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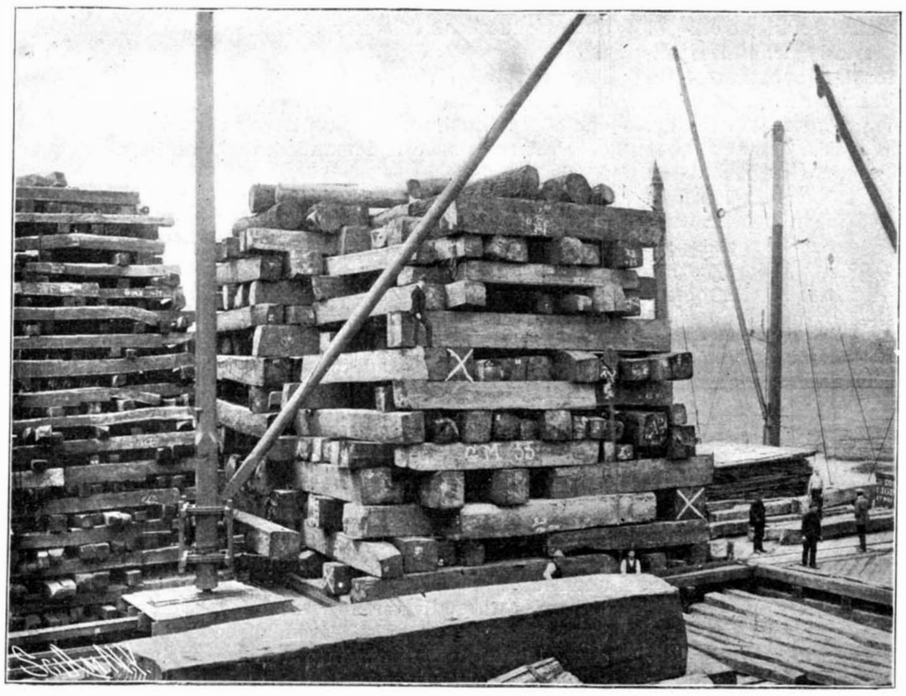
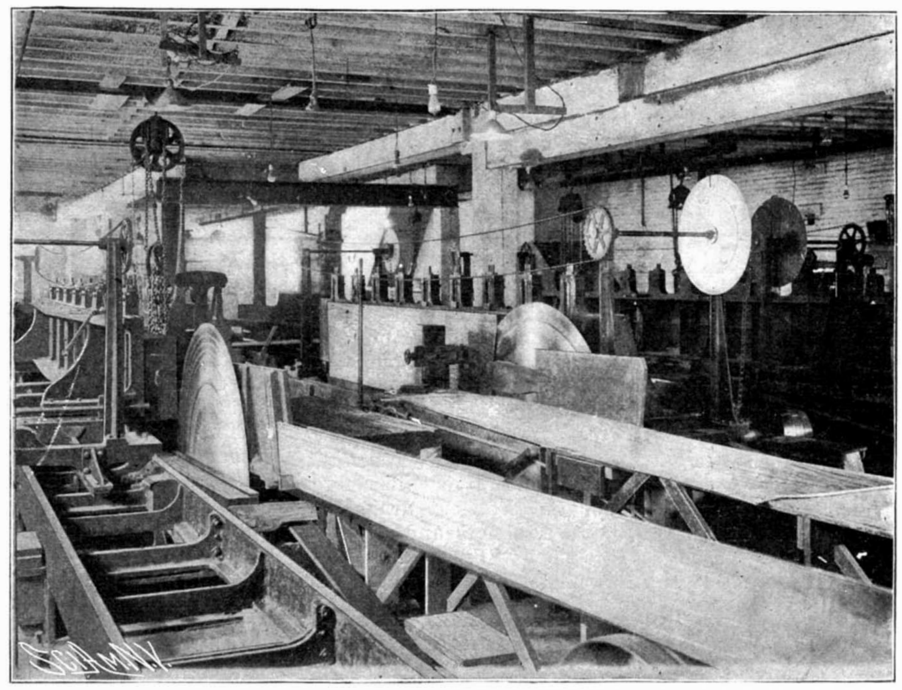
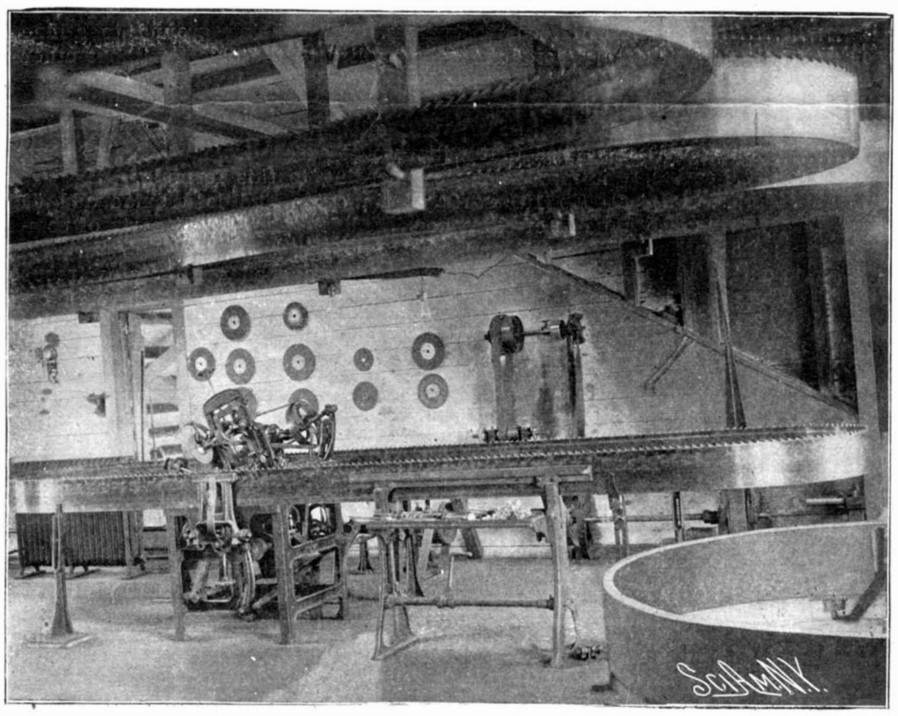


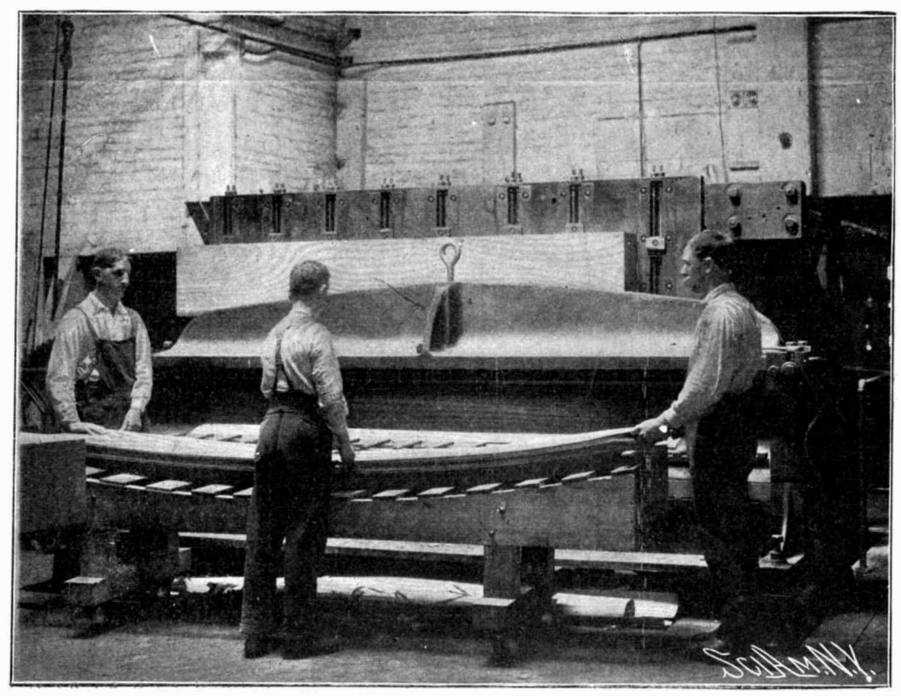
A $60,000 LUMBER PILE.



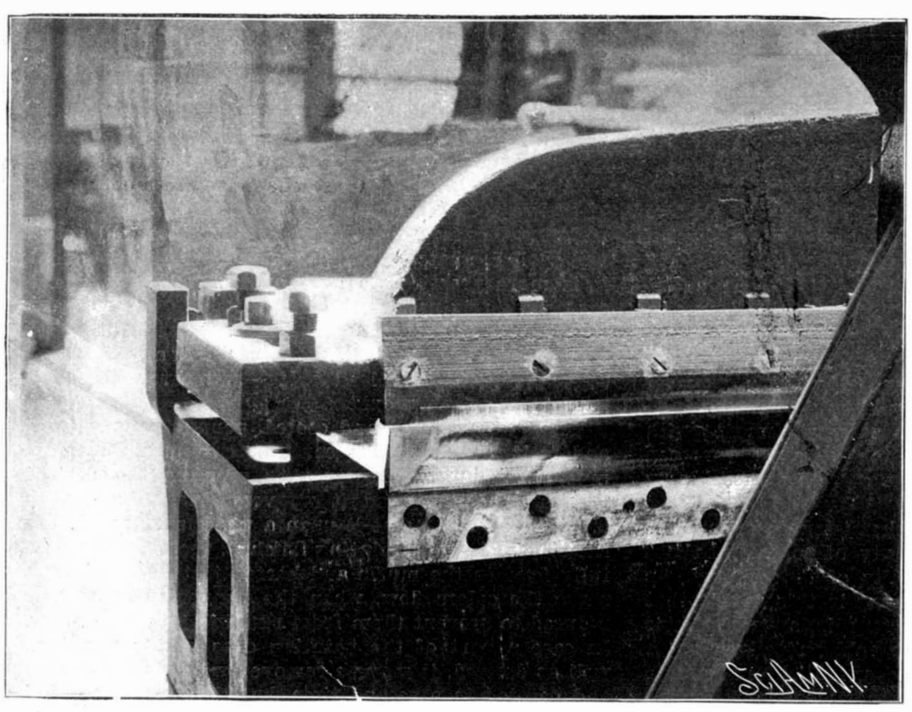
SAWING VENEERS.



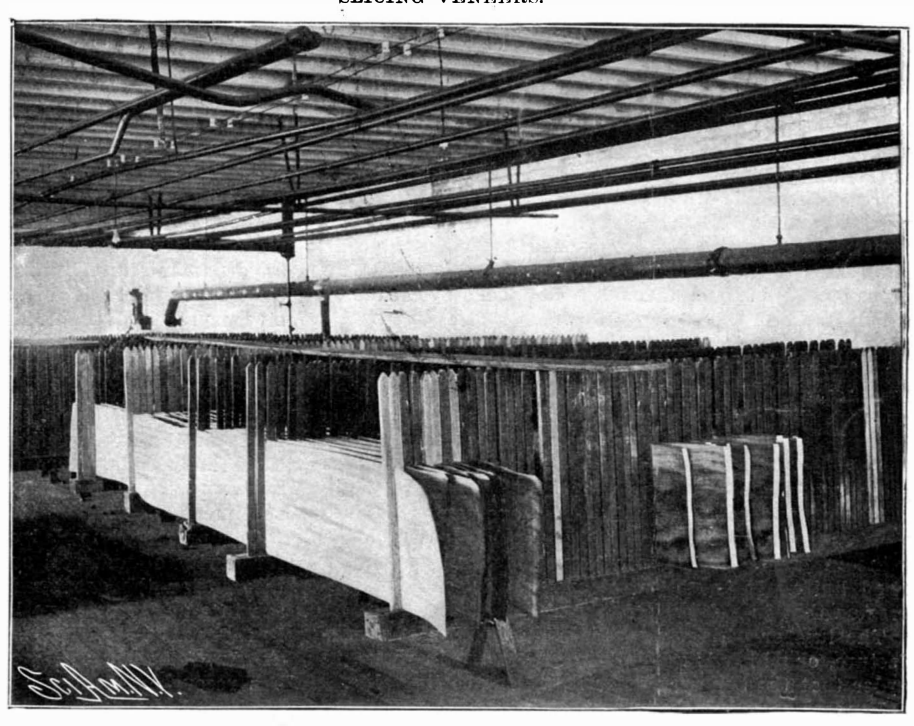
SHARPENING BAND SAWS.



SLICING VENEERS.



DETAILS OF SLICING MACHINE, SHOWING THE KNIFE.



AIR-DRYING OF VENEERS.

THE MANUFACTURE OF SAWED AND SLICED VENEERS.

THE MANUFACTURE OF VENEERS.*

A veneer is a thin sheet of wood or other material intended to give an exterior surface or finish to articles of other and usually cheaper material. Veneering is equivalent in its results to plating in the working of metals. Vast quantities of veneers are used in cabinet and piano making, and wherever a durable finish is desired. There is little tendency to crack or check when they are used, and the effects which can be obtained are really superior where veneers are used, and they are employed in many cases where expense is no object. The woods mostly used are mahogany, oak, satinwood, curly and bird's eye maple, cherry, and ash.

Veneers are either sawn or sliced, the sawn veneers being the most expensive, the waste saw-kerf taking as much of the lumber as the veneer proper. Both methods are employed at the Astoria Veneer Mills, Astoria, Long Island, now a part of Greater New York, whose plant we illustrate. The mills are located on an arm of the East River at Bowery Bay, and the logs or timber are brought to it on lighters. The veneer wood is unloaded by cranes, and stacked. One of these piles shown in our engraving is composed mostly of squared sections, or flitches of African mahogany, and is easily valued at from $60,000 to $100,000. Logs costing upward of $4,000 occasionally find their way to this market. The logs are usually cut up in lengths of a size suitable for the machines. The logs or flitches are all marked, showing their owners.

When it is desired to prepare a log or flitch for cutting, it is taken to the band sawmill, where it is reduced to oblong blocks of proper size and with fresh surfaces. The lumber taken off is nearly all utilized. The band saws are 10 inches wide, 42 feet long, and pass over 7-foot wheels. Means are provided for turning and handling the logs, but they do not differ from those ordinarily employed in sawmills. A special saw-filing plant is necessary, and is equipped with right and left-hand emery grinders, setting machines, etc. The flitch is now ready for the cross-cut drag saw, which takes off the ends, and all knots and grit are removed by cutting out the spot with an adz. The carriage of the veneer saw is 21 feet long, so that sawed veneers can be cut out of much longer stock than sliced veneers. The saws have very fine teeth, and are 7 feet in diameter. The saw is made up of a series of segments separated from each other by a space which increases as the saw is filed smaller. The great timber or flitch is lowered into place on the carriage, and is clamped by dogs top and bottom. The thickness of the veneer to be cut is regulated by the chains overhead, which act on screws which advance the carriage toward the plane of the saw. Dials indicate the thickness being cut. The saw is now started, and the veneer is sawed in the course of a couple of minutes. The carriage is run back, and the new adjustment is quickly made and the saw restarted. On the average only five veneers can be cut before refiling the saw, which requires two and one-half hours; sometimes only one veneer can be cut, if the wood is very gritty. Such flitches will be on the machine from one to three weeks before all sawn up. As each veneer is cut, the ends are pasted with muslin strips to prevent warping, and they are then placed in drying racks, and are allowed to dry from two hours to several days. They are then ready to ship. The last part of the flitch secured by the dogs is utilized as lumber.

In the sliced veneers the flitches are carefully prepared and planed and are then steamed for several hours, and finally hoisted onto the slicing machine, which weighs 26 tons and requires from 20 to 35 horse-power to actuate it. The flitch is secured to the movable bed-plate by dogs, and the large block of wood is brought down over the knife, which takes off a slice varying from 1/4 to 1-150 of an inch in thickness as desired. The bed-plate slides up and down on slides placed at an angle by means of levers, rods, and cranks. One of the machines slices veneers 10½ feet long by 32 inches wide, while the other cuts 27 inches wide and 14 feet long. The knife is drawn toward the wood by screws, which are controlled by a man who stands in a pit at the right of the machine. He controls the advance of the knife with a hand wheel. While this could be done automatically, there is always a risk of grit or iron injuring the knife, and he can stop the action of the machine instantly. The thin slips are flat, and are sent to the drying racks as before. The last bit of wood in the machine held by the dogs is utilized for lumber. A knife can be used an entire day if the wood is good and not too moist. The knives are sharpened by emery blocks secured to the periphery of a large wheel, the knife being advanced to contact with the blocks by means of a movable bed.

Veneers are often pressed to give them a high finish; and for some classes of work, nearly all oak veneers are pressed. The veneers are piled three or four high on each shelf of the press, and a pressure of 50 tons is applied by hydraulic rams, the shelves being heated to 250 deg. of heat meantime by steam. The veneers come out finished and ready shrunk.

Stumps and certain small pieces are converted into veneers by a machine which somewhat resembles a lathe in principle, the wood revolving and striking a fixed knife. It is not considered as desirable a process as that just described.

The lumber which is saved in the process of manufacture, or which is specially sawn, is put in racks, in order that the sun may color it, adding to its value.

Veneers vary greatly in cost, owing to the variety of wood, the size, thickness, color, and markings. Some of the rarer varieties bring 5 cents a square foot. Veneers are used singly, or sometimes two or more are used to give strength by lamination. One surface is roughened and glued to the body of the work, and clamped usually between zinc plates. The plates are contoured to the necessary outline when bent veneers are being planted.

The subsequent treatment does not differ materially from any other hardwood finishing. If the workmanship has been good, the veneers will last like the colonial furniture and buhl work of our ancestors.

* Specially prepared for the Scientific American Supplement

TO MAKE COLORED PENCILS.

If we melt graphite or other colors with resins, we obtain a material which is little inclined to rub off its color; if, on the contrary, we form a composition of graphite with moist clay, mold it, dry it, and then burn or fire it, we then obtain excellent lead pencils.

The process just indicated may be explained in the following manner: In the first case the binding medium (resins) impregnates each individual particle of graphite, and thus detracts materially from its natural propensity to adhere to foreign substances; in the second case each separate granule of graphite lies free alongside of its neighboring granule of clay, shrunken by drying and firing to such a degree that it touches it only at a very few points, so that indeed the abrasive tendency of the graphite is scarcely affected. If now the premises in the above argument are correct, then it may yet be possible to make good pencils with resin as a binder, provided the impregnation of the softer with the harder substance can be avoided. And this may truly be accomplished by moistening the graphite with non-drying, non-crystallizing liquids, which are soluble in water, and then mixing it with the resinous binder. Such a body is for example glycerine. Common resin may be employed as a binder either alone or in combination with a greater or lesser quantity of harder gums, such as copal, mastic, and the like. These gums must be used in the finest possible powdered state, which condition may be reached by grinding them wet, or precipitating them out of an alkaline resinous solution with acids, and later by washing and pressing.

As a coloring medium, besides graphite, any organic or inorganic substance, any natural or artificial dyestuff or mixture of these, which rubs off easily, is insoluble in water, and has no chemical affinity for either the resin or the glycerine, may be employed. Should the coloring substance be strongly absorbent, then it is advisable to mix with it a less absorbent body—talc, for instance. The color, whatever it may be, is first mixed with the glycerine, and thoroughly intermingled with the aqueous resin pressed cake; the compound is then dried in the air, and brought into the required pencil shape by compression in a hot press. Taking then as a fixed quantity either one part of resin alone or 0.7 part of resin and 0.3 part of copal, add to it 0.5 eosine, 1 talc, 0.2 to 0.4 glycerine; or 1 Prussian blue, 0.2 to 0.4 glycerine; 0.5 induline, 1 talc, 0.2 to 0.4 glycerine; 0.5 aniline violet, 1 talc, 0.2 to 0.4 glycerine; 0.5 aniline green, 1 talc, 0.2 to 0.4 glycerine; 1 ferric oxide, 0.2 to 0.4 glycerine; 1 graphite, 0.05 to 0.3 glycerine; 1.5 graphite, 0.08 to 0.5 glycerine; 0.5 graphite, 0.5 talc, 0.4 glycerine; 1 graphite, 2 talc, 0.4 glycerine.

Here we have ten pencils varying in both color and hardness. The glycerine makes it possible to incorporate with the resin as much as four times the amount of graphite and talc otherwise attainable, and provides thereby a medium for preparing many different mixtures, though they all suffer in their powers of attrition in direct proportion to the quantity of graphite, unless the quantity of glycerine is correspondingly increased. Pencils of this description are softer the more glycerine they contain; they are capable of being finely pointed, and will even write on glazed paper, as well as glass and porcelain. The writing may be erased, and if small amounts of dyes soluble in water be added, they may also be used for copying. Even without such an admixture, the drawings or writing made with pencils formed of coloring matter soluble in alcohol may be permanently fixed, if they be subjected to alkaline vapors.—Farben Zeitung.

ENAMEL AND ITS PRESENT APPLICATION.

By reason of the beauty of coloring to which it lends itself most superbly, no less than for its durability, enamel is being again called into requisition for the decoration of fancy ornaments for the house, and delicate bits of jewelry for the adornment of our persons.

Long ago, when the eyes of our progenitors were more lightly attracted by the sparkling iridescence of an ornament than by its intrinsic worth, this branch of art was more highly appreciated and more extensively practised than it is just now, for in our museums are to be found examples, by the thousands, of work done by clever enamelers of centuries gone by, that we now prize as relics of untold value.

Can anyone tell why this should be so? Except perhaps for the sake of the great accomplishments with little knowledge, there seems to be no valid reason why we should lay such great store by these early specimens.

Our present knowledge of chemistry is such that, for purity of material and beauty of color tones, not to mention the greater durability of the product, we are in a position to excel anything in this regard that has gone before. That this fact is appreciated is proven, for more and more the gold and silver smith has recourse to enamel for the embellishment of his work and the ceramic arts are not slow in following suit, particularly in the manufacture of artistically decorated earthenware vessels. There is very little, if any, difference between the composition of the enamel used upon artistic jewelry and that which serves for ordinary industrial purposes; what little difference there may be arises from the endeavor to obtain the best material for jewelry, for only with the best is it possible to get the finest colors. The matter of cost plays but a minor rôle, because the amount of enamel consumed by the jeweler is very small comparatively.

Since the enamels employed in the arts are not called upon to resist great wear or strain, they are as a usual thing compounded of materials having a low melting point because it is much easier to apply certain of these colors, and when baking them, there is greater surety of preserving their full beauty. To-day there are no secrets connected with the business or art. The formulæ for the composition of enamels have long since become public property and certain factories, of which the output has earned a world-wide reputation, the enamel work of Venice, for instance, may take advantage of the factors above indicated and produce continuously enameled wares of surpassing beauty and excellence. To obtain enamels of the lowest possible fusing properties it is necessary to use a glass composition that contains a high percentage of lead, and since, as we have said above, no power of great resistance is demanded, that can be safely and fearlessly done.

Below we take the liberty of giving some receipts that have stood the test. They are available for different artistic purposes and we must not omit to state that they may be applied in various ways. The work may be performed by a single fusing of the composition, or white grounding is first melted upon the object, and the colored substances applied to this, the whole being fused together a second time.

Where the color is solid, a single fusing is sufficient; however, if an enamel painting is to be produced, the white ground is first laid on and the colors applied afterward.

White Enamel for Articles of Jewelry.—Roast together until completely oxidized two parts of tin and one part of lead; of this take one part and to it add 2 parts of pulverized white crystal glass, with a small quantity of saltpeter, or native peroxide of manganese; either of these latter ingredients prevents discoloration; when thoroughly mixed, place them in a small crucible and melt them into a homogeneous mass and pour into cold water.

The fusing must be repeated from twice to three times, and in many cases even four times, until, in fact, the mass no longer appears honeycombed, but is a solid, compact mass. After being ground to a fine powder, it may be applied to the object without other aids or it may be mingled with lavender oil and applied to small spots on the surface with a brush as is done with ordinary oil paints. Now if an enamel be desired that will fuse at a still lower degree of heat, it may be made according to this formula.

To 100 parts of tin oxide and lead oxide add 60 parts of clean powdered feldspar and 25 parts of common salt and fuse as before.

