to form. It is furthermore patent that, with the increase in the size of the article, all these factors are brought more prominently to the front.

For the successful outcome of the varnish-dipping process a great deal depends not only upon the clever performance of the work but also upon the external shape or configuration of the object itself. Thus a prismatic or cylindrical rod may, without further ado, be dipped into an ordinary solution of alcohol and shellac, taken out, and allowed to drip. With skillful handling, that is, if it be lifted very slowly from its bath, scarcely a perceptible drop will be found on its lower extremity. If, however, even this simple rod be taken from the bath quickly and set carelessly aside, we shall soon see the so-called "curtains," which are the zig-zag lines bordering on the thicker films of varnish, and at the bottom will be found a semi-solid hemispherical prolongation too thick to drop off. One of the greatest, perhaps even the greatest inconvenience attending varnish dipping, is the formation of the thicker films of varnish—whether they appear as curtains, ridges, lumps, drops, or what not—caused by the downward flow of the liquid, which dries as it proceeds, becoming more sluggish as it descends, and finally getting too thick to flow. Less marked is this in the fatty than in the volatile varnishes. Again this inconvenience is not a little aggravated by the external character of the object itself, so that, for instance, surfaces, made up alternately of protuberances and deep cavities out of which the liquid scarcely flows at all, are not suitable for dipping.

It clearly follows, then, from what has already been said, that the different shapes and particularly the conformation of the exterior surface, as well as the circumferential area, the length, etc., of the objects to be dipped always demand that the varnish employed in each case shall possess corresponding characteristics, that is, its composition as regards its solvent in volatile varnishes, shall be suited to the object—in short that there can be no such thing as a single dipping varnish for everything, a "universal dipping varnish" that dries immediately.

Quite different is it with the fatty varnishes. Objects coated with varnishes of this description are, almost without exception, baked in ovens or drying chambers at high temperatures. More than that, the varnishes are not infrequently warmed in advance, or the objects themselves are first heated and then plunged into the bath.

When warm the excess in varnish not only runs off easily but also spreads itself evenly, so that with a very little care, "curtains," knobs, etc., never occur, or only in exceptional cases. Since it is well known that even raw linseed oil dries very rapidly and becomes hard at from 70 deg. to 90 deg. C., these fatty dipping varnishes may be so compounded that, though they contain very little or no thinning material at all, they will yet flow beautifully and evenly in a warm place and thereby afford a guarantee of a faultless coating.

As for the consistency of the volatile dipping varnishes, they may be made up according to the effect desired; for small objects, wherein the varnish is intended only to protect them against tarnishing, that is, weak oxidation upon the surface, a very thin or easy flowing varnish will undoubtedly be selected and the articles be drawn from the bath so slowly that in drying no opportunity is offered for the formation of ridges or drops.

If a higher gloss be desired, then the dipping liquid must be a trifle thicker and the objects quickly extracted and whirled around in the air until the solvent is so far evaporated that even when in a state of rest no further flowing will take place.

If an attempt were made to dry at rest objects taken from thick varnish, a whole series of "curtains" would be formed, which would become very conspicuous, especially in varnishes colored with aniline dyes.

Varnishes colored with any of the anilines offer many difficulties, because it is almost impossible, even with considerable practice, to accomplish a uniform coloration of the object. As a consequence, the steps in the process are now most often so arranged that the objects are first dipped in a colorless varnish and thoroughly dried, then the coated article is immersed in a very thin color bath, quickly extracted, and whirled around till dry.

When dipping enamels, etc., in color liquids which have a decided tendency to thicken, particularly when the baths are large, many difficulties stand in the way of keeping the combination of color and varnish evenly blended, difficulties which in the cases of heavy coloring bodies lead to but negative results; but even in small quantities the unavoidable air bubbles which occur while mixing and stirring and which are more numerous in the thinner liquids, play a very disagreeable rôle. Finally we are compelled to acknowledge that, though it appears on the surface to be a very easy process, varnish dipping is beset with many and varied difficulties. In reference to the composition of volatile dipping varnishes be it further said that while, in general, the same raw materials are employed as in the making of varnishes applied with the brush, yet shellac has proven itself the best and most consistent material, while the more expensive copals soluble in alcohol rank very low in the scale.

Additions or adulterations which tend to soften the product and endow it with elasticity, such as turpentine, castor oil, the fatty acids from linseed oil, etc., must be added to these as well as to all the other varnishes of this kind, and that very volatile solvent, ethyl alcohol, may be partly supplanted by other alcohols, by oil of turpentine, etc., whenever it is desired to produce dipping varnishes intended for special purposes.—Translated from Farben Zeitung for the SCIENTIFIC AMERICAN SUPPLEMENT.

AN AUTOMATIC LAMP LIGHTING AND EXTINGUISHING DEVICE.*

By DR. ALFRED GRADENWITZ.

THE use of selenium cells is by no means limited to wireless telephony. On the contrary, the possibilities afforded by these simple devices are so numerous, that it would be quite impossible to give an exhaustive survey of them in an article like this.

The idea of an automatic device for lighting and extinguishing lamps of any kind is due to Bidwell, who, in December, 1890, presented to the London Physical Society a selenium cell fitted with a strong battery and a relay acting on an electric bell. As soon as a gas lamp illuminating the selenium cell was put out, the bell would begin ringing, and would so continue until the gas was lit again. The bell could be replaced by an electric incandescent lamp, which would be lit and extinguished alternately.

The inconstancy of any photo-electric cell previously used was the drawback which prevented Bidwell from carrying out his idea in practice. He accordingly considered the above experiment merely as a lecture demonstration, while foreseeing the possibility that a practical application might become possible at some future date.

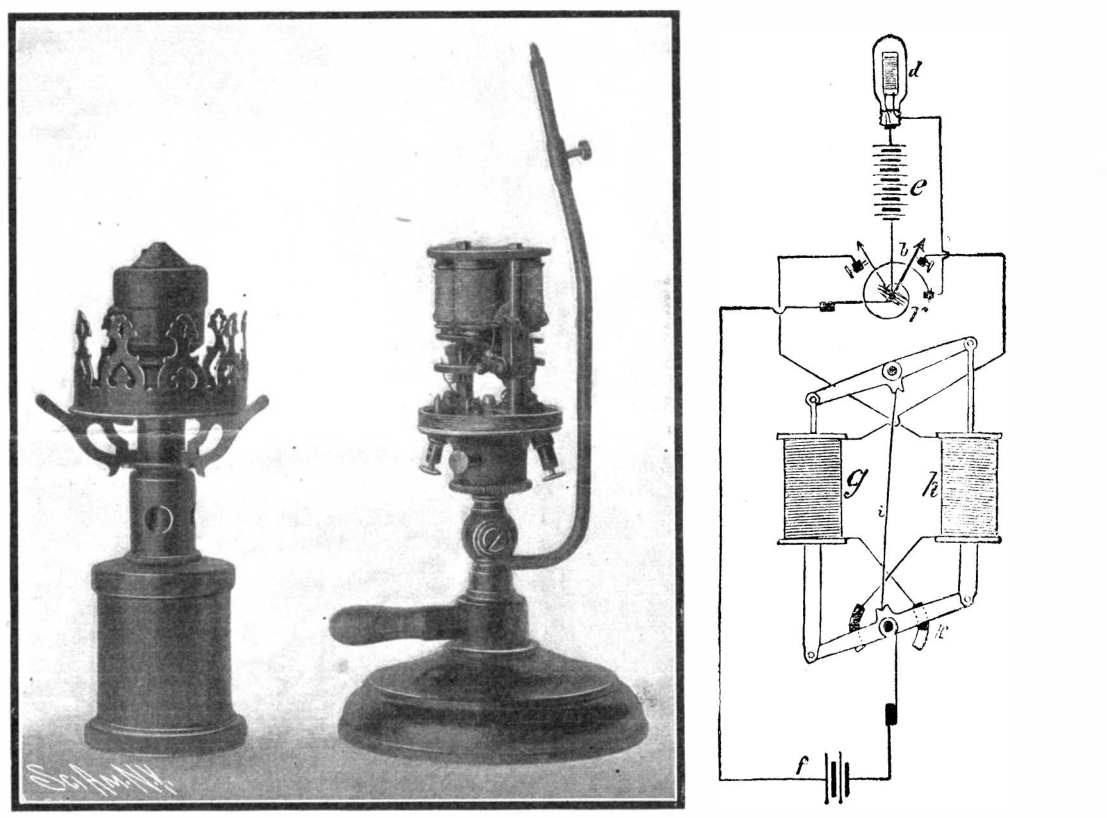
This was accomplished by Mr. E. Ruhmer, of Berlin, who was able to utilize the highly constant selenium cells designed by himself for constructing a similar apparatus. Experiments so far made on the automatic lighting and extinguishing of lamps at nightfall and daybreak respectively, have given rather satisfactory results, though the experimental apparatus was exposed for a considerable length of time to the influence of varying atmospheric conditions and temperatures, as well as to the action of brilliant sunlight.

As shown in the diagram, the apparatus consists mainly of a Ruhmer photo-electric cell, *d*, fitted in an exhausted glass bulb with a socket and connected in series with a battery, *e*, and a specially constructed relay, *r*, which is not sensitive to shocks and oscillations. According as the cell is in the light or in the dark (day or night) it will allow greater or smaller intensities of current to traverse the relay, the armature, *b*, of which touches one or the other of two contacts, when a strong local current, *f*, will flow and will operate, according to the position of the relay armature, either of the two solenoids, *g*, *h*. In the case of gas light, the cock that turns on the gas is connected to the apparatus and is either shut or opened, while, in the case of electric lighting, the circuit that supplies the lamps is made or broken, the flame or lamp thus being extinguished by day and lit at nightfall.

The selenium device is so designed as to automatically interrupt the battery circuit after the gas or electricity has been turned on, so as to prevent any useless consumption of current from the local battery, *f*. This effect is obtained by means of a steel spring, *i*, or an oscillating mercury switch, either of which changes the switch, *k*, so as to break the circuit of the solenoid that is operating toward the end of the stroke, and set the contact for the circuit of the other solenoid in advance, so that the current may be completed at any given moment from the relay. In the case of gas light, the flame has to be lighted either by a special small igniting flame, burning permanently, or by a spark or glow igniter operated also from the selenium cell relay.

The most simple device is that used in connection with electric light, where a single cell with its relay is sufficient for a whole group of lamps. A similar apparatus is being designed for a current intensity of 200 amperes, to be switched on or off at a tension as high as 110 volts. This is intended for a small lighting central station, where all the lamps, both glow and arc lamps, connected will be automatically lit and extinguished at the same time. In the case of gas light, the switching mechanism for a single flame is located, together with the electro-magnetic shut-off of the cock, in a small capsule beneath the burner, thus occupying little room, while for a larger number of flames the cut-off is inserted into the common feeding pipe.

Similar igniting devices are specially important in connection with beacons and signal buoys on shore. Beacons, as is well known, are small stationary signal fires, while buoys are floating nautical signals, both being intended for indicating the true course to the sailor. Both consist of an iron reservoir, which is stationary in the case of beacons, while with buoys, being anchored at the bottom of the sea, it floats on the surface of the water. The reservoir is filled with compressed enriched gas, which traverses a gas pressure regulator and feeds a gas flame in a lantern fitted on the top of the reservoir. It being impossible to light and to extinguish these lamps daily like a street lantern, they, of course, have to go on burning day and night; and in order to save as much as possible of the gas contained in the reservoir, the gas conduit is cut off and opened periodically, thus producing a flickering flame. It is evident that the apparatus designed by Mr. Ruhmer will enable these signaling devices to work only by night, thus saving half the amount of gas formerly used.



AN AUTOMATIC LIGHTING AND EXTINGUISHING DEVICE.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT

FARADAY ROTATION IN POLARIZED N-RAYS.—The extreme smallness of the wave-length of N-rays makes it reasonable to expect a very pronounced magnetic rotatory polarization. Such rotation has been foreseen and actually verified by H. Bagard. He used a prism of aluminium to separate out the various beams of N-rays, and polarized them by means of a glass plate held at an angle ranging from 59 to 71 deg. The source of the rays was a Nernst lamp, and the polarized rays were transmitted either through aluminium or through carbon bisulphide placed in a magnetic field of about 50 units. Even with such a feeble field, the rotation observed was very large, amounting to a maximum of 45 deg. in the case of aluminium and to 54 deg. in the case of carbon bisulphide. These rotations would, in the case of ordinary light, require fields of great intensity. They are of the order of those observed in quartz with ordinary light. The

rotation increases as the wave-length becomes smaller. On repeating the same experiments with ordinary light, the author only obtained rotations of some 4 minutes.—H. Bagard, Comptes Rendus, February 29, 1904.

ELECTROCHEMICAL INDUSTRIES.*

By F. B. Crocker and M. Arendt.

The word electrochemical is here used to include electrometallurgical, as there is no generic term for the two subjects. Electrochemistry may be defined as that branch of science relating to the electrical pro-

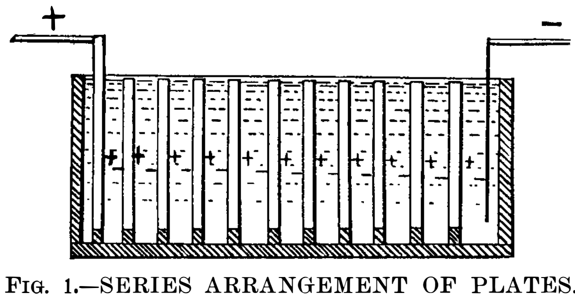


Fig. 1.—SERIES ARRANGEMENT OF PLATES.

duction of chemical substances and chemical action, or to the generation of electrical energy by chemical action. On the other hand, electrometallurgy is the branch of science that relates to the electrical production and treatment of metals. The two subjects are based upon the same principles, the theory, laws, and data of one being applicable to the other. Hence, it is proper and now customary to combine them under the head of electrochemistry.

Electrochemistry may be subdivided as follows:

A.—Electrolytic Chemistry, which consists in separating or producing other action upon chemical substances by the decomposing effect of an electric current or *vice versa*. Since the electrolyte is usually in the liquid state, there are:

"Wet methods" with solution.

"Dry methods" with fused materials.

In the latter case the materials are maintained in a state of fusion by the heat due to the electrolytic current or by external heat.

Electrolytic chemistry is applied to the following purposes:

1. *Primary batteries* including various forms of

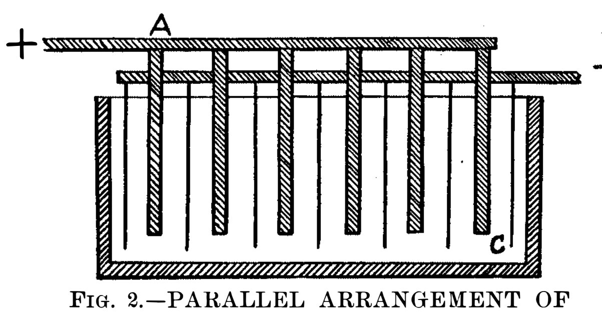


Fig. 2.—PARALLEL ARRANGEMENT OF PLATES.

voltaic cell in which electrical energy is generated by chemical action.

2. *Secondary or storage batteries* are similar to the foregoing, but the chemical action must be reversible, so that after periods of working the cell may be charged or brought back to an active condition by sending through it a current opposite in direction to that which it generates.

3. *Electrotyping* is the art of reproducing the form of type and other objects by electrodepositing metal on the object itself or on a mold obtained from it.

4. *Electroplating* is the art of coating articles with an adherent layer of metal by electrodeposition, as in nickel plating.

5. *Electrolytic refining of metals and chemicals* by the elimination of impurities, as in the conversion of crude copper into pure metal.

6. *Electrolytic production of metals and chemicals*, as in the Hall process for extracting aluminium from alumina dissolved in fused cryolite, and in the Castner process for making caustic soda and chlorine from a solution of common salt.

7. *Electrolytic chemical effects*, such as bleaching, tanning, etc.

8. *Electrolytic chemical analysis*, as in copper determination.

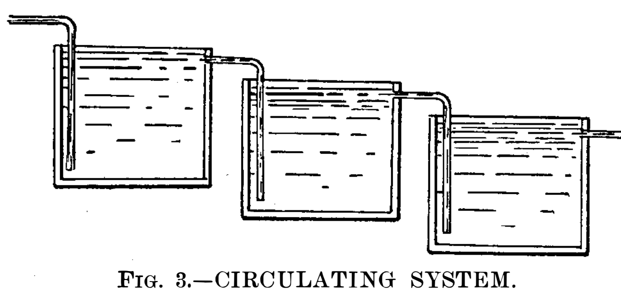


Fig. 3.—CIRCULATING SYSTEM.

B.—Electrothermal Chemistry includes those methods in which electric current raises the temperature of materials, usually to a high degree, in order to produce fusion, chemical action or other effects. Since electrolysis is not desired an alternating current is generally employed.

9. *Chemical action with electrical heating*, as in the production of calcium carbide from lime and carbon in an electric furnace.

10. *Electrical smelting* consists in reducing metallic compounds at a high temperature produced by an electric current, as in the reduction of iron ore in an electric furnace, or in the Cowles process for making aluminium bronze from a mixture of alumina, carbon, and granulated copper.

11. *Electric fusion of chemicals*, usually those that

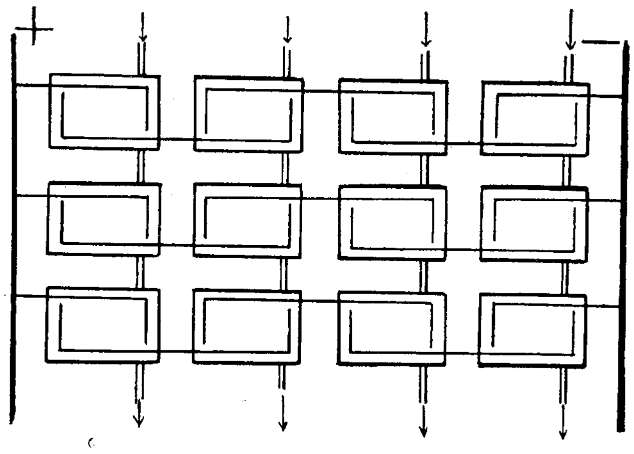


Fig. 4.—GENERAL ARRANGEMENT OF PLANT.

are very refractory, such as silica and alumina. It has been proposed to make bricks by melting instead of baking the clay; electric heat has been used in furnaces for melting glass.

12. *Electrical heating and working of metals* consists in treating metals mechanically with the aid of heat generated by electric currents, as in electrical welding, forging, rolling, casting, tempering, etc.

Strictly speaking, the last two applications are not chemical, but some chemical actions usually occur and they are similar to the others in methods and results, so that it is customary to consider them under the head of electrochemistry.

C.—Chemical Action Due to Electrical Discharges.

13. *Chemical effects of electrical arcs* to produce combinations of nitrogen and oxygen, for example.

14. *Chemical effects of electric sparks.*

15. *Chemical effects of silent electrical discharge*, as in the production of ozone.

Historical Notes.—The first electrochemical apparatus was the primary battery invented by Volta in 1799. The next year Nicholson and Carlisle discovered the chemical action of the electric current in decomposing water. In 1807 Sir Humphry Davy gave his famous lecture "On Some Chemical Agencies of Electricity," he having, the same year, discovered the metals sodium and potassium by reducing their compounds electrolytically. In 1834 Faraday established definite laws and nomenclature for electrochemistry. From 1836 to 1839 Jacobi, Spencer, Jordan, and Elkington applied these principles to practical use in the making of electrotypes. Planté began the development of the storage battery in 1859. Since that time, but mostly after 1886, the theory and applications of electrochemistry have made great progress, so that now it is one of the most important branches of science as well as of industry.

Primary and secondary batteries are prominent objects in electrochemistry, but it is customary to

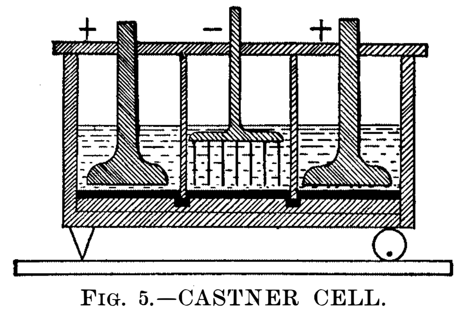


Fig. 5.—CASTNER CELL.

treat them under the general head of electricity or in special treatises.

Electroplating and electrotyping are electrochemical arts, but are usually considered as a separate branch, and so treated.

THE ELECTROLYTIC REFINING OF COPPER.

The largest and most important of all electrochemical industries is the refining of copper, which is conducted at many places in this country and abroad. The process of refining copper electrolytically consists in the transfer of copper from the anode to the cathode, by the selective action of the electric current, and in leaving the impurities behind in the anode, electrolyte, and in the slime or sediment.

It is evident, theoretically, that the mere transference of copper should require no expenditure of energy, because metallic copper is both the raw material and the product; the energy needed to precipitate it from its solution being balanced by the energy set free upon its change to copper sulphate, but practically some energy is needed on account of the resistance of the electrolyte, and differences in mechanical structure as well as in chemical purity of the anode and cathode.

The material at present subjected to profitable electrolytic refining is crude copper containing from 96 to 98 per cent pure copper and varying amounts of other elements according to the character of the ore and method of dry refining adopted. The composition of the crude material varies greatly, typical samples being given in the following table:

	I. Per cent.	II. Per cent.	III.* Per cent.
Copper	96.35	97.19	98.60
Arsenic	0.08	2.68	0.80
Antimony	0.10	0.01	0.10
Lead	1.19	.....	0.10
Tin	0.22	.....	.....
Bismuth	0.05	0.08	0.05
Iron	0.61	0.02	0.10
Nickel	.....	0.02	0.10
Sulphur	0.69	.....	0.10
Silver	.....	.....	0.05
Oxygen and loss	0.71	.....	.....
	100.00	100.00	100.00

Besides these, the crude copper frequently contains small quantities of gold (about one-tenth to one-fifth ounce per ton).

