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Title: Scientific American Supplement, No. 443, June 28, 1884

Author: Various

Release date: September 29, 2005 [EBook #16773]
Most recently updated: December 12, 2020

Language: English

Credits: Produced by Juliet Sutherland, Josephine Paolucci and the Online Distributed Proofreading Team at www.pgdp.net

SCIENTIFIC AMERICAN SUPPLEMENT NO. 443.

NEW YORK, JUNE 28, 1884.

Scientific American Supplement. Vol. XVII., No. 443.

Scientific American established 1845

Scientific American Supplement, $5 a year.

Scientific American and Supplement, $7 a year.

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PUERTA DEL SOL, MADRID.

Puerta del Sol, or Gate of the Sun, Madrid, is the most famous and favorite public square in the Spanish city of Madrid. It was the eastern portal of the old city. From this square radiate several of the finest streets, such as Alcala, one of the handsomest thoroughfares in the world, Mayor, Martera, Carretas, Geronimo. In our engraving the post office is seen on the right. Large and splendid buildings adorn the other sides, which embrace hotels, cafes, reading rooms, elegant stores, etc. From this square the street railway lines traverse the city in all directions. The population of the city is about 400,000. It contains many magnificent buildings. Our engraving is from *Illustrirte Zeitung*.

THE PUERTA DEL SOL, MADRID, SPAIN (From a Photograph.)

CONCRETE BUILDINGS FOR FARMS.

Buildings made of concrete have never received the attention in this country that they deserve. They have the merit of being durable and fire-proof, and of not being liable to be blown down by violent winds. It is very easy to erect them in places where sand and gravel are near at hand and lime is comparatively cheap. Experiments made in England show that coal screenings may be employed to good advantage in the place of sand and gravel. Mr. Samuel Preston, of Mount Carroll, Ill., has a dwelling and several other buildings made of concrete and erected by himself. They were put up in 1851, and are in excellent condition. In *The Farmers' Review* he gives the following directions for building concrete walls:

First, secure a good stone foundation, the bottom below frost, the top about one foot above ground. Near the top of the foundation bed in 2×4 scantling edgewise transversely with the walls, at such distances apart as the length of the planks that form the boxes to hold the concrete may require, the ends of the scantling to run six inches beyond the outside and inside of the wall. Now take 2×6 studding, one foot longer than the height of the concrete walls are to be, bolt in an upright position in pairs to each end of the 2×4 scantling, and, if a foot wall is to be built, sixteen inches apart, as the box plank will take up four inches. To hold the studding together at the top, take pieces of 2×6 lumber, make two mortises in each piece large enough to slip easily up and down on the studding, forming a tie. Make one mortise long enough to insert a key, so that the studding can be opened at the top when the box plank are to be raised. When the box plank are in position, nail cleats with a hole in each of them on each side of the studding, and corresponding holes in the studding, into which insert a pin to hold the plank to the studding. Bore holes along up in the studding, to hold the boxes when raised.

To make the walls hollow, and I would do it in a building for any purpose, use inch boards the same width of the box plank, one side planed; put the two rough sides together with shingles between, nailing them together with six-penny nails; place them in the middle of the wall, the thin end of the shingle down. That gives them a bevel and can be easily raised with the boxes. To tie the wall together, at every third course place strips of boards a little shorter than the thickness of the wall; cut notches in each so that the concrete will fill in, holding all fast. The side walls being up, place two inch planks on top of the wall upon which to rest the upper joists, put on joist and rafters, remove the box plank, take inch boards for boxes, cut to fit between joists and rafters, and fill with concrete to upper side of rafters, which makes walls that will keep out cold and damp, all kinds of vermin, and a roof which nothing but a cyclone can remove. In making door and window frames, make the jambs two inches narrower than the thickness of the walls, nailing on temporary two inch strips.

Make the mortar bed large enough to hold the material for one course; put in unslaked quicklime in proportion to 1 to 20 or 30 of other material; throw into it plenty of water, and don't have that antediluvian idea that you can drown it; put in clean sand and gravel, broken stone, making it thin enough, so that when it is put into boxes the thinner portion will run in, filling all interstices, forming a solid mass. A brick trowel is necessary to work it down alongside the boxing plank. One of the best and easiest things to carry the concrete to the boxes is a railroad wheelbarrow, scooping it in with a scoop shovel. Two courses a week is about as fast as it will be safe to lay up the walls.

The *Medical Summary* recommends the external use of buttermilk to ladies who are exposed to tan or freckles.

WHAT CAUSES PAINT TO BLISTER AND PEEL?

HOW TO PREVENT IT.

This subject has been treated by many, but out of the numerous ideas that have been brought to bear upon it, the writers have failed to elucidate the question fully, probably owing to the fact that in most parts they were themselves dubious as to the real cause. Last year W.S. gave a lengthy description in the *Building News*, in which he classified blistering and peeling of paint into one of blistering only. He stated in the beginning of his treatise the following:

"The subject of blistering of paint has from time to time engrossed the attention of practical men; but so far as we can follow it in the literature pertaining to the building trade, its cause has never been clearly laid down, and hence it is a detail enshrouded in mystery."