Instead of the feldspar a good quality of vitreous sand may be used, but it must be well cleansed beforehand if a clear, clean product is wanted. To this end roast 100 parts of the sand with 25 parts of common salt. The iron which is present in the sand combines with the chlorine in the salt, forming a substance which volatilizes in the heat and there remains a baked mass sufficiently free from iron for our purposes. The sand is now mixed with 25 parts of pure red lead and fused. In this manner we get a white baked mass which will produce a substance similar to lead-soda glass. Now to make with this mass a suitable enamel, it will be first necessary to pulverize it very finely and mix it either with pure oxide of tin or with the mixture given above, oxides of tin and lead in such proportions that 100 parts of the oxides go to 50 parts of the glass composition. The more oxide of tin there is in the enamel the thinner it will flow and as a consequence the better will be its covering powers. It is possible to make enamel without the aid of any oxide of tin at all by substituting sodium antimonate in its place. When this is melted with lead glass, however, the product is not very pleasing to look at. In this case, then, it would be better to melt the sodium antimonate with crystal glass. A combination which produces a beautiful enamel consists of 3 parts of the glass, 1 part of sodium antimonate, and a small quantity of saltpeter.

In preparing any of these enamels care must be had to secure a crucible with a top that fits well, else the reducing flames produced by the fire gases will get in and spoil the batch. For purposes of enamel painting, it is more practical to keep a stock of different colored glass mixtures on hand.

Prepare first an enamel batch that melts at a low temperature, being careful to exclude any covering bodies—tin oxide or lead oxide—and throw into this batch the coloring oxides.

When once melted and cooled, pound it up coarsely and melt it over again; continue this until the glass presents a uniform color. As soon as the desired end is attained, grind it up very fine, mix it with lavender oil and paint it upon a white surface of very hard enamel. The painting finished, the object is carefully fired in the muffle and heated just hot enough to make the colors flow, when the temperature must be reduced to prevent them from running into each other. In case a part of the painting does not turn out as well as desired, it may be removed with a hard graver and painted in a second time, but this is no easy job and must be executed with great care if the uniformity of the coloring is to be maintained. A muffle furnace

may be used in the preparation of easily flowing enamels. The muffle is placed in a blast furnace or well drawing air furnace heated with charcoal or coke, the fire gases playing about the muffle as they rush toward the chimney. A fire tile with an opening to look through will serve for a cover during the firing of the colors.

Cloisonné Enamel.—The sort of enameling which bears this name is done in a manner altogether peculiar to itself and a product results that is of unbounded durability. As a general thing this is worked upon copper or upon gold and the process is identical with that followed by the very early artists; it has only recently been called into a renewed life. The outlines of the design to be carried out in enamel are cut out upon the metal plate in such wise that a thin ridge of the metal separates each color. The space between the ridges is now worked out with the tool and the ridges made as rough as possible so as to afford the enamel good holding ground.

When applied to gold the outlines are made of thin strips welded to the plate by heating the latter. In these cavities or cells produced as the occasion or the material requires, the enamel, mixed with either lavender oil or even water into a thick paste, is filled and melted in the muffle, more and more of the paste is applied and melted until the cavities are completely filled up. After the last firing the object is ground off to a smooth, uniform surface and polished.

Another and perhaps a simpler method is sometimes practised. The molten enamel is pressed into metallic molds of the desired shape and incased or set in metal bands and thus mounted in position upon the object to be decorated. When all is ready the vase or what-not is fired and the enamel fused into a uniform whole. When cooled, it is ground smooth and polished as before.

The so-called champ levee enameling is accomplished by indenting thin sheets of gold with steel tools, filling these with the paste and fusing. Before closing this article, we must not omit to state that the process known as cloisonné is by far the most durable of all varieties of enameling.—Journal der Goldschmiedekunst.

THE CHEMISTRY OF MILK.*

THE chemistry of milk has, during the last few years, been subjected to much investigation, both from the chemical and biological sides. The results hitherto obtained are sufficient to show that caution must be exercised in forming any conclusion relating to the question. For, just when the matter appears to be in a fair way of settlement, new investigations either extend our knowledge or show that some modification must be made in the prevalent views relating to the milk question.

Apart from the purely scientific aspect of the matter, our knowledge of the composition and constitution of milk has an important bearing upon the welfare of the community, since the milk of the cow or other animal is being used more and more as a substitute for mother's milk in the rearing of infants. Various methods of treating cow's milk with a view to approximating its chemical and physical characters to those of mother's milk have been suggested, and each method is claimed by its originator to have solved the problem of providing a perfect substitute for the material intended by nature for the nourishment of the sucking infant. How far were the earliest efforts in this direction from deserving the claims made for them is very evident from the results published on milk investigation within the last few years, and these investigations appear to show the almost insuperable difficulty of imitating simultaneously the chemical, physical, and biological properties of human milk by any artificial treatment of cow's milk. It may be some of the proposed modifications provide a substitute sufficiently successful in most cases, but when viewed from all sides it may be seen that the best is only an approximation to perfection and leaves much to be desired.

In a recent communication to the Schweizerische Wochenschrift für Chemie und Pharmacie, 1903, 205 and 217, Franz Sidler publishes some results obtained in the examination of samples of various kinds of milk intended for infant-feeding, and gives a useful summary of the present state of knowledge relating to milk. Four varieties were examined: (1) Pasteurized, (2) sterilized, (3) centrifuged (Gärtner's), and (4) humanized (Backhaus).

Pasteurized milk is prepared by heating the milk gradually and uniformly to a temperature of 60 deg. to 70 deg. C., and maintaining it at this temperature for some time, not exceeding one hour. This treatment is based upon the observation that pathogenic organisms likely to occur in milk, particularly tubercle and typhoid, are destroyed, while the milk is not altered in appearance or taste if the temperature of 70 deg. C. be not exceeded.

Sterilized milk is prepared by heating the milk to a sufficiently high temperature to destroy all organisms present in the fluid. This necessitates raising the temperature of the milk to about 110 deg. C., under steam pressure, and maintaining it at this point for fifteen minutes, but this treatment gives it a yellowish tint, alters its flavor, and considerably modifies the chemical and physical characters of its constituents.

The centrifuged milk of Gärtner is prepared by diluting cow's milk with an equal bulk of water and centrifuging the mixture. The operation is conducted in such a manner that half the volume is obtained containing practically all the cream, while the other half, containing only 0.1 to 0.2 per cent of fat, is rejected. This Gärtner milk contains, therefore, the same proportion of fat as the original milk, but only half the proportion of the dissolved substances, viz., the proteids, sugar, and salts. A subsidiary advantage of the process is that all impurities such as dirt and hairs, which are denser than the milk, are accumulated in the rejected portion.

The humanized milk of Backhaus is prepared with a view of eliminating the excess of casein in cow's milk, which forms coarse curds difficult to digest. By means of the centrifuge the fat is removed and the fat-free milk subjected to the digestive action of trypsin in presence of sodium bicarbonate for about thirty minutes at 40 deg. C. The undigested casein is then separated by means of rennet, the liquid filtered, and the filtrate heated to 80 deg. C. to inhibit further ferment action. Sufficient cream and casein is then added so that the product contains 3.5 per cent of fat and 0.5 per cent of casein, and a further addition of milk-sugar is made so that it shall contain approximately the same as human milk.

The following table by F. Sidler shows the results obtained by the analysis of milks of the foregoing types, compared with human milk:

	Pasteurized Milk.	Sterilized Milk.	Gärtner's Milk.	Humanized Milk (Backhaus).	Human Milk.
Fat	4.06	3.34	3.40	3.32	3.78
Total dry solids	12.74	11.63	8.06	11.46	12.59
Total fat-free solids	8.66	8.29	4.60	7.82	8.81
Sugar	4.71	4.46	2.45	5.86	6.21
Ash	0.71	0.68	0.35	0.55	0.31
Total proteids	3.21	3.16	1.80	1.39	2.29
Casein	2.55	2.82	1.56	0.91	1.03
Albumin and globulin	0.56	0.24	0.13	0.36	1.26
Other nitrogenous substances	0.10	0.10	0.09	0.12	
Ratio of nitrogenous to non-nitrogenous substances	1:4.62	1:4.05	1:6.16	1:10.18	1:6.83

The figures in the lowest horizontal column for the non-nitrogenous substances (in relation to the nitrogenous) are obtained by taking the sugar + (fat × 2.5) in order to give the fat its food value in sugar units. The ratios so obtained will be seen to vary widely, except in the case of Gärtner milk, from the ratio occurring in human milk. The pasteurized milk shows the same composition as raw cow's milk. The percentage of fat in all varieties is about the same as in human milk, but the particles in the latter are much finer than in cow's milk, and the difference is accentuated after sterilization. The sugar and ash also show marked variation from the human standard. The most marked variation is, however, shown in the relative proportion of casein and albumin + globulin, since in cow's milk the casein preponderates, while in human milk the proportions are approximately equal. Edlefsens has, however, made an interesting observation relative to this important point, and has shown that the proportion varies in woman during the period of lactation. At the third day he found the proportion of casein to other proteids as 67:33, while the total percentage was 2.69. At the 116th day the total proteids had diminished to 0.83 per cent, while the ratio of casein to other proteids had altered to 37:63, or almost the reverse to the proportion at the third day. Meanwhile the fat had increased progressively from 3.2 to 4.1 per cent and the sugar from 3.59 to 5.95 per cent during the same period. All this goes to show that the mother's milk is continually altering in composition to suit the needs of the sucking infant—a result which can hardly be obtained by any form of artificial treatment of cow's milk. The larger proportion of casein in cow's milk explains why the curd obtained by the addition of acids or rennet is so much coarser and difficult of digestion than the corresponding product from human milk. In Backhaus milk, although the proportion of albumin approximates more closely to human milk than that of untreated milk, it must not be forgotten that this albumin is not of the same nature, but consists partly of peptones produced by the partial digestion of the casein.

With regard to the bacteria in the milk, Sidler found that several samples of so-called sterilized milk were by no means free from organisms. Pasteurized milk, which will not keep good more than five days at the most, may be expected to contain certain resistent organisms not destroyed at 70 deg. C., but the importance of organisms in fresh milk depends more upon their nature than number.

Sterilized milk is a valuable commodity under conditions when fresh milk cannot be obtained, but the possibility of the formation of toxines in the milk by the residual organisms must not be overlooked. It appears impossible to produce absolutely sterile milk without subjecting the fluid to such treatment as profoundly alters its composition and properties.

The ferments in milk have also been studied within recent years, and the results appear to show that in this direction lie certain very marked differences between the milk of various animals. It is evident that this hitherto unsuspected variation is of great importance in relation to the rearing of infants by cow's milk. The main difference between human and cow's milk appears to be that the former always contains diastase, but never any enzyme of the oxydase class, while in the latter the reverse holds good. Apart from their nature, the enzymes of human milk appear to be more active than those of cow's milk. Spolverini suggests that these differences are due to man being omnivorous, while the cow is herbivorous. A lipase, capable of splitting up fats, occurs in both kinds, but that in human milk is by far the more active.

* From the Pharmaceutical Journal.

RECENT CHEMICAL RESEARCH.*

By Sir WILLIAM RAMSAY.

ALL previous calculations of science are likely to be upset by radium. We may soon be compelled to reverse some of the theories of physics that are now regarded as cardinal. Nobody can tell. The future, open to the diligent laboratory student, is fraught with mysteries. One thing is certain—nobody is likely to discover a mine of radium. Some statements made about the quantity of that precious substance in existence are very absurd. Dealing with the possibilities of radium is much like speculation upon the future of a babe in arms. We must watch it develop into childhood and mature growth before we can talk much about its future.

It is a far cry at present to discuss the use of radium, or radium salts, for illuminating or heating purposes. I do not suppose there is one-tenth of an ounce of radium in the whole world. If you can imagine getting that amount of radium together it would supply more energy than 250 tons of dynamite. Few persons who talk about radium and its components realize the great scarcity of the raw material for yielding radium or the exceedingly minute particles used in the experiments that have astounded the world. It is impossible to say where the future supply of raw material is to come from. I believe that in America carnotite looks promising as a basis for it. Cleavite, a mineral found in Norway, is also looked upon as a favorable source of supply.

One extraordinary quality of radium salts is that the evolution of heat and energy goes on continuously without combustion, without chemical change of any kind, and without alteration of its molecular structure. At the expiration of a month of activity the salt is quite as potent as it was in the beginning of the experiment. There is no doubt about the conversions of radium into helium. It has been done many times. In our experiments for several days a luminous gas was continuously emitted, but we could not determine the nature of it. When examined through the spectroscope it did not at first show the characteristics of helium. But later, by the application of intense heat, a gaseous product was obtained occupying about two and one-half times the space of the original emanation, and there were unmistakable signs of the spectrum of helium.

There are various theories to account for the evolution of the heat and other strange forms of radiation from helium and its allied elements. The most satisfactory one seems to be that some of the atoms in the substances are disintegrating and thereby liberating stored energy. A few physicists assume that the energy was at one time absorbed from some external source, and is now given off again. If we judge by the rate at which gas is evolved from the salts of radium, it seems probable that any given mass of it would decay and completely disappear in from 2,000 to 2,500 years. The life of three or four other radio-active metals is very much longer. My own research, which is not yet complete, encourages me to think that the "electronic" theory of atoms has a career of usefulness before it. Our new understanding about the atom may lead to entirely unforeseen results.

Fruitful experiment is constantly going on around the basis of current research. Science has shown that the emanations of radium can be dealt with as a gas. In tubes, its passage may be followed by the eye in darkened rooms. There is still plenty of room for a complete revision of the original dicta concerning radium and helium. Experiments made by Prof. Soddy and myself determine by direct measurements the rate of the decay of radium as one one-thousandth of the mass per year, which gives the average life of the radium atom about 1,000 years. This rapid rate of decay renders it out of the question to assume that in the radium now existent we are dealing directly with the residue of a larger quantity reduced by decay to its present amount. So far as the commercial advantages of radium are concerned, they are only apparent, as yet, in medicine. Radium is, I believe, a sure cure for certain forms of cancer, tumor, and lupus.

America has made great advances in chemical science since I was last here. Naturally I shall know more about it after our tour is completed than I do now. In the various forms of bromides and in alloys manufacturers on this side of the water have been progressing along new lines. But there is much to be done. I am strongly in favor of getting students out of the laboratory and into practical work much quicker than you do here. Our London University, recently reorganized, has set the example in this. Time spent in mere experiments may easily be too much extended. A fairly good student should have done enough work in a year, or two years at most, to place him in a position where he can help himself when he is face to face with an analysis not made before.

It appears futile to extend the courses of study to merely technical students. The ideal plan for the education of technical chemists would be some system analogous to the apprenticeship of engineers. But in order to accomplish this the chemical manufacturer must throw open his works to the students. He

* From the New York Times.

must get over the fear of somebody stealing his secrets or improving on his methods. Little can be accomplished otherwise. Education should primarily consist in an effort to produce an attitude of mind rather than to instill definite knowledge. It should aim to cultivate the inventive faculty, which is most needed to-day. But inventive chemists seldom have either time or inclination for developing the commercial aspects of a discovery. It is for the manufacturer and his staff to put the discovery to practical and profitable application.

RECOIL.—I.

By Brigadier-General J. P. Farley, U.S.A.

This subject is one which has engaged the careful attention of ordnance people for some time past.

The simple relation $MV = mv$, expressed in terms of weights or masses, with velocities corresponding to a direct force and reaction, is no longer employed to determine free recoil of a piece of ordnance.

If the energy of recoil is sought for, at that instant when projectile and gun part company, and no consideration is given to the action and reaction of the powder gas after the projectile has passed from the bore, then and then only may the velocity of gun recoil be ascertained by the equating of motions, that of the mass moving forward and of that moving backward.

In this case, the muzzle velocity of the projectile must be determined instrumentally and the mean weight or mass of the powder, which is progressively being consumed from powder seat to muzzle, must be ascertained.

For this reason at the present day we are provided with a formula accurately expressed, which will give for any special powder and gun the maximum velocity of free gun recoil.

This formula is thus expressed:

$$W_1V_1 = wv + A p. \quad (1)$$

W_1 = weight of gun in pounds.
V_1 = velocity of gun recoil, to be determined.
w = weight of projectile, in pounds.
v = velocity of projectile, measured at the muzzle.
p = weight of powder charge, in pounds.
A = a coefficient experimentally determined for each weight of gun and character of powder.

In order that the application of the formula may be the better understood, a special case is taken, that of the 0.45 caliber service carbine, and smokeless and black powder charges were so prepared in point of weight as to impart to a 500-grain rifle bullet 1,279 feet second. This arm was suspended in a manner to permit of absolutely free motion.

Sixty-eight grains of black powder, twenty-nine grains of smokeless powder were the charges requisite to give the muzzle projectile velocity specified.

The coefficients A for each powder were determined, and found to be for the smokeless powder 3,236, and for the black powder 2,258.

Substituting the above values in equation (1) the velocity of recoil V_1 became known, and from this, E_1 the energy of recoil, $\frac{1}{2} MV_1^2$ was derived. The lesser energy, 17.06 foot pounds, for the smokeless as compared with that for the black powder, 19.84 foot pounds, is then to be attributed entirely to the less weight of powder charge moving forward in a semi-burned condition, and to the lesser gas action on the projectile after it has left the bore of the gun. This *after action* of gas on the projectile, with its corresponding reactionary effect on the gun, the bottom of the bore serving as a fulcrum, may best be appreciated by the accompanying plate, and is revealed through the medium of the photograph, but cannot be seen with the naked eye. The hemisphere of gas behind the projectile of a seacoast gun is here seen to follow up, and adds about 20 feet velocity or one per cent increase to the muzzle velocity of projectile.

The *rationale* of lesser recoil where smokeless powders are used, as compared with that due to the use of black powder for the same muzzle velocity and energy of projectile under the two conditions, is thought to be fully explained by the foregoing observations, and is now usually taken at *about* 1 to 1.18 in favor of the smokeless powder—a matter of some significance for all-day hunting or shooting. Tests where the firer is blindfolded, and is in ignorance of the powder being used, prevented discrimination in favor of one powder over the other.

The ratio of recoil energy as measured by the dynamometer is as 1 to 1.13 instead of as above 1 to 1.18—a difference accounted for by the extra weight of attached spindle, which increases the recoiling mass by about 60 per cent, reduces the velocity of recoil proportionately and the energy of recoil in the relation of the square of the velocity.

This now brings us to a consideration of certain views quite generally entertained and expressed by the smokeless powder manufacturers. Many of them claimed (in words we will thus formulate) that they possessed a powder which would give a low pressure long sustained, against a more sudden and less sustained pressure of the black powders in ordinary use, and therefore, that *the time* in which the shoulder of the firer must absorb a given energy of recoil would be greater, the effect would be less like that of a blow, and the *shock* correspondingly ameliorated.

This reasoning is entirely correct, but it is a question rather more of degree than of kind when we put it into practice.

Most certainly, if we have an abnormally long barrel and an extremely slow-burning charge, and yet one which will develop in the projectile a muzzle velocity the same as that of an instantaneously acting powder like that of a high explosive or detonating charge, it would seem reasonable to think that that powder by which the highest acceleration of velocity is produced in the projectile in its passage through the bore should give the greatest sensation of shock, since correspondingly sudden changes would be produced in the velocity of recoil of the rifle resting in contact with the shoulder of the firer.

The action of such a powder would be characterized by a relatively high pressure suddenly developed, and then falling off rapidly toward the muzzle. On the other hand, the least possible sensation of shock should be produced by a powder giving pressures so regulated as to cause the projectile velocity to be uniformly accelerated from seat to muzzle.

This is of course aside from the question of maximum recoil energy as usually computed, or the total work of recoil as measured by the dynamometer, in which the factor of *time* does not enter.

Let us now take an extreme case, and assume that the powder manufacturer has arrived at what may be called a theoretically perfect powder, one whose maximum and mean pressure in the bore is the same. What should be the acceleration of the projectile from seat to muzzle under this uniform force?

The query is best answered by an examination of velocity curve *B*, Plate I., and velocity curve *E*, Plate II. Both are parabolic curves, as they should be under the hypothesis of a uniformly acting force, or uniform pressure on the projectile in the bore. A comparison of *A* and *G*, *D* and *H* shows that in practice we are far from realizing this character of acceleration of the projectile in the bore, and therefore all claims for *non-recoil powders* are disproved, as they should be under the laws of physics.

But *assuming* that a powder has been found which will give a mean pressure in the bore, capable of imparting a required muzzle velocity, of service standard, to the projectile, the *time* of motion for a mean velocity of projectile through the bore being but 0.0017 of a second in the 0.45 caliber carbine under normal conditions, this element of time would *increase* by not more than 0.0003 of a second for the theoretically perfect powder. What can be said of the action of the gun in this fractional reduction of so small an element?

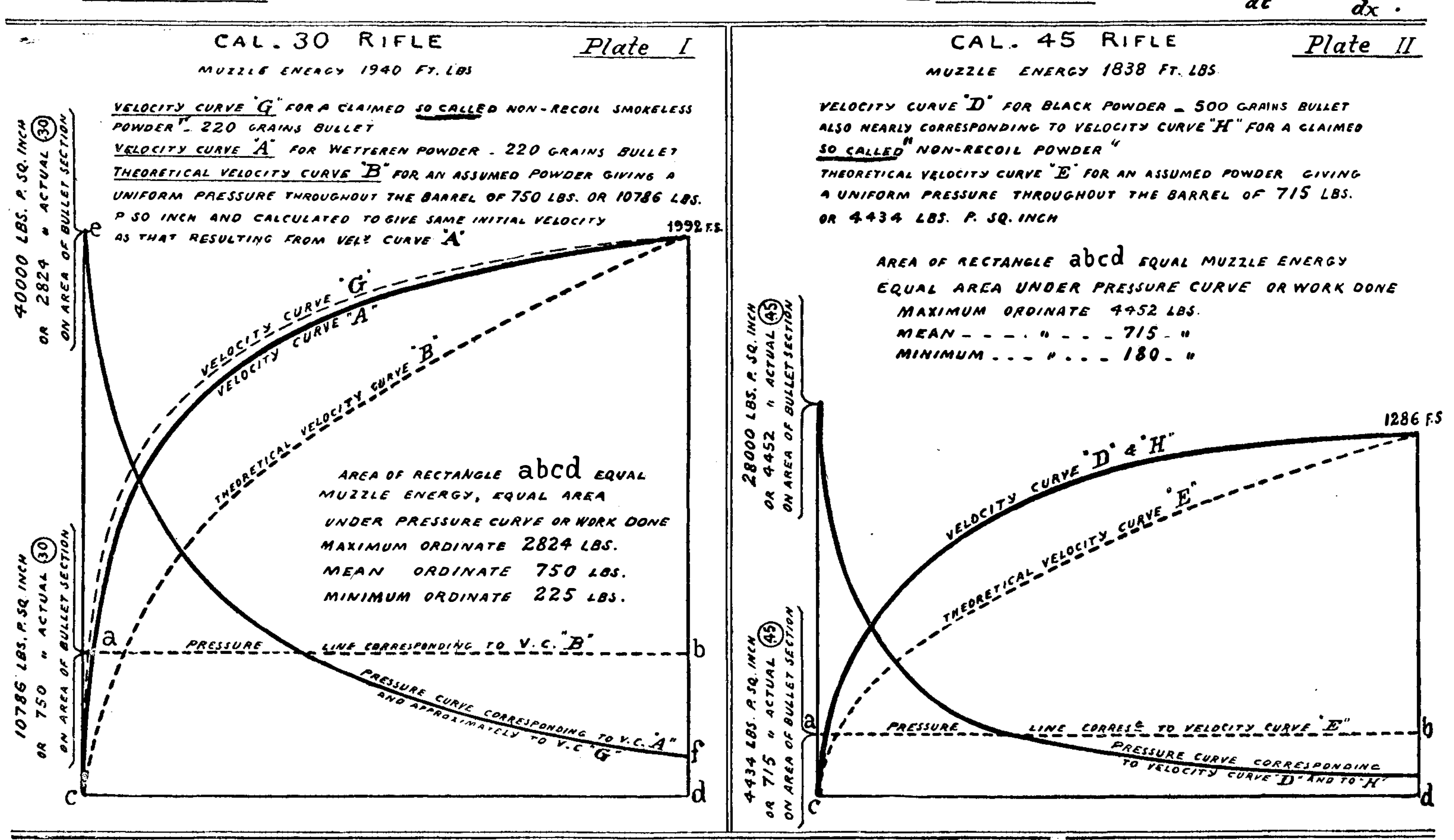
Can the senses appreciate it? And will the gun really get back against the shoulder any more fully in this restricted increment of time than it would where the time were not increased by say twenty per cent? What really does take place in this matter of recoil under normal conditions?