The crude material is cast in iron molds into anode plates, which are about three feet long, two feet wide, and one inch thick, weighing approximately 250 pounds. The cathode plates are of electrolytically refined copper practically the same in length and width as the anodes, but only one-twentieth inch thick. The electrolyte or bath in which the plates are suspended is a solution of twelve to twenty per cent copper sulphate, and four to ten per cent sulphuric acid, the latter being added to decrease the resistance of the solution. This resistance is further reduced by keeping the electrolyte warm, about 40 deg. C.

The containing tanks are of wood, usually lined with sheet lead or carefully coated with a pitch compound, and of such dimensions that a distance of about one inch exists between the faces of the plates.

In some cases the plates are arranged in series, and in others in parallel or multiple, as illustrated. The former has the advantage of requiring electrical connections to be made at the first and last plates only, whereas the parallel system requires a connection at

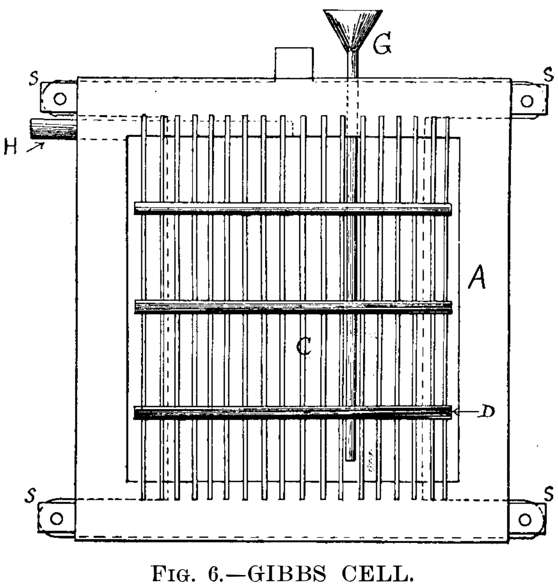


Fig. 6.—GIBBS CELL.

every plate, but in the series system the leakage of current due to the short-circuiting action of the sediment and sides of the tank, is from ten to twenty per cent, so that the parallel is more generally used.

The connections between the various plates and the circuit in the parallel systems, are made by copper rods, which are run at two different levels along the edges of the tanks, one bar for anodes and one for cathodes. In some instances these rods are of the inverted V shape, so that the edges will cut through any corrosion that may happen to form at the points of contact. The drop in pressure at these points is not more than 0.01 volt. The vats are arranged so that each is accessible from all sides, and the circulation of the electrolyte is possible. This circulation may be obtained by blowing a stream of air through the electrolyte, but more frequently, by arranging the vats in steps and connecting them by pipes so that the electrolyte may pass from the top of one vat to the bottom of the next, as shown in the illustration. This maintains a uniform density of the electrolyte, which is necessary for the proper formation of the deposit.

The electrical pressure required is from 0.2 to 0.4 volt per tank, with a current density of ten to fifteen amperes per square foot of cathode plate surface. The individual vats are connected in series with each other, so that the total voltage required may be approximately equal to that of the generator, allowing the usual drop of about ten per cent. Standard generators are built to give 125 volts, so that a working pressure of about 110 volts is obtained, which is a standard value for lighting and other purposes.

In practice from 400 to 500 ampere-hours are required per pound of copper deposited, the theoretical amount, according to Faraday's law, being only 386.2 ampere-hours. The loss varies from four to twenty per cent, according to the system employed.

The behavior during refining of the various impurities present in the anode plates is practically as follows:

Silver and gold remain undissolved in the anode sludge as metals; lead remains as a sulphate. Antimony, bismuth, and tin are partly dissolved out of the

* Portion of lecture notes on electrochemistry, Electrical Engineering Department, Columbia University. From the School of Mines Quarterly.

* Chili bar.

anode to form unstable sulphates which precipitate as basic sulphates or oxides upon standing; the larger part, however, of each remains in the anode sludge. Arsenic, nickel, and iron dissolve and are not redeposited; thus they contaminate the electrolyte, but do not injure the purified copper under ordinary working conditions. Cuprous oxide and copper sulphide remain partly in the sludge and partly dissolve, according to the acidity of the electrolyte. Their only evil effect is to neutralize some of the free sulphuric acid.

The composition of the anode sludge (residue) will evidently vary according to the composition of the anode employed, and various amounts of gold, silver and lead are obtained therefrom.

The cost of refining copper by the electrolytic method is from one-fourth to three-fourths cent per pound. The following products of refining are marketed: Commercial cathodes, which are sometimes shipped to consumers, but more frequently cast into wire bars, ingots, cakes, or slabs of standard dimensions and weight. They usually assay from 99.86 to 99.94 per cent of pure copper, a sample analysis being as follows:

	Per cent.
Copper*	99.938
Antimony	0.002
Iron	0.004
Oxygen and loss	0.056
	100.00

The yield in commercial cathodes is from 97 to 99 per cent of the anodes treated, excluding the anode scrap, which varies from 7 to 15 per cent of the original anode in parallel operated plants, but this scrap is not a loss, as it is collected and recast into anode plates. Besides electrolytic copper, most plants recover gold, silver, and nickel from the slime, as previously stated.

The electrolytic copper refineries in the world are now producing copper at the rate of 322,295 tons annually, valued at $96,688,500, with copper selling at $300 per ton. In addition the by-product in recovered

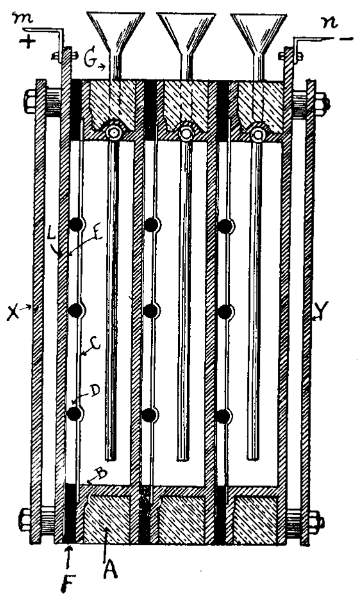


Fig. 7.—Gibbs Cell.

gold and silver is valued at $20,000,000 per annum. There are now in active operation thirty-three electrolytic copper refineries, with a total generator capacity of 20,000 kilowatts. Ten of these are located in the United States, and supply about 86 per cent of the world's output; six plants are in England and Wales, producing about 9 per cent, while the remaining plants are on the continent of Europe.

Aluminium.—Practically the output of this metal for the entire world is now produced electrolytically. The only process used on a large scale is that invented independently in 1886 by Mr. Charles M. Hall in the United States and by Paul L. V. Héroult in France. This process consists in electrolyzing alumina dissolved in a fused bath of cryolite. The alumina is obtained from the mineral bauxite which occurs abundantly in Georgia, Alabama, and other regions. The natural material, being a hydrated alumina containing silica, iron oxide and titanic oxide, must be treated in order to drive off the water and eliminate the impurities. Formerly this was accomplished by a chemical process, but now it is effected more simply and cheaply by heating the material mixed with a little carbon as a reducing agent in an electric furnace. The impurities are thus reduced and collect as a metallic regulus in the bottom of the mass. This leaves the alumina nearly pure and it may be tapped off while fused or easily separated by breaking it up after cooling. In practice it requires two pounds of alumina for each pound of aluminium produced. The flux or bath in which the alumina is dissolved consists of cryolite, a natural double fluoride of aluminium and sodium ($Al_2F_6 6NaF$) found in Greenland. This is melted in a large carbon-lined, sheet-iron tank, which constitutes the negative electrode, a group of suspended carbon rods forming the positive electrode. A direct current of about 65 horse-power at 5 to 6 volts is used. Only a portion of this voltage is required to decompose the alumina. The balance, amounting to about two or three volts, represents the heat produced, which keeps the bath at the proper temperature and fluidity necessary for electrolysis—850 to 900 deg. C.* The passage of the current causes the aluminium to deposit on the bottom of the tank as a fused metal, being drawn off periodically. The oxygen set free combines with the carbon of the positive electrodes and passes off as carbonic oxide. The reaction is $Al_2O_3 + 3C = 2Al + 3CO$. About one pound of carbon is consumed for one pound of aluminium produced. When the alumina becomes

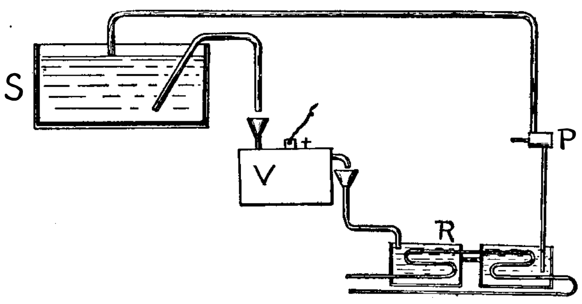


Fig. 8.—Arrangement of Gibbs Process.

exhausted from the bath, the voltage rises and lights a lamp shunted across the electrodes, thus giving notice that more material is needed. Each electrical horse-power produces about one pound of aluminium per day of twenty-four-hours. According to Faraday's law the weight of aluminium deposited by 1,000 amperes is 0.743 pound per hour. The actual yield of metal by the Hall process is about 85 per cent of this theoretical amount.

The aluminium obtained averages 0.1 per cent iron, 0.3 per cent silicon, with traces of copper, titanium, and carbon, but is guaranteed over 99 per cent pure. The selling price of aluminium of this purity is about 31 cents per pound in large lots.

The metal when drawn from the tanks is cast into rough ingots, which are afterward remelted and converted into commercial shapes, such as sheets, rods, wires, etc.

The total power used by the various works employing the Hall process is very large and amounts to

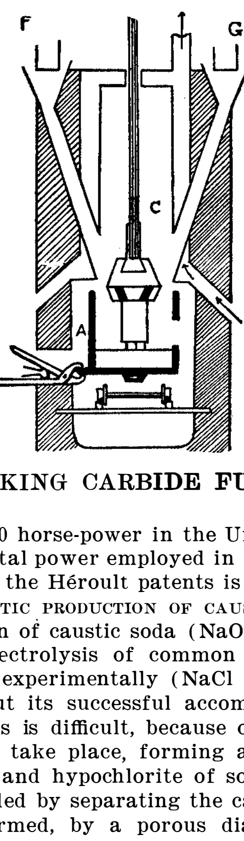


Fig. 9.—King Carbide Furnace.

more than 15,000 horse-power in the United States and Canada. The total power employed in European plants operating under the Héroult patents is nearly as great.

ELECTROLYTIC PRODUCTION OF CAUSTIC SODA.

The production of caustic soda (NaOH) and chlorine (Cl) by the electrolysis of common salt (NaCl) is readily realized experimentally ($NaCl + H_2O = NaOH + Cl + H$), but its successful accomplishment on a commercial basis is difficult, because of the secondary reactions which take place, forming a mixed product of caustic, salt, and hypochlorite of soda. These difficulties are avoided by separating the caustic soda solution that is formed, by a porous diaphragm, or by drawing it off as soon as formed; and in some cases the metallic sodium deposited is absorbed in mercury or molten lead. The two most prominent systems for the electrolytic production of caustic soda and chlorine from common salt are the Castner-Kellner and the Acker processes, one operating at moderate temperatures (40 deg. C.) and the other at high temperatures (850 deg. C.).

The Castner process employed in this country at Niagara Falls is as follows: The electrolytic tank consists of a slate box, 4 feet long, 4 feet wide, and 6 inches deep, the joints being made by means of a rubber cement. Two slate partitions reaching within one-

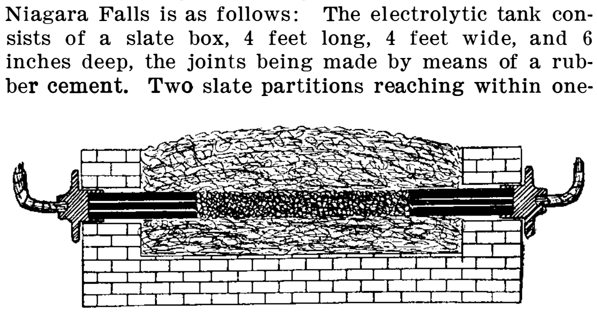


Fig. 10.—Carborundum Furnace.

sixteenth inch of the bottom (under which are grooves) divide the cell into three compartments, each 15 inches by 4 feet, sealed from each other by a layer of mercury covering the bottom of the tank to a considerable depth. The two end compartments through which the brine is passed are provided with carbon anodes, shaped like a rail section, the broader flange being placed about a half inch above the mercury. These compartments are provided with tight covers and exhaust pipes of rubber and lead to lead the chlorine away. The central compartment has an iron cathode composed of twenty upright strips, and is supplied with pure water, which is drawn off whenever its specific gravity increases to 1.27, due to the presence of the manufactured caustic, while the liberated hydrogen is led from this chamber by means of pipes and used as fuel for the concentration of the caustic. The tank is pivoted at one end on a knife blade and rests at the other on an eccentric, which raises and lowers that end of the tank about a half an inch once a minute and causes a circulation of the mercury between the outer and middle compartments. The current passes into the outer chamber, splits up the sodium chloride (common salt, NaCl) into sodium and chlorine (Na and Cl). The latter is liberated at the carbon anodes and passes through the exhaust pipe to the absorption chambers, where it combines with slaked lime to form bleaching powder. The sodium combines with the mercury, forming an amalgam con-

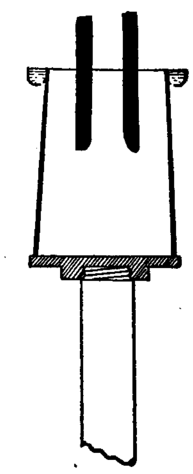


Fig. 11.—Alundum Furnace.

taining about 2 per cent of sodium, which by the tilting of the tank passes to the central chamber, where it serves as the anode, and combines with the water to form caustic soda (Na OH) and hydrogen (H), the latter appearing at the iron cathode.

Each of these tanks uses 630 amperes at 4.3 volts; 10 per cent of this current is shunted around the inner cell, because otherwise the amalgam would fail to deliver enough sodium, and the mercury would oxidize, thus producing mercury salts and contaminating the caustic. The theoretical voltage required is but 2.3, the remainder being utilized in overcoming the ohmic resistance of the electrolyte and in keeping it warm, the limit of temperature being 40 deg. C., as above this point chlorate is formed. The output of this process per horse-power per day is 12 pounds of caustic and 80 pounds of bleaching powder for each cell. The product contains from 97 to 99 per cent caustic, ½ per cent sodium carbonate, 0.3 to 0.8 per cent of sodium chloride and traces of sodium sulphate and silicate.

The Acker process, also used at Niagara, for obtaining caustic soda and chlorine from salt, is similar to the Castner-Kellner process just described, but differs in that it employs molten lead in place of mercury as a seal, fused salt instead of brine as the electrolyte, and operates at a temperature of 850 deg. C., which

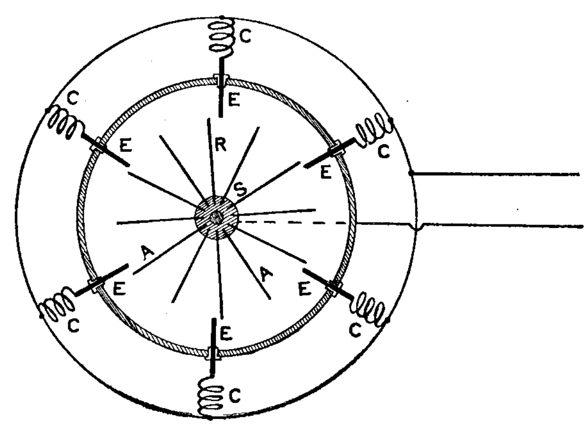


Fig. 12.—Apparatus for Production of Nitrogen and Oxygen Compounds.

is required to maintain the fused condition of the electrolyte. The containing vessel is a cast-iron tank 5 feet long, 2 feet wide, and 1 foot deep, the sides above the molten lead being covered with magnesia so that the current must pass from the carbon anodes to the lead which acts as the cathode, the lower faces of the anode blocks being three-fourths inch above the lead. At one end of the tank is a small compartment separated from the remainder of the vessel by a partition dipping in the lead to such a depth that nothing but this fused lead can pass from one compartment to the other. The chambers are loosely closed by fire-clay slabs and the escaping chlorine drawn away through side flues by powerful exhausts. In the smaller compartment the lead is subjected to a stream of steam, which, acting upon the lead sodium alloy, forms caustic soda and liberates hydrogen. The steam jet is introduced below the surface, but points vertically upward, and the resulting spray strikes a curved hood which deflects it into a third chamber, in which the lead and caustic separate, the latter flowing out of the furnace over a

* This sample was obtained by refining the crude copper given in column three of the preceding table of crude copper anodes.

* This method of using the same current for heating and electrolyzing is covered by C. S. Bradley's U. S. patent No. 468,148 of 1892.

cast-iron lip, the lead sinking and passing back to the main chamber, while the evolved hydrogen is conducted away. The fused caustic is collected in an iron pan, where it solidifies and is removed every hour. The output is 25 pounds of solid caustic per hour. This process avoids the evaporation of the water required in the Castner-Kellner process. The current employed per vessel in the Acker process is 2,100 amperes at from 6 to 7 volts, of which energy 54 per cent is used in chemical action, and the remainder in maintaining the temperature.

Potassium chlorate is produced in considerable quantities both here and abroad. The Gibbs process used at Niagara Falls consists in the electrolysis of potassium chloride solutions, using a copper or iron cathode and a platinum anode. The cells are composed of a wooden frame, *A*, covered with some metal, *B*, such as lead, not attacked by the electrolyte. The latest form of cathode consists of a grid of vertical copper wires, *C*, kept in position by cross bars, *D*, of some insulating material, as shown in Fig. 6. The grid is placed in a vertical position against one side of the cell frame, and kept in place by the anode of the adjoining cell, from which it is insulated by the strips, *F*, and bars, *D*.

The opposite side of the cell from that occupied by the cathode is partially closed by the anode (see dotted lines of Fig. 6). This consists of a thick lead plate, *L*, covered with platinum foil on the outer side, *E*, Fig. 7. This anode is held in position by the cathode and framework of the following cell. *G* is the supply pipe, reaching to the bottom of the cell, by which the potassium chloride is continuously supplied to the cell, and *H* is the overflow pipe, used to convey the mixed solution of the chloride and chlorate, and liberated hydrogen gas is conveyed away from the cell. *S*, *S*, *S*, *S* are lugs projecting from the framework, by means of which any number of cells can be bolted together to form a series of cells. Fig. 7 shows a group of three cells, the heavy plates (*X* and *Y*) being used to close the ends of the wooden framework and form a fully closed series of cells with the only openings at the various supply and overflow points. The current connections are made at the points ($m+$) and ($n-$). When in normal working the cell is continuously fed by each of the supply pipes *G*, with a solution of potassium chloride, the rate of supply being so regulated as to maintain the temperature of the cell at 50 deg. C., and the amount of chlorate in the discharged solution slightly under 3 per cent.

Since the plates *C* and *L* of each cell are in metallic contact, due to the lead lining, the electrolysis occurs between the anode of one cell and the cathode of the following cell (see narrow space between cells). This space is small, not more than one-eighth of an inch wide. The fact that the cathode is a grid allows the electrolyte to circulate around it and all the solution thus passes upward and out of the cells at *H*.

The percentage of chlorate in the overflow solution is low, thus refrigeration is necessary to recover it, and Fig. 8 is a representation of an electrolytic chlorate plant using this form of apparatus. *S* is the supply tank; *V*, the electrolytic cell; *R*, the refrigerators; and *P*, the pump, by means of which the exhausted electrolyte is returned to the supply tank, while the chlorate precipitates out as crystals. The reason for using the refrigerator is that in solutions containing only 3 per cent of chlorate the latter will not crystallize out upon natural cooling, as it would if present in large quantities. This low percentage of chlorate present is necessary to obtain quick recovery, as otherwise the presence of the hydrogen will cause secondary reactions, and cut down the efficiency of the conversion. The pressure employed is about four volts per cell, of which 1.4 is required to convert the chloride into chlorate

$$6KCl + 6H_2O + \text{Elect.} = 6KOH + \overbrace{3H_2} + \overbrace{3Cl_2}$$

$$6KOH + \overbrace{3H_2} + \overbrace{3Cl_2} = 2KClO_3 + 4KCl + \overbrace{3H_2}$$

and the remainder produces the heat that maintains the electrolyte at 50 deg. C., which is necessary for the proper reaction. The current density is high, about 500 amperes per square foot of anode surface. At Niagara the plant consists of fifty such cells, connected up into two sets of 25 cells in series. A direct current of 10,000 amperes is supplied at 175 volts, which allowing for line drop and losses at cell contacts gives the proper pressure.

Electrolytic chemical effects, such as bleaching, have been produced through the action of chlorine or other matter set free by an electric current. It is possible in this way to cause substances to act while in the nascent state and therefore more powerful. Disinfecting and deodorizing of sewage has also been accomplished in a similar manner, as in the Woolf process by the electrolysis of a salt solution mixed with the sewage. The passage of the current liberates $(\overbrace{Cl_2})$ chlorine and sodium hypochlorite (NaClO), which act upon the refuse matter.