W.S. dwells mostly, in his following explanations on blistering paints, on steam raised in damp wood. Also an English painter, according to the *Painters' Journal*, lately reiterates the same theory, and gives sundry reasons how water will get into wood through paint, but is oblivious that the channels which lead water into wood are open to let it out again. He lays great stress on boiled oil holding water in suspense to cause blistering, which is merely a conjecture. Water boils at 212° F. and linseed oil at 600° F., consequently no water can possibly remain after boiling, and a drop of water put into boiling oil would cause an explosion too dangerous to be encountered.

It will be shown herewith that boiled oil, though in general use, is unfit for durable painting, that it is the cause of most of the troubles painters have to contend with, and that raw linseed oil seasoned by age is the only source to bind pigments for durable painting; but how to procure it is another trouble to overcome, as all our American raw linseed oil has been heated by the manufacturers, to qualify it for quick drying and an early market, thereby impairing its quality. After linseed oil has been boiled, it becomes a poor varnish; it remains soft and pliable when used in paint, giving way to air pressure from the wood in hot weather, forming blisters. Turpentine causes no blistering; it evaporates upon being exposed, and leaves the paint in a porous condition for the gas in the wood to escape; but all painters agree that blistering is caused by gas, and on investigation we find two main sources from which gas is generated to blister paint—one from the wood, the other from the ingredients of the paint. The first named source of gas is started in hot weather by expansion of air confined in painted wood, which presses against the paint and raises blisters when the paint is too soft to resist. Tough, well-cemented paint resists the pressure and keeps the air back. These blisters mostly subside as soon as the air cools and returns to the pores, but subsequently peel off.

W.S. and others assert that damp in painted wood turns into steam when exposed to sun heat, forming blisters, which cannot be possible when we know that water does not take a gaseous form (steam) at less than 212° F. They have very likely been deluded by the known way of distilling water with the aid of sunshine without concentrating the rays of the sun, based upon the solubility of water in air, viz.: Air holds more water in solution (or suspension) in a warmer than in a cooler degree of temperature; by means of a simple apparatus sun-heated air is guided over sun-heated water, when the air saturated with water is conducted into a cooler, to give up its water again. But water has an influence toward hastening to blister paint; it holds the unhardened woodsap in solution, forming a slight solvent of the oil, thereby loosening the paint from the wood, favoring blistering and peeling. There is a certain kind of blister which appears in certain spots or places only, and nowhere else, puzzling many painters. The explanation of this is the same as before—soft paint at these spots, caused by accident or sluggish workmen having saturated the wood with coal oil, wax, tar, grease, or any other paint-softening material before the wood was painted, which reacts on the paint to give way to air pressure, forming blisters.

The second cause of paint blistering from the ingredients of the paint happens between any layer of paint or varnish on wood, iron, stone, or any other substance. Its origin is the gaseous formation of volatile oils during the heated season, of which the lighter coal oils play the most conspicuous part; they being less valuable than all other volatile oils, are used in low priced japan driers and varnishes. These volatile oils take a gaseous form at different temperatures, lie partly dormant until the thermometer hovers at 90° F. in the shade, when they develop into gas, forming blisters in airtight paint, or escape unnoticed in porous paint. This is the reason why coal-tar paint is so liable to blister in hot weather; an elastic, soft coal-tar covering holds part of its volatile oil confined until heated to generate into gas; a few drops only of such oil is sufficient to spoil the best painted work, and worse, when it has been applied in priming, it settles into the pores of the wood, needing often from two to three repetitions of scraping and repainting before the evil is overcome. Now, inasmuch as soft drying paint is unfit to answer the purpose, it is equally as bad when paint too hard or brittle has been used, that does not expand and contract in harmony with the painted article, causing the paint to crack and peel off, which is always the case when either oil or varnish has been too sparingly and turpentine too freely used. Intense cold favors the action, when all paints become very brittle, a fact much to be seen on low-priced vehicles in winter time. Damp in wood will also hasten it, as stated in blistering, the woodsap undermining the paint.

To avoid peeling and blistering, the paint should be mixed with raw linseed oil in such proportions that it neither becomes too brittle nor too soft when dry. Priming paint with nearly all oil and hardly any pigment is the foundation of many evils in painting; it leaves too much free oil in the paint, forming a soft undercoat. For durable painting, paint should be mixed with as much of a base pigment as it can possibly be spread with a brush, giving a thin coat and forming a chemical combination called soap. To avoid an excess of oil, the following coats need turpentine to insure the same proportion of oil and pigment. As proof of this, prime a piece of wood and a piece of iron with the same paint; when the wood takes up part of the oil from the paint and leaves the rest in proportion to harden well, where at the same time the paint on iron remains soft. To be more lucid, it need be explained, linseed oil boiled has lost its oleic acid and glycerine ether, which form with the bases of pigments the insoluble soap, as well as its albumen, which in boiling is thrown out. It coagulates at 160° F. heat; each is needed to better withstand the action of wind and weather, preventing the dust from attaching itself to a painted surface, a channel for ammonia in damp weather to dissolve and wash off the paint. In later years linseed oil has been extracted from linseed meal by the aid of naphtha and percolation, the product of a very clear, quick drying oil, but lacking in its binding quality, no doubt caused by the naphtha dissolving the fatty matter only, leaving the glycerine and albumen in the meal.