It has been found by exact experiment, which the writer himself has conducted, that the arm here discussed, the 0.45 caliber service rifle, moves to the rear about one-quarter of an inch before the ball leaves the muzzle, and that after that instant, under the hypothesis of equal muzzle projectile velocities for the perfect and the imperfect powders (as they relate to recoil) the velocity of recoil of the gun will be the same in either case. Will the butt set up hard against the shoulder for this one-quarter inch motion? We think not; and so the theory of *shock* effect being less in smokeless powders than in black powders, and operating to disturb the aim of the firer, must for the practical conditions of service rifle be given over, as disproved; and the time element, as we have considered it in the matter of *gain of time*, to reduce shock, is too small to be reckoned with even if it were found; but not being found, and only theoretically considered, it is out of the question altogether. It is not to be understood, however, that if an abnormally long barrel were employed, and a theoretically perfect powder used, so as to flatten out the parabolic velocity curve to which reference has before been made, some amelioration of *shock* would not follow. Our purpose here is to get at practical conditions, and to explode exaggerated claims based upon theoretically correct premises—a process the more dangerous because alluring. This returns the question to its original status, and enables us to state that for sound theoretical reasons, confirmed by practical tests, the best that can be hoped for smokeless powders in the way of recoil is a saving of some sixteen per cent as compared with that of black powder; and so let us hear nothing more of *non-recoil powders*.

(To be continued.)

VELOCITY AND PRESSURE CURVES

VELOCITY CURVES EXPERIMENTALLY DETERMINED FOR VARIOUS BARREL LENGTHS — PRESSURE CURVES FROM $P = m\frac{dv}{dt} = mv\frac{dv}{dx}$.



The rubber industry of Guatemala should be of far greater importance than is at present the case. There are in the republic large tracts of land suitable for the growing of rubber; but, owing to the impossibility of sufficiently policing the country, the rubber is frequently stolen from the trees, and the unfortunate proprietors actually have to buy back what really belongs to them from the thieves or their intermediaries. The

exports do not vary much; they amounted last year to 4,423 quintals, about the average for the last five years.

THE DIESEL ENGINE.

By A. W. OPPENHEIMER.

IN 1893 Mr. Rudolf Diesel began experimenting with a view to finding a more efficient prime mover than existing oil, gas, or steam engines.

Mr. Diesel succeeded in doing this after four years of hard work, by building an internal combustion engine on the following novel principles:

1. Attaining the temperature necessary for the combustion of the fuel by mechanical compression of air, previous to, and quite independent of, the introduction of the fuel into the cylinder.

2. Substituting a single adiabatic compression for the combination of isothermal and adiabatic compressions in the Carnot cycle, for the following reason:

By a single adiabatic compression, the required temperature is reached at a pressure of 30 to 40 atmospheres. On the other hand, with a four to one isothermal, followed by an adiabatic compression, the same temperature is reached at a pressure of 200 atmospheres, which pressure would give rise to practical difficulties.

3. Gradually introducing the fuel in a finely-divided state and thoroughly mixed with air, into the highly heated air, at such a rate that the temperature during combustion remains as nearly constant as possible.

4. Using a large and definite excess of air to insure the perfect combustion of the fuel.

Contrary to expectations, the first engine built on these principles showed that a water jacket was necessary. Although jacketing lowers the efficiency, it thickens up the diagram considerably; all sharp corners on the diagram are rounded off, so that in the whole cycle

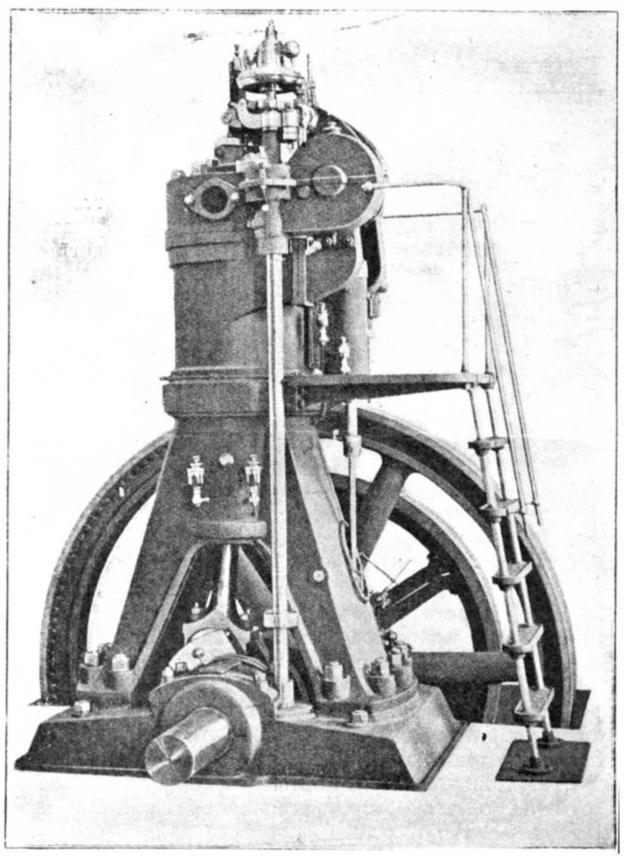


FIG. 1.—80-HORSE-POWER DIESEL ENGINE.

there is no sudden change in pressure, thus insuring steady running.

The greatest difficulty encountered in the first attempts was to design a suitable fuel-valve. At that time engineers thought that the only method of thoroughly pulverizing the fuel was to force it through successive layers of fine wire gauze, which were liable to clog. Later on, it was found that a number of fairly large but carefully arranged holes gave equally good results without clogging.

Even in the early engines, the combustion was found to be so perfect that crude and unrefined oils were consumed with ease.

Diesel engines have been running successfully on the Continent for the last six years, and so far back as 1899, Prof. Unwin, F.R.S., after careful examination, pronounced the engine to be entirely out of its experimental stage.

So much has been written about Mr. Diesel's experimental engines, that to refer to them here would be merely repetition; the author, therefore, proposes to describe the engine in its present stage, in which crude petroleum is used as fuel.

The task of developing the engine was undertaken abroad, chiefly by the Maschinenfabrik, Augsburg; Carels Frères, Ghent; and Sulzer Bros., Winterthur, who have succeeded in constructing a most efficient, trustworthy, and steady-running prime mover.

DESCRIPTION OF ENGINE.

The main details of a modern Diesel engine (Fig. 2) are:

A vertical cylinder liner, made of very hard, close-grained cast iron, fitted into a substantial frame, the space between the two serving as a water-jacket. The vertical frame is bolted to a stiff bed-plate in the ordinary way. The long open trunk piston carries six lap-jointed rings, and has only enough clearance to allow for expansion. The connecting rod turns the solid crank-shaft, to which a flywheel, made in halves, is attached by means of two wrought-iron rings. The inner edge of the flywheel rim is provided with teeth, so that the engine can be brought into the starting position by a barring gear.

The cylinder cover, which is well water-jacketed, is securely bolted to the frame, the joint being made with an asbestos ring. The cover carries the four main valves: the air-inlet valve, the fuel valve, the exhaust valve, and the starting valve. The three former are opened every two revolutions by means of rocking levers, actuated by cams keyed to a half-speed shaft.

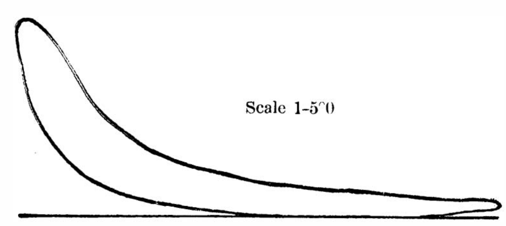


FIG. 3.—FULL LOAD DIAGRAM.

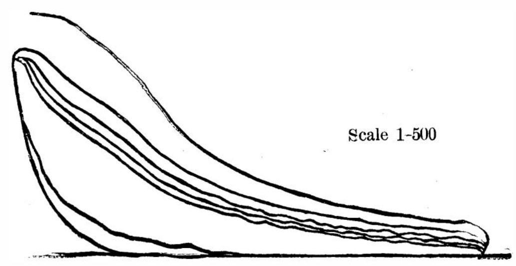


FIG. 4.—STARTING DIAGRAM.

The air-inlet, exhaust, and starting valves are of the ordinary mushroom type, and open downward. The fuel valve will be described later. The rocking levers for the fuel and starting valves can be turned on an eccentric axis. In one position of this, the starting lever is on its cam; while in the other position, the fuel lever is on its cam, and the starting lever out of action. Thus, according to the position of the eccentric, either the starting or the fuel valve opens, but it is impossible for the two to open together. I shall refer to this arrangement later, when describing the starting of the engine.

Driven off the end of the camshaft is the petroleum pump, which forces oil to the fuel valve, in quantities controlled by the governor, according to the load on the engine.

Mounted at the back of the cylinder is a water-jacketed air-pump, driven off the small end of the connecting rod by links, a rocking lever, and connecting rod.

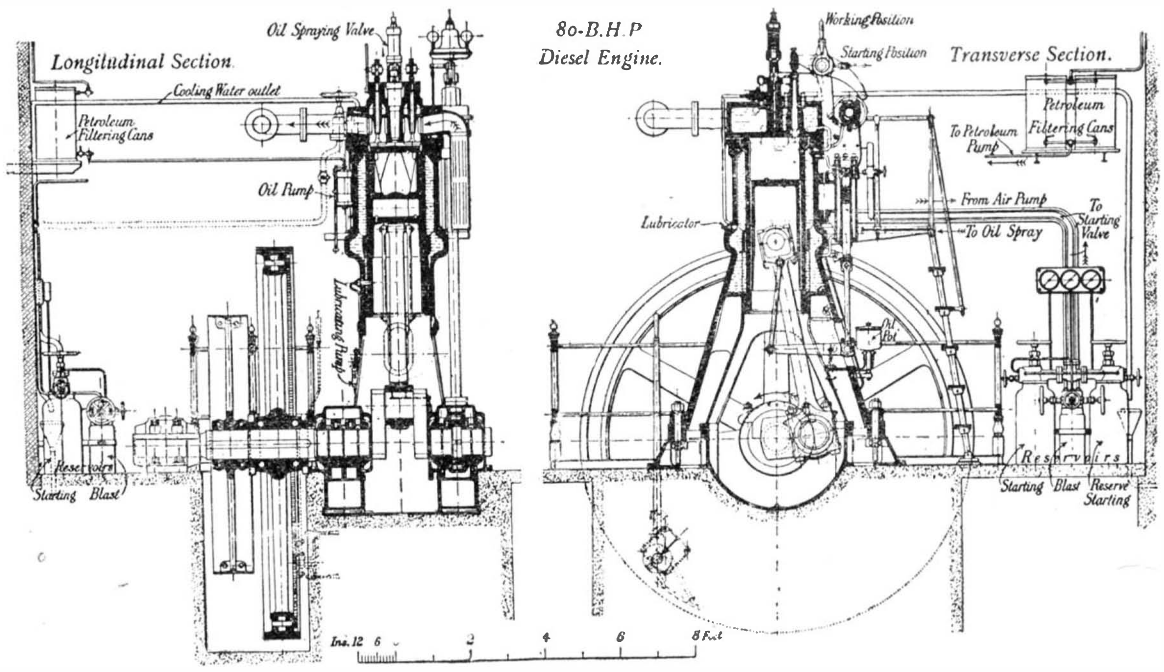


FIG. 2.—SECTIONS OF 80-BRAKE-HORSE-POWER DIESEL ENGINE.

This air-pump is of ample dimensions, and can be throttled so as to fill the cast steel reservoirs with air at any required pressure. The smaller reservoir is used for injecting the petroleum into the cylinder; one of the larger ones is used for starting the engine, the other being kept in reserve.

The governor is mounted on the vertical intermediate shaft, and is of the ordinary loaded type.

The crankshaft bearings are bushed with white metal, and are provided with ring lubricators. White metal is used to line all the bearings, except the crosshead bearing, which is made of phosphor-bronze to stand the heat.

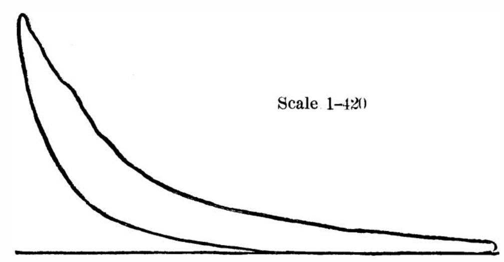


FIG. 5.—SMALL LOAD DIAGRAM SHOWING ISOTHERMAL COMBUSTION.

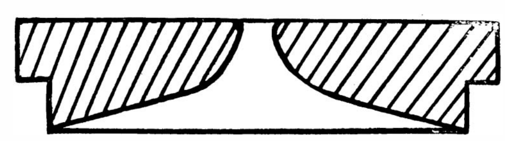


FIG. 8.—FLAME PLATE.

The lubrication of the piston and small-end presents no difficulties. At the end of the down stroke, a force pump delivers gas-engine oil to the piston at six equidistant points in a horizontal plane, and on the up stroke this oil is distributed over the liner. This injection takes place between the first and second rings, so that no lubricating oil comes into direct contact with the flame. At the same time, the force pump delivers

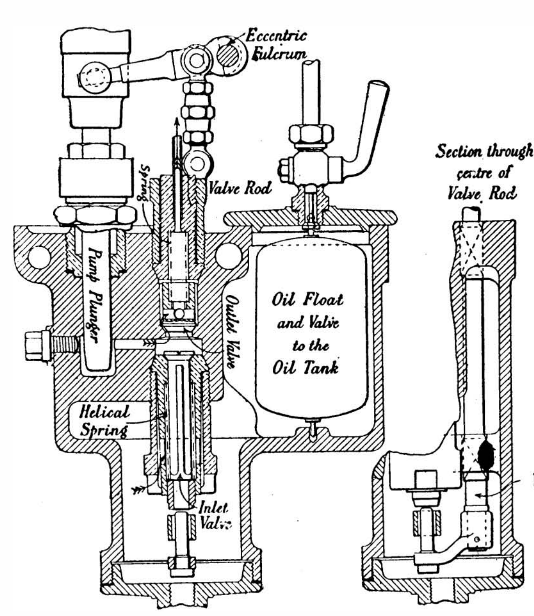


FIG. 6.—FUEL PUMP, SHOWING METHOD OF GOVERNING.

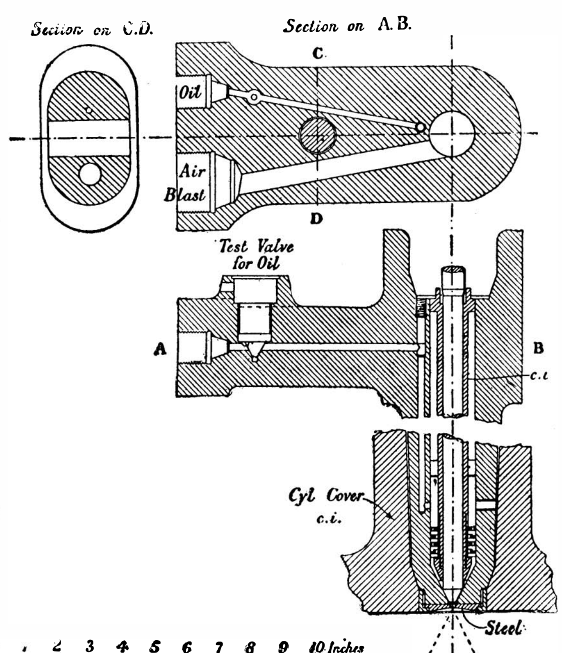


FIG. 7.—FUEL VALVE.

oil into a groove in the piston, whence it is conducted through a channel to the small end.

CYCLE OF OPERATIONS.

The cycle of operations is as follows:

1. The Suction Stroke.—The piston travels downward, while the suction valve is held open by its cam, and pure air at atmospheric pressure and temperature is drawn from the engine-room into the cylinder. The cam allows the valve to close after the end of the stroke. This quantity of air in the cylinder is constant for all loads, and is never throttled.

2. The Compression Stroke.—The piston travels upward, all the valves being closed, and compresses the air into a very small clearance—about 1-16 of the total volume. This compression is, of course, neither isothermal nor adiabatic, as it takes place in a partially conducting cylinder surrounded by a water-jacket at a temperature of about 140 deg. F. It follows very closely, however, the equation

$$PV^{1.3} = C.$$

At the end of the stroke, the air has attained a temperature of about 720 deg. F., and a pressure of 500 pounds per square inch.

3. The Power Stroke.—Slightly before the dead center, the fuel valve begins to open, and a steady spray of petroleum, pulverized into very small particles and thoroughly mixed with air, is injected by highly compressed air from the blast reservoir. Since crude petroleum, in the presence of air, takes fire spontaneously at about 450 deg. F. (232 deg. C.), and the temperature of the air in the cylinder is 720 deg. F. (382 deg. C.), the petroleum burns completely before reaching the piston or cylinder walls.

The fuel valve is opened only very slightly, so that all the oil cannot pass the narrow orifice at once; the injection lasts about ten per cent of the down stroke, during which period the pressure remains practically constant.

At full load, the temperature at the end of the combustion period is about 1,050 deg. C.—considerably lower than the temperature reached in a gas engine during explosion.

When the fuel valve is closed the products of combustion expand, doing work and being cooled thereby. The expansion curve approximately follows the equation

$$PV^{1.2} = \text{constant}.$$

Before the end of the stroke, when the pressure has fallen to about 30 pounds per square inch, the exhaust valve is opened, and release takes place into a silencer.

4. The Exhaust Stroke.—The piston travels upward, expelling the products of combustion. The exhaust valve and pipe are made so large that there is practically no back pressure. In order to expel the exhaust from the clearance, a scavenge is resorted to. Before the end of the stroke the air-inlet valve is opened. This sets up a convection current. Cold air entering through the inlet valve sweeps out the hot gases through the exhaust valve, leaving the clearance full of pure air by the time the dead-center is reached. This enables an engine of given size to develop more power, since the amount of oil which can be injected without smoke depends on the quantity of oxygen in the cylinder.

As to the excess of air, Prof. Ade Clark, in his trials on a Diesel engine running at full load, found that 48.2 pounds of air passed through the cylinder while 1 pound of petroleum was burnt; whereas 14.56 pounds of air would suffice to burn it completely. Thus 3.31 times the necessary quantity of air was used.

The exhaust gases are quite invisible, except when the engine is running light; they will not discolor a piece of white paper held in them for several minutes. Consequently, the exhaust valve and the interior of the cylinder remain in good condition, and very seldom want cleaning.

When running, the engine requires little attendance. The only thing which has to be nicely regulated is the blast pressure, which should be varied according to the load, in order to get the best shaped diagrams. When running light, 100 pounds per square inch above that in the cylinder suffices, but at overloads 400 pounds per square inch surplus pressure is required.

STARTING THE ENGINE.

The engine is started in the following way:

Assuming the lubricators filled, the jacket water running, the petroleum tanks filled, the petroleum pump charged, and minor details in order, the engine is brought into its starting position: that is, the crank is adjusted to be about 10 deg. past the upper dead-center, at that revolution when the starting valve opens. The eccentric is now pulled down, so that the starting valve opens, and the fuel valve is out of action. The cylinder is closed by taking the hook off the inlet valve. The blast and one of the starting air reservoirs are then opened. Compressed air at about 700 pounds per square inch enters the cylinder through the starting valve, and drives the piston down: this air admission lasts a considerable percentage of the stroke.

The next stroke expels this compressed air.

The third stroke draws in air from the atmosphere.

The fourth stroke compresses the same.

As the cylinder is probably cold and the speed of the engine low, the temperature of this compressed air would be too low to ignite the fuel if injected. The engine is therefore allowed to make about four power strokes with compressed air, the temperature rising each compression stroke as the speed increases.

After about eight revolutions, the eccentric is put up. This brings the fuel valve into action, and stops the opening of the starting valve. A heavy charge of petroleum is injected and ignites, the temperature being now high enough. The engine then continues its cycle as an oil-engine, and as soon as it has picked up its speed, the load may be put on. A smart man can be driving his load about 50 seconds after starting; the initial preparations occupy less than a minute.

THE FUEL VALVE.

This valve (Fig. 7) is placed in the middle of the cylinder cover; in the center is a needle valve, of which the seat has been carefully ground into the casing, the stem being well packed above. It is opened vertically upward by means of a spherical joint on the end of a bent rocking lever, and closed by means of a powerful spring. This needle runs freely through the pulverizer, which consists of a nozzle provided with vertical slits, and four rings placed one above the other and kept about 1/8 inch apart by distance pieces. These rings contain a number of fairly large holes about 1-12 inch in diameter. The holes in the first ring are further from the center than those in the second. To the bottom of the valve is fastened the flame plate—a steel disk, with a small circular hole in the middle, and sides sloping away as shown in Fig. 8. The petroleum passage is drilled down the valve casing, and enters the interior just above the top ring. A pipe also connects the interior of the valve with the blast air reservoir.

The blast pressure (of say 750 pounds per square inch) is always turned on when the engine is running, and the petroleum passage is full of petroleum. At the end of the suction stroke of the engine, the petroleum pump delivers a charge varying in quantity according to the load. The same quantity is forced out of the passage, and falls on to the first ring. It cannot leak down the side of the casing, as the rings are accurately fitted. It therefore runs into the holes of the first one or two rings, and remains there by capillary attraction. This is the condition at the end of the compression stroke of the engine.

When the needle is lifted, the difference in pressure of the blast and the compression in the cylinder (in this case 250 pounds per square inch) causes a rush of air to take place. The petroleum is dashed through the zig-zag holes, being mixed with the blast air in the process. Then, pulverized almost to vapor, it passes through the orifice, is spread out radially in all directions by the flame plate, and is burnt. To prevent the holes getting clogged up, an air blast follows the petroleum each time.

FUEL CONTROL.

The petroleum pump plunger has a constant stroke, and is driven off the end of the camshaft. A passage connects the barrel to ordinary inlet and delivery valves closed by springs. Petroleum runs into the pump, by gravity, from large filtering cans, and is kept at a constant level in the pump by means of a float valve. A pipe leads from the delivery valve of the pump to the fuel valve of the engine.

Above the pump is an eccentric fulcrum which is made to rise or fall according as the governor goes up or down. Turning on this fulcrum is a cross-bar, working in a slot in the plunger head. The cross-bar, therefore, describes an arc of a circle about some center fixed by the governor.

From a point on this cross-bar hangs a rod, going right through the pump into the oil reservoir at the bottom. This rod terminates in a cross-piece in the same plane as the inlet valve.

This rod is such a length that:

1. When the governor is right down the inlet valve is not interfered with at any part of the stroke. In this case, on the upstroke of the plunger, oil is drawn into the barrel through the inlet valve. On the downstroke the inlet valve is closed by its spring, and the full quantity of oil is forced through the delivery valve to the fuel valve.

2. When the governor is half-way up the fulcrum is raised, and the cross piece moves between two points higher up. During the first half of the upstroke, the inlet valve is opened by suction. During the second half of the upstroke, it is lifted mechanically by the cross piece. At the end of the stroke the barrel is full of oil; but on the first half of the downstroke the inlet valve is also held open by the cross piece, and half the petroleum leaks back into the reservoir. At half stroke the cross piece releases the inlet valve, which then closes by its spring. The delivery valve is then forced open, and the remaining half of the petroleum pumped to the fuel valve.

3. When the governor is right up the fulcrum will be in its higher position and the cross piece will move between two points such that the inlet valve is held open nearly the whole time, only enough petroleum being delivered to the fuel valve to keep the engine running at its proper speed at no load.

OIL CONSUMPTION AND WORKING COST.

The oil consumption varies according to size between 0.4 and 0.5 pound per boiler horse-power hour.

Mr. Ade Clark, in his trials on a twin-cylinder 160-horse-power engine at Ghent, on the 7th March, 1903, found the oil consumption at normal load to be 0.333 pound per indicated horse-power hour, and 0.408 pound per brake horse-power: corresponding to thermal efficiencies of 39.25 per cent and 32.3 per cent respectively. This engine was running on Texas liquid fuel in its natural state, having a calorific value of 19,300 British thermal units per pound and costing 45s. per ton.

The cost of fuel, therefore, works out at 0.098d. per boiler horse-power hour.

When running at small loads, the increase in the oil consumption per boiler horse-power hour is only due to the engine friction remaining constant; in fact, the consumption per indicated horse-power hour is rather less than at full load, as an isothermal combustion is more nearly attained. The above engine running at 3/4 load actually gave a thermal efficiency of 41.5 per cent on the indicated horse-power, which is probably the finest result ever obtained from a heat engine.

THE TOTAL COST OF WORKING.

The author knows of a twin-cylinder 30-horse-power engine, direct coupled to a dynamo in the sheds of the Greenock electric tramways, running for 0.66d. per unit. This figure includes the interest and depreciation of the land, buildings and plant, repairs and maintenance, fuel, oil, water, and wages. For a larger engine it would be even less.—Technics.

THE AEROPLANE.