Electrolytic chemical analysis is a special subject, the discussion of which is usually confined to books and journals relating particularly to chemical analysis; it is not ordinarily considered in connection with the general subject of electrochemistry, and it would not be regarded as an electrochemical industry.

Calcium Carbide.—This compound is produced by an electrothermal process invented by Willson in 1891, the total output throughout the world being about 300,000 tons in 1902. Its value lies in the fact that one pound of this substance mixed with water produces theoretically 5.5 and actually about 5 cubic feet of acetylene, equivalent in illuminating power to about 70 cubic feet of ordinary gas. The reaction producing acetylene is $CaC_2 + H_2O = CaO + C_2H_2$. Various forms of electric furnace have been employed in the production of calcium carbide. One type invented by King and represented in the illustration consists of an iron car, *A*, which holds the materials and carbide, at the same time acting as one electrode. It can be run into place or removed as desired, and being provided with trunnions its contents may be tipped out. The other electrode consists of a bundle of carbon plates carried by a heavy rod, *C*, composed of a copper strip strengthened by iron side bars. The material which is fed through the channels *G F* consists of a mixture of one ton of burnt lime and three-fourths ton of ground coke to produce one ton of carbide, the reaction being $CaO + 3C = CaC_2 + CO$. An arc is first formed between the electrode *C* and the floor of the truck. The resulting high temperature converts the mixture into carbide, the electrode being gradually raised and more material added until the car is nearly filled with the product, when it is run out and replaced by another. At Niagara Falls a rotary form of furnace, invented by C. S. Bradley, is used, being operated continuously and producing about two tons in twenty-four hours when supplied with 3,500 amperes at 110 volts, or about 500 horse-power. Since no electrolytic action is required, an alternating current is employed.

Barium Compounds.—The principal source of barium is barite or heavy spar, the natural sulphate. Processes for converting this material into barium hydrate, nitrate, chloride, and other soluble salts have been invented by C. S. Bradley and C. B. Jacobs. They consist in melting in an electric furnace a mixture of barium sulphate with a small quantity of carbon. If five parts of sulphate to one part of carbon be present, all the sulphate would be reduced to sulphide, but with one-fourth as much carbon a corresponding amount of sulphide is produced which reacts upon the rest of the sulphate and the oxide is obtained, the two reactions being as follows:

$$BaSO_4 + 4C = BaS + 4CO$$

$$3BaSO_4 + BaS = 4BaO + 4SO_2.$$

The carbonic oxide (CO) and sulphurous acid (SO_2) pass off as gases, the latter being used to make sulphuric acid. The fused barium oxide (BaO) is tapped off, cooled, broken up, and then digested with hot water. On cooling, barium hydrate [$Ba(OH_2)8H_2O$] crystallizes out. This is used in extraction of sugar, treating hides, making white paints, "softening" water, and producing other barium compounds.

Cyanides of potassium and sodium are produced electrochemically by the process of C. S. Bradley, C. B. Jacobs and others. A mixture of barium oxide or carbonate with carbon is heated in an electric furnace to produce barium carbide (BaC_2). While the mass is still hot, nitrogen* is passed through it and barium cyanide forms, the complete reaction being:

$$BaO + 3C + N_2 = BaC_2N_2 + CO.$$

The barium cyanide thus produced is treated with sodium carbonate, the result being a mixture of sodium cyanide and barium carbonate. The former is separated by dissolving it in water, the insoluble barium carbonate being used over again. Potassium cyanide is made in a similar manner and either salt is suitable for gold extraction and other purposes for which cyanides are employed.

Carborundum is a commercial name for carbon silicide (CSi) which is produced in large quantities according to the inventions of A. G. Acheson and his assistants. It is used as an abrasive, being hard enough to scratch ruby. It is formed by intensely heating in an electric furnace a mixture of three and one-half tons of ground coke, six tons of sand and about one and one-half tons of sawdust and salt, the yield being three or four tons of crystalline carborundum and about as much more of the amorphous material. The furnaces used at Niagara Falls consist of fire-brick hearths sixteen feet long and five feet wide, with solid brick walls at each end about two feet thick and six or eight feet high as illustrated. In the middle of each of these walls there are iron frames through which the current is led to a core composed of carbon, weighing about 1,000 pounds and extending the entire length of the furnace. This core is raised to a very high temperature by passing through it for 36 hours an alternating current of about 1,000 electrical horse-power at 190 decreasing to 125 volts. The heat from the core permeates the mass and converts it into carbon silicide which is broken up after the furnace has cooled and used to make hones, wheels for grinding, etc.

Artificial Graphite.—As an outgrowth of the carborundum process, Mr. Acheson has developed on a large scale the manufacture of artificial graphite. The material ordinarily used is anthracite coal ground to about the size of rice which is raised to an exceedingly high temperature in a long electric furnace in the form of a trough about 2 feet square and 30 feet in length. An alternating current of about 1,000 horse-power at 220 decreasing to 80 volts is passed for 20 hours longitudinally through the mass which becomes converted into graphitic carbon. Another line of manufacture consists in graphitizing molded articles of carbon such as blocks and rods for electrodes, which are piled in a furnace similar to that described for converting coal into graphite. By using different materials and conditions the two methods produce different kinds of graphite suitable for lubrication, crucibles, pencils, stove polish, electrodes, etc.

Alundum, the trade name for artificial corundum, is an abrasive made by a process due to C. B. Jacobs and others. Bauxite, a natural hydrated alumina, the same material as used in the Hall process, is calcined to drive off the water and then fed into an electric furnace, the construction of which is as shown in the illustration, and it consists of a conical sheet-iron shell mounted on a hydraulically operated plunger, that raises and lowers it, to keep the current of 80 volts constant at 2,000 amperes. The electrodes consist of two carbon rods that project into the shell, which is cooled by water, from the U-shaped trough, trickling down its outer surface.

The time consumed for fusion is about 12 hours. The mass is allowed to cool and is then removed from the furnace, by holding the sheet-iron shell in position and lowering the plunger; in this manner the product is brought to the ground where it is broken up and sorted. It consists of four parts; namely, a red and blue mass in the interior, crystals that form in the blowholes, a porous outer portion and a by-product consisting of a metallic regulus of ferrosilicon which is used for the treatment of iron in the Bessemer and open hearth furnaces. The porous outer part is used as a recharge, and the mass as well as the crystals, which are of the nature of rubies and sapphires, in fact chemically identical with these gems, are ground up and used to make grinding wheels, and general abrasives.

Electric Smelting.—One of the earliest commercial processes in electro-chemistry was that devised by E. H. and A. H. Cowles in 1884. A mixture of about 2 parts of alumina, 1 or 2 parts of granulated copper and 1 or 2 parts of carbon was introduced in a brickwork chamber. Bundles of carbon rods inserted at the ends formed the electrodes between which a current of 3,000 amperes at 50 volts was maintained. At a very high temperature the alumina was reduced ($Al_2O_3 + 3C = Al_2 + 3CO$) and the resulting aluminium combined with the copper to form aluminium bronze.

Iron and steel can be produced by reducing iron ore with carbon in an electric furnace. For example, a mixture of magnetite and carbon can be heated by passing a current through it as in the Cowles aluminium bronze process; through a carbon core in contact with the material as in the carborundum process; or by the action of an arc as in the carbide process. The reaction is simply $Fe_3O_4 + 4C = 3Fe + 4CO$. Pure (i. e. wrought) iron, cast iron or steel may be produced, depending upon the proportion of carbon. The chief advantages are the directness of the process and the fact that the impurities in the fuel (sulphur, silicon, etc.) are not introduced. On the other hand, it is a question whether the electric furnace can compete in economy with the blast furnace and Bessemer converter.

Compounds of nitrogen and oxygen are produced by the electrical process of C. S. Bradley and D. R. Lovejoy. The apparatus consists of a cylindrical chamber through which a number of iron wire electrodes *EE* are introduced as illustrated. The ends of the radial arms *AA* carried by a revolving spindle *S* pass very close to the electrodes. A pressure of 6,000 to 8,000 volts maintained by the generator *C* between the arms and the electrodes produces arcs 4 to 6 inches long that are drawn momentarily. The current is unidirectional, but being pulsating an inductance coil *C* in series with each electrode cuts the current down to about 0.005 ampere per arc. There are 180 stationary electrodes in each chamber and as the arms revolve 500 or more times per minute at least 18,000 arcs are formed in each chamber in that time. Ordinary air after being dried is passed through the chamber where the arcs cause a certain percentage of the nitrogen and oxygen to combine. This compound absorbed in caustic soda forms sodium nitrite or nitrate; with potassium hydrate it forms potassium nitrite or nitrate, and by absorption in water nitric acid may be produced.

Ozone is produced in chambers through which a silent electric discharge is caused to pass from a static electric machine, induction coil or very high voltage transformer. If air circulates through the chamber a certain portion of its oxygen is converted into ozone.

Organic compounds, such as dyestuffs, vanillin, iodoform, chloroform, are also produced electrically.

LOCOMOTIVES USING SUPERHEATED STEAM IN GERMANY.

On the distance between Sommerfeld and Berlin an accurate record was kept of the performance of a twin locomotive using superheated steam and of two similar compound locomotives using ordinary steam, and it was found that the engine with superheater showed an economy in the amount of coal used amounting to 10.9 per cent and of 25.8 per cent in the amount of water used. During these trips the engine with superheater made much better time at starting than the compound engines at the fifteen stations where the train stopped, and it made better time in climbing a considerable ascent near Frankfort-on-the-Oder. Judging by calculations based on the amount of steam produced, it was estimated that the real saving in coal should have been 15.3 per cent instead of 10.9 per cent, the saving actually attained.

According to the report of J. Obergethmann, professor at Aix la Chapelle, locomotives equipped with the most perfected form of superheaters and compound locomotives were tested by the Halle railroad directory, and the average economy in the amount of coal used by engines with superheaters was 11 per cent, and 23 per cent less water was used. Scientific investigations also showed too great a difference between the economy in water and that of coal. The most exhaustive comparative tests that have been made public

* Air cannot be used, as the oxygen present would oxidize the barium and the carbon.

were described in a lecture of Mr. Unger, a railroad inspector, to the Union of German Mechanical Engineers, which has been subsequently published in Berlin. The management of the Stadtbahn of Berlin, whose lines run through and around the city, caused three engines of types considered best adapted to the service of the railroad, to be tested under conditions as nearly alike as possible. Owing to the fact that engines using superheated steam gather speed much more rapidly at the start than other locomotives, they are especially adapted for urban traffic, and the locomotives with superheaters gave much better results than the two competitors using ordinary steam.

The conclusion reached by Mr. Unger as a result of the trials made on the Stadtbahn was that the three-fourths coupled locomotive with superheater is, owing to its greater efficiency and economy, the only locomotive worthy of consideration for the hauling of heavy trains in interurban traffic. Taking the amount of coal consumed by the locomotive with superheater as the unit of consumption or 1, the consumption of the three-fifths locomotive with three cylinders was 1.50, and that of the three-fourths coupled engine was 1.37. The saving in coal of twin locomotives using superheated steam, over compound locomotives using ordinary steam, varies according to the nature of the service rendered, but the results indicated above would show that 10 to 11 per cent economy may be at present attained under normal conditions of traffic, and it is likely that this economy may be increased by further improvements in construction.

The fact that the compound engine can be replaced by the simpler twin engine, with increase of power and lower pressures in the boiler, would seem to warrant the satisfaction of the Prussian railroad authorities with the results obtained by them in the use of superheated steam, even if no economy in fuel were attained. DEAN B. MASON.

Berlin, Germany.

SUBSTANCES LIABLE TO DECOMPOSITION BY LIGHT.*

By F. A. Upsher Smith, Ph.C.

Acidum Carbolicum and its Preparations (glyc. ac. carbol., etc.).—The purest grades of Calvert's acid are usually put up in amber-tinted bottles. The B. P. states that "exposed to moist air it may acquire a pinkish tinge." It would be interesting to know whether the reddening of carbolic acid on keeping is due alone to exposure to moist air. Certain it is that chemical change is liable to occur in carbolic acid, with formation of rosolic acid, and it is therefore included in this list as a member of the class of compounds liable to chemical change in darkness, and therefore more liable to change when exposed to white light.

Acidum Hydrobromicum Dilutum.—See Acidum Hydriodicum.

Acidum Hydriodicum.—Though not official this preparation may be mentioned as stating a case for the more careful preservation of hydrobromic acid. Hydriodic acid exposed to sunlight for one month at ordinary temperatures is decomposed to the extent of 80 per cent.

Acidum Hydrocloricum.—Though not coming under the subject of decomposition by light it is worth mentioning that for storing this acid dark blue bottles are found to be the best, and white and green bottles the worst, owing to the danger of arsenical contamination from white and green bottles. Amber glass is also suitable, being free from lead.

Acidum Hydrocyanicum Dilutum.—The Pharmacopœia directs this preparation to be "stored in a dark place, in small stoppered bottles of amber-colored glass; the bottles being tied over with impervious tissue, and the bottles inverted." These admirable directions might with advantage be applied to the preservation of all liquid medicinal preparations liable to chemical change. The tendency of an aqueous solution of hydrocyanic acid to change into ammonium formate is here checked in every possible way. The bottles are to be small, so that when once opened the contents shall soon be used up; when not in use the bottles are kept in darkness, the amber tint protecting them when brought into the light for use. The inversion of the bottles prevents escape of hydrocyanic acid vapor. It is important to shake before use in this case, as with all liquids giving off volatile vapors.

Acidum Nitricum is less prone to decomposition when kept in amber bottles, well filled.

Adeps and ointments and pomades containing it do not become rancid so quickly as usual when preserved from white light.

Æther and its Preparations.—The tendency of ether to produce hydrogen peroxide would no doubt be retarded by inhibiting white light. This has not been verified. It has been suggested that a globule of metallic mercury placed in a bottle of ether would keep it free from hydrogen peroxide. In addition the precautions as to preservation given in the B. P. under Acidum Hydrocyanicum Dilutum are also applicable here.

Amygdalæ and their preparations are included in the list partly owing to the presence of fat liable to become rancid, and partly owing to the rapid decomposition of powdered almonds if at all damp. They should, however, be freshly powdered and not stored for any length of time.

Amyl Nitris.—The official directions for preserving prussic acid are quite as necessary in this case. It is to be hoped that the next Pharmacopœia will in other important cases, such as this, give particular directions to insure the preservation of potent drugs.

Aniline, as is well known, acquires a dark color when exposed to the action of white light.

Argenti Nitras and its preparations, as well as all gold and silver salts, should be preserved in amber bottles.

Arsenii Iodidum is an unstable compound. It is very important to prevent decomposition as far as possible.

Carbonis Bisulphidum acquires a yellowish color by keeping.

Chloroformum "should be kept cool and in a dark place," according to official directions. Not only sunlight and ordinary diffused white light, but gaslight and other artificial lights prejudicially affect chloroform, carbonyl chloride and hydrochloric acid resulting. David Brown (Pharmaceutical Journal [4], 11, 669) recommended the use of lime as a preservative, and I submit the desirability of applying the official directions for preserving prussic acid in this case also. The ill-effects of administering decomposed chloroform are so liable to a fatal termination that no well proved precaution should be omitted. Not long ago a valuable paper was published on the preservation of medicaments by Madsen, wherein he stated that white glass protected chloroform less than red and yellow glass.

Coccus.—Cochineal is included merely as an example of a colored vegetable substance that is liable to be more or less decolorized by the action of white light.

Creosotum acquires a yellowish to reddish color on keeping.

Ergota, as containing a fixed oil, is included in the list, though it should not be kept longer than a year. The Pharmacopœia states "it is liable to deteriorate by keeping and by exposure to damp." The hollow stopper of the containing vessel should be filled with quicklime and the constricted neck plugged with cotton wool, to prevent access of moisture. A method largely employed by cigar dealers for keeping cigars dry is to sprinkle ordinary tea among the cigars. I have tried this method and found it successful, even when the box was kept on a high shelf, exposed to damp air in an unheated room with the door generally open. It would doubtless answer in the case of ergot, but the odor of the tea would be a disadvantage.

Filix Mas and Extractum Filicis Liquidum.—Male fern is another drug that should not be kept more than a year, owing to the conversion of the active filicic acid into amorphous inactive filicin, which is the anhydride of the acid. When the internal bases of the petioles are no longer green the drug is unfit for use. The liquid extract, on keeping, is also prone to a similar change. It is not known whether this change was due to the action of light or other causes, but it is desirable to take care that these and similar medicaments prone to chemical change are protected from the action of white light.

Fœniculi Fructus.—See Oils, Volatile.

Hydrargyri Perchloridum.—Müller, experimenting with an aqueous solution containing mercuric chloride and oxalic acid, found that black, red, orange, and dark yellowish-brown bottles were most efficient in preventing reduction; that brownish-yellow, pure dark green, and dark brownish-green protected well; but that bluish-green, blue, or white afforded little or no protection.

Injectio Morphinæ Hypodermica and other Preparations of Morphine.—It is usual to wrap vessels containing morphine salts in solution in ruby or yellow paper, to exclude the actinic rays of solar light.

Iodoformum, in alcoholic solution, is decomposed under the influence of light, iodine and methylene iodide being produced. Oxalic acid accelerates this decomposition, and, generally speaking, iodoform was very prone to decompose with formation of free iodine. I make a practice of excluding iodine preparations as far as possible from light.

Iodum and its Preparations.—A well-known method of producing decolorized iodine consists in adding solution of ammonia and exposing to a bright light. This forms an excellent illustration of the potency of solar light in promoting or accelerating chemical change.

Liquor Ammonii Citratis, Liquor Ammonii Acetatis, and other solutions that dissolve lead should be stored in amber glass.

Liquor Calcis Chlorinatæ is an unstable solution of available chlorine, and requires protection from solar light.

Liquor Ethyl Nitritis.—The loss of strength on keeping this preparation has been referred to by Barclay (Pharm. Journ. [4], 9, 615), and Harvey (C. and D., 1901, 1, 833). It is most important to store this preparation in small, full amber bottles, in a cool place.

Liquor Hydrogenii Peroxidi.—Many methods have been devised and practised for preserving this unstable solution. Madsen has shown that orange glass preserves it best, then red glass, white glass being very much worse. If orange or amber glass would preserve this solution without the addition of an acid, it would be far preferable.

Liquor Pancreatis, being an animal extract, is prone to decompose. Doubtless all such preparations are best kept in amber bottles.

Liquor Sodæ Chlorinatæ.—See Liquor Calcis Chlorinatæ.

Mucilago Acaciæ, as a fermentable liquor, is included in this list.

Oils, Fixed, and Fats.—These, as a rule, are liable to become rancid. The usual method of storage in jars or a cellar naturally preserves from light, but it is not uncommon to see bottles of olive and almond oils exposed to bright light in shop-rounds. Again, pomades containing fixed oils and fats are usually put in clear glass bottles. In such cases amber bottles not only help to preserve, but in addition have a nice appearance. It is only to be expected that the beautiful natural green tint of olive oil should become brown on exposure to light.

Oils, Volatile.—The tendency of volatile oils to resinify and become dark in color is well known. Such action should be checked as far as possible by storing in amber glass. Madsen has shown that in the case of Fœniculi Fructus orange glass preserves the odor better than red or white glass. This, I think, states a good case for storage of all volatile oils in amber glass. The following oils suggest themselves to me as specially liable to change, but I should go further and store all solutions containing volatile oils, e. g., tinctures and perfumes, and all crude drugs containing volatile oils in amber glass.

Oleum Anthemidis becomes yellowish brown on keeping.

Oleum Caryophylli becomes reddish on keeping.

Oleum Crotonis darkens with age.

Oleum Limonis loses its delicacy on keeping. I have frequently known absolute alcohol to be added, 1 oz. to the pint, but in practice I have never seen this oil preserved in amber bottles.

Oleum Menthæ Piperitæ becomes darker by age.

Oleum Menthæ Viridis.—The same.

Oleum Morrhuæ requires the most careful preservation from heat and light.

Oleum Phosphoratum.—See Phosphorus.

Paraldehydum, as an ethereal preparation, is included in this list.

Phosphorus and its preparations require preservation, not only from air but from light, which produces the amorphous variety.

Physostigmatis Semina and the salts of physostigmine. Eserine sulphate, as is commonly known, becomes red by exposure to air and light.

Pilula Phosphori.—See Phosphorus.

Potassii Iodidum after standing for a long time in a bottle frequently not only smells strongly of iodine, but frequently shows visibly the presence of free iodine.

Pulvis Glycyrrhizæ Compositus, as an example of an aromatic powder, is here included. The damaging effect of light may often be seen in a bottle of compound liquorice powder that has been exposed. The portion facing the light is distinctly bleached.

Pulvis Rhei Compositus.—See Pulvis Glycyrrhizæ Compositus.

Santoninum, as everybody knows, turns yellow on exposure to light, probably owing to the formation of photo-santonic acid, which is a yellow substance. Amber glass should be used to prevent this change.

Spiritus Ætheris Nitrosi is officially directed to be preserved in well closed vessels, preferably in a cool dark place and in small bottles. There is no preparation with which we have to deal that requires amber glass more than this. It is to be regretted that so many shop-rounds used for this purpose are of white glass, and also are too large. The aim should be always to keep a full bottle of sweet niter, whatever the size may be, and to let the size be as small as compatible with convenience. A valuable paper dealing with the preservation of this galenical by David Gilmour will be found in the Pharmaceutical Journal [4], 12, 54, and by Farr and Wright in the "Year Book of Pharmacy," 1901, 447. They confirmed Harvey's recommendation to use amber glass, recognizing in it a perfect protection. Permit me to recall the conclusive experiments carried out by Farr and Wright. The bottles were placed in a window facing east and south:

	June 15.	July 9.
(1) Stoppered amber glass, 3 fl. oz., full	36.4	36.2
(2) Ditto, half full	36.4	31.4
(3) White stoppered, 2 oz., full	36.4	14.2

The figures denote yield of gas from 5 cubic centimeters.