All pigments of paint group according to their affinity to raw linseed oil into three classes. First, those that form chemical combinations, called soap. This kind is the most durable, is used for priming purposes, and consists of lead, zinc, and iron bases, of which red lead takes up the most oil; next, white lead, the pure carbonate Dutch process made, following with zinc white and iron carbonates, as iron ore paint, Turkey umber, yellow ocher; also faintly the chromates of lead—chrome-green and chrome-yellow, finishing with the poorest of all, modern white lead, made by the wet or vinegar process. The second class being neutrals have no chemical affinity to linseed oil; they need a large quantity of drier to harden the paint, and include all blacks, vermilion, Prussian, Paris, and Chinese blue, also terra di Sienna, Vandyke brown, Paris green, verdigris, ultramarine, genuine carmine, and madderlake. The last seven are, on account of their transparency, better adapted for varnish mixtures —glazing. The third class of pigments act destructively to linseed oil; they having an acid base (mostly tin salt, hydrochloride of tin, and redwood dye), form with the gelatinous matter of the oil a jelly that will neither work well under the brush nor harden sufficiently, and can be used in varnish for glazing only; they are not permanent in color, and among the most troublesome are the lower grades of so-called carmines, madderlakes, rose pinks, etc., which contain more or less acidous dyes, forming a soft paint with linseed oil that once dry on a job can be twisted or peeled off like the skin of a ripe peach. All these combinations of paint have to be closely observed by the painter to insure his success.

Twenty-five years ago a house needed to be painted outside but once in from five to seven years; it looked well all the time, as no dust settled in the paint to make it unsightly. Painters then used the Dutch-process-made white-lead, a base and raw linseed oil, a fat acid, which formed the insoluble soap. They also put turpentine in the following coats, to keep up the proportions of oil and pigment. All held out well against wind and weather. Now they use the wet-process-made white lead, neutralized by vinegar, with oil neutralized by boiling, from the first to the last coat, and—fail in making their work permanent.

W.S., in the *Building News*, relates an unaccountable mysterious blistering in a leaky house, where the rainwater came from above on a painted wood wall, blistering the paint in streaks and filled at the lower ends with water, which no doubt was caused by the water soaking the wood at the upper ends where there was no paint, and following it down through the fibers, pushed and peeled off the soft, inadhesive paint. Green, sappy, and resinous wood is unfit for durable painting, and to avoid blistering and peeling wood should be well seasoned and primed with all raw linseed oil, some drier, to insure a moderately slow drying, and as much of a base pigment as the painter can possibly spread (much drier takes up too much oil acid, needed for the pigment base to combine with), which insures a tough paint that never fails to stand against blistering or peeling, as well as wind, weather, and ammonia.

The coach, car, and house painter can materially improve his painting where his needs lie by first oiling the wood with raw oil, then smoothing the surface down with lump pumicestone, washing it with a mixture of japan drier or, better yet, gold sizing and turpentine, wiping dry, and following it up with a coat of white lead, oil, and turpentine. The explanation is: the raw oil penetrates the wood and raises the wood fibers on the surface to be rubbed down with pumicestone, insuring the best surface for the following painting: to harden the oil in the wood it receives a coat of japan drier, which follows into the pores and there forms a tough, resinous matter, resisting any air pressure that might arise from within, and at the same time reacts on the first coat of lead as a drier. This mode insures the smoothest and toughest foundation for the following painting, and may be exposed to the hottest July sun without fear of either blistering or peeling.

LOUIS MATERN.

Bloomington, Ill.

OLIVE OIL.

The following particulars with regard to the production of olive oil in Tuscany have been furnished to Mr. Consul Inglis by one of the principal exporters in Leghorn:

The olive oil produced in Tuscany from the first pressing of the fruit is intended for consumption as an article of food. Hence, great attention is paid both to the culture of the olive tree and the process of making oil.

The olive crop is subject to many vicissitudes, and is an uncertain one. It may be taken as a rule that a good crop does not occur more frequently than once in three years. A prolonged drought in summer may cause the greater part of the small fruit to fall off the trees. A warm and wet autumn will subject the fruit to the ravages of a maggot or worm, which eats its way into it. Fruit thus injured falls to the ground prematurely, and the oil made from it is of very bad quality, being nauseous in taste and somewhat thick and viscous. Frost following immediately on a fall of snow or sleet, when the trees are still wet, will irretrievably damage the fruit, causing it to shrivel up and greatly diminishing the yield of oil, while the oil itself has a dark color, and loses its delicate flavor.