MAJOR B. BADEN-POWELL, president of the Aeronautical Society, read a paper recently before the British Association on "The Development of the Aeroplane." He said:

The day is undoubtedly drawing near when we shall be utilizing the highway of the air for travel, and it is becoming an interesting question as to what form the motor-car of the skies is to take. A great number of abortive attempts to produce a practical apparatus have thrown considerable light on the prospects. During the last few years we have seen a great development in the construction of navigable balloons, and, in my humble opinion, these many attempts have only shown clearly what immense difficulties have to be contended with, and how little hope there is of our attempting any real success in this direction. I do not wish to imply that the navigable balloon is an utter failure, and though such a machine may prove itself most useful on certain particular occasions, and for special purposes, such as military observation, even that is a long way from being a really practical conveyance, capable of going up in all weathers, and stemming such winds as it may be likely to encounter on any average day. A balloon must of necessity be of huge size, and it must, therefore, offer a great resistance to rapid propulsion. Speed, however, is everything in practical aerial navigation, since the great object is to be able to progress in a given direction without interference from the wind force. If the same propelling power were applied to some smaller form of apparatus, would it be possible for the machine to maintain itself in midair, and progress through it? Theory answers very decidedly, Yes, and even practice may point to many promising results. The aeroplane (using the word in its widest sense) may be defined as a plane, or nearly plane, surface propelled through the air in such a manner that the resulting pressure acts so as to support it against the action of gravity. The frontal resistance of such a plane, even of very large surface, seems bound to be less than that offered by a large balloon, and should, therefore, be able to travel quicker. Devices for attaining artificial flight may usually be classed under one of three headings—(*a*) wing action, similar to a bird's flight; (*b*) vertically-acting screws to lift the weight upward; (*c*) aeroplanes proper, or plane surfaces propelled horizontally, with a slight upward inclination. All these three, however, are but aeroplanes according to the above definition. The wing is but the aeroplane moved up and down. The vertically-acting screw is but a pair of small aeroplanes moving round a common center. What we have, then, to study, is the action of air on inclined surfaces, and this is a subject not at all well understood. Theory and practice are much at variance. Theorists have worked out their problems, and shown what is, or should be, possible, but practice has been unable to even approximate the attainments suggested. Take the thrust of aerial screw propellers. The following are some of the records I have been able to collect: Nadar in 1863, as the result of small experiments, computed that a thrust of 33 pounds should be got from 1 horse-power. Wenham with a spring motor calculated on 33½ pounds per horse-power. Dieuiade, with a small steam-engine, got a pull of 26.4 pounds; and Forlanini made a little engine giving exactly the same results. Vogt, a marine engineer, made some careful comparisons between aerial and submarine screws, finding the former produced 33 pounds thrust per horse-power. Later, with large screws rotated by manual power, he calculated that he got 55 pounds per horse-power. Yet, when we come to trials on a large scale, we find Maxim, with his great steam-engine of 360 horse-power and screws of 17 feet 10 inches diameter, only gets a thrust of 2,000 pounds, or at the rate of 5.7 pounds per horse-power. Santos Dumont, taking the best of aerial engines tried, obtains a pull of 175 pounds with 16 horse-power, or 11 pounds per horse-power. Zeppelin, with two engines of like power, only gets 220 pounds thrust, or 7 pounds per horse-power. With my own little petrol motor of 1½ horse-power I have only been able hitherto to get 5 pounds pull out of the screw. It is true that Walker, in his experiments with large propellers, shows from 11 pounds up to no less than 74 pounds, but these, again, may be classed as laboratory experiments. Then it has been usual for theorists to consider only the pressure of the air on the under surface of the plane. But recently a little more light has been thrown on the subject of what we may call the lack of pressure on the upper side, which undoubtedly has a considerable effect in sucking the plane upward. Even the pressure of the air acting on a plane surface moving in a normal direction—that is to say, so that the air strikes it perpendicularly—has been variously measured. All the older textbooks give the formula thus: Pressure = velocity$^2 \times$ 0.005. But the more recent experiments of Langley, Renard, Dines, Stanton, and others vary from 0.0027 to 0.0039, showing a very marked and important difference from the old formula.

Commandant Renard made many trials at the French Military Aeronautical Establishments. But the results, which have not been published in full, seem to have been very variable, ranging between 48 pounds and 17 pounds per horse-power. He remarks, significantly, that some forms of screw are so much more efficient than others, and that there must be "a screw very much better than others, and its form cannot be much departed from without producing very bad aerial screws." Another matter of importance on which authorities disagree is that of skin friction. Hitherto it has been supposed that the friction of the air on surfaces moving rapidly through it was negligible. Thus Langley, in his "Aerodynamics," says: "The friction of the air is inappreciable—this fact may be stated as the result both of my own experiments and of well-known experiments of others." Maxim, making his experiments with aerial screws, tested a contrivance like a screw propeller, but with perfectly flat blades, the results of which were that he found "the skin friction between the air and the polished surface is so small that it need not be taken into consideration." It might then have been considered that this point was settled. But no. During the last few months Mr. Zahm has read a paper before the Philosophical Society of Washington, giving an account of a series of careful experiments he has made, which seem to prove that the frictional resistance is at least as great for air and water in proportion to their densities. In other words, it amounts to a decided obstacle in high-speed transportation. It is well known that, according to theory, an aeroplane should be far more efficient as a carrier of weight through the air than a lifting screw. Thus, while the lifting screw only raises the amount of its thrust, an aeroplane at a suitable inclination and practicable speed should lift about four times as much. Speaking only of my own rough experiments, I find, however, that with the same amount of propulsive power I can lift quite as much with the one as with the other. In these little models, which, however, can doubtless be greatly improved upon, this fact is clearly shown. On the other hand, it is true that Maxim, with his large aeroplane, though only able to obtain a thrust of about 2,000 pounds, got a lift of 10,000 pounds, or at the rate of 28 pounds per horse-power. Yet this amount is what we might have expected from vertically-lifting screws. Puzzled as I have been by so much conflicting evidence and non-reliability of known data, I have been at work thrashing out certain practical results by what is known as "sheer force and stupidity." It may be said that the most successful practical flying machine is the well-known little toy butterfly. So I started making apparatus on similar lines, getting each machine larger and heavier than the last. Several of them are here shown, the largest having a screw of 38 inches in diameter and weighing something over 3 pounds. The most efficient of them can lift a weight (for a few seconds) of ten times the weight of india-rubber. In this way a number of facts may be collected which may prove of use in constructing still larger apparatus. There is also another line in which I have been making trials. It seemed desirable to get some idea of how a man-carrying machine would behave while traveling in midair. Would, as has often been suggested, the balance be a matter of extreme delicacy and importance? What structure is necessary for the supporting aeroplanes to make them strong and rigid enough? I also wished to experiment with steering gear and methods of landing, etc. The best way of obtaining such data seemed to be to give the machine an initial impetus by running it down an inclined plane, and then letting it glide through the air, and to prevent serious damage to machine or man, to "land" on water. During this summer I have had an inclined track erected beside a small lake at the Crystal Palace, and have built up a machine consisting of a canvas boat on wheels, with various forms of aeroplane fixed above it. With this I have made a number of glides, and though the experiments are not nearly completed —for I have been delayed beyond expectation by trivial mishaps and difficulties—a good deal has already been learned, notwithstanding the short duration of the glides. As regards balance, I am inclined to believe that it is not of such supreme importance. I have moved forward while in midair, so as to shift my weight 2 feet or 3 feet (which is a good deal, considering the breadth of the wings was only 5 feet 6 inches), and, as far as I could tell it did not have any great tilting effect. But it is especially in the constructive details that much experience has been gained. Planes stretched on two transverse bamboo poles (1½ inches in diameter at base) about 27 feet across, proved quite strong enough to support the weight—some 270 pounds—without any staying. But these poles bent upward considerably, showing that they were near the limit of weakness, and would require some form of staying if rigidity were necessary. I then added an upper plane, which both took off some of the pressure from the lower planes, and also, by the structure, stiffened them. I regret not being able to describe more definite results, but hope to continue the experiments and collect valuable data later on.

The timber industry of Guatemala is one of the first importance. At present rather over 2,000,000 square feet are exported annually, but in the almost virgin forests in the Peten district there are millions of trees, principally mahogany, the due exploitation of which is only hampered by the lack of sufficient means of transport. The natural outlet for this region would be through British Honduras, via Belize, and a railway connecting the two countries should prove to be a paying concern.

THE RELATION OF THE HYPOTHESIS OF COMPRESSIBLE ATOMS TO ELECTROCHEMISTRY.*

By Prof. T. W. RICHARDS.

THEORETICAL electrochemistry may be divided into two closely related sections—that which treats of the phenomena at the electrode, and that which treats of the phenomena in the unchanged electrolyte. The former of these sections is the more important practically, and is likewise a more certain domain theoretically.

In the first place, then, one may ask: How would a compressible atom behave on leaving an electrode and going into solution as an ion? It would then be attacked by an entirely new set of affinities, being in its new position surrounded by molecules of the solvent instead of by atoms similar to itself, and those new affinities exerting new intensity of pressure would be expected to change its volume. Moreover, the solvent, being itself in part exposed to new internal pressures, would also change in volume. As a matter of fact, a marked change of volume is always observed when a positive and negative element go into solution in the ionized condition. For example, a liter of a normal solution of potassic chloride occupies 43 milliliters less space than the solid potassium, liquid chlorine and water from which it may be made; the change of volume in the case of common salt is 31 milliliters, and that in the case of lithic chloride 17 milliliters. Potassic bromide in the same way gives a contraction of 33 milliliters. Among these similar compounds, and in many other cases, it usually appears that the greater the electrical potential afforded by the double ionization the greater the change of volume; also, the greater the compressibility of the elements concerned the greater the change in volume. It is worth while also to call attention to the fact that these changes of volume on ionization seem to be approximately parallel with the changes of volume on forming the corresponding hydroxides; just as the heats of ionization are approximately parallel with the heats of formation of the hydroxides. This parallelism may indicate that the effective agency causing ionization or galvanic solution of a metal is the attraction of the metal for the oxygen or the hydrogen of water—most probably the oxygen.

Although these regularities are fairly prominent on comparing the properties of similar elements in a natural group, exceptions are not hard to find on comparing very dissimilar substances. Reason for these irregularities may partly be found in the extremely complex mathematical relations which must obtain if the atom is really compressible; but probably, at least, a part of the exceptions may be traced to the expected simultaneous contraction of the solvent already predicted. That the solvent really often contracts is manifest from the fact that in some cases (notably the hydroxides of lithium, sodium, and barium and the sulphates of zinc, cobalt, nickel, and magnesium) the solution occupies less space than the water alone from which it is made. In this connection it is worth while to call attention to the well-known fact that during the formation of 18 grammes of water from its ions in the neutralization of a strong acid by a strong base, an increase of volume of 20 millimeters occurs—an increase greater than the volume of the water formed.

Although by no means all possible cases can now be studied because of lack of data, there is good reason to believe that in all cases both the solvent and the dissolved substances change in volume under the readjustment of internal pressures of ionization; and the resultant effect is so complicated that it is impossible at present, except in the most exaggerated cases, to determine the mode of the distribution of the change.

Nevertheless, since changes of volume actually occur on ionization, and since in the more marked cases this volume-change seems to correspond roughly to the known compressibilities of the substances and to the free-energy change during the reaction, the theory of compressible atoms is supported. At least, even supposing that the explanation herein given is rejected, the theory is here able to call attention to an interesting series of facts concerning volume-change, which must receive an explanation before a complete interpretation of the nature of a dissolved electrolyte is obtained.

Another less direct relation of the theory of compressible atoms to electrochemistry is to be found in the effect of change of volume of reacting systems upon their specific heats. Thomsen pointed out long ago that a contraction in a reaction between aqueous solutions is usually accompanied by a loss of heat capacity of the reacting system; and it is possible to cite many other cases in which this is true. Probably, however, the cause of this loss is not so much the decrease in volume as the irregular stress caused by the simultaneous presence of very different affinities. In terms of the hypothesis of compressible atoms, atomic distortion seems to cause a diminution of heat capacity. As a kinetic conception this interpretation is plausible.

* Abstract of a paper presented before Section C of the International Electrical Congress of St. Louis, on September 12, 1904. Mr. Richards is Professor of Electrochemistry at Harvard University.

The relation of this change of heat capacity to electrochemistry is very important. Recent study has made it appear highly probable that a change in heat capacity during a reaction is the chief, if not the only reason why the total-energy change (or the heat of the reaction) is not equal to the electrical work which the reaction performs in a galvanic cell. In colloquial language, the heat energy which is displaced, or forced out, by a diminution of heat capacity, does not seem to be able to perform work. If this is true, change of heat capacity is responsible for the "bound energy" of a galvanic cell, and, therefore, according to Helmholtz's equation, for its change of potential with the temperature. If, further, the preceding conclusion based upon the theory of compressible atoms be also accepted, the fundamental cause of this temperature coefficient of the electromotive force is referred back to atomic compression and distortion which diminish the possibility of heat vibration in the compressible atom.

One essential condition of ionization has not yet been dwelt upon; namely, the relation of ionization to the quantity dimension of electricity. Recent investigation has shown that Faraday's law is not merely an approximation, but is rather one of the most exact of the laws of nature. If the atomic theory be accepted, one must therefore admit that each similar atom, on ionizing into a liquid, receives or releases exactly the same charge, which is a precise, simple multiple of a given unit. What now does this unit of change signify? In other words, what are the essential attributes of electrical quantity, and what explanation for this exact and fundamental law can be found in the theory of compressible atoms?

To the electrochemist who has nothing to do with electrical capacity, the quantity-dimension of electricity is important merely as a number. He recognizes it only because it is proportional to equivalent weight of deposited metal, or to equivalent volume of evolved gas. Still more simply, it may be said to represent to him nothing but the number of atomic contacts which are made or broken in a given reaction. Therefore, the electrochemist, attempting to discover the relation of the compressible atom to galvanic deposition, naturally first seeks to imagine what would happen to a compressible atom on making or breaking a firmly united atomic contact with another atom.

Evidently, for each union with other atoms, a given atom would give and suffer a shock of impact or combination. The exact effect of this shock upon the atom itself cannot be determined; but if the atom is compressible throughout, many forms of vibration or temporary rhythmical distortion might be possible because of this shock. One of the most probable forms is perhaps a vortex motion; and it will be seen that this form lends itself best to further interpretation. If the atom were perfectly elastic, such a vortex would continue to exist indefinitely when once formed.

Let us imagine, then, that each collision of atomic combination starts or transfers a vortex or some other form of self-perpetuating shock. Then the deposition of a given number of chemical equivalents will result in the transfer of a given number of shocks, or a given quantity of electricity, and Faraday's law is explained. In short, in order to conceive logically of this law, one need not ascribe weight or mass to the electron—a permanent vortex will represent the needed unit as well as a ponderable particle. But only a compressible atom could hold or carry such an infinitesimal vortex, hence this hypothesis is dependent upon the hypothesis of compressible atoms.

This easy explanation of Faraday's law without a material conception of electricity leads one to inquire whether or not other relations of electricity might not likewise be satisfied by a vortical conception of the unit of electrical quantity. A complete study of the details of this possible explanation would be out of place, but a few of the electrical properties of substance may be mentioned in this connection. For example, the electrical conductivity of solids is in many cases what it would be expected to be if their atoms were compressible. Atomic distortion would be expected to interfere with the ready transference of the vortices. The simpler the crystalline form, the less distorted would be the individual atoms, and the more easily would the vortices be received and transmitted from one atom to another. On the other hand, with irregular atoms, permanently distorted by chemical affinity, the uneven structure would receive and transmit the vortices less easily, and the potential energy of the mutual repulsion would be converted into heat. As a matter of fact, the two best electrical conductors among metals, silver and copper, crystallize in the regular system, and the poorest solid conductors among pure metals, bismuth, antimony, and arsenic, are of less symmetrical crystalline structure. The non-metals which are all poor conductors, are still more noticeably complex in symmetry; and such non-conducting substances as bromine and iodine must be very much distorted in atomic shape, if their atoms are compressible, because these atoms must be much compressed on one side, by their firm union, to form the diatomic molecules, and only slightly compressed on the other side, by their feeble cohesion, indicated by great volatility. The relatively slight conductivity of alloys and compounds points in the same direction; for heterogeneity of atomic structure would imply

irregular internal pressure, great atomic distortion, and hence poor conductivity. The considerable effect on conductivity of even slight impurity in a metal and the extremely low conductivity of substances like glass and cellulose are well known, and accord with this interpretation.

Again, it is easy to see how increased thermal energy, which, if atoms are compressible, must be supposed to exist as a simpler oscillation of a portion of the atomic centers, would interfere with the reception and transmission of this new vortex motion, and hence to see why the conductivity of solids should decrease on raising the temperature. Moreover, one would expect the slightly distorted atoms, easily receiving the electrical vortex, should usually likewise transmit more rapidly the simpler oscillations of heat energy, which is a fact.

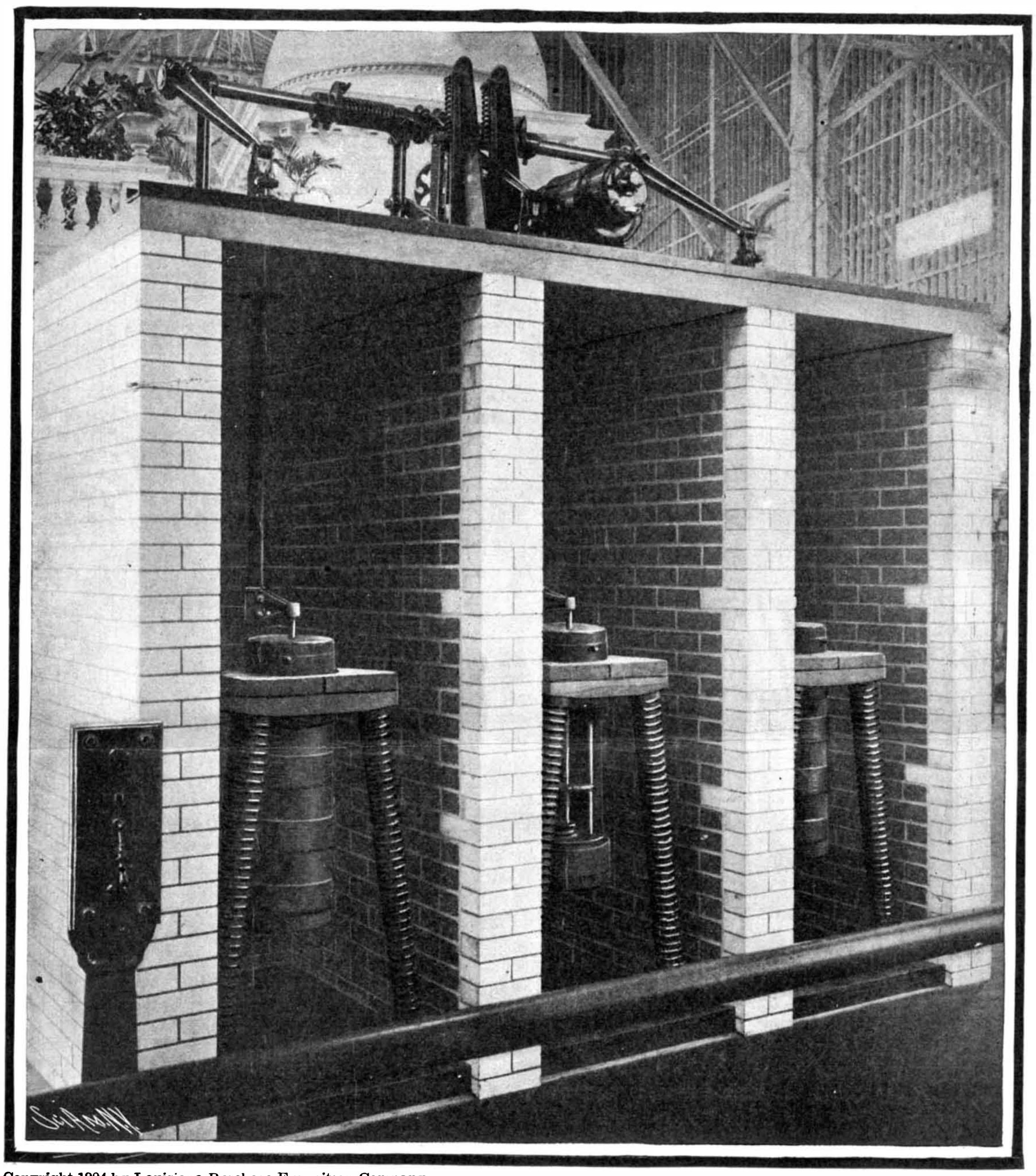
In applying the vortex idea to the statical and magnetic manifestations of electricity, one must imagine the vortex to cause stress in the surrounding wave-bearing medium, giving rise to the repulsion of similar vortices. Such a stress must be imagined whatever conception one forms of the electron, and is at least as easily conceivable from a vortex as from a small particle of matter.

The explanation of the brilliant experiments of J. J. Thomson and his pupils on the basis of the vortical electron is possible, if one admits, as Thomson is quite willing to do, the existence of electrical inertia independent of gravitational effect. In this case, the cathode ray is to be considered as a collection of disembodied vortices, which may only be driven through the wave-bearing medium under the stress of great difference of potential. Another alternative must be adopted if one doubts the somewhat complicated evidence concerning the relative masses of the cathode corpuscle and the atom, and believes the two to be identical. In this case it is necessary to imagine that a single atom can receive many vortices under the peculiar circumstances attending the cathode discharge; i. e., that it is poly-atomic.

Other possible relations of the hypothesis of compressible atoms to electrochemistry and to the new and surprising facts of radio-activity might be pointed out, but these examples will serve the present purpose. The object of this paper has been to show that the hypothesis is a suggestive one, because it views well-known phenomena from a new standpoint, and therefore may excite the imagination into devising new methods of experimental attack. The discovery of the probable relation of the change of heat capacity on the temperature coefficient of a galvanic cell is among the new relations to which this hypothesis has already led.

The long-continued illusion of phlogiston, supported by eminent minds not much over a century ago, is enough to show the danger of a one-sided scientific consciousness, and the familiar conception of inflexible atoms may also to a less degree lead the literal mind into an intellectual rut. Of course, no claim is made that the hypothesis of compressible atoms represents truly the actual fact; indeed, atoms, in any shape, are an imaginary conception which may have no counterpart in reality. Even if the thinker progresses no farther than to admit that, provided atoms exist, they may be elastic and compressible, he has broadened the train of his thought and enlarged the realm of his imagination.

It has been claimed by a few that any hypothesis is harmful; but some of the most brilliant of scientific workers have used them as a continual inspiration. Faraday, one of the greatest of pioneers, dreamed thousands of such scientific day-dreams. To him, these were nothing but a benefit; for, although led on by visions, he knew well the difference between substance and shadow. He never confounded hypothesis with fact; and when new facts overthrew a favorite imagination, he would discard the latter gladly, rejoicing that it had led him to the discovery of new truth.



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THE 60,000-VOLT OIL SWITCH AT THE FAIR.

A 60,000-VOLT OIL SWITCH AT THE FAIR.

By the St. Louis Correspondent of the SCIENTIFIC AMERICAN.

ONE of the most striking electrical exhibits at the Fair is undoubtedly the General Electric Company's 60,000-volt switch, the practical result of much study and experiment. The switch in question is amply insulated for 60,000 volts, and is capable of rupturing circuits under the severest conditions, even when fed by immense currents.

The illustration shows the switch as it is installed at the Fair. This particular installation is of the three-pole type, the different legs of the circuit being inclosed in brick or concrete compartments having removable doors. Two oil vessels are provided for each phase. The wires to and from the vessels connect through the bottom of the vessels with the contacts inside. Within the two vessels, the contacts are connected to close the circuit by means of copper rods and a crosshead. Heavy wooden guide rods are secured to the crossheads which are in turn joined to lever arms on the operating mechanism.

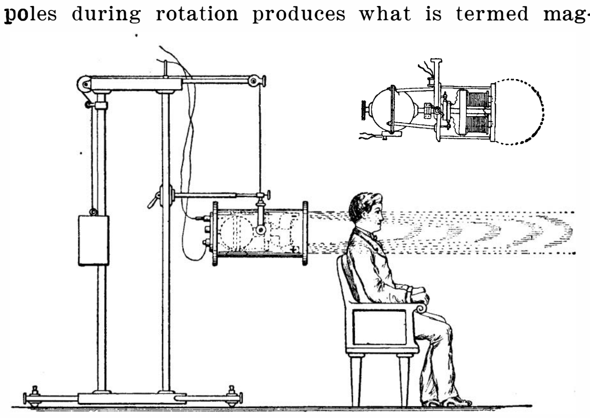
Motion is imparted to the operating mechanism through a magnetic clutch by a small direct-current motor at 125 or 250 volts. The clutch is connected with a ratchet worm gear revolving in the same direction for opening and closing the oil switch. The ratchet permits the quick movement of the switch levers in advance of the starting of the motor by means of two heavy springs which are compressed alternately. The weight of the moving parts is counterbalanced by torsion springs on the upper rocker shaft, giving uniform movement in both directions.