Sulphuris Iodidum.—This loose combination of sulphur and iodine requires better protection from solar light than white glass affords.

Syrupus Ferri Phosphatis cum Quinina et Strychnina deposits ferric phosphate on standing. It is interesting to recall the fact that one of the ingredients, quinine, exhibits the phenomenon of fluorescence when dissolved in hydroxy-acids. Fluorescence is due, as you are aware, to the fact that quinine and other fluorescent bodies have the power of absorbing certain rays of the invisible spectrum (ultra-violet rays), converting them into rays of longer wave length, which are emitted and rendered visible, their color being sky-blue. It is natural to anticipate that the use of amber glass for preparations of quinine would be beneficial.

Tinctura Ferri Perchloridi.—An alcoholic solution of ferric chloride exposed for a few minutes to sunlight is partially reduced to the ferrous state, a fact which has been made use of in photography, since those portions of the ferric chloride paper which have been altered by light give a blue color on treatment with ferricyanide of potassium. It should be noted that an aqueous solution of ferric chloride does not suffer this change. From this it follows that the Liquor Ferri Perchloridi differs materially in its constitution from the Tinctura Ferri Perchloridi, and it is important for therapeutists to determine in which form they wish to administer iron as tincture, whether in the ferric or ferroso-ferric state. If the former be required, then the pharmacist requires to preserve the tincture in amber glass.

* Extracted from a paper read before the Sheffield Pharmaceutical and Chemical Society.

LIFTING A 7,500-TON BUILDING.

THERE has just been completed, in what is known as the flooded district of Brooklyn, one of the most remarkable and successful pieces of engineering ever attempted in the United States, if not in the world. The feat consisted in raising from its foundation to a height of thirty-four inches the building known as Public School No. 85, at Evergreen Avenue and Covert Street.

This structure, which is of brick, measures 150 by 84 feet along the base line, is four stories high, contains thirty-one class rooms, and weighs about 7,500 tons, or 16,800,000 pounds.

The preparations for this huge venture were begun by digging a trench eight feet wide around the building, to the depth of the foundation, and placing heavy yellow pine timbers, running parallel with the walls, in it.

Above the intrenched timbers, and on either side of the foundation walls, were built the cribbing blocks of various dimensions, upon which were placed the jack-screws, and resting thereon were the screwing timbers. Upon these were placed, at right angles with each other, the cross timbers and top-sticks, the last-named carrying the beams of the building. After the above-described raft was built, the actual work of raising began.

Seventy-five men, selected for the purpose, were sent into the foundation, and were there divided into small gangs upon the different sections of cribbing, each gang patroling its own section. In single file the men followed each other, giving each of the twelve hundred screws a quarter turn.

In this manner the twelve hundred jack-screws were operated, and the massive structure lifted safely to the desired height, and securely held until the new foundation was built under it. The average weight lifted by each of the seventy-five men was 100 tons, or 220,000 pounds.

The lifting of the building was deemed necessary by the New York Board of Education, to prevent the flooding of the lower part of the building, which has been very frequent, especially after a heavy rain.

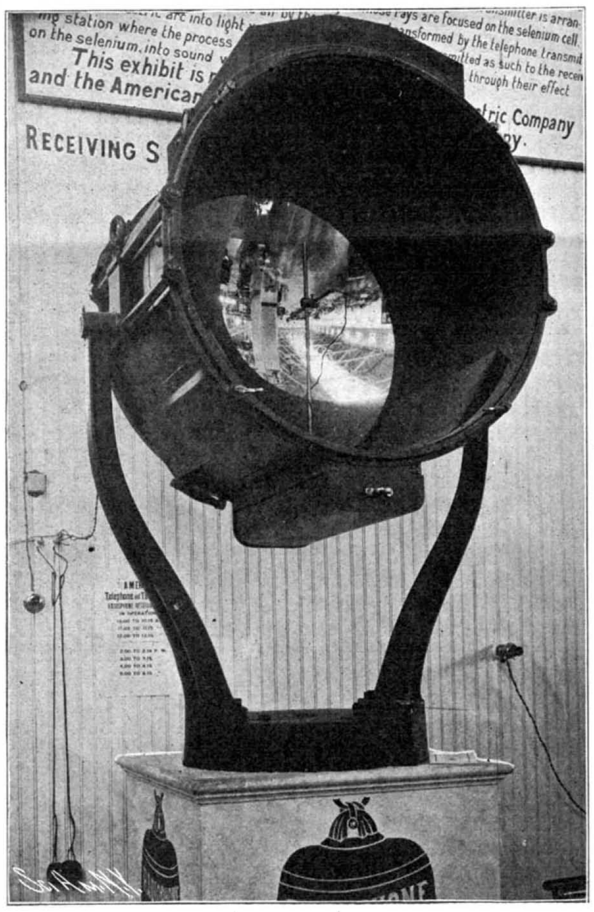
From an engineering viewpoint, the raising of this building from its foundation was a remarkable piece of work, and was considered by many experts as a very hazardous undertaking; and its successful accomplishment reflects great credit upon the ability of Messrs. William R. Daybill, Charles E. Holme, and Alfred Daybill, who were in charge of the work, and who compose the firm of Miller, Daybill & Co., Inc., shorers and contractors, with headquarters in Brooklyn.

LUMINOUS EMISSION UNDER N-RAYS.—R. Blondlot has found a probable explanation of the failure of many other physicists to repeat his observations. It lies in the fact that the emission of light is affected by the N-rays in the sense of being concentrated upon the normal rather than upon the tangent plane. Thus, an observer watching the surface perpendicularly sees it brighten up, while, if he watches it along the edge, it appears to become duller. In the case of the N′-rays, the reverse is the case. The influence of sound-waves discovered by de Lépinay, and that of the magnetic field observed by Gutton, act in the same manner.—R. Blondlot, Comptes Rendus, February 29, 1904.

THE WIRELESS TELEPHONE STATION AT THE LOUISIANA PURCHASE EXPOSITION.

By the St. Louis Correspondent of the SCIENTIFIC AMERICAN.

ONE of the most striking exhibits in the Electricity Building at the Fair is undoubtedly the wireless telephone station. The apparatus in question is a radiophone, in which the speaking arc is employed in the transmitting station, and a selenium cell located in the focus of a parabolic mirror at the receiving station.



RECEIVING STATION.

Upon the peculiar attributes of selenium the apparatus depends chiefly for its operation. The substance has the property of varying in electrical conductivity with the amount of light with which it happens to be illuminated at a given moment. This remarkable property was applied some twenty years ago by Alexander Graham Bell. In his instrument, a mica or glass diaphragm covered with a silver foil was used to reflect a powerful beam of light upon a selenium cell placed in the focus of a silvered reflector. To the selenium cell were connected a pair of telephones and a battery. At the back of the silvered diaphragm was a flexible tube and a mouthpiece into which words were spoken. Sound waves cause the diaphragm to vibrate and send pulsations of the reflected light upon the selenium cell, producing corresponding variations in its resistance, and reproducing audible sounds in the telephone. This instrument was used by Prof. Bell with signal success over very short distances.

In 1898 Prof. H. T. Simon, of the University of Erlangen, devised his interesting speaking arc, by means of which he superimposed sound waves produced by the telephone upon the circuit in which the arc was placed. He connected the lamp circuit with the secondary winding of an induction coil, the primary circuit being connected with the carbon transmitter and the battery. The sounds thus produced originally were very weak; but by employing a suitable carbon microphone, the sound was reproduced to a large audience.

Very similar to this instrument of Simon's is that which is shown at the Fair. It includes, however, various improvements which have been made since Simon's day.

It has been found that the transmitter battery may be omitted, and a shunt from the arc circuit may be used with the transmitter at a suitable resistance. Again, this resistance may be displaced by storage batteries, and in this case self-induction coils ("reaction coils") should be placed in the circuit of the arc lamp, allowing the direct current to pass without obstruction; but offering extremely high resistance to the alternating currents produced by the carbon transmitter. By compensating in this way, any disadvantage with the use of the shunt is obviated. The theory advanced to account for the phenomenon of the speaking arc is that variations in the temperature of the arc are produced by the variations of the current, and the change in the Joule effect produces a corresponding variation in the volume of the conductive gases in the arc.

The most successful and most extensive experiments which have been made with the speaking arc are those of Ernst Ruhmer, of Berlin, Germany, who has employed it in conjunction with the selenium cells of wireless telegraphy with remarkable success. He has succeeded in transmitting speech over a beam of light four and one-half miles in length.

A REMARKABLE ENGINEERING FEAT. RAISING A 7,500-TON BUILDING A DISTANCE OF 34 INCHES.

A SHORT HISTORY OF COAL MINING IN THE UNITED STATES.

IN early colonial days, when every hilltop was covered with forests, fuel was plentiful enough above ground, and there was no need to search for it in the bowels of the earth. Coal mining in the United States is, therefore, of comparatively recent origin. Mr. Edward W. Parker, who has made a brief *résumé* of its history in his report on the Production of Coal in 1902, which is soon to be published by the United States Geological Survey as part of its annual volume on Mineral Resources, states that the earliest record of coal production in the anthracite region of Pennsylvania is for the year 1814. That is the chronicle of 22 short tons of anthracite coal. The most complete record of coal production which we have is that of the anthracite region of Pennsylvania. Shipments from there began in 1820, and since that date the records have been carefully preserved. In the 89 years from 1814 to 1902, inclusive, the total production of anthracite in Pennsylvania has amounted to approximately 1,554,200,000 short tons.

So far as is known, the earliest production of bituminous coal was made in the Richmond basin in Virginia. About 54,000 short tons were produced in 1822, and the amount gradually increased until 1832, when it began to decline, and about the middle of the last century had almost disappeared. About that time the development of the Piedmont region began, and for the next 30 or 40 years, practically all of Virginia's production came from the northern part of the State.

Next to those of the anthracite region of Pennsylvania, the most authentic records we have of coal production in the United States are of the Cumberland-Piedmont district of Maryland and West Virginia. The first openings were made in Maryland, and shipments began as early as 1842.

It is practically certain that some bituminous coal was produced in Pennsylvania prior to 1840, but this is the earliest date on record. The total output of bituminous coal in Pennsylvania is estimated to have been approximately 1,251,000,000 short tons, making the entire production of coal in Pennsylvania approximately 2,805,000,000 short tons.

The next earliest statistics of coal mining which we have are for the State of Illinois. It is stated that coal was mined on the Big Muddy River in Jackson County, in 1810, but there is no record of the amount produced. The mine was worked by drift along outcrops in the bluffs. A flatboat was loaded with coal at this place and shipped to New Orleans. The census of 1840 states that coal was mined in 19 counties of Illinois, and that year's production amounted to 16,968 tons. It is calculated that the total output of the State has amounted to nearly 442,000,000 short tons. It is interesting, in this connection, to remember that Father Hennepin noted in his journal in 1679 the existence of a coal mine on the Illinois River, near the site of the present Ottawa.

The first year in which any production of coal was recorded in Ohio was 1838, when the output was 119,952 tons. The census of 1840 and that of 1860 took note of the production, but for the years between 1840 and 1860 no data are available. Since 1860 the records are fairly accurate. The total output of the State is estimated to have been somewhat over 358,250,000 tons.

The earliest producers among the States west of the Mississippi River were Missouri and Iowa. The coal-mining industry began there about 1840.

The first coal discovered on the Pacific coast was in the State of Washington in 1852. The first mine was opened in Whatcom County in 1854.

California has never taken high rank as a coal-producing State, but it comes next in order in the history of early production, as an output of 6,620 tons was reported in 1861. This increased steadily until 1874, when the maximum output of 215,253 short tons was attained. It began then to decline rapidly, and since 1876 the industry has been rather irregular, the production depending upon many outside influences.

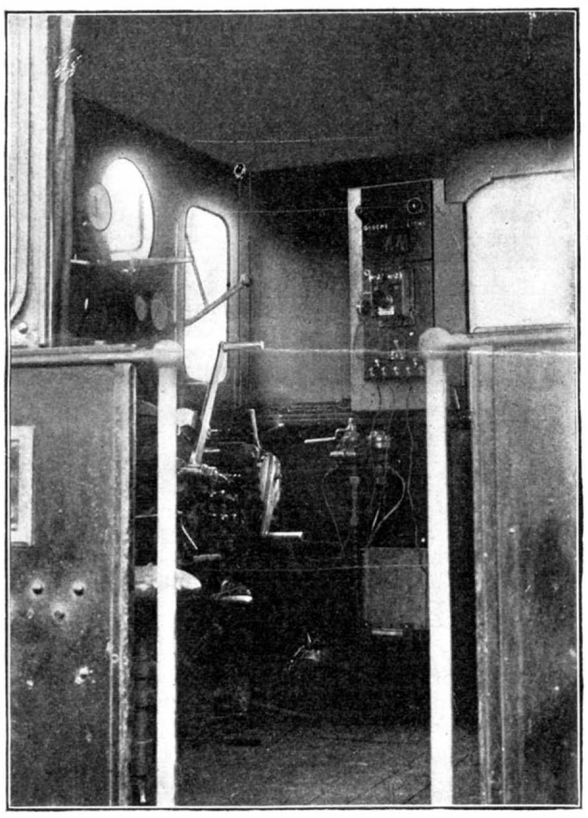
The first reported coal production for Indiana, Kentucky, Tennessee, Alabama, and Washington was given in the census of 1870, but all these States were undoubtedly producing coal before that time.

The total coal production for the United States up to December 31, 1902, is estimated at 4,860,000,000 short tons. That means that a pyramid built of this material as high as Pike's Peak (14,108 feet) would have for its base a rectangle 1.14 miles square. If the coal were spread out over the States of Rhode Island and Connecticut it would cover both of them a foot deep.

A NEW SYSTEM FOR THE PROTECTION OF TRAINS BY ENGINE-CAB SIGNALS.

By Emile Guarini.

The Gesellschaft für Eisenbahn Zugdeckung, of Frankfort, has recently been experimenting in Germany, and with satisfactory results, with a system of electric signaling by means of an apparatus carried by the locomotive. The device was invented by MM. Pfirmann and Wendorf. Briefly described, the system is as follows: Between or at the side of the ordinary rails is laid a third rail, which may be of smaller size than the others. Upon each locomotive there is a current collector that rubs against the third rail, and which is connected with the axles, and consequently with the ordinary rails, through a battery and a relay so regulated that it is only when the intensity of the current reaches a certain limit that the armature is attracted and closes a local circuit, thus actuating some such signal as a bell or lamp, or even a brake.

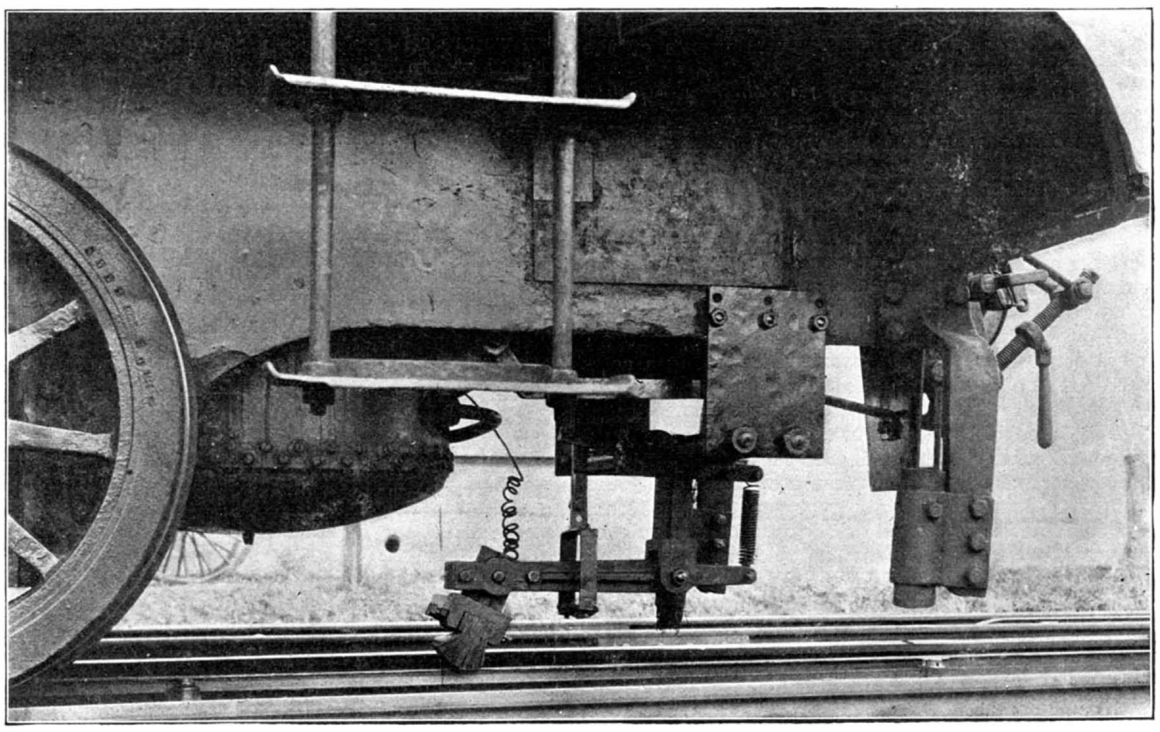


CAB OF A LOCOMOTIVE FITTED WITH THE SAFETY APPARATUS.

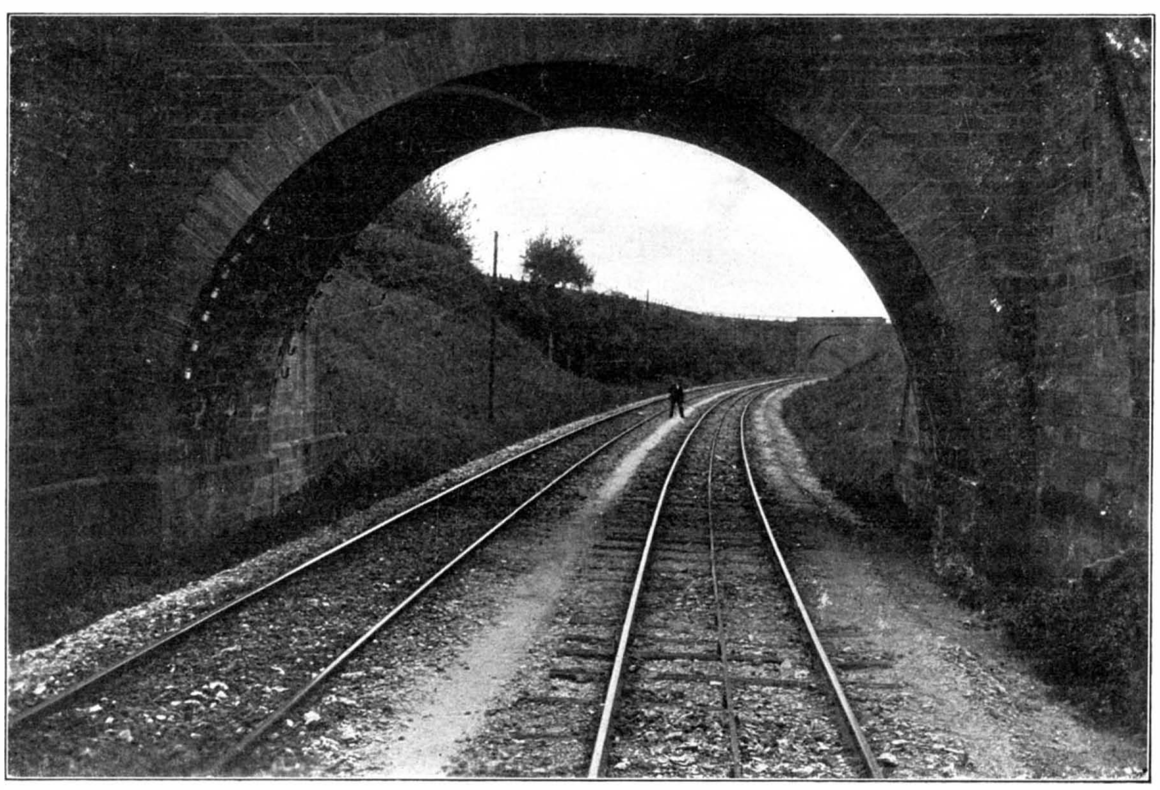
By means of this arrangement the engineer can tell whether a switch is open, or can be warned of any other danger. In a normal state, the circuit of the battery on the locomotive is open and the relay is not excited. If, on the contrary, the signal is set in the danger position or a switch is open, things are so arranged that a short circuit is made between the live rail and the ordinary one. If a train runs upon the track, the circuit of the battery and relay will be closed by the live and ordinary rails, which are connected together electrically by the signal or open switch. In spite of this, the armature of the relay will not be attracted, because it is still at too great a distance from the signal where the rails are connected, and consequently the intensity of the current, which is a function of the resistance of the rails and thereby of the distance, is not yet sufficient. In order to obtain the best results, there is interposed in the live rail at about every 328 feet a resistance coil of 7 ohms. When the train is near enough to the danger signal or the open switch, the resistance of the rails and supplementary coils having fallen to a determinate value, the intensity of the current traversing the relay will be sufficient to attract its armature and give a signal of alarm upon the locomotive.