The olive tree in Tuscany generally blossoms in April. By November the fruit has attained its full size, though not full maturity, and the olive harvest generally commences then. The fruit, generally speaking, is gathered as it falls to the ground, either from ripeness or in windy weather. In some districts, however, and when the crop is short, the practice is to strip the fruit from the trees early in the season. When there is a full crop the harvest lasts many months, and may not be finished till the end of May, as the fruit does not all ripen simultaneously.

Oil made early in the season has a deeper color, and is distinguished by a fruity flavor, with a certain degree of pungency; while as the season advances it becomes lighter in color, thinner in body, and milder and sweeter in taste. Oil made toward the close of the harvest in April or May from extremely ripe fruit is of a very pale straw color, mild and sweet to the taste, though sometimes, if the fruit has remained too long on the trees, it may be slightly rancid. Oil very light in color is much prized in certain countries, notably France, and hence, if it also possesses good quality, commands a higher price in the Tuscan markets.

The fruit of the olive tree varies just as much in quality as does the grape, according to the species of the tree itself, the nature of the soil, exposure, and climate of the locality where it grows. Some varieties of the olive tree largely grown, because thought to be better suited to the special conditions of some districts, yield a fruit which imparts a bitter taste to the oil made from it; such oil, even when otherwise perfect, ranks as a second rate quality.

The highest quality of oil can only be obtained when the fruit is perfectly and uniformly sound, well ripened, gathered as soon as it has dropped from the trees, and crushed immediately with great attention. Should the fruit remain any time on the ground, particularly during wet weather, it deteriorates fast and gets an earthy taste; while if allowed to remain an undue length of time in the garners it heats, begins to decompose, and will yield only bad oil.

The process of making oil is as follows: The fruit is crushed in a stone mill, generally moved by water power; the pulp is then put into bags made of fiber, and a certain number of these bags, piled one upon another, are placed in a press, most frequently worked by hand; when pressure is applied, the oil flows down into a channel by which it is conveyed to a receptacle or tank.

When oil ceases to flow, tepid water is poured upon the bags to carry off oil retained by the bags. The pulp is then removed from the bags, ground again in the mill, then replaced in the bags, and pressed a second time. The water used in the process of making oil must be quite pure; the mill, press, bags, and vessels sweet and clean, as the least taint would ruin the quality of the oil produced.

The oil which has collected in the tank or receptacle just mentioned is removed day by day, and the water also drained off, as oil would suffer in quality if left in contact with water; the water also, which necessarily contains some oil mingled with it, is sent to a deposit outside, and at some distance from the crushing house, which is called the "Inferno," where it is allowed to accumulate, and the oil which comes to the surface is skimmed off from time to time. It is fit only for manufacturing purposes.

After the second pressing the olive-pulp is not yet done with; it is beaten up with water by mechanical agitators moved by water-power, and then the whole discharged into open-air tanks adjoining the crushing house. There the crushed olive kernels sink to the bottom, are gathered up and sold for fuel, fetching about 12 francs per 1,000 kilos, while the *debris* of the pulp is skimmed off the surface of the tank and again pressed in bags, yielding a considerable quantity of inferior oil, called "olio lavato," or washed oil, which, if freshly made, is even used for food by the poorer classes. The pulp then remaining has still further use. It is sold for treatment in factories by the sulphide of carbon process, and by this method yields from seven to nine per cent. of oil, of course suitable only for manufacturing purposes. Only the first two pressings yield oil which ranks as first quality, subject of course to the condition of the fruit being unexceptionable. New oil is allowed to rest a while in order to get rid of sediment; it is then clarified by passing through clean cotton wool, when it is fit for use.

The highest quality of olive oil for eating purposes should not only be free from the least taint in taste or smell, but possessed of a delicate, appetizing flavor. When so many favorable conditions are needed as to growth, maturity, and soundness of the fruit, coupled with great attention during the process of oil-making, it is not to be wondered at that by no means all or even the greater part of the oil produced in the most favored districts of Tuscany is of the highest quality. On the contrary, the bulk is inferior and defective.

These defective oils are largely dealt in both for home consumption and export, when price and not quality is the object.

In foreign countries there is always a market for inferior, defective olive oil for cooking purposes, etc., provided the price be low. Price and not quality is the object, so much so that when olive oil is dear, cotton-seed, ground-nut, and other oils are substituted, which bear the same relation to good olive oil that butterine and similar preparations do to real butter.

The very choicest qualities of pure olive oil are largely shipped from Leghorn to England, along with the very lowest qualities, often also adulterated.

The oil put into Florence flasks is of the latter kind. Many years back this was not the case, but now it is a recognized fact that nothing but the lowest quality of oil is put into these flasks; oil utterly unfit for food, and so bad that it is a mystery to what use it is applied in England. Importers in England of oil in these flasks care nothing, however, about quality; cheapness is the only desideratum.

The best quality of Tuscan olive oil is imported in London in casks, bottled there, and bears the name of the importers alone on the label. There is no difficulty in procuring in England the best Tuscan oil, which nothing produced elsewhere can surpass; but consumers who wish to get, and are willing to pay for, the best article must look to the name and reputation of the importers and the general excellence of all the articles they sell, which is the best guarantee they can have of quality.