The oil vessels, which are of specially-treated wood, are insulated by means of porcelain insulators and wooden rods supported upon a wooden frame. This insulation is a late improvement on the corrugated wood insulating posts formerly employed.

Only two small wires and a small, single-pole, double-throw switch are required to control the operation of the motor, there being special cut-off switches on the operating mechanism actuated from cams on the shaft.

THE APPLICATION OF ELECTRO-MAGNETISM FOR THERAPEUTIC PURPOSES.

IN the appended diagram we illustrate a new portable device, which is intended to effect cures for nervous disorders by means of interrupted electro-magnetism. Briefly, the device consists of a standard adjustably arranged to move about on a floor, having suspended therefrom a motor and a rotating electro-magnet secured to the axis of the motor. The whole is incased in a neat cylindrical box. A counterbalancing weight is provided on one side of the upright standard, to balance the weight of the motor and the electro-magnet. The motor and magnet are adjustable in a vertical position to any suitable height. The wires from the motor may be connected to any incandescent electric light current of 110 volts, and a shunt current brought from a switchboard provided with suitable resistance to regulate a flow of four amperes of current is led through brushes to rings insulated from each other on the rotating shaft and connected to the spools of the rotating electro-magnet. When the current is turned on, the motor rotates the magnet, through which a continuous current from the shunt wire is flowing; the constant change of the plus and minus poles during rotation produces what is termed magnetic undulations or vibrations. The dotted horizontal lines show the extent of the magnetic field.



TRÜB'S ELECTRO-MAGNETIC THERAPEUTIC APPARATUS.

The patient is placed adjacent to the rotating magnet, and it is stated that ten to twenty minutes' treatment by this method for about twenty to twenty-five times will alleviate the pain, such as rheumatism, lumbago, and gout, and other similar difficulties.

It will be noted that the construction permits the magnet to be adjusted to any suitable part of the body where the pain exists, and it is not necessary to remove the dress or anything of that kind, as the magnetism permeates the clothing.

The upper small diagram in the illustration shows more in detail and more clearly the motor on the left-hand end and the rotating electric magnet, through which a constant current of about four amperes is traveling.

This magnetic soothing or quieting effect on the nerves was discovered by a Swiss engineer of the name of Eugene Conrad Müller, who first noticed the curative properties of an alternating magnetic field. He began by using an alternating current, but as this required an expensive transformer to produce a direct current, it was found that the same effect could be obtained without danger of heating the iron, by simply alternating by rotation the position of the poles of an electro-magnet.

The newer system was discovered by Trüb, which has been in successful use in Germany and some other European countries for the past two years. We are informed that this method of treatment is being introduced into the New York Post-Graduate Medical School and Hospital.

ACTION OF N-RAYS.—J. Becquerel has made some experiments to determine how much of the increased luminosity and distinctness of a feebly luminous surface is due to the direct action of the N-rays upon the luminosity of the body, and how much due to their action upon the eye of the observer. It is known that there is some objective increase in luminosity in the case of small flames at all events, as shown by the photographic records, but the author shows that in case of a feebly luminous surface the action consists in the liberation of N-rays from the surface, and these N-rays proceed to the eye together with the light rays, and impart a greater sensitiveness to the retina. He quotes the following experiment in support of this view. He interposes a plane parallel glass trough filled with distilled water between the eye and the sensitive screen. No effect of the ordin-

ary sources of N-rays upon the screen can then be detected, owing to the N-rays being arrested. If, on the other hand, salt water is used instead of distilled water, the effects are visible again.—J. Becquerel, Comptes Rendus, May 16, 1904.

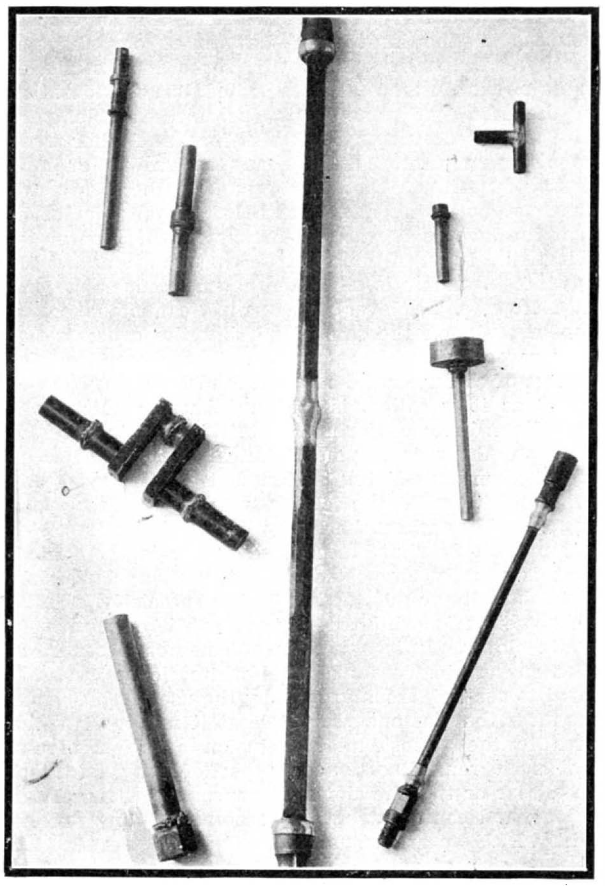
ELECTRIC WELDING.*

By EMILE GUARINI.

GROUND was broken a few years ago in the metallurgic industry for the application of welding by electricity, two systems of which are now employed, viz., welding by the electric arc and welding by the heat due to resistance. It is to the last named system that belongs the process exploited by the Allgemeine und Union Elektricitäts Gesellschaft. It consists in taking the pieces to be welded (bars or wires), thinning them and smoothing the surfaces to be united, and pressing the pieces tightly together in appropriate clamps, through which is then passed a current of sufficient intensity. The resistance offered to the passage of the current by this imperfect contact produces a very high temperature, and, since the resistance increases at the same time that the temperature does, a welding white heat is easily and quickly obtained. If, then, the two pieces to be united be kept pressed firmly against each other, a perfect welding will be found to have been effected after the current has been interrupted.

The heat is developed in the central part of the two pieces to be welded, and, under such circumstances, the interior of the weld is as perfect as the exterior. Nothing is easier in this process than to pass into the metal to be heated a current that has exactly the intensity necessary for bringing the parts to be welded to the proper temperature. The same is not the case in welding by the electric arc, in which the heat disengaged is much greater than that which is practically utilized by the operation. In this process the heat necessary for the fusion of the metal is communicated to the latter by convection or otherwise. The pieces to be welded are placed upon a cast-iron table connected to one of the poles of a dynamo, the other pole of which is connected to a stick of carbon. This latter is brought into contact with the point to be welded, and then moved slightly away from it. The arc thus produced above the point to be welded fuses the metal and effects the welding of the pieces in contact. This method is not devoid of drawbacks. Although the oxidation of the part heated is prevented by covering its surface with a fusible silicate that protects it against the air, the workman nevertheless has to be protected against the very intense light of the voltaic arc and the extreme heat disengaged by means of smoked or colored glasses that do not, however, ward off all danger. He is obliged, moreover, to work blindly, since it is very difficult for him to look at the pieces to be welded, and to watch them constantly, because of the dazzling light and of the smoke produced by the forming of the arc. This process, on account of such inconveniences, is evidently no better adapted for welding than that by forge or furnace, in which it is necessary to heat almost the entire piece to be welded. In the resistance process, on the contrary, the heat is produced in the metal itself and only at the welding point, and hence there is a less output of heat and a complete utilization of the energy. When, moreover, the metal to be welded is heated from the exterior toward the interior, there is never any certainty that the internal part of the welding will be as solid as the external; and it may even happen that the external part will be burned before the interior has reached the desired temperature.

In the Allgemeine-Union electric process, this inconvenience is done away with, since the heat is produced solely at the extremities of the pieces, and such heat, in the interior, is at least equal to that of the



VARIOUS MECHANICAL PARTS ELECTRICALLY WELDED.

external parts. Besides, since the passage of the current is abruptly interrupted as soon as the metal has reached the temperature necessary for making the weld, and the pieces are firmly pressed against one another, all burning or damage due to an excess of temperature is avoided.

The welding done by this process is completely homogeneous, and the nature of the metal at the place of the joints is absolutely identical with that of all the other parts of the piece. The welding is effected almost instantaneously when the pieces to be united have a small section. With pieces of greater section, it takes but a short time as compared with the power employed.

The parts to be welded are always firmly held by clamps that press one against the other, and are always perfectly adjusted during the entire time of the operation. In this way there is obtained a perfect junction of the two pieces. The current employed is an alternating and not a continuous one, as in welding by the electric arc, and is of a low tension. The power of the alternator, when it supplies only the welding machine, varies from 4 to 150 horse-power. The welding machine, whatever be its type (for the type varies with the pieces to be welded) always consists of a transformer provided with clamps adapted for grasping the two parts to be united and for holding them firmly in place. In order to press the surfaces against each other, a mechanical or hydraulic arrangement is employed. As a general thing, the transformer is placed under a table upon which slide the clamping pieces. Sometimes, when the machines are small, the pressing of the pieces against each other is effected automatically. The current is also cut off automatically at the proper time.

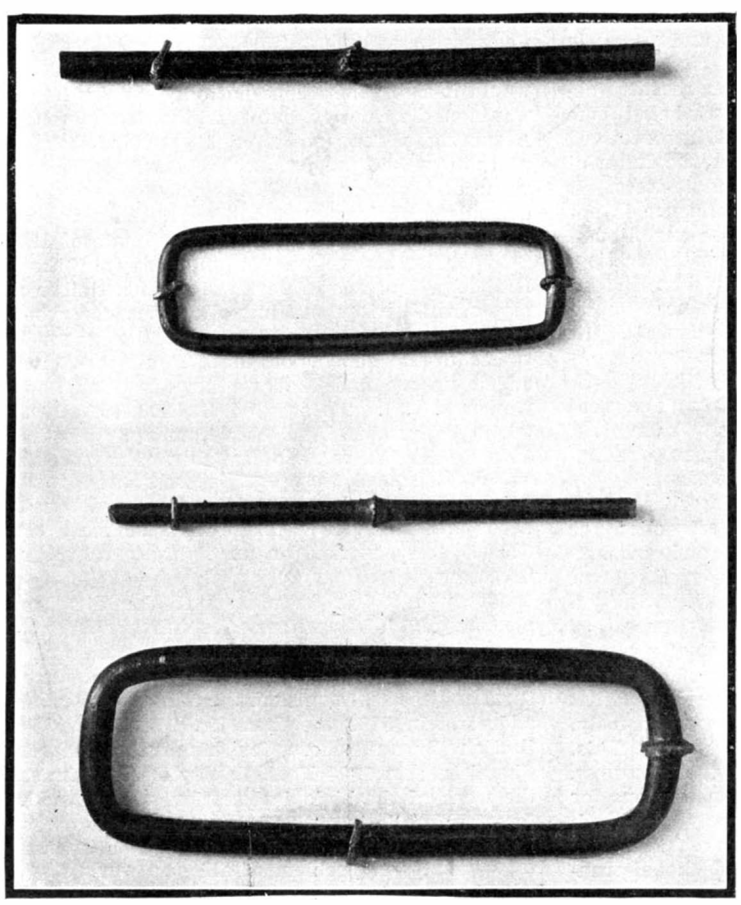
The secondary circuit of the transformer is generally cooled by a permanent circulation of water, so as to prevent an undue heating of the machine.

The current is regulated by a rheostat in cases in which the machine is to be used for pieces of variable dimensions. The primary is always controlled by a switch which, in particular cases, is automatic. It is evidently possible to dispense with the transformer and employ current from the mains where these furnish an alternating current of 50 or 100 volts. The frequency can never be less than 80 periods nor more than 250. When the pieces to be welded have a section of more than 280 square millimeters (4.34 square inches), a special generator becomes necessary for supplying the machine. According to the type of the latter, the power absorbed varies from 1 to 40 kilowatts. The power necessary for effecting the different weldings varies nearly proportionally to the transverse section of the piece of metal at the place where the welding is to be done. The greater the power at hand, the more rapidly will the welding be effected.

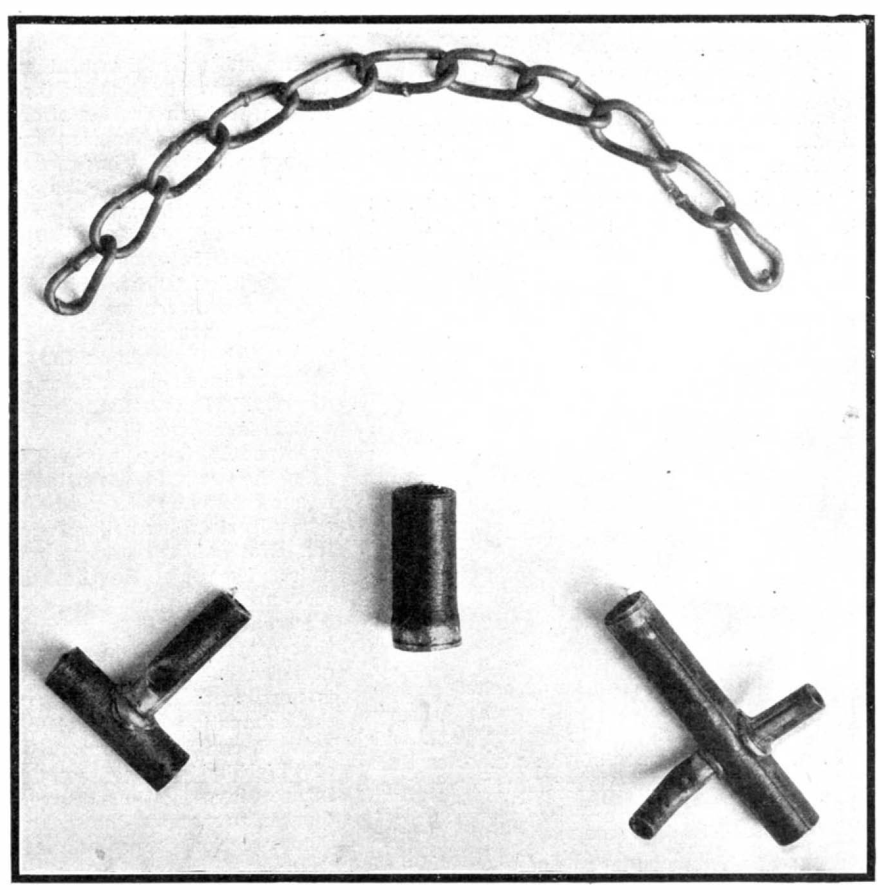
The number of weldings that can be accomplished in an hour evidently depends upon the machine, and the size and form of the pieces operated upon, no less than upon the skill of the workman. The same is the case with the time that it takes to do the work. This may vary within wide limits, according to the dimensions of the piece and the care to be taken in securing it in the clamps that hold it. If the pieces are light and easy to put in place, the work can be done very rapidly. In the first case it is not possible to effect more than 30 weldings an hour. In the second, and with an entirely automatic machine, it is possible to make 800 in the same period.

The best results are obtained with pieces free from rust and touching each other at points near their center. The pressure exerted upon the metal in fusion at the moment of the welding causes the production of a seam that remains after the operation. This may be removed by placing the joint on coming from the machine, and while the metal is still very hot, under a press provided with a matrix of an appropriate form to cause the re-entrance of the seam. The seam may also be removed by hammering it upon an anvil, or, if the pieces are small, by submitting it to the action of an emery wheel.

The following figures may prove of interest: Extra strong iron tubes of 13 millimeters (0.511 inch) internal diameter can be welded in 33 seconds with 8.9 horse-power at the dynamo, and those of 76 millimeters (2.992 inches) in 106 seconds with 96.2 horse-power. Round iron or steel bars of 30 square millimeters (.465 square inch) section can be welded in 10 seconds with 2 horse-power, and those of 285 square millimeters (4,417 sq. inches) in 30 seconds with 13 horse-power; pieces of iron of 250 square millimeters (3.875 square inches) in 33 seconds with 14.4 horse-power, and those



SPECIMENS OF ELECTRICAL WELDING OF COPPER ARTICLES.



IRON OBJECTS WELDED BY ELECTRICITY.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

of 2,000 square millimeters (31 square inches) in 90 seconds with 83.8 horse-power; pieces of copper of 62 square millimeters (0.941 square inch) in 8 seconds with 10 horse-power, and those of 500 square millimeters (7.75 square inches) in 23 seconds with 82.1 horse-power.

The industrial applications of electric welding are evidently very numerous. Aside from those that we shall presently mention, this method of welding is used for the manufacture of flat, square, and round copper, iron, or steel rings of different sections and diameters; squares; buckles; parts of writing machines; lattices; wire fencing, etc.

In carriage work it is used for welding the tires of wheels, axles, hubs, spokes, steel wire for rubber fellies, hollow fellies for rubber tires, etc.

In the manufacture of bicycles it is possible to weld electrically the handle bars, crank hangers, tires, pedals, saddle posts, forks, tubes, sprocket chains, etc.

In the wire-drawing industry, the electric method is used for the end to end welding of steel, iron, and copper wire and metallic cables, as well as for the manufacture of iron and steel hoops for casks, barrels, pails, etc.

The welding machines are likewise rendering great services in the repairing of the most diverse tools, such as twist drills, axes, hatchets, band saws, gear wheels, blades, cam shafts, knives, etc.

Finally, electric welding may be successfully employed for the manufacture of iron or steel tubes, worms for ice machines, retorts, frogs and crossings for railway tracks, fish joints, etc.

Electric welding by the method under consideration is therefore a rapid and economical process of manufacture for the metallurgic industry in general, and this can but contribute toward its widespread application therein as well as in the majority of other industries.

SCIENTIFIC AGRICULTURE.*

By William Somerville, M.A., D.Sc., D.Œc.

The audience that I have to-day the honor of addressing may be assumed to consist of a considerable proportion of the members of the British Association, and some others, who are primarily interested in, and have themselves made appreciable contributions to the progress of agricultural science. I may, therefore, take the opportunity of congratulating you on this fresh evidence of progress in the subject that you have at heart, and of offering to the British Association our thanks for the encouragement and stimulus which are associated with the formation of an agricultural subsection. Perhaps I rightly interpret your feelings when I say that for the present we are satisfied with the position attained by our subject, but that we trust to see this and other meetings demonstrating that agricultural science is not unworthy of further advancement.

In view of the large amount of work that lies before us during the next few days, I do not propose to intervene for long between you and the contributions to original research which we have been promised. The scope of my remarks will be limited no less by time than by the fact that it would be presumptuous in me to attempt to traverse the whole field of agricultural science, including, as it may be held to do, the no small compartments of horticulture and forestry. What I propose to do, therefore, is to confine myself to touching upon a few of the subjects that have recently been receiving attention at the hands of scientific investigators, especially abroad. I have purposely avoided discussing English work, partly because it may be assumed that we are all familiar with it, and partly because, where friends are concerned, selection is difficult.

Although agriculture has only now been elevated to a position of semi-independence in the programme of this association, it has, in the aggregate, received much attention at the meetings inaugurated with that at York in 1831. It is interesting to turn up the early volumes of the reports, and to ascertain what was running in the minds of our predecessors, and what the problems that they thought it vital to solve. In the account of the first meeting in this town in 1833 we find a report by Lindley on the Philosophy of Botany, two of the items in which are of interest to students of rural economy. Apparently at that time much attention was being given to the mode of the formation of wood. Two theories appear to have divided botanists—the one that wood was organized in the leaves, and sent down the stem in the form of embryonic but organized fibers, to be deposited on the surface of wood already formed. The other theory was that wood was secreted *in situ* by the bark and older wood. It is to the former of these theories that Lindley gives his adherence. Although this problem has ceased to interest, the same cannot be said of another subject discussed in the same report, namely, the so-called "fæcal excretions" of plants. In the words of Lindley, "A new apple orchard cannot be made to succeed on the site of an old apple orchard unless some years intervene between the destruction of the one and the planting of the other; in gardens no amount of manure will enable one kind of fruit-tree to flourish on a spot from which another tree of the same species has been recently removed, and all farmers practically evince, by the rotation of their crops, their experience of the existence of the law." He attributes to Macaire the demonstration of the fact that all plants part with a fæcal matter by their roots. These excretions he held to be poisonous, maintaining that, although plants generate poisonous secretions, they cannot absorb them by their roots without death, concluding that "the necessity of the rotation of crops is more dependent upon the soil being poisoned than upon its being exhausted." He indicated the lines along which investigation might with advantage proceed, one of the questions put forward being "the degree in which such excretions are poisonous to the plants that yield them, or to others."

In 1833 botanists and agriculturists had not the advantage of the knowledge that is at our disposal through the continuous growth for a long series of years of certain crops at Rothamsted, but consideration of the fact that some crops (as, for example, pure forests of beech, silver fir, Scots pines, and other trees, as also permanent pasture) may be grown for hundreds of years on the same ground without any evidence of poisoning might have led to the conclusion that the law, as it was called, was not of general application. It is, of course, true that rotations are an advantage, and it is a matter of experience that certain crops, e. g., clover and turnips, cannot be grown continuously on the same land, but the cause is not now associated with excretions. The reason for the failure of clover, or the cause of land becoming "clover sick," as it is called, is still a debated point; but I may hazard the conjecture that it is due to the fact that organisms or enzymes inimical to the vital activity of the minute living bodies, that exist in symbiotic relationship with the clover plants, increase with great rapidity when the living bodies that they affect are present in abundance. Red clover is the species that is usually associated with the term clover-sickness, but it would appear that a precisely similar phenomenon is exhibited in the growth even of wild white clover. It is a matter of common observation that on certain classes of land white clover is stimulated to such vigorous growth by the use of phosphatic manures that for one year at least it monopolizes the area to the almost total exclusion of other plants. But such rank luxuriance is not of long duration. In a year or two the clover disappears to a very large extent, and cannot at once be restored by any process with which we are acquainted. The land has, in fact, become sick of white clover. But given a period of rest, during which the inimical agents will disappear, and it again becomes possible to stimulate white clover to vigorous growth. We have, it seems to me, an analogous state of things in the case of certain insects. On the Continent the caterpillar of the Nun moth (*Liparis monacha*, L.) periodically proves extremely destructive to certain conifers, and it is found that in the first year the insects are moderately abundant, in the second they are excessively abundant, while in the third the visitation begins to decline, and usually terminates quite suddenly. The causes of this cessation have been thoroughly worked out, and are found in the great increase of parasitic insects, and insecticidal fungi, including bacteria. I believe it will be found that the almost sudden cessation of our periodic visitations of the diamond-back moth is due to a similar cause.

The failure of turnips is apparently largely, if not entirely, due to the increase of insects and parasitic fungi.

The subject of harmful excretions has recently obtained renewed attention through the work being done at the Woburn fruit station. No point has received more striking demonstration there than the harmful influence that growing grass exerts on fruit trees. It has been shown that this prejudicial influence is not due to the withdrawal of moisture, to the curtailment of supplies of plant food, to interference with aeration, or to modifications of temperature. In Mr. Pickering's opinion,* "the exclusion of all these possible explanations drives us to believe that the cause of the action of grass is due to some directly poisonous action which it exerts on the trees, possibly through the intervention of bacteria, or possibly taking place more directly." It is satisfactory to know that the subject, which is of considerable scientific and practical importance, is likely to be vigorously followed up.

In the early forties attention was being directed to a subject that even now has a great attraction for agriculturists, namely, the stimulating and exhausting effect of artificial manures, especially nitrate of soda. The principle that "stimuli lose their full effect upon living matter when frequently repeated" was generally held to account for the want of response that crops exhibited to repeated dressings of nitrate of soda; but Prof. Daubeny in 1841† pointed out what is now generally accepted as the true cause, namely, the exhaustion of the soil of other substances. This, he said, can be counteracted by giving other manures, of which he instanced bone meal. His suggestions for future investigations have been largely followed, though, as we now know, they are of theoretical rather than practical importance. He proposed the alternatives:

(1) Analysis of the soil, discovery of the amount of available plant food, and the application of the substances found to be deficient up to the probable measure of the crop's requirements.

(2) Discovery, by analysis of the yield, or estimation by calculation, of the amount of plant food removed in the produce, and the application to the soil in the form of manure of what was withdrawn by the crop.