The inventors, and those who are exploiting their system, have even desired more, for they have likewise tried automatic signaling, that is to say, a method of causing each train to make known its presence to another train automatically, and that, too, despite the errors and absent-mindedness of the track inspectors. Were things arranged solely as above described, it might happen that the batteries of two trains, according to the positions of the latter, would be one moment in opposition and the next in series or tension. Now every time that they were in opposition (and this would be most frequently the case), the trains would be at some yards' distance without the relays being excited. Therefore no signal would be given and there would be a possibility of collision. The difficulty has been surmounted in the following manner: The inventors have provided their arrangement with a commutator actuated by the axles of the train. The current is thus rapidly commutated, and, since the speed of the two trains is not likely to be identical, the result is that the currents of the two batteries will be alternately in opposition and in tension. It might be objected that, from the moment the train stops, there will no longer be any commutating of the current. This inconvenience may be remedied by arranging things in such a way that when the train is stopped, its battery will be thrown out of circuit and the third rail will be directly connected with the axle through the relays. Apart from the fact that, in case the trains are running, intermittent signals are given, the operation is exactly the same as in the case of stationary signals. It is only when the two trains have reached a dangerous proximity and the current has attained a determinate intensity that the alarm signals operate. When one train is at a standstill and another one runs the risk of colliding with it, it may be easily seen that it is the train in motion that must stop. But what would occur were both trains in motion? According to the inventors, both should come to a standstill. As such a situation could not be prolonged, without detriment to the traffic, the trains are provided with telephone arrangements, so that as soon as they come to a standstill, their crews can at once communicate.

As compared with other systems, the one under consideration has the advantage of giving a signal not only during the passage from one section to another, but whenever there is any danger. It has, it is true, the inconvenience of necessitating the installation of a special rail, but that is a question that is of interest only to the management, which is often too desirous of effecting an ill-advised saving. Apart from this, the system might render service merely for indicating to the engineer the position of the semaphores. It is the same with this system as with all non-automatic ones (with few exceptions) that are employed upon the Continent of Europe. When an accident occurs and the public and press loudly demand an improvement in the regulation of signals and in signaling itself, we inevitably hear the railway managers exclaim in chorus: "The regulations and the signals are perfect —provided that the men do their duty!" But it appears that the men do not do their duty, or, to speak more correctly, cannot do it. The same is the case with the systems in question. Provided that the circuit of the rails were interrupted or the resistance of the electric connections were modified or the apparatus got out of order, the absence of an alarm signal would give the engineer a false security, and in such a case, because of the lack of the signal, the trains might come into collision. The system can therefore prove efficient only on condition that there be a vigilant and continual surveillance of the apparatus. This is a question that the future only can solve for us. Meanwhile, the apparatus installed upon a mile and a half of the State Railway System is operating well, at least in an experimental way.



THE APPARATUS MOUNTED BENEATH THE LOCOMOTIVE.



THE ROAD ON WHICH THE SYSTEM WAS TESTED.

A NEW SYSTEM FOR THE PROTECTION OF TRAINS BY AN AUDIBLE SIGNAL IN THE ENGINE CAB.

MAIL-CARRYING MOTOR OMNIBUSES IN ENGLAND.

Last August the Great Western Railway Company began a very interesting experiment by establishing passenger motor omnibuses as feeders to their railroad service—supplemented last Easter by luggage omnibuses—these omnibus automobiles running in outlying districts; and it is announced now by a correspondent of the London Times that they have served so successfully as "perfectly adequate substitutes" in sparsely settled districts for fixed lines of costly railways that the Postmaster-General has decided to take advantage of the opportunity they offer for a quicker distribution of the mails. An arrangement has been effected for the carrying of the mails between the Helston terminus of the Great Western and Lizard, the immediate result of which will be that people living at the Lizard will receive their letters at 9 A. M., an hour earlier, and will be able to post letters for the night mails up to 4:15 instead of 2:45. The following particulars from the Times' report will be found interesting, as indicating that "an important problem in the operation of railways" has been solved, and suggesting to American railroad managers possibilities of increases of the revenues and profits of the companies they control:

"The construction of small branch lines into sparsely populated country districts naturally involves the expenditure of considerable sums of money for which there is little hope of a profitable return, while the steady increase of local taxation—which in rural districts falls with especial severity on railway companies—renders almost prohibitive the making of further lines which can but act as 'feeders' to the main system. What the Great Western Railway Company has now established by its two types of motor omnibuses—passenger and luggage—is the fact that an efficient service of such conveyances, involving a comparatively small expenditure, may, in many outlying districts, be regarded as perfectly adequate substitutes for fixed lines of costly railways. In fact, the 'luggage omnibuses' introduced on the Helston-Lizard Town route, and now being taken advantage of by the Postmaster-General, not only represent a great convenience for railway travelers, but fulfill the role of motor carrier carts for the particular districts in which they operate. In addition to a compartment for passengers only, seating ten persons, they have one which is nominally a luggage van, though by an ingenious arrangement it can, in case of need, be readily converted into an additional compartment for passengers. Provided that such transformation be not necessary, something like a ton of passengers' luggage, consignments by rail, and parcels collected from local tradesmen or others can be stowed away in it, further provision for luggage, etc., being also made on the roof. Passengers are taken up *en route*, after the manner of ordinary omnibuses, so far as the seats have not been occupied, and in case of need the entire available space is given up to passengers, luggage and parcels being then kept back for the next journey. To judge from some trips made on these luggage cars, they are not only performing a most useful purpose and certain to secure a great popularity among the visitors to one of the most attractive spots in the west of England, but they have already completely established their value as successful substitutes for railways. It is not a little singular that, whereas few, if any, of the trains on the branch line of railway from Gwinear Road (on the mail line of the Great Western Railway) to Helston are ever run at a profit, the motor omnibuses between Helston and Lizard Town paid their way even with the ordinary local traffic of last winter, while their prospects during the forthcoming tourist season are very promising. So satisfied, in fact, is the Great Western Railway Company with the results of its experiments that it has given an order for the construction of a considerable number of other motor omnibuses, which are to be run between other points on its system where there is a need for increased facilities for travel, but where the construction of lines of railway would not be likely to prove remunerative."—Marshal Halstead.

THE ZIEGLER RELIEF EXPEDITION.

W. S. Champ, who was sent by Ziegler to the relief of Anthony Fiala, on the "America," has sent the following report to Mr. Ziegler describing his recent experiences:

"We entered the ice on the 9th of July and bucked our way up to about 77 deg. 30 min. between 35 deg. and 46 deg. longitude, where we met such a heavy pack ice that we were simply powerless to go further north in this position. We then forced our passage through the ice westward and got a good lead northeast, but again met the heaviest ice so far encountered. From the crow's nest we thought there was open water to the north, and if we could get through the ice ahead of us we believed we could make Franz Josef Land, so at full speed we bucked the heavy pack ice until we were many miles in the pack.

"The ice gradually became more closely packed and larger floes, and to continue in this course meant being caught fast and drifting with the ice as a whole. Therefore, we again extricated ourselves from this position and continued for a week to look for a favorable lead to northward. We followed the pack ice, however, to within thirty miles of Nova Zembla, when it again turned southward to the shores of that island.

"We worked northward again on the 26th of July and between 44 deg. and 45 deg. longitude forced our way to 78 deg. 30 min. north latitude, about seventy miles from Cape Flora. Here we met the floe ice, and although we spent a week trying to force a passage, could not make a further northing.

"On the morning of July 31, for the first time in three weeks, the horizon was free from fog, and we were enabled to get a good view of the ice in every direction. We found that we could not do anything more until the wind or swells broke up the floes, which were rotten but impossible to navigate. It was at this stage that the chief engineer reported 105 tons of coal on board, which was an inadequate amount for us to be of any service to the "America," i. e., so far as being able to coal her. It was then decided to take advantage of the conditions to return to Vardoe for coal.

"We have had nothing but warm weather, rain, and fog all the time, no wind—with the exception of one day—so the ice has gradually rotted, and if we only get a good blow the whole situation will change in a few days. We will be back to our last position not later than August 9 or 10, so that we will have a full month to accomplish our mission, and have no doubt we will get through.

"This failure has been a great disappointment to us, as we are all anxious to reach Franz Josef Land and be of aid to the boys on the "America," in case of need. The party on board are all well, and we shall spare neither ship nor coal to get through. There has been very little game to be seen, which is difficult to explain, as we have been on favorable ice for all kinds of Arctic game.

"During our eastward voyage we reached 78.06 deg. north latitude. This was our course in 1901.

"12 P. M., August 4, 1904. W. S. Champ.

"We are coaling by the midnight sun and have every hope of success. Champ."

THE DEAD SEA OF THE NEW WORLD.

The Great Salt Lake of Utah has been called the Dead Sea of the New World, and with good reason, for it bears a striking similarity to the famous body of water described in the Bible. The Great Salt Lake, however, is one of the greatest mysteries of nature. For fifty years its rise and fall have been studied by scientists in an effort to account for the changes; but to-day they have reached no solution of the problem as to what is the principal cause of the decrease in its depth. But it is known that this great inland sea is passing away. Those who are familiar with its depth and the shrinking of its size each year say that at the end of twenty-five years the bed of the lake will be nearly all exposed, with the possible exception of a few shallow pools of water. Then the mystery connected with it will probably be solved.

The lake is truly a sea in its dimensions, being about seventy-five miles in length and fifty miles across at its greatest width, and therefore containing over two thousand square miles of surface. The New World also has a Jordan River, which is the principal water supply of the lake so far as known. This is an important stream, draining a very large area of the mountainous country as well as three large lakes of fresh water. During the season when rainfall is prevalent in this portion of the United States, several creeks ranging from thirty to seventy-five feet in width and from one to five feet in depth also empty into the lake; but it has no visible outlet in spite of the fact that the Jordan has been pouring its waters into the lake for centuries. Proof that it is drying up is given by the tables of its rise and fall which have been prepared since the year 1863. These show that during the last thirty-five years the lake has fallen at an average rate of one foot in every three years. During some periods it has risen from one foot to two feet; but this increase has been counteracted by the decrease, which, as the tables show, has amounted to over ten feet during the period mentioned.

The change has brought about some curious conditions. Near the shores the water is so shallow that there are places where a man may wade out from the beach for a distance of over a mile yet will not be immersed up to his shoulders. The buoyancy of the water is such that it is almost impossible for a person to remain on his feet at a greater depth, his body being lifted up as a strip of wood thrown into the water in a vertical or oblique direction like a dart is returned to the surface in a horizontal position. In fact, it is believed that the Great Salt Lake will support more weight to a given volume of water than even the Dead Sea. It is a very popular resort with bathers for the reason that it is impossible for a person to drown unless he should deliberately place his head under the surface or tie a weight to his feet. The bather can float upon the water, lying on his back or chest, and keep his head entirely above the surface with no effort of the arms or legs. He can also lie upon his back, keeping his legs down to the knees out of the water, and both of the forearms.

The large quantity of salt in solution is the principal reason for the buoyancy; and as the lake recedes, its bottom is shown to be composed of a heavy crust of salt, which is almost pure, lying upon a stratum which consists principally of sand. In this respect the bed of the lake is very similar to some of the deserts in the Southwest, which once contained bodies of water equal in size to that in Utah, or even larger. The most striking indication of the rapidity with which the lake is receding is the present location of the principal bathing pavilion. This was constructed in 1893, and forms one of the most elaborate pleasure resorts of the United States, for it comprises not only the bathing houses, but a music hall, a hotel, and other structures under the same roof. The edifice is over one thousand feet in length, and when it was built, rested upon thousands of wooden posts driven into the lake at a distance of no less than four miles from the shore. To-day, however, the pavilion is half a mile from the water's edge, and bathers must go a mile from the houses before they can reach a depth of water sufficient for complete immersion.

It is known that the Great Salt Lake loses a large quantity of water yearly by evaporation; but estimates of this quantity indicate that it is far less than that annually poured into the lake from the rivers and creeks entering it. As already stated, no natural outlet thus far has been discovered; but the lake supplies an irrigating system in the country adjacent to it which requires a quantity of water yearly equal to a depth of four inches of the present area. This is a very small proportion of the volume which enters it through its feeders; so the scientists know that the water escapes in some other manner than by the irrigation canal or by evaporation. This is proved by the fact that the increase in the quantity which enters the lake at a rainy season at times does not increase its depth, and the records show that actually it has sometimes fallen immediately after the Jordan and the other streams have contributed a larger volume than usual. The curious nature of the bottom is indicated by the attempt to build a railroad across the lake, which has been in progress for the last two years. In places near the center the engineers have discovered what appear to be enormous beds of quicksand or of mire, into which the longest posts cannot be driven to a firm foundation. In an effort to construct the railroad track across these places thousands of carloads of earth and rock have been emptied into them; but most of the material has sunk to a point where it cannot be touched by the sounding instruments. There are some spots in these portions of the lake where material has been thrown almost daily for over a year without thus far finding solid bottom. Several of the railroad engineers who have carefully examined the conditions have a theory that the depressions which it seems impossible to fill are at the entrance of an underground river, so that as fast as the rock is thrown in the current of the river carries it away, and that this outflow is steadily increasing each year, causing the decrease in depth. Near what is called Antelope Island is another indication that a subterranean opening exists. Frequently the waters near the island are so violently disturbed that people in the vicinity call this place the "maelstrom" and carefully avoid it when on the lake in boats. A number of years ago a sailing vessel loaded with sheep chanced to approach too near the "maelstrom," and, in spite of the strong breeze which was blowing, the force of the water was greater than the power of the sails, the vessel being drawn into the middle of the disturbance and capsized. Although sheep are naturally strong swimmers, and land was but a few hundred feet away, not one of the animals escaped, and most of the carcasses went under water never to appear again.

While the buoyancy of the water is so great that it will support a person without aid, the boats which are designed to be used upon the lake must be constructed especially to counteract this feature. The ordinary wooden vessel when empty is actually too light to be navigated with safety upon it, since such a small portion of it would be immersed. Therefore care has to be taken, in building sail boats especially, lest they be top-heavy. For this reason navigation is very dangerous on the lake when the wind is blowing even moderately, unless the sailing vessel is heavily loaded so that it sits deep enough in the water to counteract the buoyant tendency. The quantity of salt held in solution is so great that it is dangerous for one to swallow even a mouthful of the water, as it is liable to cause strangulation. Several deaths from this cause have ensued among persons who have ventured into the lake.—Chambers's Journal.

[Continued from Supplement No. 1498, page 24007.]

STEAM TURBINE PROPULSION FOR MARINE PURPOSES.*

By Prof. A. Rateau.

TORPEDO BOAT NO. 243.

Five years ago, in 1898, the French Admiralty began to experiment with steam turbines for the propulsion of warships. Knowing that we had already given attention to this question, the Admiralty invited Messrs. Sautter-Harlé and the author to supply engines of this kind for a torpedo boat of 92 tons. The object of the experiment was also to investigate the working of combinations of propellers. In order to reduce expenses, it was laid down that the hull of an ordinary torpedo boat should be used, and that the turbine should be installed in the space usually occupied by the reciprocating engines, in order to allow the latter to be replaced in position if necessary, at the end of the experiment. This arrangement caused a great deal of inconvenience in the installation of the turbines and propellers, and it ultimately resulted in the trial not being so conclusive as it should have been. It was naturally very difficult to adapt turbines to a hull designed for a reciprocating engine, as the cross-section of the boat has a distinctly V-shaped outline in its lower part, whereas, for the turbines, which have to be arranged one on each side of the center line, the cross-section should have been much flatter on the

* Read at the spring meeting of the forty-fifth session, held in the hall of the Society of Arts, London, 1904.

floor. Hence the impossibility of sufficiently lowering the main shafts where they enter the turbines, which involved their being very steeply inclined, viz., 11 per cent off the horizontal. Each shaft carried three propellers, and was supported at two points by long brackets fixed to the hull.

These conditions were very unfavorable, the steep inclination of the shafts operating against the efficiency of the propeller, and this was fully brought out in the trials; while the excessive length of the brackets aft considerably increased the total resistance of the vessel. As regards the turbinesthemselves, theyhave given very satisfactory results, as shown in the reports of the trials. The two turbines, of 900 horse-power (nominal) each, are quite independent of one another. On the exhaust side they inclose a single moving ring for going astern, and in this first attempt we voluntarily sacrificed power in going astern. The chief object, as has been stated, was to see if the combination of turbines and small propellers could give the vessel anything like the speed she would have obtained with the reciprocating engines. In point of fact, 21 knots only was the speed obtained, whereas it should have been 24 knots, as the turbines themselves gave rather more power than had been estimated, and this difference is principally attributable, as already stated, to the steep sloping of the propeller shafts.

At the first trials we had some trouble with oil getting into the condenser. This arose from having designed a joint of oil under pressure at the point where the shaft enters the turbine on the low-pressure side. This joint effectually prevented the ingress of the air, but caused a considerable flow of oil to the condenser. To remedy this we put the low-pressure bearing completely outside the turbine, and used a novel system of stuffing. As to the other bearings, one at the middle of the shaft and the other at the high-pressure end, they both remained inside the turbine. Lubrication was effected by pumping in oil from the outside, and the excess oil afterward collected.

After the alteration in the low-pressure bearing, the engines worked very satisfactorily, and, although each turbine now has two internal bearings, the leakage of oil to the condenser is very slight, and compares favorably in this respect with a reciprocating engine. Since July, 1902, there have been a large number of trials with this boat in the presence of French Admiralty engineers, and no less than six different arrangements of propellers, distributed in pairs or by threes in each shaft, have been tried. The speeds obtained have varied greatly, according to the arrangement of the propellers, but at full power, the highest speed varies from 18 to 21 knots, corresponding to a variation of efficiency of 40 per cent. The full details of these trials cannot be given here. I will, however, give the results of two trials made with propellers of 23.6 inches pitch and 20.9 inches diameter in one case and 19.7 inches pitch and 23.6 inches diameter in the other. The first trials are summarized in Table A.

TABLE A.

Torpedo Boat No. 243. Trials of January 22, 1903. Six propellers: Diameter, 23.6 inches; Pitch, 19.7 inches.

Number of Trial.	I.	II.	III.	IV.
Speed of vessel (in knots)—mean of three runs	17 07	19.59	20.94	21 26
Rotation of turbines—Revs. per minute	1348	1572	1748	1774
Effective pressure of steam on admission to turbines—lbs. per sq. in	68 26	100.98	129.42	132.26
Condenser vacuum—inches	28	28	27	27 5
Mean slip of propellers	0.217	0.230	0.260	0.260

With the other arrangement of propellers (19.7 in. pitch and 23.6 in. diameter), the following results were obtained:

TABLE B.

Torpedo Boat No. 243. Trials of December 6, 1902. Propellers: Diameter, 20.9 inches; Pitch, 23.6 inches.

Number of Trial.	I.	II.	III.	IV.	V.
Speed of vessel (in knots)—mean of two runs	14.90	16.59	18.73	18.83	20.89
Rotation of turbines—Revs. per minute	1051	1213	3686	1392	1556
Effective pressure of steam on admission to turbines—lbs. per sq. in	104.5	80	* ?	99 5	115
Condenser vacuum—inches	26.4	26.4	26	26.4	26.8
Mean slip of propellers	0.279	0.304	0.311	0.311	0.316

*Owing to the failure of the gages, the pressures in the turbines could not be taken on this trial.

The torpedo boat No. 243 was built by the Société des Forges et Chantiers de la Méditerranée at Havre, where its trials were run.

BOAT BUILT BY MESSRS. YARROW & CO.

The author's system of turbines has been installed on the vessel built by Messrs. Yarrow & Co. She is a sister ship to the "Tarantula," which, as is well known, was fitted with a Parsons turbine, and is similar, apart from the system of propulsion, to the first class torpedo boats of the British Navy. Displacement, 140 tons; length, 152 feet 6 inches; breadth, 15 feet 3 inches.

The boilers, of the well-known Yarrow type, are the same as are usually fitted on first-class torpedo boats, and are capable of giving a maximum speed of from 26 to 27 knots with ordinary reciprocating engines.

The boat here described was fitted with three propeller shafts, actuated simultaneously and separately by turbines and a reciprocating engine; the latter (of 250 horse-power) works the central shaft, and is quite independent of the turbines, receiving steam directly from the boilers, and exhausting directly into the condenser. The central shaft only carries one propeller.

The side shafts, which are arranged to carry either one or two propellers each, are worked by a turbine in two sections, arranged in series, and rotating in opposite directions. The supports for the thrust bearings have been increased in order to take the full thrust of the propellers. This thrust being nearly balanced by that of the steam on the drum inside the turbine, it would have been quite possible to reduce the bearings by one-fifth.

The combination of reciprocating engine and turbine as adopted by Mr. Yarrow, had already been advocated by Mr. Nabor Soliana, director of the Ansaldo Works, Genoa (see Engineering, March 28, 1902). But this is not the only possible arrangement, and an even better one, in the author's opinion, is, instead of letting the reciprocating engine exhaust directly into the condenser, to lead the exhaust steam into the low-pressure turbine, or even, under certain circumstances, into the high-pressure turbine. The author had previously arrived at this conclusion as being the only rational arrangement for economical working at slow speeds.

The turbines were built at the Oerlikon Works in Switzerland.

The total weight of the turbines, which are capable of giving upward of 2,000 horse-power, is 17,200 pounds, or 8.6 pounds per horse-power, and this could be reduced by diminishing the thickness of the turbine casings which have been made unnecessarily heavy, and by suppressing the supports of the thrust blocks.

At the point where the shafts pass through the ends of the casing, watertightness is obtained by the same system of stuffing that is employed with land turbines. A special regulator governs the pressure on the four glands so as to prevent any access of air. With this arrangement it is easy to obtain a good vacuum in the condenser, and one of the two air-pumps originally installed has consequently been suppressed. As will be seen in the following table, the vacuum has, with a single air-pump, been kept constant at 27 inches at all powers.