BEESWAX AND ITS ADULTERATIONS.

Beeswax is a peculiar waxy substance secreted only by bees, and consisting of 80.2 per cent. carbon, 13.4 per cent. hydrogen, and 6.4 per cent. oxygen. It is a mixture of myricine, cerotic acid, and cerolein, the first of which is insoluble in boiling alcohol, the second is soluble in hot alcohol and crystallizes out on cooling, while the third remains dissolved in cold alcohol.

Although we are unable to produce real beeswax artificially, there are many imitations which are made use of to adulterate the genuine article, and their detection is a matter of considerable difficulty. Huebl says (*Dingl. Jour.*, p. 338) that the most reliable method of estimating the adulteration of beeswax is that proposed by Becker, and known as the saponification method.

The quantity of potassic hydrate required to saponify one gramme or 15 grains of pure beeswax varies from 97 to 107 milligrammes. Other kinds of wax and its substitutes require in some cases more and in others less of the alkali. This method would, however, lead to very erroneous conclusions if applied to a mixture of which some of the constituents have higher saponification numbers than beeswax and others higher, as one error would balance the other.

To avoid this, the quantity of alkali required to saponify the myricine is first ascertained, and then that required to saturate the free cerotic acid. In this way two numbers are obtained; and in an investigation of twenty samples of Austrian yellow beeswax, the author found these numbers stood to each other almost in the constant ratio of 1 to 3.70. Although this ratio cannot be considered as definitely established by so few experiments, it may serve as a guide in judging of the purity of beeswax.

The experiment is carried out as follows: 3 or 4 grammes of the wax that has been melted in water are put in 20 c.c. of neutral 95 per cent, alcohol, and warmed until the wax melts, when phenolphthaleine is added, and enough of an alcoholic solution of potash run in from a burette until on shaking it retains a faint but permanent red color. The burette used by the author is divided in 0.05 c.c. After adding 20 c.c. more of a half normal potash solution, it is heated on a water bath for ¾ hour. Then the uncombined excess of alkali is titrated with half normal hydrochloric acid. The alcohol must be tested as to its reaction before using it, and carefully neutralized with the acid of phenolphthalein.

To saturate the free acid in 1 gramme of wax requires 19 to 21 milligrammes of potassic hydrate, while 73 to 76 milligrammes more are necessary to saponify the myricine ether. The lower numbers in the one usually occur with low numbers for the other, so that the proportions remain 1 to 3.6 or 1 to 3.8.

For comparison he gives the following numbers obtained with one gramme of the more common adulterants:

	To neutralize the acid.	To convert the ether.	Total saponification.	Ratio.
Japanese wax	20	200	220	10
Carnauba wax	4	75	79	19
Tallow	4	176	180	44
Stearic acid	195	0	195	0/195
Rosin	110	1.6	112	0.015
Paraffine	0	0	0	0
Ceresine	0	0	0	0
Yellow beeswax	20	75	95	3.75

The author deduces the following conclusions as the results of these investigations:

1. If the numbers obtained lie between these limits, 19 to 21, 73 to 76, 92 to 97, and 3.6 to 3.8 respectively, it may be assumed that the beeswax is pure, provided it also corresponds to beeswax in its physical properties.

2. If the saponification figures fall below 92 and yet the ratio is correct, it is adulterated with some neutral substance like paraffine.

3. If the ratio is above 3.8, it is very probable that Japanese or carnauba wax or grease has been added.

4. If the ratio falls below 3.6, stearic acid or resin has been used as the adulterant.

PHENOL IN THE STEM, LEAVES, AND CONES OF PINUS SYLVESTRIS.

A DISCOVERY BEARING ON THE FLORA OF THE CARBONIFEROUS EPOCH AND THE FORMATION OF PETROLEUM.

By A.B. GRIFFITHS, Ph.D., F.C.S. Membre de la Societe Chimique de Paris, Medallist in Chemistry and Botany, etc.

Having found, in small quantities, alcohols of the C_nH_{2n-7} series, last summer, in the stem, acicular leaves, and cones of *Pinus sylvestris*, I wish in this paper to say a few words on the subject.

First of all, I took a number of cones, cut them up into small pieces, and placed them in a large glass beaker, then nearly filled it with distilled water, and heated to about 80° C., keeping the decoction at this temperature for about half an hour, I occasionally stirred with a glass rod, and then allowed it to cool, and filtered. This filtrate was then evaporated nearly to dryness, when a small quantity of six-sided prisms crystallized out, which subsequently were found to be the hydrate of phenol $(C_6H_5HO)_2H_2O$. Its melting point was found to be 17.2° C. Further, the crystals already referred to were dissolved in ether, and then allowed to evaporate, when long colorless needles were obtained, which, on being placed in a dry test tube and the tube placed in a water bath kept at 42° C., were found to melt; and on making a careful combustion analysis of these crystals, the following composition was obtained:

Carbon	76.6
Hydrogen	6.4
Oxygen	17.0
	100.0

This gives C_6H_6O, which is the formula for phenol.