Daubeny suggested that manuring should be undertaken on a system of bookkeeping—on the one side being entered all the items of plant food taken out by crops, and on the other all that is applied in the form of manures, the two sides of the account being made to balance. This theory of manuring is distinctly suggestive, and often fits in rather remarkably with actual practice, though the comparative agreement between theory and practice is due to causes that the author of the theory probably hardly contemplated. Take, for instance, the case of wheat. An average crop removes from an acre about 50 pounds nitrogen, 30 pounds potash, and 20 pounds phosphoric acid. This loss would be restored by the use of some 3 hundredweight of nitrate of soda, 2 hundredweight kainit, and 1½ hundredweight superphosphate; and on many soils wheat could, no doubt, be grown continuously for many years on such a mixture, aided by good tillage, without the yield suffering materially. But we now know that much of the plant food offered in manure never enters the crop at all, so that the balancing of the account is due almost as much to chance as to calculation. This becomes more apparent when we regard such a crop as meadow hay, which in actual practice is often grown for a long series of years on the same land. To balance the withdrawal of phosphoric acid by an average yield of this crop only about ¾ hundredweight of superphosphate per acre is theoretically necessary, but on most soils an average yield would not be maintained by the use of so small a quantity.

During the fifties the volumes of the association contain several important contributions from the two distinguished Englishmen to whom the world's agriculture owes so much, Lawes and Gilbert. Their first contribution was made in 1851, and dealt with Liebig's mineral theory, a subject with which their names will always be associated. They drew upon their rich store of experimental data to prove that the yield of wheat is much more influenced by ammonia than by minerals, and they gave it as their deliberate opinion that the analysis of the crop is no direct guide whatever as to the nature of the manure required to be provided in the ordinary course of agriculture. With the reservation "in the ordinary course of agriculture," the dictum cannot be questioned, though in the circumstances of the continuous growth of wheat, as has been pointed out, conclusions indicated by the analysis of a crop happen to accord, at least approximately, with manurial practice.

Field experiments or demonstrations, which have been such a prominent feature of the educational work of the past decade, appear to have been first introduced at the meeting of the association in 1861 by Dr. Voelcker.

While agricultural subjects have claimed a considerable share of the time of the association, forestry has not been altogether overlooked. As early as 1838 we find attention being directed to what has of recent years come to be a burning question—namely, the maintenance of our timber supplies. At that early date, when the industrial development of the country was, comparatively speaking, in its infancy, the estimate of our timber requirements was, in the light of present experience, amusing in its modesty. Capt. Cook estimated that "100,000 acres of waste taken from the Grampian Hills for the growth of larch would in two generations not only supply the ordinary wants of the country, but enable us to export timber."* Assuming a rotation of eighty years, this estimate postulates that the produce of some 1,200 acres, of a value of about £120,000, was sufficient to make us independent of foreign supplies. Such is the estimate of 1838; now let us turn to the estimate of 1904. Dr. Schlich, in his volume on "Forestry in the United Kingdom,"† passes in review Britain's timber requirements, and, after making allowance for woods like mahogany, teak, etc., which cannot be grown here, he comes to the conclusion that "if all these items are added up we find that we now pay for imports in timber . . . the sum of £27,000,000, all of which could be produced in this country." Assuming as before that the value of an acre of mature forest is £100, it means that our imports are drawn from 270,000 acres, and to maintain our supplies merely at their present level a forest area of more than 20,000,000 acres, worked on an eighty years' rotation, is necessary.

Although it has been reserved for the Cambridge meeting of 1904 to witness the delivery of an address from the chair of an agricultural subsection, this is by no means the first occasion on which an agricultural subject has furnished the theme for a presidential address. In 1880 the then Dr. Gilbert presided over Section B, and chose for his subject Agricultural Chemistry; in 1894 Prof. Bayley Balfour inaugurated the work of the biological section with an address on forestry; while in 1898 the president of the association focused the vision of all thinking men on the greatest agricultural problem of all—the world's supply of wheat.

GERMAN INVESTIGATIONS ON THE ACTION OF CONSERVATION AGENTS ON FARMYARD MANURE.

Those who have followed the progress of agricultural science in Germany must have noticed how much attention has been given during the past ten years to investigating the changes that take place in farmyard manure during storage under varying conditions. The stimulus and funds for this work have for the most part been supplied by the German Agricultural Society, which in 1892 resolved to carry through an ex-

* Read before the British Association for the Advancement of Science.

* "The Effects of Grass on Apple Trees." Journal R.A.S.E. Vol. lxiv, p. 365.

† "On Manures Considered as Stimuli to Vegetation."

* Cook, "On the Genera Pinus and Abies."

† Bradbury, Agnew & Co., 1901.

haustive inquiry. For this purpose it enlisted the co-operation of several of the most fully equipped stations in the empire, and the reports that have appeared bear testimony to the industry and analytical ingenuity that have been brought to bear on this important subject.

The experiments were originally designed to extend over four years, the first, 1892-3, being devoted to preliminary, chiefly laboratory, experiments; the others, to work on a scale more in accordance with farm practice. But although the period originally contemplated is now long past, the problem is by no means solved, and the society has recently been making a fresh grant for additional experiments of a similar character. In point of fact, the subject has been found to bristle with difficulties, and the results obtained with small quantities of manure, or in summer, have not always been confirmed with large quantities of manure, or in winter.

In 1897 I published an account* of the more important results obtained up to that time, confining myself chiefly to questions of temperature and the loss of organic matter, and the conclusion arrived at was that "none of the conservation agents usually employed appears to have any very important influence on the decomposition of farmyard manure."

Since then several important reports† have appeared, and I propose shortly to refer to their contents.

While the experiments have in almost all cases dealt with the fate of nitrogen, phosphoric acid, and potash, the chief interest centers round the nitrogen, for, given reasonably satisfactory conditions of storage, it is only this constituent of farmyard manure that is likely to suffer loss. But much importance, from the experimental point of view, attaches to the analytical results obtained with the other two substances, for the reason that the quantities of these found are the surest test of the accuracy of the work. The general method of procedure has been to employ a fairly simple but sufficiently nutritious food-mixture, and to allow a definite quantity of this and of litter for a certain number of selected cows. The weight of nitrogen, phosphoric acid, and potash in the food is accurately determined, all of which ultimately reaches the manure, less what goes into the milk, and into the live-weight increase, if any. If the account of what the animals receive as food and litter, and what they furnish as liquid and solid fæces, milk, and animal increase, approximately balances as regards mineral matter, it may be assumed that the sampling and analysis have been sufficiently accurate to justify definite conclusions being based on any deficiency in nitrogen that may be found.

The work of Hansen and Günther, Pfeiffer, and Immendorff was carried out at consecutive periods from 1893 to 1902, at the experimental station of Zwätzen, near Jena, where stalls and dung-pits had been constructed for the purposes of this research. Schneidewind's experiments were conducted at the station of Lauchstädt, near Halle.

Effects of Kainit.—This was used by Hansen and Günther at the rate of 0.75 kilogramme per 1,000 kilogrammes live weight of stock per day, while Pfeiffer and Immendorff used twice as much. The kainit was in no case spread on the litter in the stall, as this would have caused inflammation of the skin of the udder, legs, and abdomen of the cows, but was sprinkled on the manure as spread and pressed into the pits. In certain series of the experiments the manure was removed from the stalls daily, in others it was only removed once a week. Two weeks was the usual time necessary to collect a sufficient quantity of manure, which, with the liquids, usually amounted to about 8,000 kilogrammes at Zwätzen, and about one-fifth of this weight at Lauchstädt. The period of storage was generally about four months.

Hansen and Günther found that in pits the untreated manure lost 11.5 per cent of nitrogen; while the manure treated with kainit lost 14.4 per cent.

Pfeiffer found that the loss of nitrogen in untreated manure was 17.2 per cent, which compares with a loss of 19.5 per cent in the presence of kainit. The loss of nitrogen when kainit was used by Immendorff was 21.3 per cent, the loss in the untreated manure not being given in his tentative report so far available. Schneidewind did not experiment with kainit. The results of these experiments are in complete relative agreement, and show that the loss of nitrogen is greater when kainit is used than when it is withheld.

Effects of Superphosphate.—This substance was spread twice daily over the litter in the stall at the rate of 0.75 kilogramme per 1,000 kilogrammes live weight. The results obtained were as follows:

	Per Cent Loss of Total Nitrogen.	
	In untreated dung.	When super. used.
Hansen and Günther	10.25	16.25
Pfeiffer	17.20	20.80
Immendorff	—	19.80

With superphosphate, as with kainit, the loss of nitrogen during the storage of dung has been increased. It may, however, be mentioned that Hansen and Günther and Immendorff found that superphosphate conserved nitrogen to an appreciable extent so long as the dung lay in the stall, but that its effects disappeared whenever its acid phosphate and free sulphuric acid had been neutralized by ammonia, and this rapidly occurred in the pit.

Effects of Precipitated Phosphatic Gypsum.—This at the rate of 1 kilogramme per 1,000 kilogrammes live weight was tried by Hansen and Günther and Immendorff, the substance employed containing fully 8 per cent P_2O_5. It was spread twice daily on the litter in the stall. The result obtained by Hansen and Günther was that after lying for seventeen weeks in the pits the manure that had been untreated had lost 10.35 per cent of nitrogen, whereas that treated with the phosphatic gypsum showed a loss of 14.47 per cent. The loss of nitrogen found by Immendorff when this substance was used amounted to 19.8 per cent. This substance, like the others, would therefore appear to be valueless as a fixer of nitrogen.

Effects of Gypsum.—This substance has long been recommended as an agent for conserving nitrogen in the dung-heap. The results of its use, spread twice daily on the litter in the stall at the rate of 1 kilogramme per 1,000 kilogrammes, live weight, in the experiments conducted by Hansen and Günther, were that in the presence of gypsum the loss of nitrogen amounted to 11.89 per cent, which compares with a loss of 8.56 per cent when nothing was mixed with the dung.

Schneidewind, using a much larger quantity of gypsum, namely, 5 pounds per 100 pounds of dung, found that the loss of nitrogen was reduced from 35.69 per cent to 15.22 per cent. In this connection he says: "The use of gypsum has markedly reduced the loss of nitrogen. Assuming the conserved nitrogen to have a good action on the crop, this agent may be said to have paid. But as the bulk of the nitrogen so conserved was found to consist of slow-acting albuminoid compounds, and seeing that the sulphate of lime was largely reduced to sulphides, which are directly injurious to plants, we cannot conclude that the use of gypsum has been profitable. Investigations with this substance will, however, be continued."

Hansen and Günther carried their experiments the length of using the various lots of manure on crops, but this part of their researches was hardly more favorable to the use of conservation agents than the other. They thus express themselves: "When the various manures were used on crops, five times in six the treated manure acted no better than the untreated. Only on one occasion was an improvement observable. Field and pit experiments alike have proved that the conservation agents employed are of no value." Schneidewind expresses himself equally forcibly when he says: "As the result of many experiments conducted by ourselves and others, we have arrived at the conclusion that chemical substances are valueless as conserving agents."

Pfeiffer also tried sulphuric acid sprinkled over the manure as it was placed daily in the pit, when it was found that the loss of nitrogen was reduced from 27.8 per cent to 7.1 per cent. In this connection Pfeiffer says: "The cost, however, was nearly a mark for each kilogramme of nitrogen conserved, and the use of sulphuric acid is associated with so many drawbacks that its employment cannot be recommended."

Schneidewind came to a similar conclusion, and thus expresses himself: "As a result of numerous conservation experiments carried out with various quantities of sulphuric acid, and with various acid sulphates, we cannot advise the use of these substances."

But although no benefits have been obtained from the use of the substances indicated, some useful information is available as to the advantages of giving attention in other directions to the management of farmyard manure. Hansen and Günther took four lots of manure of similar character, storing two of the lots in pits and placing the other two in heaps in the open field. From the end of September until the middle of December the pitted material had on an average parted with 13.25 per cent of total nitrogen, whereas the loss in the manure in heaps averaged 25.3 per cent. When the behavior of the ammoniacal nitrogen was investigated it was found that the loss was 35.73 per cent in the pits and 82.5 per cent in the heaps. The loss, therefore, is greatest in that part of the nitrogen which is the most active and the most valuable.

In another series of experiments by the same investigators the manure was all placed in pits, but in one case it was spread equally and trodden down, while the escape of liquids was prevented. In the other case the manure was simply thrown loosely and irregularly into the pit without spreading or treading, the surface being left uneven and therefore much exposed to the air, while the liquids were allowed to drain away. After lying for twenty-two weeks the loss of nitrogen was 15.76 per cent in the pit containing the carefully treated manure, whereas in the other pit the loss amounted to 34.58 per cent.

Pfeiffer in a series of experiments proved that much of the nitrogen that disappears from manure is lost before the manure is transferred from the stall to the dungstead. He is strongly of opinion that stalls, boxes, and the like, should either be cleaned out twice daily, or, if the construction admits, the manure should be left to accumulate until it is some feet in depth, as in the system of management that prevails in cattle-courts and yards in this country.

The general conclusion arrived at, and clearly expressed by Pfeiffer, is that excessive loss in manure can be best avoided by storing it in a deep mass in a water-tight dung-stead placed in a well-shaded situation, in which the material is firmly compressed. The necessary compression can be secured in various ways, perhaps most conveniently and effectively by means of the treading of cattle. The use of a considerable proportion of moss-litter is strongly recommended. This substance not only absorbs and retains the liquids, but, being acid, it fixes ammonia. In the absence of moss-litter, loamy soil rich in humus will prove a useful substitute.

The Chemical Fixation of Atmospheric Nitrogen.

It has for long been the dream of chemists to discover, or welcome the discovery of, a chemical process, capable of industrial application, by which the nitrogen of the air could be made available to replace or to supplement our rather limited supplies of nitrogenous manures. In his presidential address, Sir William Crookes had something to say on this fascinating subject, and looked hopefully to electricity to solve the problem. He pointed out that with current costing one-third of a penny per board of trade unit a ton of nitrate of soda could be produced for 26 pounds; while at a cost of one-seventeenth of a penny per unit —a rate possible when large natural sources of power, like Niagara, are available—the cost of such artificial nitrate of soda need not be more than 5 pounds per ton.*

Dr. von Lepel, in giving an account of recent work on this subject to the winter meeting of the German Agricultural Society in February of this year,† puts the cost of electric nitrate, as compared with Chili nitrate, in the proportion of 24 to 39, which is in close agreement with Sir William Crookes's estimate. Lepel points out that the material obtained, neutralized by some alkali, consists of a mixture of nitrate and nitrite. When used in pot-culture experiments it has given results closely agreeing with those furnished by Chili nitrate.

Good progress would also appear to have been made in another direction in the commercial fixation of atmospheric nitrogen, and a short account of the results was communicated by Prof. Gerlach, of Posen, to the meeting of the German Agricultural Society already referred to, and is published in the same issue of the Mittheilungen.

When air which has been freed of oxygen is conducted through finely disintegrated calcium carbide at a high temperature, one atom of carbon is displaced by two atoms of nitrogen, and calcium cyanamide ($CaCN_2$) is formed. This substance is also produced when a mixture of lime or chalk and charcoal is heated to a temperature of 2,000 deg. C. in a current of air.‡ When pure, this substance holds 35 per cent of nitrogen, but in its crude commercial form it contains only about 20 per cent. Treated with acids, calcium cyanamide is changed into dicyandiamide, a substance holding nearly 67 per cent of nitrogen, but directly poisonous to plants. Or, if heated in superheated steam, calcium cyanamide parts with all its nitrogen as ammonia, which, of course, is easily brought into a portable form.

But experiments conducted at Posen and Darmstadt during the past three years, both in pots and in the open field, have shown that calcium cyanamide itself is a useful nitrogenous manure, field experiments giving results about 20 per cent below those obtained by the use of an equal amount of nitrogen in the form of sulphate of ammonia. In prepared soil in pots the results fully surpassed those obtained both with nitrate of soda and sulphate of ammonia, the less satisfactory yields obtained in the field being perhaps due to the organic acids inducing the formation of a certain amount of the poisonous dicyandiamide.

So far as one may judge from the information available, it would appear that agriculture will not have long to wait until it is placed in the possession of new supplies of that most powerful agent of production, nitrogen, and Sir William Crookes will see the fulfillment of his prediction that "the future can take care of itself."

(To be continued.)

PECULIARITIES OF SOME PRECIOUS STONES.

Of all the gems, the emerald is the most rare and the most costly upon the market for precious stones. True it does not possess the *éclat* or the play of light common to the diamond, or the rich coloring or hardness of the ruby, and yet the emerald is pleasing to the eye, and its soft green hue comforts the organs of vision and adds restfulness to the tired eyes.

That the ancients appreciated this quality in the emerald will be seen from the following passage quoted from Pliny:

"There is no color more agreeable to the eye than that of the emerald; whatever pleasure we take in considering the green leaves and plants is greatly enhanced by the contemplation of the emerald, of a green hue to which no other color is comparable." Moreover, the emerald possesses the property of preserving its transparency as well as its diaphaneity, whatever may be its thickness, and its condition remains unchanged whether placed in the shadow or in the beaming rays of the sun.

When of a beautiful or prime quality this gem attains to a truly fabulous price; for fine specimens of emeralds have been seen of which the appraised value was from 5,000 francs to 6,000 francs per carat. From a mercantile viewpoint and rarity its only real rival is the ruby. While the blue sapphire is considered as a relatively common stone, its value rarely surpassing 600 francs per carat, and that only for speci-

* Journal Board of Agriculture, September, 1897.

† Hansen and Günther, "Versuche über Stallmist-Behandlung," Arbeiten der Deut. Land. Gesell. Heft 30, 1898. Pfeiffer, "Stallmist-Konservirung." Ibid. Heft 73, 1902. Immendorff, "Ueber Stallmist-Bewahrung," Mitt. der Deut. Land. Gesell. Heft 21, 1903. Schneidewind, "Fünfter Bericht über die Versuchswirtschaft," Lauchstädt, Land. Jahrb. xxxiii, p. 190.

* Crookes, "The Wheat Problem," p. 47.

† Dr. von Lepel, "Neuere Versuche zur Nutzbarmachung des atmosphärischen Stickstoffs durch Elektrische Flammenbogen," Mittheil. d. Deut. Land. Gesell., 1904, Stuck 8.

‡ Bull. Imp. Inst. June 30, 1904.

mens of first choice, the red sapphire or ruby, when it is really prime, is worth as much as 2,500 francs per carat.

Of the light colors "dove blood" is the rarest, and of the deep reds that known as "beef blood" is of equal rarity.

Cambodia, Indo-China, is the country which produces the greatest quantity of rubies. Under enormous difficulties and at the cost of many human lives do the Burmese miners snatch these precious gems from the lap of earth. Having discovered a valuable ruby, the miners use every imaginable subterfuge for deceiving the inspectors, and thus appropriating the stone. One of the tricks, which we believe is unknown here, consists in making an incision in some part of the body, and, after having inserted the stone under the skin, assuring the rapid healing of the wound by means of a special bandage. There only remains now an opportunity for delivering the stone from its hiding place and converting it into cash. Rubies are very fashionable as engagement rings. The reason for this is the innumerable virtues which the Orientals attribute to them; according to these mystical people, the stone heals all wounds, brings concord and happiness into the domestic circle, endows its wearer with eloquence, preserves the eyes from disease and cures dropsy, with other qualities too numerous to mention.

The Italians consider the blue sapphire capable of conferring happiness, and this stone, though more common than its near relation the ruby, is still very highly esteemed in some countries. Those of the deepest shades are the most rare, and when they occur without blemishes, they attain to considerable value.—Translated from Bulletin Mensuel de l'Horlogerie.

THE NEW ZEALANDERS.

In proportion to the dimensions of New Zealand, the population is very small; and even in the earliest days of our acquaintance with it, the land seems to have been but thinly inhabited. Taken as a whole, the natives are a singularly fine race of people—tall, powerful, and well made. Their color, although varying somewhat in shade, is always a brown of some kind, the complexion being sometimes as light as that of a Spaniard, and sometimes of a dark umber. The nose is straight and well formed, and in many cases is boldly aquiline; the mouth is large, and the lips are moderately full. The cheekbones are high, and the eyes are large, dark, and vivacious. The teeth are remarkably white and even, and feet and hands small and shapely. The men have naturally a full beard; but they always remove every vestige of hair on the face, in order to show the patterns that are tattooed upon it. Now and then a very old chief will allow his beard to grow, but, as a rule, the face is divested of all covering; so that the absence of the beard, together with the profusion of tattoo, destroys all evidence of age, and makes the countenance of young men of twenty look nearly as old as that of a man aged sixty.

The hair is plentiful, and mostly straight, being twisted and curled by art into various fashionable forms. In some instances it is light, even reddish in color; and in such cases accompanies a peculiarly fair complexion.

There seem to be two castes of men among these people. The upper is distinguished by the above characteristics, but the lower is of shorter stature, and has coarse, curly, though not woolly hair, more prominent cheek bones, and a much blacker skin. This second race is mixed in insensible gradations with the former, and is far less numerous.

From the existence of two races in New Zealand, it might be thought that the darker were the original proprietors of the soil anterior to the arrival of a stock of true Polynesian origin, and that they were conquered by the latter and nearly exterminated; but it is very doubtful whether the differences observed among the natives are really due to such a source, for similar varieties are found in all Polynesian islands.

There is undoubtedly a greater variety of color and countenance among the natives of New Zealand than one would expect—a circumstance that might prove either an early blending of different races, or a difference of social conditions, a supposition which would go far toward explaining the fact. All the New Zealanders speak of the Mango-Mango, or Blacks of New South Wales, as unconnected with and inferior to themselves; but they never make such a distinction regarding their own tribes.

As is often the case with uncivilized peoples, the women are decidedly inferior to the men, being much shorter, and not nearly so well made. They are not treated with that harshness which is the usual characteristic of married life among savages, and are even taken into their husband's counsels, and have great influence in political affairs. Still, the drudgery of the household falls upon their shoulders, and the lot of an ordinary New Zealand wife is a hard one. She has to cultivate the ground, to carry the produce of the distant fields to the house, and, when the family is traveling, is obliged to carry all the heavy load. Those who preserve their beauty longest are the daughters of wealthy chiefs, who can afford slaves by whom all the hard work is done, and who therefore free their mistresses from one of the causes of deterioration.

A very lax code of morality prevails among them, a young girl being permitted the utmost freedom until she is married, although afterward she becomes a model of constancy.

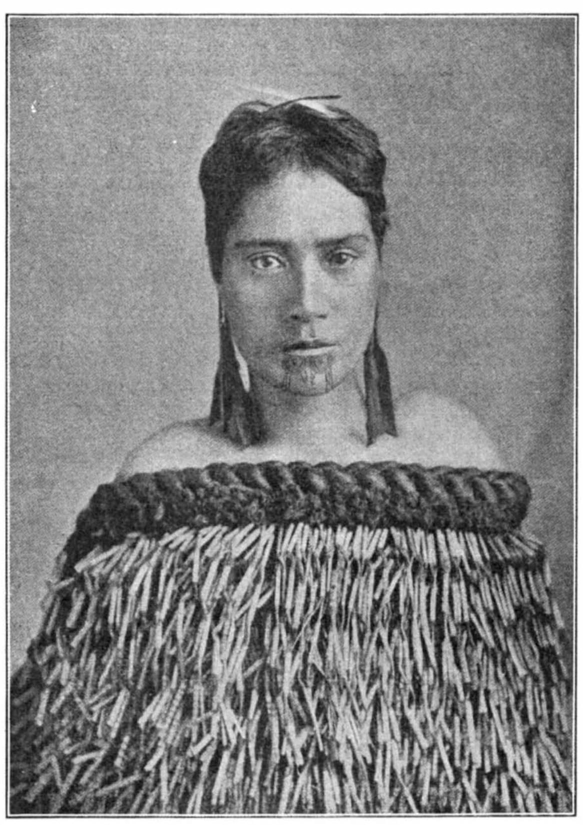
Unlike the men, the women do not disfigure their faces by the tattoo, which gives that stern and fixed expression so characteristic of a New Zealand warrior; and they thus allow their really flexible and intelligent features to have full play. The only parts of the face that are marked with the tattoo are a space beneath the mouth, and also the lips, which are

Tekooti, a Celebrated Maori Chief in State Costume with Mantle of Phormium, Lance or "Tai-Aha," Huia Feathers in the Hair, a Sign of Nobility and Authority.

rendered blue by the process, it being considered disgraceful for a woman to have red lips. The tattooing is always performed at the period when the child is allowed to take her place among women; and, as may be imagined, it gives a livid and very unpleasant appearance to the mouth. The children are very pleasing and interesting little creatures—full of intelligence, and unusually free and open in their manner.

The government of the New Zealanders is a curious mixture of simplicity and complication. Monarchy is unknown, each tribe having its own great chief, while an inferior chief presides over each clan or sub-tribe. The entire population may be divided into three ranks. First come the nobility, then the free men, and lastly the slaves. The nobility go by the general name of "Rangatira"—a title which is always given to officers, missionaries, and other white men placed in command over others.