Several trials have been made with this boat from October 13, 1903, up to quite recently, and the author was present at some of these trials, which were under the immediate supervision of Mr. Marriner, chief engineer to Messrs. Yarrow & Co.

First Trials.—The first trials were made on October 13, 1903, each propeller carrying a single screw of three blades of 32 inches diameter, and 30 inches pitch. Table C gives a summary of the results obtained by progressively increasing the pressure of steam supplied to the high-pressure turbine. In the first run no steam was supplied to the turbines, the reciprocating engine alone being employed, and the turbines turning idly by the action of the water on the propellers.

TABLE C.

Messrs. Yarrow & Co.'s Torpedo Boat. Trials of October 13, 1903.

Wind rather strong.

Number of Trial.	I.	II.	III.	IV.	V.
Number of runs on measured mile.	3	2	2	2	3
Effective pressure of steam on admission to h. p. turbine—lbs. per sq. in	—	50	50	100	145
Condenser vacuum—inches	26.8	28	28	27.2	26.9
Speed attained in various runs (in knots)	10.68 13.50 10.30	17.39 13.70 —	20.66 16.76 —	23.84 20.00 —	27.69 22.36 27.48
Mean speed of vessel (in knots).	11.98	15.54	18.71	21.92	24.97
Rotation of reciprocating engine—Revs. per minute	369	411	441	475	516
Rotation of h. p. turbine—Revs. per minute	393	688	955	1172	1455
Rotation of l. p. turbine—Revs. per minute	395	687	994	1357	1657
E.H.P. developed on shaft of reciprocating engine	239	260	251	235	232
Slip of propellers:					
Reciprocating engine—per cent.	39.5	29.7	21 0	14.0	9.7
H. P. turbine—per cent	—	8.9	20.6	24.5	30.5
L. P. turbine—per cent	—	8.9	24.0	35.0	39.0

The e.h.p. developed on shaft was arrived at by deducting 10 per cent from the h.p. recorded by the watt indicator.

The estimated speed of 25 knots was obtained at the first trial, although the turbines were never working at the full effective pressure allowed for in the design, viz., 156 pounds. The curves of the slip of the screws show that at 21 knots speed the propeller surface is sufficient, but above this speed, it is rather too small, and it was consequently decided to increase its surface by adding a second propeller to each of the shafts.

It is interesting to follow the variation in slip of the different screws, as the power of the turbines is increased. With no steam in the turbines, and the vessel being propelled by the reciprocating engine alone at a speed of about 12 knots, the slip of the central propeller is about 40 per cent, while the water causes the wing propellers to turn the turbines at the rate of about 400 revolutions per minute. As the power of the turbines increases, the slip of the middle screw is reduced to about 7 per cent, while the slip of the turbine propellers, on the contrary, beginning at zero, increases progressively to upward of 30 per cent for the high-pressure turbine and 39 per cent for the low-pressure turbine propeller. The difference between these two figures arises from the fact that the low-pressure turbine gives notably more power than the high-pressure turbine, owing to its condenser being better than was expected.

Owing to the considerable reduction in the slip of the central propeller, as the wing propellers come more and more into play, the speed of rotation of the reciprocating engine does not increase in proportion to the speed of the vessel. By referring to the table, it will be seen that at the reduced speed of 12 knots the speed of rotation of the reciprocating engine is 369 revolutions, and at 25 knots (or double the first speed) only 516 revolutions per minute. On examining the curves of the turbines it will be seen that their speed of rotation rises from 393 to 1,455 revolutions for the high-pressure turbine, and from 395 to 1,657 for the low-pressure turbine, while the speed of rotation allowed for in the design was 1,500 to 1,600 revolutions per minute. As regards the steam consumption, with the combined system of engines, this is very moderate at a speed of 10 knots, and probably considerably less than when reciprocating engines, equal to the full power required, are worked at very low powers.

Second Trials.—A second series of trials was made on January 19, 1904, after the propellers had been altered, the middle one being reduced to 3 feet 6 inches diameter, the pitch being kept up at 5 feet 6 inches. The high-pressure turbine was fitted with propellers of 2 feet 4 inches and 2 feet 8 inches diameter respectively, but both of the same pitch, while the low-pressure turbine was fitted with propellers of 2 feet 4 inches and 2 feet 10 inches diameter, and 2 feet 6 inches and 2 feet 10 inches pitch respectively. The results obtained are summarized in Table D.

TABLE D.

Messrs. Yarrow & Co.'s Torpedo Boat. Trials of January 19, 1904.

Number of Trial.	I.	II.	III.	IV.
Effective pressure of steam on admission to h.p. turbine—lbs. per sq. in	50	100	150	170
Condenser vacuum—inches	28	27.5	27	27
Speed of vessel (two runs) knots	15.58 20.00	19.25 23.53	23.22 26.67	25.714 27.067
Mean speed of vessel, knots	17.79	21.39	24.94	26.39
Rotation of reciprocating engine—Revs. per minute	458	508	555	576
Rotation of h.p. turbine—Revs. per minute	836	1052	1207	1258
Rotation of l.p. turbine—Revs. per minute	836	1065	1232	1307
Slip of propellers:				
Reciprocating engine—per cent	28.7	22.4	17	15.3
H.P. turbine—per cent	13.6	17.4	16.4	14.8
L.P. turbine—per cent	24.0	28.2	27.8	27.8

It will be seen that a speed of 26.39 knots has been obtained by giving the turbines rather more steam than they had been designed for. For the same steam pressure at admission, that is, for the same steam consumption, the speed is less than in the first trials, except at the maximum speed, when it is about the same. The slip of the screw is much reduced, as also the speed of rotation of the turbines. It may, therefore, be inferred that two screws give better results than the single screw originally employed; for, the speed of rotation of the turbines having been greatly reduced, their efficiency is much less. To increase this speed and obtain the estimated efficiency, the propeller surface must be reduced, and this was done for the third series of trials.

A point of interest is that the addition of a screw revolving in the neighborhood of the hull gave rise to considerable vibration, whereas, in the first trials, the complete absence of vibration was specially noteworthy.

Third Trials.—A third set of trials was made on March 4, 1904, with propellers all of the same pitch (2 feet 6 inches) and rather smaller diameter (2 feet 6 inches, 2 feet 4 inches, 2 feet 1 inch). The speeds obtained were approximately equal to those of the second trials, for the same steam pressures in the high-pressure turbine, but the speeds of rotation of the turbines were increased by 16 per cent. The increase in the efficiency of the engines was therefore balanced by the reduction in the efficiency of the screws, the slip of which rose to 24.6 per cent for those of the high-pressure turbine, and 33.1 per cent for those of the low-pressure turbine. It seems to be difficult to obtain more than this with propellers grouped in pairs on each shaft. This arrangement of two propellers, one in front of the other, is defective in so far that the second propeller works in the water already disturbed by the first propeller. The highest efficiency is certainly obtained with a single propeller on each shaft, but in order that the slip should not exceed 25 per cent, which seems to be the maximum for a good duty, the propelling surface, and, consequently, the diameter, must be increased. This can easily be done when the shafts are nearly horizontal. On Messrs. Yarrow's boat, the inclination of the shafts is rather steeper than it should be with propellers having a diameter greater than the pitch. Nevertheless, the speed of 26.4 knots, which has already been obtained, is no doubt capable of being improved upon, and the maximum obtained with reciprocating engines can, no doubt, be easily reached.

In conclusion, it will be seen from what has been said that steam turbines can be made practically equal to reciprocating engines for propelling ships at high speeds, but in order to obtain their full effect they must be mounted upon shafts very slightly inclined, and, if possible, with only one propeller on each shaft. The necessity for having horizontal shafts leads to a more

sudden rise in the hull aft than is usual when reciprocating engines are installed. Hence, hulls constructed for reciprocating engines are not generally suitable for steam turbines. It must not be concluded from the fact that, *cæteris paribus*, a higher speed is not obtained by merely substituting turbines for reciprocating engines, that the former are, therefore, inferior to the latter. A new form of propelling engine obviously calls for new lines of hull. At reduced speeds, the turbines are not economical, and they are inconvenient for going astern and for maneuvering, but this drawback can quite well be remedied by combining turbines with a reciprocating engine, working a special shaft and mechanically independent of the turbines. Another arrangement, different from that in the Yarrow boat, whereby the reciprocating engine would supply about 40 per cent of the total power, would give an increase of 15 to 20 per cent of the power obtained with a reciprocating engine alone, besides having the general advantages characteristic of turbines.

SHELL HEAPS OF THE LOWER FRASER RIVER, BRITISH COLUMBIA.*

By HARLAN I. SMITH.

INTRODUCTION.

THE Jesup North Pacific Expedition was organized for the investigation of problems relating to man, of both the past and the present, as presented along the North Pacific coasts of both America and Asia. It was started early in 1897, and was financed by Morris K. Jesup, Esq., president of the American Museum of Natural History.

The field operations of the expedition have been concluded, and the resulting scientific reports have already begun to appear.

The investigations relating to man of the past, or the archæological work on the American coast, were intrusted to the author of this paper. This archæological work was conducted for seven months during 1897 in the village sites and burial places of the southern interior of British Columbia and in the shell heaps, or village sites and cairns, or stone sepulchers of the southern part of the coast of that country. In 1898 the work was continued for six months by revisiting the interior and carrying on extensive excavations on the coast as far as the northern end of Vancouver Island. An account of these operations of 1897 and 1898 was published in Science for April 14, 1899.

In 1899, during five months' field work, many of the sites previously explored were revisited and the reconnoissance was continued by work on Puget Sound and the Pacific coast of Washington. The Lillovet Valley, British Columbia, was also examined. An account of this year's reconnoissance was given in the American Anthropologist for 1900.

The specimens collected and the photographs and plaster casts taken on the expeditions are deposited in the American Museum of Natural History, and the results of the investigations are being published in the memoirs of that institution as archive records. The specimens are being put on exhibition with labels referring to the pages of the memoirs on which they are figured or described. Some popular accounts, including the important results, but without the minute details necessarily included in the memoirs, and with the addition of enlivening incidents are prepared to accompany the exhibits. Lectures, illustrated by lantern slides, made from the expedition's photographs, are constantly being delivered. Thus the student, the museum visitor, the school child, and the lecture-going public are all reached by the results of the expeditions, and both artists and the press constantly use them.

The following archæological reports have been published in the memoirs:

Smith (Harlan I.). "Archæology of Lytton, British Columbia." 33 pages (pp. 129-161), 1 pl. (pl. XIII.) and 117 text figures of 118 specimens. May 25, 1899. Price, $2.00. Part III., Vol. II. The Jesup North Pacific Expedition. Memoirs American Museum Natural History.

Smith (Harlan I.). "Archæology of the Thompson River Region, British Columbia." 42 pages (pp. 401-442), 3 pl. (pl. XXIV.-XXVI.) and 50 text figures of 125 specimens. May, 1900. Price, $2.00. Part VI., Vol. II. The Jesup North Pacific Expedition. Memoirs American Museum Natural History.

Smith (Harlan I.) and Fowks (Gerard). "Cairns of British Columbia and Washington." 21 pages (pp. 55-75), 5 pl. (pl. I.-V.) and 9 text figures of 2 maps, 5 plans and 2 specimens. January, 1901. Price, $1.00. Part II. Vol. IV. The Jesup North Pacific Expedition. Memoirs American Museum Natural History.

Smith (Harlan I.). "Shell Heaps of the Lower Fraser River, British Columbia." 57 pages (pp. 133-191), 3 pl. (pl. VI., VII.) and 50 text figures of 128 specimens. March, 1903. Price, $1.00. Part IV., Vol. IV. The Jesup North Pacific Expedition. Memoirs American Museum Natural History.

A memoir on "The Shell Heaps of Southern Vancouver Island and the Coast of Washington" is in preparation.

The SCIENTIFIC AMERICAN SUPPLEMENT published an illustrated abstract of the memoir on "The Archæology of Lytton" in its issue of July 21, 1900, and herewith it presents an illustrated abstract of the memoir on "The Shell Heaps of the Lower Fraser River." The archæology of Lytton being typical of that of the Thomson River region, it has thus given to its readers a very complete idea of all the archæological results of the expedition thus far made public.

* A full report on this subject is given in Harlan I. Smith's "Shell Heaps of the Lower Fraser River, British Columbia," which appeared as Part IV. of Vol. IV. of the publications of the Jesup Expedition in the Memoirs of the American Museum of Natural History, March, 1903.

THE Fraser River empties into the Gulf of Georgia, forming a delta which extends along the coast about 14 miles, from near the northern boundary of the United States, to Point Gray, about 6 miles southwest of Vancouver, B. C. The effect of the tide is felt for about 20 miles above the mouth; and for a still greater distance we find one or both shores formed of alluvial soil, which at certain seasons receives deposits from the river. The westerly winds, in ascending the slopes of the Coast Range, precipitate their moisture, and consequently there is a considerable amount of rain, principally in winter. Vegetation is dense and luxuriant. Many of the trees are of gigantic size.

The Indians inhabiting this region subsist largely upon fish and shellfish. Whales, seals, deer, bear, etc., roots and berries are also used. The people depend largely upon the wood of the cedar and other trees for the manufacture of their implements and utensils. The bark of the cedar is made into garments, bags, mats, etc. They build immense houses of cedar planks. The arts of carving and painting, which are characteristic of the North Pacific coast, are well developed. Most of the implements or objects of art are made of wood.

The most extensive remains of the early inhabitants of the coast are shell heaps made up of layers of shell and other refuse from their villages. They are found on many flats along the coast, and at the mouths of most streams where the beach is smooth enough for canoe landing. In front of many shell heaps, where the beach is covered with bowlders, the stones have been removed to make canoe paths up from the water; and at low tide these paths, which are at right angles to the beach, may yet be seen, clearly marked by the bowlders piled in parallel rows at their sides. These often direct attention to a shell heap at the edge of the forest which might otherwise be passed unobserved. The streams were highways to the interior, sources of fresh water and of food. At their mouths, mud flats are formed, on which shellfish live.

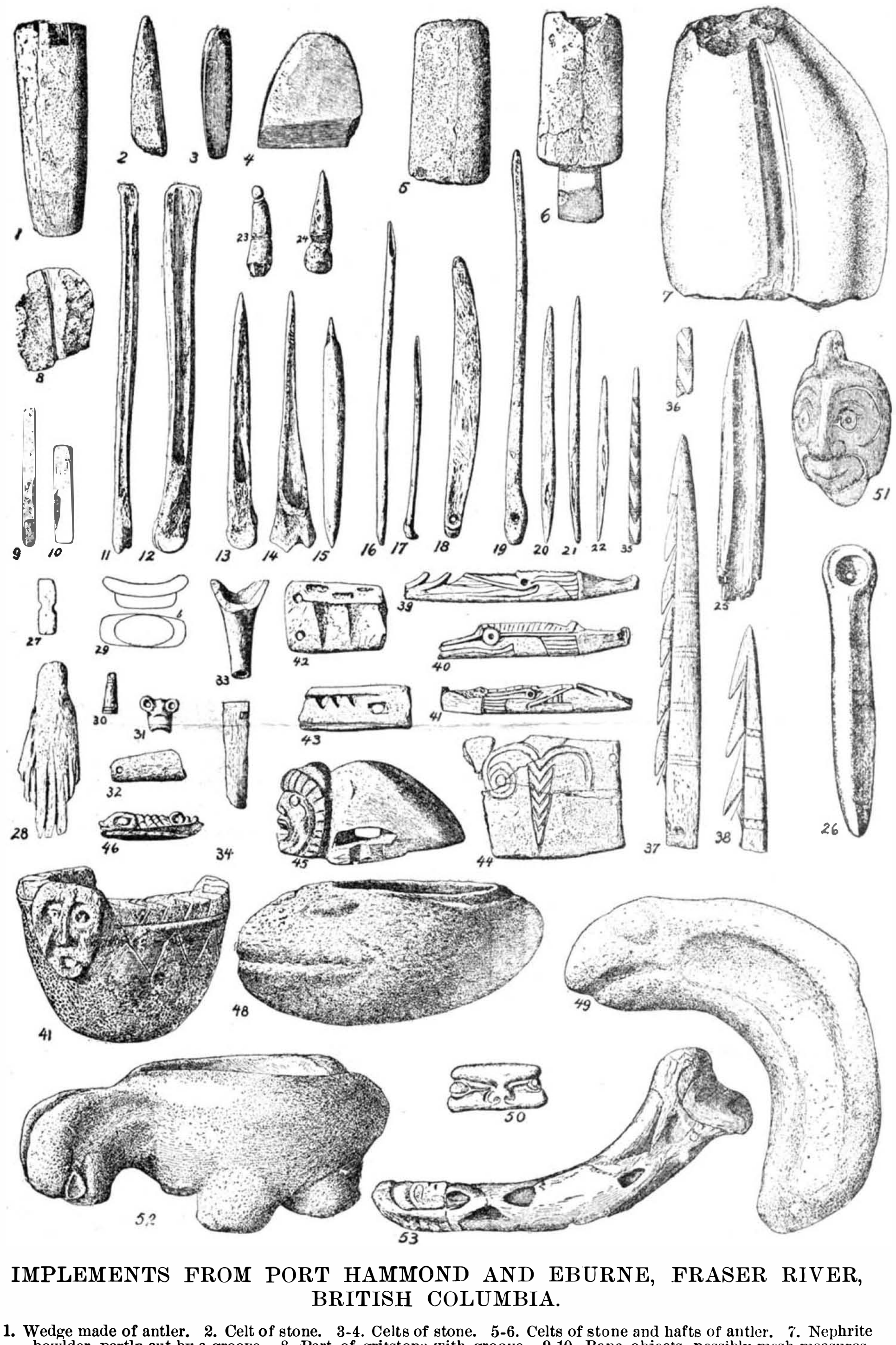
The typical shell heap is several hundred yards in length, about 30 yards in width, and 3 or 4 feet in height. Others are miles in length and some reach a height of over 9 feet.

The age of some of these heaps is considerable, as indicated by the presence of Douglas fir stumps over 7 feet in diameter, standing on 9 feet of unbroken layers, many of which are only an inch or two in thickness. One stump only 4 feet in diameter exhibited over 400 rings of growth, but on the larger stumps such evidences were obliterated by decay. Judging from these stumps, the top layers of the shell heaps cannot be less than 500 years old, while the lower layers must have been deposited a considerable time before, to allow for the formation of 9 feet of strata above them.

The shell heap at Port Hammond, in the upper part of the Fraser Delta, is over 20 miles by water from the present seashore, where the shells, of which it is largely composed, are found. By land the nearest point of the seashore is over 10 miles. Judging from the customs of the present natives, the water route would have been used in bringing the shellfish to the village; but the Indians prefer to live near the shell beds. It is hard to believe that they would have carried from the present seashore the large quantity of shells which compose the shell heap at Port Hammond. The rate of encroachment of the delta upon the sea, or of changes in the level of the land, may furnish some clue to the age of the Port Hammond shell heaps. At present, according to information given by the late Dr. George M. Dawson, little or nothing is definitely known in regard to the geological age of the Fraser bottom lands and the surrounding gravel terraces.

The strata in the shell heaps are often entirely composed of the remains of shellfish, largely clams, mussels, and in some cases oysters.

Vegetable mold and general refuse also make up a large part of some heaps. The shell heaps on delta



IMPLEMENTS FROM PORT HAMMOND AND EBURNE, FRASER RIVER, BRITISH COLUMBIA.

1. Wedge made of antler. 2. Celt of stone. 3-4. Celts of stone. 5-6. Celts of stone and hafts of antler. 7. Nephrite bowlder, partly cut by a groove. 8. Part of gritstone with groove. 9-10. Bone objects, possibly mesh-measures. 11-12. Bones cut longitudinally, 13-17. Bone awls. 18-22. Needles of bone. 23-24. Antler-tips with carved knobs. 25. Dagger of bone. 26. War or ceremonial club of stone. 27. Bone button. 28. Comb-like object of antler. 29. Stone labret, side and bottom views. 30. Pendant made of ivory. 31. Stone object, possibly a fragment of an earring. 32. Fragment of stone object, probably wristlet. 33-34. Tubular pipes of steatite. 35-36. Bone objects bearing incised geometric designs. 37-38. Harpoons bearing incised geometric designs. 39-41. Fragments of harpoon points of bone or antler. 42-43. Fragments of bone objects, probably wristlets. 44. Bone object bearing incised geometric design. 45. Sculpture in stone. 46. Fragment of stone pipe. 47. Ornamented stone mortar. 48. Sculpture in stone mortar. 49. Mortar from the north arm of the Fraser River. 50. Sculpture of stone. 51. Sculpture in hydro-carbon, probably used as a pendant. 52. A sculptured mortar. 53. Carved piece of antler.

land along large rivers, as compared to those along sea beaches, seem to contain more black vegetable mold; most of the shells seem to be broken and in a more advanced state of decomposition; skeletons are nearly as well preserved, and are much more frequently found in order; and implements of various kinds are more numerous among the layers.

In the shell heaps of the lower Fraser River the skeletons and stray human bones found were deposited at the time of the formation of the layers, and were not intrusive burials, as was clearly shown by the numerous unbroken strata extending over them. The bodies usually lie on the side, with knees close to the chest. Unlike the skeletons found in the interior, there are but few if any objects accompanying them, except in rare instances a few shell beads, copper ornaments, and chipped and ground stone points for arrows, spears, etc. Such specimens, as well as other artifacts, were frequently found scattered in the layers, and it is likely that they were only accidentally near the skeletons. This is particularly true of the stone points.