On dissolving some of these crystals in water (excess) and adding ferric chloride, a beautiful violet color was imparted to the solution. To another aqueous solution of the crystals was added bromine water, and a white precipitate was obtained, consisting of tribromophenol. An aqueous solution of the crystals immediately coagulated albumen.

All these reactions show that the phenol occurs in the free state in the cones of this plant. In the same manner I treated the acicular leaves, and portions of the stem separately, both being previously cut up into small pieces, and from both I obtained phenol.

I have ascertained the relative amount of phenol in each part of the plant operated upon; by heating the stem with water at 80° C., and filtering, and repeating this operation until the aqueous filtrate gave no violet color with ferric chloride and no white precipitate with bromine water.

I found various quantities according to the age of the stem. The older portions yielding as much as 0.1021 per cent, while the young portions only gave 0.0654 per cent. The leaves yielding according to their age, 0.0936 and 0.0315 per cent.; and the cones also gave varying amounts, according to their maturity, the amounts varying between 0.0774 and 0.0293.

Two methods were used in the quantitative estimation of the amount of phenol. The first was the new volumetric method of M. Chandelon (*Bulletin de la Societe Chemique de Paris*, July 20, 1882; and *Deutsch-Americanishe Apotheker Zeitung*, vol. iii., No. 12, September 1, 1882), which I have found to be very satisfactory. The process depends on the precipitation of phenol by a dilute aqueous solution of bromine as tribromophenol. The second method was to extract, as already staled, a known weight of each part of the plant with water, until the last extract gives *no* violet color with ferric chloride, and no white precipitate with the bromine test (which is capable of detecting in a solution the 1/60000 part of phenol). The aqueous extract is at this point evaporated, then ether is added, and finally the ethereal solution is allowed to evaporate. The residue (phenol) is weighed directly, and from this the percentage can be ascertained. By this method of extraction, the oil of turpentine, resins, etc., contained in *Pinus sylvestris* do not pass into solution, because they are insoluble in water, even when boiling; what passes into solution besides phenol is a little tannin, which is practically insoluble in ether.

From this investigation it will be seen that phenol exists in various proportions in the free state in the leaves, stem, and cones of *Pinus sylvestris*, and as this compound is a product in the distillation of coal, and as geologists have to a certain extent direct evidence that the flora of the Carboniferous epoch was essentially crytogamous, the only phænogamous plants which constituted any feature in "the coal forests" being the coniferæ, and as coal is the fossil remains of that gigantic flora which contained phenol, I think my discovery of phenol in the coniferæ of the present day further supports, from a chemical point of view, the views of geologists that the coniferæ existed so far back in the world's history as the Carboniferous age.

I think this discovery also supports the theory that the origin of petroleum in nature is produced by moderate heat on coal or similar matter of a vegetable origin. For we know from the researches of Freund and Pebal (*Ann. Chem. Pharm.*, cxv. 19), that petroleum contains phenol and its homologues, and as I have found this organic compound in the coniferæ of to-day, it is probable that petroleum in certain areas has been produced from the conifers and the flora generally of some primæval forests. It is stated by numerous chemists that "petroleum almost always contains solid paraffin" and similar hydrocarbons. Professors Schorlemmer and Thorpe have found heptane in Pinus, which heptane yielded primary heptyl-alcohol, and methyl-pentyl-carbinol, exactly as the heptane obtained from petroleum does (*Annalen de Chemie*, ccxvii., 139, and clxxxviii., 249; and *Berichte der Deutschen Chemischen Gesellschaft*, viii., 1649); and, further, petroleum contains a large number of hydrocarbons which are found in coal. Again, Mendelejeff, Beilstein, and others (*Bulletin de la Societe Chemique de Paris*, No. 1, July 5, 1883), have found hydrocarbons of the—

$$C_nH_{2n2+},\ C_nH_{2n\text{-}6},$$

also hydrocarbons of the C_nH_{2n} series in the petroleum of Baku, American petroleum containing similar hydrocarbons.

I think all these facts give very great weight to the theory that petroleum is of organic origin.

On the other hand, Berthelot, from his synthetic production of hydrocarbons, believes that the interior of the globe contains alkaline metals in the *free* state, which yield acetylides in the presence of carbonic anhydride, which are decomposed into acetylene by aqueous vapor. But it has been already proved that acetylene may be polymerized, so as to produce aromatic carbides, or the derivatives of marsh gas, by the absorption of hydrogen. Berthelot's view, therefore, is too imaginative; for the presence of *free* alkaline metals in the earth's interior is an unproved and very improbable hypothesis. Byasson states that petroleum is formed by the action of water, carbonic anhydride, and sulphureted hydrogen upon incandescent iron. Mendelejeff thinks it is formed by the action of aqueous vapor upon carbides of iron; and in his article, "Petroleum, the Light of the Poor" (in this month's—February—number of *Good Words*), Sir Lyon Playfair, K.C.B., F.R.S., etc., holds opinions similar to those of Mendelejeff.