The free men form the great body of the warriors;



A Maori Beauty.

some of them being the sons of Rangatira, and others merely having the privilege of free birth, which carries with it the right of tattooing the face. The slaves are always procured from two sources; they are either captives taken in battle, or are the children of the same. The value of such slaves is very great. All savages are idle, but the New Zealander is one of the laziest mortals in time of peace. In war he is all fire and spirit; but in peace he lounges listlessly about and will not do a stroke of work that can possibly be avoided. Whatever real work is to be done is left to the women or the slaves. There are slaves of both sexes, to whom the appropriate work is allotted.

VARIOUS METHODS USED IN FORECASTING THE WEATHER.

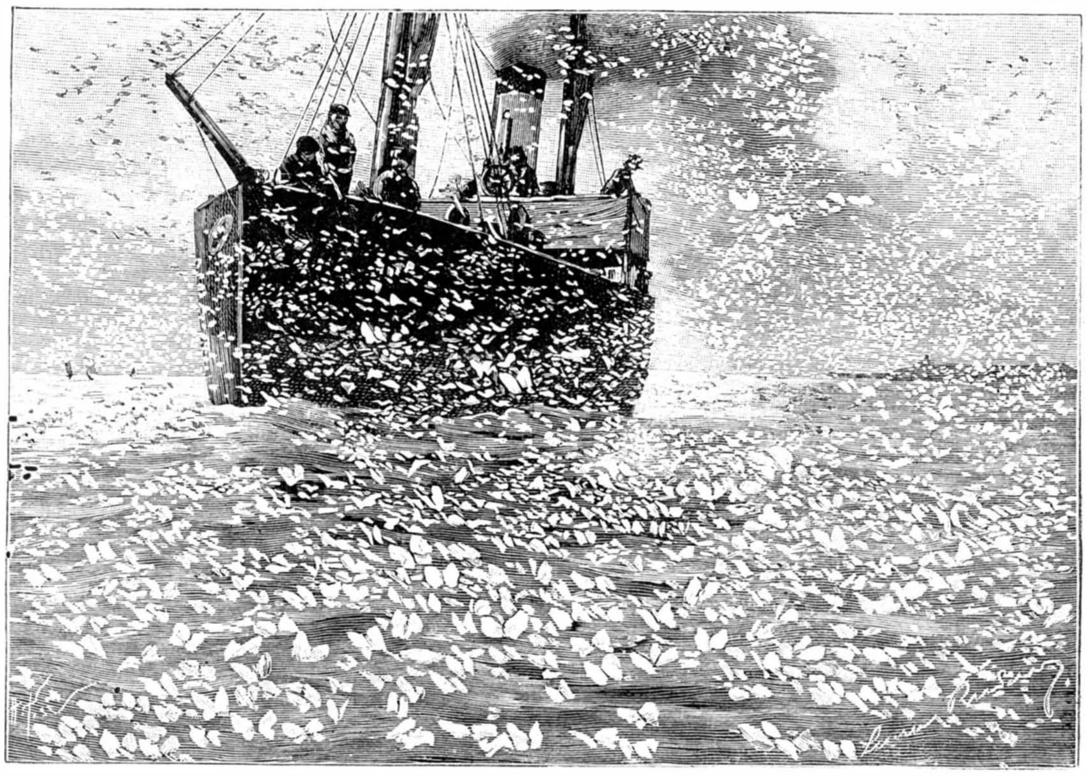
A LECTURE delivered by Prof. J. M. Pernter to the Association for the Advancement of Scientific Knowledge, in Vienna last winter, is printed in the Monthly Weather Review. He says that all methods of weather forecasting, not excepting those in use by the central meteorological offices, are based upon observed weather conditions and have, therefore, an empirical foundation. Many of them do not even make the slightest attempt to put their methods on a theoretical basis, and content themselves with setting up "weather rules." Even the scientific methods of professional meteorologists have not yet succeeded in deducing a theory capable of determining in advance the changes of the weather as the effect of one or several known causes. Only the advocates of the influence of the moon have ventured, solely by means of aprioristic theories, to "calculate" the weather for long periods in advance. Prof. Pernter then goes on to tell of the widely different methods by which the various weather prophets carry on the work of weather forecasting, such as those who make use of the behavior of animals; hunters who recognize the character of the approaching season from the action of the wild animals; the observers of birds, spiders, crickets, ants, and other animals; those who make use of the dead substances of the animal or vegetable kingdoms, such as hairs, strings of instruments, roots, and fibers of plants; those who consult stones and walls, learning from the "sweating" or dryness, and those who rely on their own bodies for foretelling the weather—assuming that these have nerves, joints, and corns, sometimes making use of the stomach and sometimes even the head. He commiserates these persons, and says: "They are far behind that class which forms its conclusions of the approaching weather from observations of the weather conditions themselves. You are all well acquainted with this latter class of weather prophets; in every community there is at least one person who is especially relied upon, whether he be a farmer, a miller, a teacher, or a pastor of long standing. They look up at the sky, observe the clouds and the direction of their motion, and from these they forecast the weather for the next day, with good results. These local weather prophets rely indeed upon phenomena which have the closest connection with the coming weather. For the weather does not spring like a *deus ex machina* down from a distant cuckoo's nest in the clouds, but is drawn from comparatively near regions, or if you prefer, forms gradually in the place itself. This approaching change in the weather is announced by the appearance of the sky sometimes for a longer, sometimes for a shorter time in advance, and the skill of the weather prophet consists in rightly interpreting for the near future the appearance of the sky and the weather conditions. Since it is generally necessary, in order to grasp the weather conditions correctly, to have a clear judgment founded on long experience in observing, together with an accurate eye and, I might almost say, an inborn quickness of perception, therefore, there are, as a rule, only single individuals in every community who enjoy the reputation of being good weather prophets. Certain phenomena, however, are of so typical a nature that they have been reduced to fixed rules and are everywhere expressed in popular language."

"An old and by far the most widespread method of weather prediction," says Dr. Pernter, "is based on the idea, which is, I might say, universal among mankind, that the heavenly bodies have an influence on everything which takes place on the earth, and particularly upon the weather. The moon is that one which was supposed to more especially influence the weather, although this power was attributed to the planets also, so that each one produces a certain kind of weather, and therefore divides the year into damp, dry, stormy, quiet periods, etc., according as one or the other planet is the 'ruler for the year.' The moon is credited with being the principal dominator of the changes of the weather. The weather is supposed to change by preference with the moon; therefore the new moon and the full moon especially possess the power of influencing the weather, and one of the most widely spread weather rules is that the weather changes with the new moon and the full moon. However, by many others the first and last quarters are considered of greatest importance. Especially clever observers of the influence of the moon upon the weather pretend to have also observed the distinctive individual influences of the phases known as octants. In general the opinion is very widespread that the decreasing moon exercises a weak, and the increasing moon a strong, influence. Thus far the theory of the influence of the moon on the weather is the direct result of the popular belief in the moon, without regard to any scientific basis."

Prof. Pernter then proceeds to take up the modern scientific methods, shows how the reports of various stations throughout a country are assembled, and deductions made, which are generally correct, although even the scientific method can give no positive certainty, since in Europe it can offer only a little above 80 per cent of verifications of the weather.

A SWARM OF BUTTERFLIES AT SEA.

DURING the days of the 10th and 11th of July, the surface of the ocean between Chausey and Granville islands was literally covered with immense clouds of butterflies. This curious phenomenon has been described by several eye-witnesses, and, among others, by the captain of the boat of the Board of Public Works, who gives the following account of it: "The white butterflies appeared as numerous as flakes of snow, and a person might have thought that he was in the midst of a storm, since the insects at times formed very compact clouds that produced the appearance of an approaching squall." During the two days noted above, the voyage from Chausey to Granville Island was effected entirely under such conditions. The distance between these two islands is about ten miles. Beyond Chausey Island, thinly scattered swarms were encountered. Many of these insects fell into the water, while the mass was always endeavoring to ascend, and the wind blowing from the east was ever carrying it seaward.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.



A SWARM OF BUTTERFLIES ENCOUNTERED ON THE OCEAN.

WHO GOES FIRST IN ENGLAND?

EVERY one knows that in the scale of general precedence for men, dukes come before marquesses, marquesses before earls, earls before viscounts, viscounts before barons, barons before baronets, and baronets before knights; but it may not be so generally known that these grades of rank come as far down on the scale as the nineteenth, twentieth, twenty-second, twenty-fifth, twenty-ninth, fifty-first, and fifty-fifth places respectively.

The members of the royal family, down to the nephews of the reigning sovereign, hold the first six places; and, after them, the Archbishop of Canterbury has the highest precedence in the scale of social gradation. He is immediately followed by the Lord High Chancellor of Great Britain (eighth) and the Archbishop of York (ninth); but the Prime Minister, to whom these dignitaries owe their positions, has no place whatever on the scale, nor has the First Lord of the Admiralty, the President of the Board of Trade, the President of the Local Government Board, the Postmaster-General, the Under Secretaries of State, the members of the House of Commons, the Viceroy of India, or the Governor-General of Canada.

The representation of parliamentary boroughs before the Reform Bill of 1832 does not bring out in sharper contrast the changed conditions between two given periods than the scale of precedence does, but it supplies a striking analogy. For instance, places which had been insignificant villages or non-existent in the reign of Henry VIII. were large centers of population at the beginning of the nineteenth century, while important towns of the Tudor period had become villages or even hamlets in the Hanoverian. Similar revolutionary changes have taken place in the social, and especially the political, world; while the scale of general precedence remains virtually the same as fixed in the sixteenth century.

A few of the outstanding landmarks in the history of England and of the British Empire illustrate and explain, in a most vivid way, the chief anomalies. When James I. ascended the English throne in 1603, the only foreign possession held by England was Newfoundland, and that only in name. India and Canada were not won until the middle of the eighteenth century, when the foundation of the empire on a solid basis was really laid.

The Tudors were absolute kings with most obedient parliaments, and the Stuarts lost the crown in consequence of their endeavoring to continue the personal autocratic monarchy of their predecessors; hence the representatives of the people were not likely to receive, and did not receive, any recognition in the scale of general precedence. The Speaker of the House of Commons, however, ranks next to a baron—that is, he is thirtieth on the scale; while the Secretaries of State, who originally owed their appointments directly to the Crown, come thirty-sixth. The "Juncto" Ministry of 1695 is usually regarded as the first cabinet, while Sir Robert Walpole was our first Prime Minister proper; and these facts account for the greatest anomaly—the omission of all mention of the premier and cabinet ministers, other than secretaries of state and the Chancellor of the Exchequer, on the scale.

There was no need for a President of the Board of Trade in the reign of Henry VIII., still less for a Postmaster-General. In those days the real executive power resided in the Privy Council; hence the high positions on the scale of the Lord President of the Privy Council (eleventh) and of the Lord Keeper of the Privy Seal (twelfth). While present-day under secretaries of state are unrecognized, privy councillors come forty-first on the list.

The Lord High Chancellor owes his exalted position on the scale not to his being head of the judicature, but to the fact that in the sixteenth century he represented in his person the joint offices of Justiciar and Chancellor of the Middle Ages—that is, he was Prime Minister *de facto*. The Lord High Treasurer was then also a great officer; hence his coming tenth. The Chancellor of the Exchequer, who is now directly responsible for the handling of the national purse, comes as low down as forty-second on the scale.

The Lord High Constable of England (fourteenth), the Earl Marshal (fifteenth), and the Lord High Admiral (sixteenth) were also great officials in Tudor times; while the commander-in-chief, field-marshals, and admirals of the fleet of our day have no places as such on the scale. As a matter of fact, a standing army was not constitutionally established until the reign of William III. and Mary.

The Lord Great Chamberlain of England comes thirteenth on the list, and the officers of the royal household rank seventeenth, eighteenth, thirty-second, thirty-third, thirty-fourth, and thirty-fifth.

At the bottom of the scale come esquires (sixty-second) and gentlemen (sixty-third). Heralds and lawyers are agreed that "gentlemen" are those who, by inheritance or grant from the Crown, are entitled to bear coat-armor.

All the clergy except bishops (twenty-eighth), all lawyers except judges (forty-seventh), and all officers of the army and navy, from field-marshals and admirals of the fleet downward, are left out in the cold. The church, law, army, navy, diplomacy, and learning have scales of special precedence, confined to their own respective spheres, determining the ranks of their members; but such are wholly ignored in the scale of general precedence.

The question is, of course, not so vital; but, from the facts submitted, many will be of opinion that there is as great necessity for reform of the scale of general precedence to-day as there was for parliamentary reform in 1832.

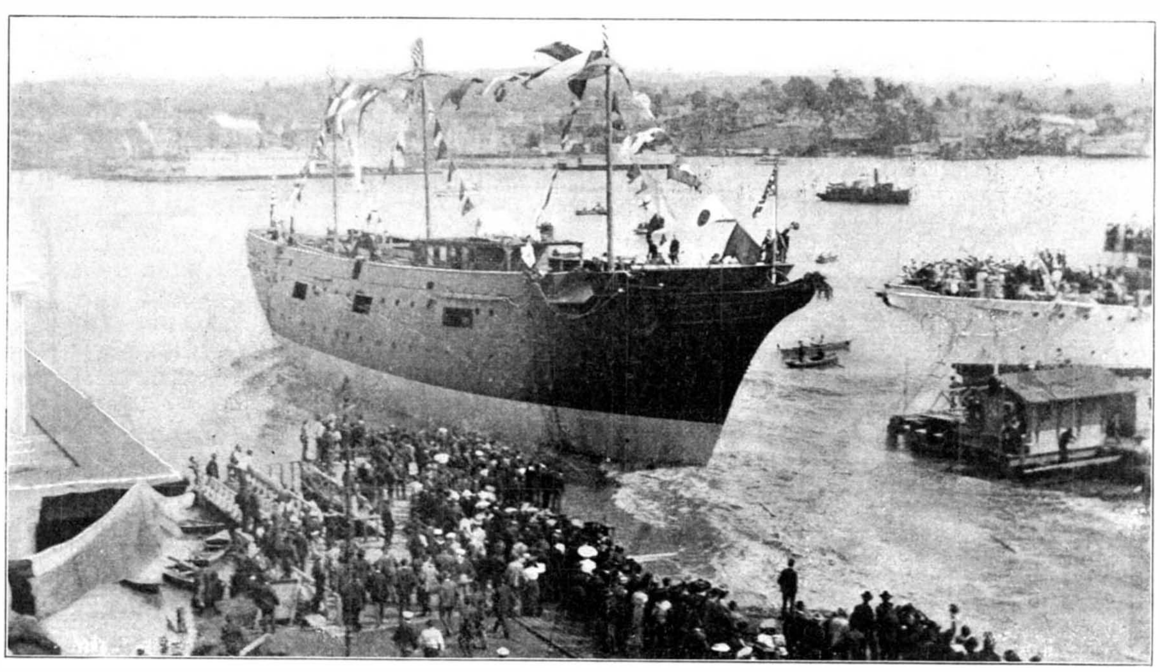
The scale of general precedence for women necessarily presents fewer anomalies than that for men; duchesses come immediately after the wives of the sovereign's nephews, and are followed by marchionesses, countesses, and so on downward to gentlewomen. The wives and children, it may be added, of the Archbishop of Canterbury, the Lord High Chancellor, or the Speaker of the House of Commons do not participate in his substantive—that is, official—rank, but only in his personal rank, whatever it may be.—Chambers's Journal.

THE LAUNCH OF THE TRAINING SHIP "INTREPID."

IT is not always that the launch of a naval ship takes place amid such picturesque surroundings as those shown in the accompanying view of the launch of the training ship "Intrepid" of the United States navy. This little craft, whose construction was authorized by Congress March 3, 1903, will be bark-rigged. She is a sister ship to the "Cumberland," recently launched at the Boston navy yard, a cut of which, as she will appear under full sail, was published in the issue of the SCIENTIFIC AMERICAN of October 22, 1904. The order for the construction of the "Intrepid" was placed at the navy yard, Mare Island, San Francisco. The "Intrepid" is a steel vessel, to be used in the training of landsmen and apprentices. She is to cost, when completed, $370,000. She will be propelled by sail only, and will be bark-rigged. Her general dimensions and features are as follows: Waterline length, 176 feet 5 inches; extreme breadth, 45 feet 7¾ inches; mean draft for a displacement of 1,800 tons, 16 feet 5¼ inches.

The armament consists of six 4-inch, 40-caliber rapid-fire guns, four 6-pounder rapid-fire guns, two 1-pounder rapid-fire guns, two Colt automatic 0.30-caliber guns. The battery will be mounted as follows: The 4-inch guns in broadside on the gun deck; the 6-pounder guns, forward and aft on the main deck; the 1-pounder guns, amidships on the main deck; the Colt automatic guns, midway between the 1-pounder guns and the after 6-pounder guns on the main deck. Arrangements will be made for dismounting and stowing the 4-inch guns on the main deck.

The magazines are located aft, and are well isolated from the compartment containing the dynamos, etc., and from the boilers. The vessel is supplied with two 24-kilowatt generators, two evaporators and two distillers, one condenser, and pumps for drainage, fire, and other purposes, besides a steam capstan windlass and an electric winch. Steam is supplied to this machinery by two boilers with a total heating surface of about 1,500 square feet, and it is the presence of these boilers on board that accounts for the existence of the smokestack between the fore and main masts. Accommodations are arranged for a complement of 9 wardroom officers, 6 warrant officers, and 320 men.



Length, 176 feet 5 inches. **Beam,** 45 feet 7¾ inches. **Draft,** 16 feet 5¼ inches. **Displacement,** 1,800 tons.

LAUNCH OF THE UNITED STATES TRAINING SHIP "INTREPID" AT MARE ISLAND NAVY YARD, SAN FRANCISCO.

Cotton has been cultivated in Paraguay for many years, but hitherto little or no attempt has been made to export it. In the past year, however, considerable interest has been manifested in this product by cot-

ton dealers and experts who have visited the country. Samples forwarded to the United Kingdom have met with considerable approval, and one shipment to Manchester was pronounced "very good standard quality." Paraguayan cotton is said to resemble the Egyptian variety. Besides the white variety there is also a colored cotton. The prices obtained for Paraguayan cotton in Europe are 5d. per pound for the white variety and 6d. for the red.

THE FORMS OF NEBULÆ.*

By AGNES CLERKE.

SIR WILLIAM HERSCHEL'S celestial surveys first made the classification of nebulæ practicable. Until he began grinding specula at Bath very few such objects were known, and those too imperfectly for the effectual discrimination of their differences. Arrangement presupposes comparison, and comparison some variety of specimens to be compared, which became available only through Herschel's scrutiny. The rapidity and penetrative power of his observations in this field almost passes belief. He detected with discernment. Discovery and enrollment did not satisfy him; he was, besides, keen to note analogies and contrasts, likenesses and dissimilitudes. He could not see without at the same time setting in order what he saw; and the law of order that commended itself to him was founded on an evolutionary principle. The contents of the heavens seemed to fall spontaneously, as he regarded them, into genetic sequences; and the nebulæ with particular facility. The criterion adopted was that of progressive condensation. Development must clearly, he judged, be attended by contraction and local brightening. Diffused milky tracts represented cosmic formations in their most rudimentary form; they assumed, through the unremitting action of gravity in drawing their particles together, a more compact texture, more definite shapes, and a heightened luster.

But things have changed somewhat in aspect during the last hundred years. Herschel's simple rule of arrangement, although of unquestioned validity, needs to be supplemented by others. Much auxiliary knowledge has been acquired since it was formulated. In attempting to estimate the comparative antiquity of nebulæ, we no longer depend exclusively upon one set of indications. The conclusions drawn from their immediate inspection can at least be checked by the study of their spectra and distribution.

The Milky Way might be figuratively described as the nursery-garden from which the parterres of the universe are stocked. A primitive condition is usually assigned, not without good reason, to any class of objects markedly tending to collect in its plane. And this is the case with gaseous, or "green" nebulæ. Moreover, their materials appear to be in a highly elementary state (if it be permissible to speak of one kind of matter as more elementary than another); their spectra including no rays due to metallic incandescence, but mainly those of nebulium, hydrogen, and helium. These substances, inconceivably attenuated, constitute the vast irregular formations placed by Herschel at, or near, the start of cosmical development. And so far he has been justified by the outcome of modern research. But he has not been justified in his description of planetary nebulæ as "very aged, and drawing on toward a period of change or dissolution." For, despite their determinate shape and definite boundaries, they do not appreciably differ in composition from nebulæ of the "irregular" class, and must be reckoned as, in a manner, coeval with them.

There is, on the whole, a concurrence of evidence that gaseous nebulæ are at a very early stage of growth. They are the least elaborated of sidereal objects; they seem, many of them, barely to have crossed the threshold of creation. Their mutual relations in time are, however, by no means obvious. They cannot easily be disposed in any kind of sequence. Each of the great nebulæ, at any rate, exhibits features and occupies a position shared by none of its fellows. The most discerning cosmologist cannot pretend to say that the Argo nebula, for instance, is of greater or less antiquity than the Orion or the "America" nebula. They are individual growths, simultaneous, not successive. The line of development indicated for them is rather toward the formation of star-clusters than of diverse nebular species. Thus the Pleiades may illustrate the probable future condition of the Orion nebula, the contained stars having gained predominance, though still wrapt in filmy swaddling-bands, later, presumably, to be shaken off.

Planetary nebulæ have much more in common than irregular nebulæ, and their minor varieties might, with some plausibility, be associated with differences in relative age. They are marked chiefly by the character of the nuclear star which, in nearly all such objects, appears to act as the pivot of the surrounding vaporous structure. The supposition lies close at hand that it is designed as a provision for the nourishment of the star—that the star gains in mass and light at the expense of the nebula, which it is eventually destined to absorb wholly and supersede. On this view, planetaries like the green glow-lamp at the pole of the ecliptic (N.G.C. 643) should be regarded as the most advanced, while Webb's planetary in Cygnus (N.G.C. 7027) would exemplify an inchoate condition. In the former the central star is of 9.6 magnitude, and sharply stellar; in the latter it is double and diffuse,† perhaps a wide binary system in embryo.

The question is, however, still open as to the real

* Knowledge.

† Keeler, Lick Publications, vol. iii., p. 214.

nature of the connection between planetaries and their central stars. The pabulum-theory is a promising conjecture; but no facts with which we are acquainted stringently enforce it. Ideas on the subject will need complete revision if the traces of spirality noted from time to time in some of these peculiar objects prove to be of radical significance. The *oculi*, distinctive of the "Owl nebula" (N.G.C. 3587) as originally shown by the Parsonstown reflector, consisted of luminous traceries coiled round *two* interior stars,* but the appearance was either due to illusion, or became effaced by change, since the camera has refused to indorse it as genuine. The "helical" planetary in Draco,† however, is doubtless essentially a spiral conformation‡; and Prof. Schaeberle, by means of exposures with a thirteen-inch reflector of twenty inches focus, has compelled not only the Ring nebula in Lyra,§ but the Dumb-bell in Vulpecula to betray the surprising secret of their whorled structure. Both these nebulæ give a spectrum of bright lines, and invention is baffled by the problem of building up gaseous materials into strongly characterized edifices. The materials, however, may not be purely gaseous;‖ or we possibly see (as Prof. Darwin long ago suggested) merely illuminated stream-lines of motion furrowing an obscure mass. But if this be indeed so, there is the further question to be asked: What direction does the motion take? Do the tides set inward or outward?

Our spontaneous impressions are all in favor of concentrative tendencies. We cannot easily shake off centripetal prejudices. Our lives are passed under a regimen of central attraction, and we naturally incline to universalize our experience. Hence Herschel's scheme of sidereal evolution invites at first sight ready acceptance. Stars seem as if they could not act otherwise than as foci of condensation in nebulæ; the lucid stuff involving them must, apparently, with the efflux of ages, settle down toward their surfaces, and become absorbed into their substance. Such processes indeed, apart from counteracting causes, belong to the inevitable order of Nature; but these may, and probably do, exist. From sundry quarters the conviction is pressed upon us that cosmic bodies can drive out matter as well as draw it in. Repulsive forces insist upon recognition, and their effects become more palpable the more attentively they are considered. Under certain conditions they get the better of gravity; and stars may possibly, like cocoon-spinning insects, expend their organic energies in weaving themselves unaccountably educed envelopes. The example of Nova Persei is fresh in every mind, but we make no pretension to decide the controversy it raised. A dogmatic pronouncement is unadvisable where the unknown elements of the question obscure and outweigh those that are known. A less slippery foundation for reasoning is afforded by the permanently visible spiral nebulæ, and features charged with an emphatic meaning have been revealed in them by photographic means.

Looking at the entire contents of the nebular heavens, we find the spiral type very largely predominant. It claims more specimens, and emerges more distinctly with each development of delineative power. Its chief prevalence, however, is among "white" nebulæ, showing continuous spectra.