At Eburne two types of skeletons are found which belonged apparently to co-existent people, as they were excavated from the same layers. If one of these types consisted of captives or slaves, there was nothing in the manner of burial to indicate it.

The shell heaps of Vancouver Island and of the adjacent region have been known for many years, and were mentioned by Bancroft* in 1875 and by Dawson† in 1877.

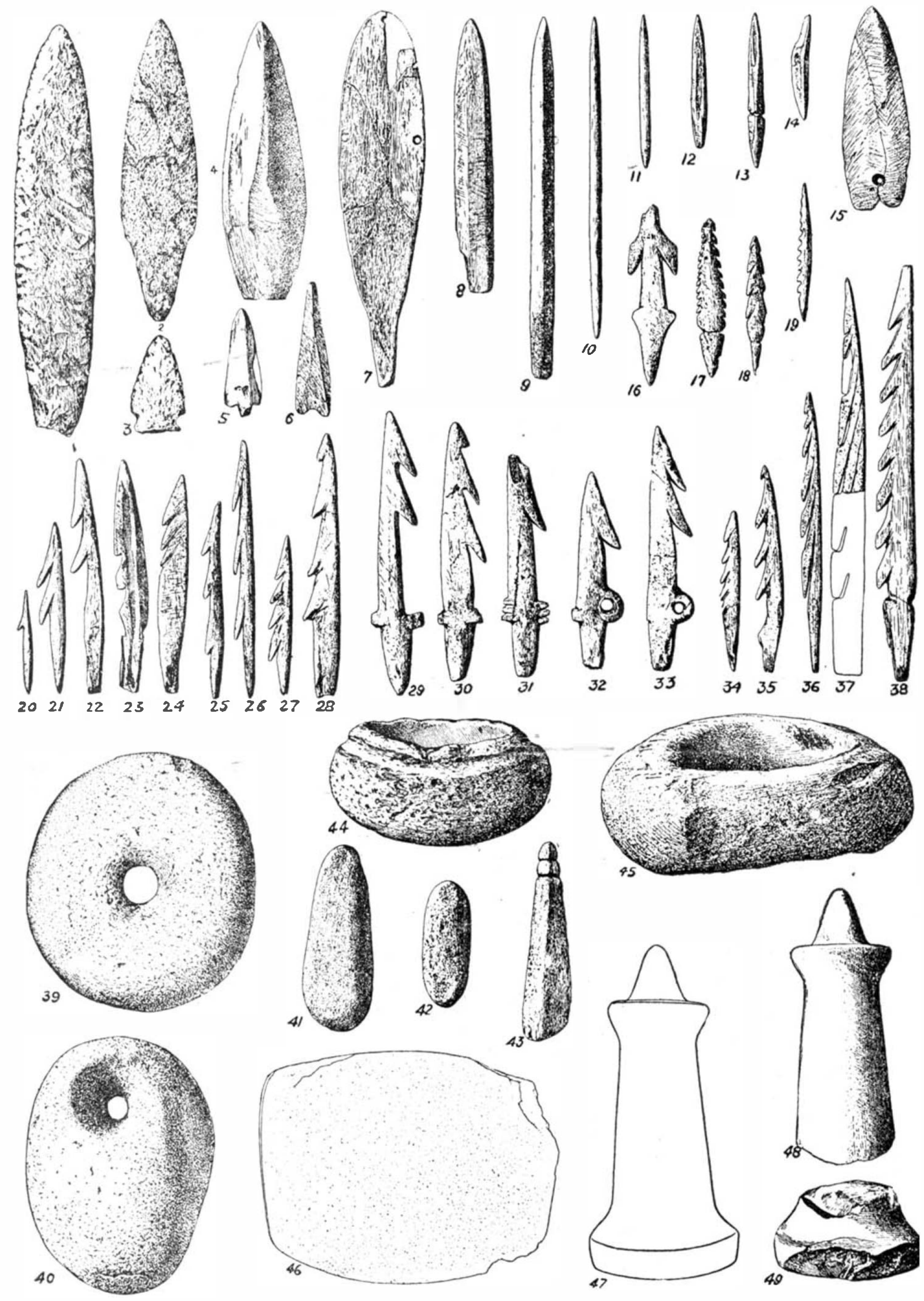
The large shell heap near Eburne has been known for some years—ever since the piece of southeast road between the end of the road running due south from Vancouver and the bridge at Eburne was cut through the middle of it. Mr. William Oliver, who was in charge of this work, observed the occurrence of artifacts, and caused the men to save such objects of antiquity as came to their notice. His observations at this time, and the collection which was then made, drew the attention of other observers to the place. The collection was secured by me and is now in the American Museum of Natural History.

* "Native Races of the Pacific States," Vol. IV., pp. 736, 739, 740.

† "Note on Some of the More Recent Changes in Level, etc." Canadian Naturalist, April, 1877.

In 1884 the Rev. H. H. Gowan and Mr. James Johnson examined this shell heap, and secured from it a human skull which was peculiarly long and had a narrow forehead. A bone spear point was said to have been found piercing the left temporal bone of this skull. Both skull and spear point were deposited in the Natural History Museum of New Westminster, B. C. A photograph of the skull was sent to the Smithsonian Institution, and I secured two negatives of it for the American Museum of Natural History. Mrs. Ellen R. C. Weber, now of Vancouver, while living at Port Hammond some years prior to 1897, made a collection of the specimens turned up in her garden, which was on the shell heap.

In September and October, 1897, I conducted explorations for the Jesup North Pacific Expedition in the shell heaps of the Lower Fraser River at Port Hammond. This work was continued in June, 1898, near Eburne; and in September of that year Port Hammond was revisited. The following descriptions are based upon these explorations.* In the field, assistance was rendered by Dr. Roland B. Dixon and Mr. Reginald C. Brooke. Thanks are due to the land owners who allowed our explorations on their property; to Mr. R. L. Codd, who personally facilitated explorations on his land; and to Mr. James M. Dale for specimens collected by him. The accompanying illustrations are from drawings made by Mr. Rudolf Weber, and the plates are reproductions of photographs taken by the author.



IMPLEMENTS FROM PORT HAMMOND AND EBURNE, FRASER RIVER, BRITISH COLUMBIA.

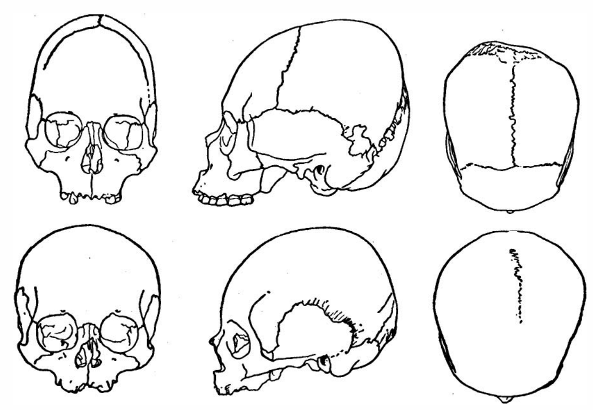
1-3. Chipped points from main shell-heap at Eburne. 1. Whitish chert; 2, black trap; 3, crystalline quartz. 4-6. Ground points. 4, of slate from surface near main shell-heap; 5, mica schist; 6, slate from main shell-heap. 7. Bone object, main shell-heap. 8-9. Bone point from main shell-heap. 10-14. Bone barb points, or awls. 15-18. Bone points. 19-20. Bone harpoon points. 21-22. Bone points. 23. Bone harpoon point. 24-28. Bone harpoon points. 29-33. Bone harpoon points with guards. 34-38. Bone harpoon points. 39-40. Perforated stones. 41-42. Stones showing pecked pits. 43. Stone sinker (?). 44. Mortar made of lava. 45 Mortar made of sandstone. 46. Fish knife made of slate. 47. A reconstructed pestle of the lower Fraser valley. 48-49. Parts of pestles.

The explorations along the Lower Fraser River were largely confined to the shell heaps at Port Hammond and Eburne. At Port Hammond the main shell heap is located on the alluvial ridge parallel to the north bank of the Fraser River, and is always within 50 feet of the stream, which in places has cut into shell layers. It extends along this ridge continuously for about half a mile downstream, beginning at the base of the gravel terrace through which a cut has been made for the Canadian Pacific Railway, and on which was located a burial mound.* There are some oval shell knolls on the most westerly part of the main shell heap where it is low. There are also some such knolls on the natural ridge beyond. They occur at intervals of from perhaps 100 to 150 feet and probably mark spaces where refuse was thrown between the ancient houses, or in close proximity to the doorways. It is possible, however, that they mark centers of habitation. Beyond the end of the ridge where the land is low there are a few low oval shell heaps, probably refuse from isolated houses. Back of the ridge along which the shell heap extends, the land is low, and in some places was swampy before the making of dikes and ditches. It is said that in the rear of the shell heap there was formerly a water course, which extended from near its eastern end northwestward to Pitt Meadows, and farther on into Pitt River, thus affording canoe communication from the rear of the village to the north, while the Fraser River afforded connection with the east and west.

* Preliminary reports of this work were published as follows: "The Jesup Expedition to the North Pacific Coast," Science, N. S, Vol. VI, No. 145, October 8, 1897, pp. 535-538; Franz Boas, "Operations of the Jesup North Pacific Expedition in 1897," Memoirs, Am. Mus. Nat. Hist. Vol. II, June 16, 1898, pp. 7-11; Harlan I. Smith. "Archæological Investigations on the North Pacific Coast of America," Science, N. S, Vol. IX, No. 224, April 14, 1899, pp. 535-539; also separate; Harlan I. Smith, "Archæological Investigations on the North Pacific Coast in 1899," American Anthropologist, N. S., Vol. II, July-September, 1900, pp. 563-567; also separate.

The shell heap is, on an average, about 100 feet wide, and reaches a maximum height of 8 feet. During unusually high floods silt is sometimes deposited on it. At least six gardens are located on the shell heap, but parts of it are yet protected by natural vegetation. Below the surface soil, and down to the bottom of the shell heap, clam and mussel shells are found mingled with charcoal, a very few oyster shells, and the bones of animals. Usually the purest shell layers are found within 3 feet of the surface, the lower layers being largely of black vegetable mold, refuse, charcoal, and ashes. The general characteristics of the specimens found in the lower layers are the same as those found in the highest strata and on the surface. The fir trees growing upon this shell heap suggest that it is of considerable age, but there is no evidence of any very great antiquity.

A shell heap on the oval knoll farthest downstream beyond the main site was entirely excavated by our party. On the northwestern edge of this heap stood the stump of a Douglas fir tree. The fallen tree belonging to this stump measured over 4 feet in diameter at a point over 10 feet above its base. A second stump stood to the north-northwest of the heap. Its roots extended over some of the lower shell layers. The stump, reduced in thickness by fire, still measured 13 feet in circumference at a point 8 feet above the ground, where the trunk was smooth. It was 29 feet in circumference at a point 3 feet above the ground, but below the point where the trunk begins to expand into buttresses.



TYPES OF SKULLS FROM SHELL-MOUNDS AT EBURNE.

Above, three views of narrow type of skull. Below, three views of broad type.

The main shell heap near Eburne is north of the north arm of Fraser River, and parallel to its bank. It is opposite the eastern end of Sea Island, and is located along the edge of the gravel terrace which here drops abruptly to the alluvial bottom land, that is perhaps one-eighth of a mile wide and subject to occasional inundation.

The heap is at least several hundred feet long, and is from 50 to over 200 feet wide, covering several acres. The extreme limits have not been determined because covered with forest growth. In some places it rises to form knolls similar to those at Port Hammond, but larger. Its maximum depth is about 9 feet, and it is made up of layers composed of shells of clams, cockles, mussels, barnacles, of ashes, and other refuse, somewhat similar to that in the heap at Port Hammond. Here, however, the lower strata are composed largely of whitish shell material similar to the material of the shell heaps along the sea beaches, except that it is broken into small pieces, and few large shells are entire. While at Port Hammond the lower layers overlie black earthy matter, they seem to rest here on the natural yellow gravel, with little or no signs of any old surface soil intervening. Back of the heap the surface of this gravel is higher than the bottom land, but it is slightly lower than that under the shell heap. Except in places protected from erosion, it has little or no covering of surface mold.

On this heap stood a Douglas fir stump 29 feet in circumference at a point 5 feet above the ground, and another 29½ feet 3 feet above the ground. The hollow log fallen from this stump was 6 feet 7 inches in diameter at the butt, and 6 feet 3 inches at the upper end of the first section, 5 feet higher.

* See description of this mound in Memoirs Am. Museum of Natural History, Vol. IV, p. 60.

Many unbroken strata under this stump extended to the eastern limit of the trench, as far as 30 feet, showing that all objects found below them, even if not directly below the stump, were older than the strata under the tree.

Implements made of stone, bone, and antler, were numerous down to the depth of 6 feet. In the deeper layers, which consist of white shell material, implements made of bone were more plentiful than stone objects.

Two distinct types of human skeletons were found above a depth of 6 feet, and most frequently in the northern inland slope of the heap. The first type, of which the greater number were secured, had a skull resembling in shape those found at Port Hammond. The other type, with very narrow forehead, seems to be artificially deformed by lateral pressure.

The shell heaps of the Lower Fraser River seem to have certain peculiarities of their own, and vary in detail not only from most of the shell heaps of the coast region, but also from those of the delta areas of the Stillaguamish and Skagit Rivers. The objects secured from the former are more numerous and of a higher artistic value than those found in the coast shell heaps, or even in those of the other deltas. Human skeletons are frequently found in the shell heaps of the Lower Fraser. They are rarely met with in the coast shell heaps, and are only occasionally found in the shell heaps of the Skagit and Stillaguamish deltas.

On the whole, the difference in character between the delta shell heaps and those of the coast seems to be due to the blackness of the surrounding soil, poor drainage and the dissimilarity between the mode of life of a delta and that of a seacoast people. The more frequent occurrence of skeletons is an unsolved problem, since the scarcity of cairn burials is common to the immediate neighborhood of both the Lower Fraser River, where skeletons are found in the shell heaps, and to the northern part of Vancouver Island, where they are absent from the shell heaps. The difference between the various delta shell heaps seems to be due to the fact that the culture of the inhabitants of the Lower Fraser River was more highly developed than that of the inhabitants of other parts of the coast, probably on account of a more favorable environment and a location where intercourse between the tribes of different cultures was greater than in neighboring regions.

There is no apparent difference in the character of the specimens found in the upper and in the lower layers. The general style of the objects is similar to those made by the present tribes of the coast. Several exquisite specimens of stone and bone carvings were discovered which rival in artistic merit the best sculptures of the existing natives.

The implements most commonly found are points chipped from stone or ground from slate or bone and used for arrows, knives, harpoons, or spears; stone pestles or hammers; mortars of stone; fish-knives rubbed out of slate; wedges made of antler; celts of stone; celt-handles made of antler; whetstones or grinding stones; awls and needles of bone; and engraved and carved objects made of bone and stone.

The finds indicate that the prehistoric people whose remains are found in these shell heaps had a culture resembling in most of its features that of the present natives of the Fraser Delta. They subsisted to a great extent on fish, which were caught by means of hooks and harpoons resembling in form the corresponding modern devices of the region. Large sea mammals were hunted with retrieving harpoons, upon whose manufacture much care was bestowed, some of them exhibiting highly artistic designs. Shellfish constituted an important part of the diet of the people. They hunted on the mountains and probably utilized the meat and horn of the mountain goat. Deer and elk were eaten, and their bones and antlers used for many purposes. Dogs were probably used in hunting. Skins of animals were prepared and served as garments. There is no evidence that the hair of goats or dogs was spun and used for weaving, as has been done in modern times. The people were workers in wood. They used wedges and chisels for splitting and hewing planks. The frequency of these implements indicates that woodwork was no less important in their economy than it is among the modern Indians. No indication as to the character of their habitations has been found. Possibly some of the small knolls may be the piles of refuse thrown near houses. The presumption seems justifiable that they lived in houses made of cedar planks. They must have had canoes. Shredded cedar bark was used for a variety of purposes, among others probably for clothing. It was shredded with the same kind of implements as are used at the present time. Possibly mats like those used by the present natives of the region were made by sewing together cat-tail stalks. This is suggested by the flat needles made of bone.

There are, however, some points of difference between the people of the past and those of the present. First of all, the physical type of part of these people differed very much from that of the modern Indians, while another part seems to have been of the same type. Prof. Franz Boas describes these two types as follows:

"The one type is characterized by a narrow head, the narrowness of which was emphasized by lateral pressure, with a marked median ridge on the forehead, narrow and high nose, and rather narrow face; the other, by a wide head (produced partly by antero-posterior pressure) and a wide face."

Differences in culture may also be noticed. Among the natives of the coast of British Columbia the art of chipping points was not practised. Isolated specimens of chipped stones are found along the coast, but they are frequent only on the Fraser River and at Saanich on Vancouver Island, where many of them resemble both in shape and material those of the Thompson River region. The chipped points of Puget Sound and of the west coast of Washington are, on the whole, more similar to the chipped points of Columbia River. These chipped points, the peculiar pipe, which occurs also at Saanich, and the geometrical designs before described, all point to a close affiliation of the early culture of this region with that of the interior of British Columbia. Some classes of objects that are frequent in the archæological finds of the interior do not occur in the shell-mounds of Fraser River. No drills chipped from stone were found, unless some of the narrower specimens described as arrow points served that purpose. Some of the more irregular chipped points may have been used as carving knives, but no other such knives were seen. Pairs of half-cylinders of sandstone for smoothing and straightening arrow shafts were not found. Beaver teeth or woodchuck teeth made into dice, which are now used both in the interior and on the coast, were not found. No objects were found buried with the skeletons, as is the case in the Thompson River region and in modern burials in the Fraser River Delta.

The coincidence of the similarity of culture of the prehistoric people of the Fraser Delta and of Saanich with the distribution of languages at the present time is quite striking. The Salish languages reach the coast on the Gulf of Georgia and southward as far as Shoalwater Bay. Their dialects are distributed in such a way that in the same latitude the same dialect is spoken east and west of the Gulf of Georgia. Vancouver Island and the parts of the mainland just opposite must therefore have had a common history, and this is also borne out by the finds at Saanich and on the Lower Fraser River.

It would seem, therefore, that we have here very good evidence of a close connection between the interior and the coast in prehistoric times, much closer than in later periods. It is probable that at an early time a migration took place from the interior to the coast and Vancouver Island. This migration carried the art of stone chipping, pipes and decorative art to the coast.

It should be mentioned in this connection that the most highly developed type of Northwest coast art never extended south of Comox, and never reached the west coast of Vancouver Island. Although more realistic than the decorative art of the interior, the modern art of the region south of Comox and along the west coast of Vancouver Island is crude, as compared with that of the more northern regions.

A few specimens point at similarities between the prehistoric people of the Fraser Delta and those of the north. The most striking is the occurrence of the labret, which in historic times was not found south of Milbank Sound.

The migration referred to before may account for certain changes in ethnological customs, such as the rapid modification of the method of burial on the southeastern part of Vancouver Island. The earliest known kind of burial, and the one that is known to have antedated contact with the whites by a considerable period, was in stone cairns.* Later, and even since contact with the whites, the bodies were placed in wooden chests, which were deposited on the ground, in the branches of trees, in caves, or on little islands. A canoe was sometimes used instead of a box.

The fact that skeletons were found in shell heaps indicates that the customs of this people must have differed from those of the people who made the shell heaps on northern Vancouver Island, in which skeletons have not been found.

We may sum up the results of our inquiries by saying that the culture of the ancient people who discarded the shells forming these heaps was in all essential particulars similar to that of the tribes at present inhabiting the same area, but that it was under a much stronger influence from the interior than is found at the present time.

* Smith and Fowlie, "Cairns," Memoirs of the Am. Mus. Nat. Hist., Vol. IV, Part II.

ELECTRICITY IN PLANT LIFE.

A most interesting project is being considered by the scientific section of the British Royal Horticultural Society. As soon as the necessary funds can be raised it is proposed to establish at the new gardens at Wisely, near Weybridge, a scientific station or botanical laboratory, and one of the special studies to be undertaken will be the growth of plants by electric light as a substitute for sunshine. To be independent of the gloomy English climate, and to produce the most beautiful flowers, and even ripen strawberries and other delicious fruits in winter, is one of the gardener's most cherished dreams. The fact that artificial light will enable plants to grow and fruits to ripen has long been known to scientists. More than forty years ago, M. Hervé Mangon found that the electric rays would enable plants to form the green chlorophyl or coloring matter of their leaves, and that flowers turned toward the electric lamp just as they turn toward the sun.

In 1879 and 1880 the late Sir William Siemens made some remarkable experiments at Tunbridge Wells, the results of which he showed to the Royal Society. By supplementing the sunlight of day with electric lamps at night, both in the open air and in greenhouses, he caused roses and arums to bloom long before their usual time, melons and cucumbers, vines and strawberries also responding most gratefully to the stimulus of the added light. The sunlight of millions of years ago, stored up in plants which afterward became coal, was thus disinterred and made to do its work over again in ripening fruits and causing flowers to bloom. Although electricity then cost three times as much as now, Dr. Siemens, as he then was, was enthusiastically convinced of the value of the electric light for the garden.

As usual, there were many objectors to the new proposal. A sort of humanitarian outcry was started on behalf of the poor plants themselves. To make them grow night and day would give them no rest. They would be old and exhausted before their time, and would perish miserably as the result of their artificial mode of life. Experience since then has shown, however, that the plant does not need rest, like an animal. In Norway, Sweden, and Finland, during the short two months of summer, while the sun never goes down, vegetation flourishes with astounding luxuriance and rapidity. Flowers take on the most gorgeous colors and have exquisite perfumes, vegetables grow like magic, and then comes the long winter, and they have a correspondingly long rest.