Taking in consideration the facts that solid paraffin is found in petroleum and is also found in coal, and from my own work that phenol exists in *Pinus sylvestris*, and has been found by others in coal which is produced from the decomposition of a flora containing numerous gigantic coniferæ allied to Pinus, and that petroleum contains phenol, and each (*i.e.*, petroleum and coal) contains a number of hydrocarbons common to both, I am inclined to think that the balance of evidence is in favor of the hypothesis that petroleum has been produced in nature from a vegetable source in the interior of the globe. Of course, there can be no practical or direct evidence as to the origin of petroleum; therefore "theories are the only lights with which we can penetrate the obscurity of the unknown, and they are to be valued just as far as they illuminate our path."

In conclusion, I think that there is a connecting link between the old pine and fir forest of bygone ages and the origin of petroleum in nature.—*Chemical News*.

THE SCHOOL OF PHYSICS AND CHEMISTRY OF PARIS.

Recently we paid a visit to the New Municipal School of Physics and Chemistry that the city of Paris founded in 1882, and that is now in operation in the large building of the old Rollin College. This establishment is one of those that supply a long-felt want of our time, and we are happy to make it known to our readers. The object for which it was designed was, in the intention of its founders, to give young people who have just graduated from the higher primary schools special instruction which shall be at once scientific and practical, and which shall fit them to become engineers or superintendents in laboratories connected with chemical and physical industries. To reach such a result it has been necessary to give the teaching an essentially practical character, by permitting the pupils to proceed of themselves in manipulations in well fitted laboratories. It is upon this important point that we shall now more particularly dwell; but, before making known the general mode of teaching, we wish to quote a few passages from the school's official programme:

"Many questions and problems, in physics as well as in chemistry, find their solution only with the aid of mathematics and mechanics. It therefore became necessary, through lectures bearing upon the useful branches of mathematics, to supplement the too limited ideas that pupils brought with them on entering the school. Mathematics and mechanics are therefore taught here at the same time with physics and chemistry, but they are merely regarded in the light of auxiliaries to the latter.

"The studies extend over three years. Each of the three divisions (1st, 2d, and 3d years) includes thirty pupils.

"During the three first semesters, pupils of the same grade attend lectures and go through manipulations in chemistry, physics, mathematics, and draughting in common.

"At the end of the third semester they are divided into 10 physical and 20 chemical students.

"From this moment, although certain courses still remain wholly or partially common to the two categories of pupils (physical and chemical), the same is no longer the case with regard to the practical exercises, for the physical students thereafter manipulate only in the physical laboratories, and the chemical only in the chemical laboratories; moreover, the manipulations acquire a greater importance through the time that is devoted to them.

"At each promotion the three first semesters are taken up with general and scientific studies. Technical applications are the subject of the lectures and exercises of the three last semesters. At the end of the third year certificates are given to those pupils who have undergone examination in a satisfactory manner, and diplomas to such as have particularly distinguished themselves."

When pupils have been received at the school, after passing the necessary examination, their time of working is divided up between lectures and questionings and different laboratory manipulations.

The course of lectures on general and applied physics comprises hydrostatics and heat (Prof. Dommer), electricity and magnetism (Prof. Hospitalier), and optics and acoustics (Prof. Baille). Lectures on general chemistry are delivered by Profs. Schultzenberger and Henninger, on analytical chemistry by Prof. Silva, on chemistry applied to the industries by Prof. Henninger (for inorganic) and Prof. Schultzenberger (for organic). The lectures on pure and applied mathematics and mechanics are delivered by Profs. Levy and Roze.

GENERAL VIEW OF A LABORATORY AT THE PARIS SCHOOL OF PHYSICS AND CHEMISTRY.

The pupils occupy themselves regularly every day, during half the time spent at the school, with practical work in analytical and applied chemistry and physics and general chemistry. This practical work is a complement to the various lectures, and has reference to what has been taught therein. Once or twice per week the pupils spend three hours in a shop devoted to wood and metal working, and learn how to turn, forge, file, adjust, etc.

The school's cabinets are now provided with the best instruments for study, and are daily becoming richer therein. The chemical laboratories are none the less remarkably organized. In the accompanying cut we give a view of one of these—the one that is under the direction of Mr. Schultzenberger, professor of chemistry and director of the new school. Each pupil has his own place in front of a large table provided with a stand whereon he may arrange all the products that he has to employ. Beneath the work-table he has at his disposal a closet in which to place his apparatus after he is through using them. Each pupil has in front of him a water-faucet, which is fixed to a vertical column and placed over a sink. Alongside of this faucet there is a double gas burner, which may be connected with furnaces and heating apparatus by means of rubber tubing. A special hall, with draught and ventilation, is set apart for precipitations by sulphureted hydrogen and the preparation of chlorine and other ill-smelling and deleterious gases. The great amount of light and space provided secure the best of conditions of hygiene to this fine and vast laboratory, where young people have all the necessary requisites for becoming true chemists.—*La Nature*.