They are vastly numerous. Gaseous nebulæ are reckoned by the score, white nebulæ by tens of thousands. Moreover, they collect near the poles of the Milky Way,¶ while the gaseous variety crowd toward its plane, both branches of the family thus manifesting galactic relationships, though of an opposite character. Now these facts of distribution are not without indicative import as to relative age. There is a consensus of opinion that objects showing a marked preference for the Milky Way are at an earlier stage of growth than those withdrawn from it, and the inference derives countenance from the circumstance that nebulæ situated in high galactic latitudes shine with continuous light, those near the galactic equator with interrupted radiance. Yet it would be rash to assume that any individual nebula traverses these successive stages. The series could be satisfactorily established only if we could point to a number of intermediate instances, which seem to be almost wholly lacking. We cannot trace in nebular as we can in stellar growth the insensible gradations of progressive change. They are, perhaps, complicated in nebulæ by influences of a different kind from those which have gained the ascendency in stars. Diffusive effects may in them be more conspicuous than concentrative effects;** or a balance may be temporarily struck between antagonistic tendencies.

Spiral conformation is the real crux of nebular cosmogony. The conditions from which it arises are met with only in the sidereal heavens, but are there widely prevalent. Though remote from our experience, they are fundamental in the realms of space. If we could define and comprehend them we should be in a better position for determining the cosmical status of nebulæ.

The choice is open between two rival theories of nebulous spirals. The first is the more obvious, and readily falls in with admitted mechanical principles. Sir Robert Ball has adopted and ingeniously advocated this view.

* Rosse, Trans. Roy. Dublin Society, vol. ii., p. 93.

† First detected as such by Holden and Schaeberle in 1888, Monthly Notices, vol. xlviii, p. 388.

‡ Deslandres, Bull. Astr., Feb., 1900.

§ Astr. Jour., Nos. 539, 547.

‖ Maunder, Knowledge, vol. xix., p. 39.

¶ Dr. Max Wolf places the point of nebular concentration in R. A. 12h. 53 min. D. + 61 deg. 20 min., that assigned to the galactic pole being in R.A. 12h. 49 min. D. + 62 deg. Königstuhl Publ. Bd. I. p. 174.

** T. J. J. See, "Repulsive Forces in Nature," Pop. Astr., No. 100, Dec. 1902.

A globular collection of promiscuously revolving particles inclines, if left to itself, to flatten down into a disk. The reason is this: in a system of the kind, moment of momentum is invariable, while energy constantly diminishes. To render the contrast intelligible we have only to consider that moment of momentum is the algebraic sum of all the products of mass and motion in the aggregation, reduced to, or projected upon its "principal plane," while energy is independent of the varied directions of velocity. Collisions consequently involve no diminution of moment of momentum, but combine with radiative waste to produce a steady loss of energy. Inevitably, then, the system will assume the form in which it possesses the minimum of energy that is consistent with the maintenance of its original momentum; and it is that of a disk extended in the principal plane. Retrograde movements will by this time have become eliminated; the constituent particles circulate unanimously in one direction; and Sir Robert Ball adds that their circulation, owing to the more rapid rotation of the central mass, is along spiral paths.* They would accordingly present the twisted conformation so commonly observed in the heavens, and might even include subordinate centers of attraction, fitted to ripen and strengthen into a full-blown retinue of planets. Such are spiral nebulæ regarded in their direct mechanical aspect. Spherical nebulæ are their immediate progenitors; suns, with or without trains of dependent worlds, their lineal descendants.

Let us, however, consult some autographic records and weigh attentively what these peculiar objects tell us about themselves. We see at once that their curving lines are not laid down at hap-hazard, but according to a strictly defined plan. Spiral nebulæ are not formed like watch-springs by the windings of a single thread. They are always two-branched. From opposite extremities of an elongated nucleus issue a pair of nebulous arms, which enfold it in double convolutions. Their apparent superposition and interlacements occasion, in the Lyra nebula, the noted effect of a fringed and ruptured annulus, and it is of profound interest to perceive that even in gaseous masses the same constructive rule prevails as in the great Whirlpool in Canes Venatici.

It is, however, almost irreconcilable with the hypothesis that an influx of material is in progress. Falls due to gravity could not be limited to two narrow areas on the central body. Matter ejected from it might, on the other hand, quite conceivably follow this course. Interior strain could easily be supposed to cause yielding along a given diameter, and nowhere else. Solar disturbances partially and dimly illustrate such a mode of action. Diametrically opposite prominences are not unknown. They indicate the action of an explosive force right across the solar globe. Similarly, the formation of a spiral nebula cannot be rightly apprehended otherwise than as the outcome of long-continued, oppositely directed eruptions.

The history of the heavens involves the law of spirality. The scope of its dominion continually widens as research becomes intensified. The Huygenian "portent" in the Sword of Orion now figures as merely the nucleus of the "great winding Nebula" photographed by Prof. W. H. Pickering in 1889. That the vast nebulosity encompassing the Pleiades is an analogous structure seems eminently probable, though the brilliancy of the inclosed stellar group obliterates most traces of its ground-plan. The magnitude of the phenomenon, we are told by Prof. Barnard,† who detected it in 1893 by means of a ten-hours' exposure with the Willard lens, transcends our powers of realization. It covers 100 square degrees of the sky with intricate details. About four minutes of arc to the northwest of the Ring in Lyra lies a small nebula discovered visually by Prof. Barnard in 1893, and photographically resolved by Keeler into a delicate spiral. It is a two-branched, left-handed spiral, as the large adjacent object has also proved to be. One is, in fact, the miniature of the other, and they are now shown, by Prof. Schaeberle's short-focus reflector, to be linked together by winding folds of nebulosity into a compound spiral system. The Dumb-bell is held, on the same authority, to be similarly conditioned, and the analogy frequently noted in the aspects of these remarkable formations has thus become incalculably widened in scale.

The galactic relations of the Magellanic Clouds are not easily defined. They are within the Milky Way, yet not of it. Enigmatical excrescences upon the universe, they suggest an origin from gigantic eddies in the onflowing current of sidereal arrangement. Their miscellaneous contents are, at any rate, disposed along eddying lines. Mr. H. C. Russell's photographs‡ rendered this, in 1890, to some extent manifest, and their indications were ratified by the Arequipa plates from the study of which Prof. Pickering gained the conviction that the great Looped Nebula, 30 Doradus, is the structural nucleus of the Nubecula Major. "It seems," he wrote,§ "to be the center of a great spiral, and to bear the relation to the entire system that the nebula in Orion bears to the great spiral nebula which covers a large part of that constellation."

On all sides, in the sidereal heavens, we can discern the signs of the working of a law of convolution. Sometimes they are patent to view; sometimes half-submerged; but they can generally, with attention, be disentangled from overlying appearances. They are exhibited by stars no less than by nebulæ, as the late Dr.

* The Earth's Beginnings. pp 243-7.

† Monthly Notices. vol. lx., p. 259.

‡ See Knowledge, vol. xiv., p. 50.

§ Harvard Annals, vol. xxvi. p. 206.

Roberts pointed out from convincing photographic evidence; the "hairy" appendages of globular clusters betray them by their curvilinear forms; they meet us in every corner of the wide nebular realm. Many investigators recognize in the Milky Way itself the stamp of spirality. Stephen Alexander, of New Jersey,* regarded the majestic galactic arch as a four-branched spiral, resulting from catastrophic breaches in a primitive, equatorially loaded spheroid, the streams of matter ejected by which should, owing to their lower angular rotation, lag behind as they retreated from the nucleus, and thus flow along helicoidal lines. R. A. Proctor subsequently devised convoluted galactic streams, which, however, corresponded imperfectly with what the sky showed. And M. Easton† has designed an elaborate series of spires, originating possibly from that vague entity, the "solar cluster," the projection of which upon the sphere may, he thinks, account for the noted peculiarities of the Milky Way. Our interior situation, nevertheless, makes it extremely difficult to determine the real relations in space of the star-streams circling around it. The observed facts are, perhaps, equally compatible with many other structural schemes besides those based on the idea of spirality; and the wiser course may be to adopt none, for the present, with settled conviction. We can, however, gather one sufficiently definite piece of information regarding the history of the Cosmos. All the inmates of the heavens, stellar and nebular, represent quite evidently the débris of a primitive rotating spheroid. Its equator is still marked by the galactic annulus, its poles by a double canopy of white nebulæ. The gyrating movement which it once possessed as a whole doubtless survives in its parts, but ages must elapse before the fundamental sidereal drift can be elicited.

* Astr. Jour., vol. ii., p. 100. 1852.

† Astroph. Jour., vol. xii., p. 158.

ELECTRICAL NOTES.

The Gray telautograph, which can hardly rank among the new inventions, has recently taken a new lease of life and is being thrust very energetically before the public. In some of the larger cities it is being used supplementary to the newspaper bulletin boards, "stations" having been established in prominent places somewhat remote from the newspaper offices, and here the news is written by the mysterious finger as quickly as it is posted on the main bulletin boards. The apparatus has been recently pressed into a more practical service in the office of the dispatcher at the union station in St. Louis, Mo., where it is desired to have orders delivered quickly and simultaneously at five different points, which is said to be done in a very satisfactory manner by the telautograph.

E. H. Anderson has studied by means of the oscillogram the phenomena occurring in the short-circuited coil, due to variations of the line current, and also the influences causing flashing over at the commutators of railway motors. The pressure between two exploring brushes, set a small distance apart on the commutator, was plotted with time as abscissæ; and the variation of this pressure from a minimum up to 4 volts as a maximum, leads to the assumption that a large short-circuit current exists in the commutated coil, increasing the density of the current at the brush tips to several times its normal value. The instantaneous pressure between the commutator bars at different loads of the motor is shown by very interesting curves, and while the wave-form at full load is very nearly the same as that of the terminal voltage, at one-third load it is distorted to a considerable extent. This same pressure is also plotted with the motor driven at a constant speed, with an armature current of 300 amperes, but no current in the field. To find the influences causing the flashing over of railway motors, the writer has conducted an extensive investigation in the laboratory of the General Electric Company, and a part of these experiments related to the occurrences in motors provided with field coils with short-circuited turns, as compared with motors in whose field coils no short-circuited turns are provided.

Some highly successful and valuable experiments with an electrical process for the purification of sewage have been carried out at Guildford, England. For some time past Dr. Rideal has been investigating the possibility of this treatment and has attained great success. The process consists of the electrical decomposition of salt and water, or if more convenient ordinary sea-water, in a specially designed electrolyzer which has a large superficial area of electrical surface and permits of the utilization of a large volume of current at a low voltage. The oxychloride solution, as it is called, obtained thereby is added to the sewage in quantities which vary in accordance with the nature of the effluent, and the water into which it is discharged. The advantage of this method is that it enables any kind of effluent to be treated. It has been used with raw sewage septic tank effluents, as well as those from primary, secondary, and tertiary filters, and in every instance the solution removed efficacious-ly putrefactive organisms, comparable in origin and vitality with those responsible for typhoid fever and cholera, as well as organic matter in solution. Demonstrations have shown that the solution which is adopted as the agent in this oxychloride process is a powerful deodorant and germicide. No difficulty has been experienced in converting the worst forms of sewage to a purity from bacteria equal to drinking water. With a primary effluent 7½ gallons of oxychloride per 1,000 gallons of sewage reduced the bacillus coli, which is allied to the typhoid bacillus, and the enteritis spores from over 100,000 to 100 respectively, so that none could be discovered in one cubic centimeter in 80 minutes after treatment. In raw sewage 18½ gallons of the solution to 1,000 gallons of sewage reduced the coli from over 1,000,000 so that none were found in one cubic centimeter, and the enteritis spores were reduced from over 1,000 to less than 10 in five hours, and the total number of organisms from 23,200,000 to 540. The process is very simple and inexpensive. The necessary plant can be installed very cheaply, and the operation of the process can be carried out economically.

TRADE NOTES AND RECIPES.

To Make Textiles Fireproof.—Up to the present this has generally been accomplished by the use of a combination of water-glass or soluble glass and tungstate of soda. We can recommend the following, both as being cheaper and more suitable for the purpose.

Equal parts by weight of commercial white copperas, Epsom salt, and sal-ammoniac are mingled together, and mixed with three times their weight of ammonia alum. This mixture soon changes into a moist pulp or paste, that must be dried by a low heat. When dressing the material, add ½ part of this combination to every 1 part of starch. Good results are also obtained from the following formula: Supersaturate a quantity of superphosphate of lime with ammonia, filter it, and decolorize it with animal charcoal. Concentrate the solution and mix with it 5 per cent of gelatinous silica, evaporate the water, dry, and pulverize.

For use mix 30 parts of this powder with 35 parts of gum and 35 parts of starch in sufficient water to make of suitable consistency. To make wood fireproof, a coat of paint consisting of equal parts of fluid chloride of lime, as it comes in the shape of a by-product from the gelatine factories, and fat lime of a doughy consistency is recommended.—Technischer Centralblatt.

Insect Powder as a Moth Exterminator.—As a means for annihilating vermin, insect powder stands easily paramount. The blossoms of the *Pyrethrum carneum* and *Pyrethrum roseum* furnish the Persian, while those of the *Pyrethrum cinnerariaefol* the Dalmatian insect powder. The latter is now almost exclusively used, though the name "Persian" is still continued. The effectiveness of the powder depends upon whether or not closed blossoms only have been used and pulverized as finely as possible. When buying this powder never let an offer of a cheap grade influence you, for in the cheaper grades very often the stems and blossoms of ineffective chrysanthemum varieties are mixed with it, an adulteration very difficult to circumvent. In order to restore the prevailing color of this powder, which is lost in a marked degree by the adulteration with chrysanthemum, turmeric is often added and this adulteration is easily detected by the use of ammonia—spirit of sal ammoniac—which turns it a deep, dark brown. Besides the pure and unadulterated insect powder, two other ingredients find more or less favor as mixtures with other drugs inimical to the moth. The following is very serviceable: Insect powder, pulverized camphor, and pulverized paprika or Spanish pepper (the fruit of *Capsicum annuum*) in equal parts. By the use of alcohol or ether, camphor may be readily rubbed down to a medium fine powder. The Spanish pepper should not be too dry, else the pulmonary organs of the compounder will suffer. In the beginning the color of the preparation is reddish-gray, but it soon becomes of a lively red.—Der Parfümeur.

Simple Method of Producing Quick-Water.—That the amalgam may easily take hold upon bronze objects and remain there, it is customary to cover the perfectly cleansed and shining article with a thin coat of quicksilver which is usually accomplished by dipping it into the so-called quick-water bath.

In the form of minute globules the quicksilver immediately separates itself from the solution and cleaves to the bronze object, which thereupon presents the appearance of being plated with silver. After it has been well rinsed in clean water, the amalgam may be evenly and without difficulty applied with the scratch-brush.

This quick-water, in reality a solution of mercurous nitrate, is made in the simplest manner by taking 10 parts of quicksilver and pouring over it 11 parts of nitric acid of a specific gravity equal to 1.33; now let it stand until every particle of the mercury is dissolved; then, while stirring vigorously, add 540 parts of water. This solution must be kept in closed flasks or bottles to prevent impurities such as dust, etc., from falling into it.

The preparatory work on the object to be gilded consists mainly in cleansing it from every trace of oxidation. First it must be well annealed by placing it in a bed of glowing coal, care being exercised that the heating be uniform. When cooled, this piece is plunged into a highly diluted sulphuric-acid bath in order to dissolve, in a measure, the oxide.

Next it is dipped into a 36-deg. nitric acid bath, of a specific gravity equal to 1.33, and brushed off with a long brush; it is now dipped into nitric acid into which a little soot and table salt have been thrown. It is now ready for washing in clean water and drying in unsoiled sawdust. It is of the greatest importance that the surface to be gilded should appear of a pale yellow tint all over. If it be too smooth the gold will not take hold easily, and if it be too dull it will require too much gold to cover it.—Journal der Goldschmiede-kunst.

ENGINEERING NOTES.

A scheme for constructing at Dover a torpedo boat harbor in addition to the national harbor is understood to be under the consideration of the Admiralty. The proposal appears to have arisen from the Admiralty considering that the whole of the great national harbor of over 600 acres will be required for the anchorage of battleships and cruisers.

United States Consul-General Richard Guenther, Frankfort, Germany, sends the following from a recent public statement of the Krupp works: The total number of persons employed by the firm on April 1, 1904, including 4,190 officials, was 45,289. Of these the cast-steel works at Essen employed 25,041, the Gruson works at Buckau 3,329, the Germania shipbuilding yard at Kiel 2,811, the coal mines 7,877, the iron mines, etc., 6,231. The average daily wages in the cast-steel works were as follows:

Year.	Daily Wage.	Year.	Daily Wage.
1853	$0.32	1890	$0.85
1860	.49	1900	1.14
1870	.73	1901	1.00
1875	.93	1902	1.08
1879	.72	1903	1.09

The use of sewers by large manufacturing corporations is a subject which has caused city officials much anxious thought. It sometimes happens that the waste liquids from an industrial establishment are of very large volume, so that the size of the public sewers into which they are discharged is largely determined by them. In addition the offensive character of the waste liquors increases at times the difficulty of sewage disposal. It is perfectly clear that in such cases the industry pays for but a small part of the expense of the sewerage system, although it is responsible for a much greater proportion of its cost. As a matter of strict justice, the extra cost of construction and maintenance should be assessed on the manufacturing company, yet very few cities are willing to do this lest the industries be driven away. That such a fear is well grounded is shown by the experience in Millburn, N. J., where a paper company has threatened to leave town if it is specially assessed for discharging wastes into the sewerage system. As the company's mills are the leading manufacturing establishment in the town, their dismantling would practically kill it for years to come.—Engineering Record.

After several years of careful investigation and experiment by experts in this line of work, it has been found that the old channel placer deposits of the West, more especially those of the Southern Oregon mineral zone, contain the rare metal platinum in considerable quantity; furthermore, a successful method for mining the platinum at the same time the gold is mined, and with no additional expense, has been devised, and is being followed by several large hydraulic properties. These results have been brought about largely through the efforts of representatives of the Welsbach Gas Mantle Company, of Philadelphia, which company is ever on the lookout for platinum, as it uses a large quantity in the manufacture of its articles. Since the early days the placer miners have known of a strange, dark metal, occurring as a coarse black powder, with the black sand, and near the bed rock of the old channel placer deposits of Southern Oregon. Being ignorant of its identity and value, the miners have been throwing this metal from their sluices, and were not aware, till recent years, that it was platinum, and of as great worth as the yellow metal they so persistently sought. But even after the metal was recognized there was no available method of saving it. The placer miner bent on getting gold, had no inclination to master the problem, and gave it but little thought, so it remained for the experts to solve the question. The method of saving platinum is primarily that of attaching a system of undercurrents to the placer sluices. These undercurrents are quite similar to those employed in saving flour gold, and the principle involved is just the converse of that used in saving placer gold. Platinum, being lighter, must be kept stirred, and like coffee grounds in a cup of liquid, will not settle while in motion. The sands are first drawn through a ½-inch grizzly on the sluice bottom and spread out over a broad riffle table. On this table much of the black sand, and nearly all of the fine or flour gold settles. The method thus far is simply that of undercurrents, but it goes farther, in that the water is carried on, drawn through another grizzly, and spread out over a coco-mat riffle. Here the water flows more sluggishly, and the platinum concentrates settle and are gathered up, by lifting the coco matting and rinsing it in vats or tanks made for the purpose, and into which the platinum concentrates settle. A peculiar feature of these platinum sands is that they are a refractory article, in part, carrying platinum in both the free and concentrate composition, and require a method of refining that is understood by only a few of the platinum refineries of America. The sands are shipped from the mines in the shape they are found, when scooped up from the bottom of the vats, and screened of the coarser pebbles that manage to get through the second ¼-inch grizzly through which they must pass to reach coarse, black gunpowder, and only a close inspection reveals their metallic luster. Not only platinum itself is carried, but all of the metals of the platinum group as well, to a greater or less extent, including rhodium, osmium, iridium, and palladium.—Mines and Minerals.

SELECTED FORMULÆ.

Aluminium Silver.—3 parts of aluminium and 1 part of silver. This alloy is very easy to work.

Gray Gold Alloy.—94 parts of gold and 6 parts of iron or 95.5 parts of gold united with 4.5 parts of iron.

To Stain Wood the Color of Mahogany.—First rub the surface of the wood to be stained with a solution of nitrous acid, then apply with a brush a solution made up of 1 part of dragon's blood, ⅛ part of carbonate of soda, and 20 parts of alcohol. This preparation should be filtered before it is used.

Waterproof Glue for Cardboard.—This preparation is a desideratum which permits of an absolutely permanent gluing of pieces of cardboard, even when they are moistened by water. Melt together equal parts of good pitch and gutta-percha; of this take 9 parts, and add to it 3 parts of boiled linseed oil and 1½ parts of litharge. Place this over the fire and stir it till all the ingredients are intimately mixed. It may be diluted with a little benzine or oil of turpentine, and must be warm when used.

India-Rubber Varnish.—An excellent and rapidly-drying waterproof varnish is prepared in the following manner: Heat a weighed quantity of boiled linseed oil until it fumes strongly. A vessel with plenty of extra room in it must be used. Have ready some India-rubber cut small, and one ounce of it for every pound in the original weight of the oil. When one piece thrown in melts at once, put in the rest gradually, and when all is melted stop the heating. When cold dilute the varnish with turps to the required consistency.—Gummi Zeitung.

Japan Bronze.—The formulæ that we give below contain a large percentage of lead, which greatly improves the patina. The ingredients and the ratio of their parts for three sorts of modern Japanese bronze follow:

1. Copper 81.62 per cent, tin 4.61 per cent, lead 10.21 per cent.

2. Copper 76.60 per cent, tin 4.38 per cent, lead 11.88 per cent, zinc 6.53 per cent.

3. Copper 88.55 per cent, tin 2.42 per cent, lead 4.72 per cent, zinc 3.20 per cent.

Sometimes a little antimony is added just before casting, and such a composition would be represented more nearly by this formula:

4. Copper 68.25 per cent, tin 5.47 per cent, zinc 8.88 per cent, lead 17.06 per cent, antimony 0.34 per cent.

Colorings for Jewelers' Work.—We give here several receipts for this purpose: Take 40 parts of saltpeter, 30 parts of alum, 30 parts of sea salt or 100 grammes of liquid ammonia, 3 grammes sea salt and 100 grammes water. This is heated without bringing it to a boil, and the articles dipped into it for from two to three minutes, stirring the liquid constantly; after this bath they are dipped in alum water and then thoroughly rinsed in clean water. A second receipt is: 100 grammes of calcium bromide and 2 grammes of bromium. The objects are allowed to remain in this solution (which must be also constantly stirred) for from two to three minutes, then washed in a solution of sodium hyposulphite, after which they must be rinsed in clean water. Receipt No. 3: 30 grammes of verdigris, 30 grammes of sea salt, 30 grammes of hematite, 30 grammes of sal-ammoniac, and 5 grammes of alum. This must be all ground up together and mixed with strong vinegar; or we may also use 100 grammes of verdigris, 100 grammes of hydrochlorate of ammonia, 65 grammes of saltpeter, and 40 grammes of copper filings, all of which are to be well mixed with strong vinegar.

Production of Metallic Coating, Without a Battery.—It is often desirable to cover certain metallic objects with a thin coating of another and more costly metal, and this often happens where the galvanic battery is not conveniently at hand, or where the electric current cannot be quickly had. This may be easily done in a variety of ways, of which some of the methods, together with the necessary formulæ, are given below:

To silver articles made of copper, brass, bronze, or copper-plated articles, dissolve, according to Langbein, 10 grammes of lunar caustic in 500 grammes of distilled water; dissolve separately 35 grammes of 98 per cent potassium cyanide also in 500 grammes of distilled water, mix these two solutions, stirring them well, and heat up to 80 deg. or 90 deg. C. in an agate-ware vessel, then subject the articles to be coated, which have been previously well cleansed from grease and other impurities, to this bath until they are evenly coated.

Articles of zinc, brass, or copper may also be silver-plated by applying to them a pasty mass of the following composition: First dissolve 10 grammes of nitrate of silver in 50 grammes of distilled water; also 25 grammes of potassium cyanide in sufficient distilled water to dissolve it. Pour the two together, stir well, and filter. Now 100 grammes of whiting or levigated chalk and 400 grammes of potassium bitartrate, finely powdered, are moistened with the above solution, sufficiently to form a soft paste, which may be applied to the objects, previously well cleansed, with a brush. After this coating has dried well, rinse it off, and dry the object in clean sawdust.

A coating of silver may also be applied to brass or copper by rubbing, thus: rub on the objects well cleared of grease, a paste formed of 10 grammes of silver chloride, 20 grammes of common salt, 20 grammes of pulverized tartar, with sufficient water to soften it. A soft cloth is best adapted for applying the paste.—Deutsche Goldschmiede Zeitung.

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