An even stronger illustration of the power of plants to do without a nightly rest is the great natural gas fire, a steeple of flame, which has burned for generations in the Pittsburg district in this country. All round and just outside the circle of its scorching heat is a ring of tropical vegetation, which the warmth and light have produced, the plants seeming all the richer and more luxuriant for living in a blaze of light night and day alike. Even if plants were really exhausted by artificial light, we grow them not for their own sakes, but for our use. When a greenhouse plant dies there are plenty of recruits to fill its place.

Dr. Siemens found that all plants could not be treated alike. Particularly they varied in the amount of stimulation they could undergo. The delicate lily of the valley, grown by the aid of heat alone, and with a deficiency of sunlight, was sickly and anæmic, flimsy in texture, and with its petals thin and colorless. The electric light gave the flowers their natural rich, white, creamy color, and made the leaves strong, firm, and green. Generally the natural colors of flowers were enriched by the light, and plants which would wither in a high temperature without the light, with its aid flourished exceedingly. The electric light, Dr. Siemens pointed out, would almost save its cost in stove fuel by the heat it supplied and the quicker maturing of plants, and it might be used in the orchard to counteract the effects of night frost. But banana leaves too near the lamp were scorched by its rays. Melons, cucumbers, strawberries, mustard, carrots, beans, tulips, pelargoniums, all matured under the electric lamp long before the same plants under daylight alone. Subsequent investigations have shown that a great deal of caution must be used in the application of artificial light. Every plant has its own way of responding to the stimulus.

For instance, Prof. Bailey, at Cornell University, and the authorities of the West Virginia Agricultural Station, have found that cauliflowers will grow very tall, but have smaller heads, and radishes develop extraordinary profusion of "top" under the influence of the lamp. But as we do not prize the cauliflower for its stature, or the radish as a foliage plant, these advantages were not worth the cost of producing them. Nearly all flowers are found to bloom sooner, and sometimes with brighter colors. Lettuce becomes marketable four to ten days earlier, thriving best when the artificial light is only used half the night, but some other plants run to seed under its influence instead of developing weight and succulence, and still others mature very quickly, but do not grow big, ending as tough and ancient little dwarfs of no use for the table. Spinach is particularly grateful for the electric beam, but as society does not clamor for spinach out of season the game is not worth the candle. Peas grow more quickly and are larger in the pod. Endive does better without the electric light.

Many points remain for investigation at the proposed experimental station of the Royal Horticultural Society. We want to know just what kind of light and how much of it is needed by each plant. It should be remembered that a plant five feet from the lamp gets ten times as much light as one sixteen feet away. Then the "ultra-violet" rays of the arc lamp, of such immense value to the scientist, are not good for most plants. Dr. Siemens thought if the bare light were used the benefit to the plant would increase. But the opposite has proved to be the case, and lamps with glass coverings or jackets of liquid to shut off the invisible rays have been found better. The incandescent or glow lamp and incandescent gas have also been tried at West Virginia with success. M. Deherain, at Paris, found that the invisible rays were most injurious from a 2,000-candle-power arc lamp unless shut off by glass. His conclusion was that the electric light will maintain a fully grown plant for two and a half months, but is too feeble to support a plant from infancy upward. At the Winter Palace, at St. Petersburg, some ornamental plants placed under the electric light turned yellow and died in a single night.

Prof. Bailey considers that it is well established that maturity and ripening can be greatly hastened by artificial light, and that plants are not injured by "want of rest," but considers that there are many problems to be settled as to the protection of plants from too much light, and the prevention of too rapid seeding and early maturity. In short, it remains for the scientific investigator to observe the exact effect at each stage

of growth of the artificial illuminant on the formation of chlorophyl, of starch, sugar, gluten, alkaloids and the plant's own essential oils, and to determine when and how long the imitation sun should be made to shine.—Boston Transcript.

ENGINEERING NOTES.

Such has been the success of the Assuan Dam on the Nile, that a scheme has been formulated to increase its height by nineteen feet and a half. The realization of such an idea will enable the irrigation department to retain behind the barrage an additional thousand million cubic meters of water, which will suffice for an increase to the perennially irrigated area of half a million acres and add $75,000,000 to the wealth of Egypt. According to the recently published report of the Assuan reservoir compiled by Sir William Willcocks, late director-general of reservoirs, the whole of the water kept back by the dam has been devoted to special tracts, and the Egyptian government cannot entertain any applications for water. The cost of raising the barrage will involve an expenditure approximating $2,500,000, which sum will be defrayed out of the public debt surplus.—Boston Transcript.

The Journal of the American Chemical Society contains some notes by Mr. E. E. Sonermeier on the forms in which sulphur occurs in coal, their calorific values, and their effects on the accuracy of the heating powers, calculated by Dulong's formula. The author observes that the estimation of the calorific value of coal from the ultimate analysis involves the calorific value of the sulphur present. When the amount of sulphur is large, the question is important especially as to how the heating value is affected by the different forms in which sulphur may occur. The author has studied the question experimentally. Since pyrites does not burn completely in a calorimeter, the samples used were burned with coal. As an average of three determinations with one sample and four with another, the value 2,637 calories for 1 gramme of pyrites was obtained. With 53.2 per cent of sulphur in the pyrites, the calorific value per gramme of sulphur as pyrites is 4,957 calories; 2,915 calories is the heat of combustion of 1 gramme of sulphur as pyrites under ordinary conditions of combustion.

Springfield, Ohio, seems disposed to repair and utilize the twenty-six old fire cisterns, which have been closed since the waterworks system was installed in the city. Chief Hunter, of the fire department, favored the plan, on the ground that the cisterns give much better facilities for fire-fighting than the present method of attaching the steamers to the fire-plugs. He says cisterns are not out of date, and that several cities, including Cincinnati and Columbus, are having new cisterns built. He would connect the old cisterns with laterals to the water mains, the laterals to be fitted with a valve, so that the engineer can turn the water on at will, and be furnished with a steady supply. The water-works pressure is sufficient for ordinary fires, but under certain circumstances it would prove wholly inadequate. Three engines can pump from one cistern at one time and furnish all the water wanted at a sufficient pressure to flood any building in the city. He added that, in case several engines should be pumping from the water mains direct at one time, and some of them were temporarily suspended, it would be likely to burst the main and completely disarm the department.—Fire and Water Engineering.

The Susquehanna Iron Company's big plant will be in operation within thirty days. It has been finished, and the great furnaces are ready for the ore. The stupendous task of digging a canal or inland harbor nearly a mile in length from the new outer harbor to the company's plant is now in progress. This canal is to be 200 feet wide and 23 feet deep. That is to say, it is to be 23 feet below the mean level of the lake, so that in some places the excavation is to be 40 feet in depth. That is quite a hole to dig in the ground a mile long, but the Buffalo Dredging Company expects to dig it and build solid cement wharves on both sides of its entire length by April 1 next. It requires great engineering skill and an enormous amount of physical power to accomplish such a task. There are 1,400 feet of it through the solid rock. Steam power and compressed air are accomplishing it. When examinations were made it was found that a strip of rock nearly a mile long, 200 feet wide, and 10 feet in thickness had to be cut out. It is not shale rock or slate, but solid living rock. The Buffalo Dredging Company is ripping through that solid ledge of rock with a steam shovel. The dredge used for that purpose is the greatest tool of its kind in the world. It looks like a giant mud dredge, and is built on the same principle as an ordinary horse-power steam engine. Its anchors or spuds are made of giant Oregon fir, 53 feet long and 44 inches through. It has a dipper or dredge with a capacity of seven cubic yards. One man with a dozen levers before him operates the whole machine. The dredge of the dipper is armed with steel teeth about 15 inches long and 6 inches thick. The man at the levers drops the great dipper, with its massive handle, down 15 feet to the rock bottom. Then he moves another lever, and the big engine down in the hold gets under way. The great steel cable attached to the dipper quivers under the strain. There is a sound of ripping and tearing and grinding, as if the earth was being turned inside out, and up comes the dipper, with its enormous maw choked with huge masses of splintered rock. It has ripped up seven cubic yards, and when it has been swung over to the rock scow its mighty under jaw drops, and it spews out bowlders weighing tons. The teeth of that dipper bite out seven cubic yards of rock a minute.—Buffalo Express.

TRADE NOTES AND RECIPES.

Cement for China, Glass, Etc.—Liquid Glues.—There is, in our opinion, no better agent than an alcoholic solution of shellac. Make it about as thick as old-fashioned molasses. Heat the fragments to about the boiling point of water, apply the solution to both edges to be joined, quickly join them, and hold them together tightly for a moment, or until they adhere of themselves. If the shape of the object will permit it, spring a rubber band around to hold the fragments as closely together as possible. Remember that the less cement that is used (provided the surfaces of the fractured part are quite covered with it), and the closer the fragments are approximated to each other, the stronger and better the joint. This joint will stand a temperature up to that of boiling water.

The next best agent is the so-called Armenian cement, which is made as follows: Soak 4 parts of Russian isinglass (the dried bladder of the sturgeon) in cold water for 12 hours, or until it has absorbed as much of the water as it will take up; then throw the isinglass in a strong piece of linen (a towel will answer) and squeeze out all surplus water. Upon the thoroughness with which this is done depends, to a considerable extent, the quality of the finished product. Put the fish glue in a capsule and melt it in the water-bath. Have ready a solution of 2 parts of gum mastic and 1 part powdered gum ammoniac, dissolved in 16 parts of 95 per cent alcohol. Remove the capsule from the bath, add the solution of gums to the glue and stir well together. This cement has a milky appearance and when properly made (and *properly used*) is one of the strongest possible cements for uniting porcelain, glass, ivory, etc. The cement remains fluid, in very hot weather, but at other times is solid, and the container must be placed in warm or hot water to liquefy the cement before using the latter. Have the fragments to be united warmed up to the temperature of the cement, or even warmer will not hurt. Use as little of the latter as possible, but be careful to cover the broken edges of both pieces with it, adapt them as neatly as possible, press out the surplus cement, and bind the parts together. Do not remove the binding thread or wire for at least 36 hours (and the joint will be all the better if the ligature is left on for twice that long). To render this cement so that it will withstand boiling water, place the object in a hot oven and leave it there over night. Keep the containers of the cement tightly corked.

A slightly cheaper form of this cement is made as follows: Dissolve 16 parts of powdered mastic in sufficient alcohol of 95 per cent to make a saturated solution. Soak, as described above, 16 parts of fish glue in cold water until it is thoroughly softened, get rid of the surplus water, then melt in the water bath and add the solution of mastic. Keep the temperature of the bath at a point just sufficient to maintain its fluidity. Stir the mixture until it becomes homogeneous, then stir in 8 parts of finely-powdered gum ammoniac. Maintain the heat for 1 minute longer, then remove and pour into vials of 2 drachms each.

OTHER CEMENTS.

Mix 100 parts of acetic acid with 400 parts of water and in the mixture soak 500 parts of the best glue for 6 hours, then dissolve by the aid of heat and add 1 part of crystalline carbolic acid.

To make this cement proof against water, cold or hot, all that is necessary is to add to it 20 parts of ammonium bichromate as follows: Melt the preparation, and when fluid pour into a dark brown container. Dissolve the bichromate in as little water as possible, add, and mix well. Preserve in dark brown vials or bottles, and label as follows: "Smear the edges of the broken parts with the cement, join the edges and place in direct sunlight to set. It should have several days exposure."

The preparation may be rendered permanently fluid by the addition of a little more acetic acid.

The volumes of the National Druggist for years past contain hundreds of formulæ for good cements, glues, liquid glues, etc. See the indexes under the various headings.

LIQUID GLUES.

There are numerous substances which, added to solutions of glue or gelatin, render them permanently fluid, without injuring the adhesive properties of the glue.

The most commonly used of these are acids—vinegar, acetic, nitric, hydrochloric, sulphuric acids, chloral hydrate, whisky, etc. The following are some of the formulæ for such preparations:

1. Dissolve glue in an equal weight of water and add nitric acid until the solution no longer jellies in the cold. Add cautiously, giving the solution plenty of time to react. Very little acid is necessary.

2. Carpenter's glue, 32 parts; water, 8 parts; nitric acid, 5 parts. Dissolve the glue in the water by the aid of heat. When dissolved, add the acid, a little at a time, under constant stirring. This may be diluted to suit. As it stands, it is a capital agent for mending glass, porcelain, etc., but will not stand water.

3. Make a syrup of 4 parts of sugar and 12 parts of water and to it add 1 part of freshly slaked lime. Heat this mixture to about 170 deg. F. for about a half hour, then set aside in a cool place for several days, giving it an occasional vigorous shake. When the greater part of the lime has disappeared, decant or strain off the liquid thus obtained—the so-called saccharate of lime. This is in itself an excellent mucilage, but to convert it into an excellent liquid glue, break up into a coarse powder, and add to it 3 or 4 parts of good glue (the latter, if you desire the finished product extra strong). Let stand at normal temperature until the glue "jellies," then put in a water-bath and heat, with stirring, until the glue is melted and a homogeneous liquid is formed. This costs, at the outside, not over 50 cents per gallon.—Nat. Drug.

Deposition of Gold on Glass.—The following is a comparatively new process which we have tried and found to work very satisfactorily. For this purpose three solutions are required, as follows:

a. Dissolve 1.03 parts of red gold chloride (representing 1 part of pure metallic gold) in 120 parts of distilled water.

b. Solution of sodium hydrate in distilled water of specific gravity 1.06.

c. (Reducing liquid.) Dextrose, 2 parts; distilled water, 24 parts; alcohol, 80 per cent, 24 parts; aldehyde, 24 parts.

To prepare the gilding fluid mix 4 volumes of solution a with 1 volume of solution b.

Of the reducing fluid (solution c) but very little is needed, say about 1-35th or 1-36th of a volume, or if 4 ounces of solution a were used, only 15 minims of solution c are requisite. Solution c should never be prepared until within an hour of its use, and, consequently, should not be kept over. The other solutions keep indefinitely, provided the gold solution (a) be kept in a very dark blue container and away from the light.

The method of using is similar to that used in silvering. Solutions a and b are mixed in equal parts and poured into a container large enough to admit the article to be gilt, the latter is placed *in situ* and the whole placed in direct sunlight or in a very warm room, i. e., one of from 110 deg. to 120 deg. F.—Nat. Drug.

ELECTRICAL NOTES.

The Western Electrician of Chicago describes a telephone booth. This booth has double walls. The inside and outside walls both extend to the floor on which the booth stands. The edges of the booth floor fit into grooves plowed crosswise of the inside walls. The inside walls were first put into position; the edges of the walls fit into grooves plowed lengthwise of the front and back walls; screws draw them tightly together at the corners of the booth. The outside walls are put into position and fastened in the same manner as are the inside walls. The ceiling fits over the inside walls, the top over the outside walls, giving a clear air-space on all sides and at the top. The floor rests on felt cushions. The outside and inside walls are held the proper distance apart by four small cushioned blocks at the extreme corners of each side. The door walls are separate, and swing on different sets of hinges, necessitating the use of an adjustable extension lock, which is supplied with each booth. By this construction the best possible sound-proof qualities are obtained.

H. Bordier has found that the refractive index of an electrolyte is reduced when a current passes through it, and that the reduction of the refractive index—in other words, the increase in the velocity of light through the electrolyte—is proportional to the current intensity, and, inversely, proportional to the amount of electrolyte in solution. He operated with salts of such metals as copper and zinc, which do not give rise to a secondary reaction at the cathode, and containing a radicle which is largely disengaged in the gaseous state at the anode. Chlorides were employed by preference. The effect of heating by the current was at first carefully determined and allowed for. There remained a substantial residual effect due to the passage of the current. Using a current of 300 milliamperes and a solution of cupric chloride, the author obtained a diminution of 0.4 per cent with a 1 per cent solution and a diminution of 0.3 per cent with a 3 per cent solution. As the author does not quote any greater dilutions, it is not evident what the limiting value at infinite dilution is likely to be. He mentions, however, that the concavity of the diminution concentration curves is turned upward. As regards the current density, the author found a regular growth of the effect in proceeding from 50 to 300 milliamperes. He points out that we have thus a new method of measuring current densities, and also a criterion of the amount of electrolyte in solution.

It is reported that the committee appointed by the Punjab government to investigate the question of increasing the water supply of Simla will submit its report in a few days. The members have definitely rejected General Beresford-Lovett's scheme, so far as it relates to the pumping of water from the Sutlej, but have, at the same time, decided that the electrical power shall be derived from Nauti Khud. It is understood that they will recommend a modification of a project worked out by the Public Works Department of the Punjab in 1889 for tapping the streams north of Mahasu, where a very ample supply is obtainable. The motive power will, as suggested by the Simla Extension Committee of 1898, be derived from the water of the Nauti Khud stream, and will be transmitted electrically to the pumps, which will be situated in the bottom of the valley below Phagu. If the recommendations of the committee now assembled are accepted, practically all the houses at Mahasu and Mashobra, as far as Naldera, will be served from the new water-mains, and an increase of the supply up to one million

gallons a day can be sent into Simla to meet the future demands of population, and still leave a margin for further extensions. The cost of the hydroelectric installation will be about 10 lakhs, which sum will not only provide electric power for the pumps in the day time and electric light at night, but will also include the cost of the laying down of electric mains all over the station for public and private lighting.

SELECTED FORMULÆ.

Rose Powder.—As a base, as is ordinarily done in preparations of this nature, take 200 parts of powdered iris root, add to this 600 parts of rose petals, 100 parts of sandalwood, as many parts of patchouli, and only 3 of oil of geranium, and finally 2 parts of true rose oil.

Glycerine Cosmetic.—This is offered as a substitute for cucumber cream for toilet uses. Melt 15 grammes of gelatine in hot water containing also 15 grammes of boracic acid and 150 grammes of glycerine; the total amount of water used should not exceed 300 grammes. It may be perfumed or not, to suit the taste.—Fundgrube.

Cements for Rubber Boots and Shoes.—To repair boots and shoes of this description, a material based upon caoutchouc is essential. Take then 100 parts of crude rubber or caoutchouc, cut it up in small bits, and dissolve it in sufficient carbon bisulphide, add to it 15 parts of rosin and 10 parts of gum-lac. The user must not overlook the great inflammability and exceedingly volatile nature of the carbon bisulphide.—Gummi Zeitung.

To Restore Tarnished Gold to Its Original Color.—This preparation is made up by carefully mixing together 20 parts of bicarbonate of soda, 1 part of calcium chloride, and 1 part of common salt in 16 parts of water. Of this a small quantity is spread upon the surface to be cleansed with a soft brush, and afterward rubbed well with a piece of tissue paper until it is perfectly dry. The liquid may be applied either luke-warm or cold, according to convenience.

Blacking for Harness.—In a water-bath dissolve 90 parts of yellow wax in 900 parts of oil of turpentine; aside from this mix well together, all the ingredients being finely powdered, 10 parts of Prussian blue, 5 of indigo, 50 parts of bone black, and work this well into a portion of the above-mentioned waxy solution. Now throw this into the original solution, which still remains in the water bath, and stir it vigorously until the mass becomes homogeneous, after which pour it into any convenient earthenware receptacle.

Stain Remover.—The Quarterly Therapeutic Review gives the following:

Extract of quillaya	1 part
Borax	1 part
Ox gall, fresh	6 parts
Tallow soap	15 parts

Triturate the quillaya and borax together, incorporate the ox gall, and, finally, add the tallow soap and mix thoroughly by kneading. The product is a plastic mass, which may be rolled into sticks or put up into boxes.

Cheap Label Paste.—

Dextrin	3 pounds
Borax	2 ounces
Glucose	5 drachms
Water	3 pints 2 ounces

Dissolve the borax in the water by warming, then add the dextrin and glucose, and continue to heat gently until dissolved.

Another variety is made by dissolving a cheap Ghatti gum in lime water, but it keeps badly.—Chemist and Druggist.

A Rapid-Drying Alcohol Varnish.—This is particularly well adapted for use on furniture, models in wood, etc. In 75 parts by weight of alcohol dissolve 40 parts of pulverized and soluble Manila copal, add to this 20 parts of pale American rosin, 1 part of thick turpentine, and finally 1 part of linseed oil varnish. A place slightly warmed above the ordinary temperature is best suitable for the complete dissolution of the ingredients; set it aside for a time to settle. The color may be given by means of mineral pigments or any of the aniline dyes soluble in alcohol.—Nouvelles Scientifiques.

A Powder to Make Hens Lay.—While we recommend these powders for the purpose indicated, we consider it also our duty to mention the fact that in pushing the hens this way they are sooner exhausted than in Nature's slower process, and it becomes consequently necessary to kill them earlier. Form a compound of 2 parts of Cayenne pepper, 4 parts of mixed spices, and 6 parts of ginger.

To every kilo (2.2 pounds) of this mixture add a spoonful of ground coffee. This may be fed to the fowls twice or three times a week either alone or mixed in with the chopped food.—Science Française.

To Clean a Gas Stove.—Every housewife is more or less annoyed by the facility with which the top of her gas stove becomes soiled, if not, indeed, clogged with spatterings of grease. An easy method of removing this will be very acceptable, no doubt. It is well to immerse the separable parts for several hours in a warm lye, heated to about 70 deg. C., said lye to be made of 9 parts of caustic soda and 180 parts of water. These pieces, together with the fixed parts of the stove, may be well brushed with this lye and afterward rinsed in clean warm water. The grease will be dissolved away, and the stove returned almost to its original purity.—La Nature.

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