DUST-FREE SPACES.[1]

Within the last few years a singular interest has arisen in the subject of dust, smoke, and fog, and several scientific researches into the nature and properties of these phenomena have been recently conducted. It so happened that at the time I received a request from the secretary of this society to lecture here this afternoon I was in the middle of a research connected with dust, which I had been carrying on for some months in conjunction with Mr. J.W. Clark, Demonstrator of Physics in University College, Liverpool, and which had led us to some interesting results. It struck me that possibly some sort of account of this investigation might not be unacceptable to a learned body such as this, and accordingly I telegraphed off to Mr. Moss the title of this afternoon's lecture. But now that the time has come for me to approach the subject before you, I find myself conscious of some misgivings, and the misgivings are founded upon this ground: that the subject is not one that lends itself easily to experimental demonstration before an audience. Many of the experiments can only be made on a small scale, and require to be watched closely. However, by help of diagrams and by not confining myself too closely to our special investigation, but dealing somewhat with the wider subject of dust in general, I may hope to render myself and my subject intelligible if not very entertaining.

First of all, I draw no distinction between "dust" and "smoke." It would be possible to draw such a distinction, but it would hardly be in accordance with usage. Dust might be defined as smoke which had settled, and the term smoke applied to solid particles still suspended in the air. But at present the term "smoke" is applied to solid particles produced by combustion only, and "dust" to particles owing their floating existence to some other cause. This is evidently an unessential distinction, and for the present I shall use either term without distinction, meaning by dust or smoke, solid particles floating in the air. Then "fog"; this differs from smoke only in the fact that the particles are liquid instead of solid. And the three terms dust, smoke, and fog, come to much the same thing, only that the latter term is applied when the suspended particles are liquid. I do not think, however, that we usually apply the term "fog" when the liquid particles are pure water; we call it then mostly either mist or cloud. The name "fog," at any rate in towns, carries with it the idea of a hideous, greasy compound, consisting of smoke and mist and sulphur and filth, as unlike the mists on a Highland mountain as a country meadow is unlike a city slum. Nevertheless, the finest cloud or mist that ever existed consists simply of little globules of water suspended in air, and thus for our present purpose differs in no important respect from fog, dust, and smoke. A cloud or mist is, in fact, fine water-dust. Rain is coarse water-dust formed by the aggregation of smaller globules, and varying in fineness from the Scotch mist to the tropical deluge. It has often been asked how it is that clouds and mists are able to float about when water is so much heavier (800 times heavier) than air. The answer to this is easy. It depends on the resistance or viscosity of fluids, and on the smallness of the particles concerned. Bodies falling far through fluids acquire a "terminal velocity," at which they are in stable equilibrium—their weight being exactly equal to the resistance—and this terminal velocity is greater for large particles than for small; consequently we have all sorts of rain velocity, depending on the size of the drops; and large particles of dust settle more quickly than small. Cloud-spherules are falling therefore, but falling very slowly.

To recognize the presence of dust in air there are two principal tests; the first is, the obvious one of looking at it with plenty of light, the way one is accustomed to look for anything else; the other is a method of Mr. John Aitken's, viz., to observe the condensation of water vapor.

Take these in order. When a sunbeam enters a darkened room through a chink, it is commonly said to be rendered visible by the motes or dust particles dancing in it; but of course really it is not the motes which make the sunbeam visible, but the sunbeam the motes. A dust particle is illuminated like any other solid screen, and is able to send a sufficient fraction of light to our eyes to render itself visible. If there are no such particles in the beam—nothing but clear, invisible air—then of course nothing is seen, and the beam plunges on its way quite invisible to us unless we place our eyes in its course. In other words, to be visible, light must enter the eye. (A concentrated beam was passed through an empty tube, and then ordinary air let in.)

The other test, that of Mr. Aitken, depends on the condensation of steam. When a jet of steam finds itself in dusty air, it condenses around each dust particle as a nucleus, and forms the white visible cloud popularly called steam. In the absence of nuclei Mr. Aitken has shown that the steam cannot condense until it is highly supersaturated, and that when it does it condenses straight into rain—that is, into large drops which fall. The condensation of steam is a more delicate test for dust than is a beam of light. A curious illustration of the action of nuclei in condensing moisture has just occurred to me, in the experiment—well known to children—of writing on a reasonably clean window-pane with, say, a blunt wooden point, and then breathing on the glass; the condensation of the breath renders the writing legible. No doubt the nuclei are partially wiped away by the writing, and the moisture will condense into larger drops with less light-scattering power along the written lines than over the general surface of the pane where the nuclei are plentiful, and the drops therefore numerous and minute. Mr. Aitken points out that if the air were ever quite dustless, vapor could not condense, but the air would gradually get into a horribly supersaturated condition, soaking all our walls and clothes, dripping from every leaf, and penetrating everywhere, instead of falling in an honest shower, against which umbrellas and slate roofs are some protection. But let us understand what sort of dust it is which is necessary for this condensing process. It is not the dust and smoke of towns, it is not the dust of a country road; all such particles as these are gross and large compared with those which are able to act as condensers of moisture. The fine dust of Mr. Aitken exists everywhere, even in the upper regions of the atmosphere; many of its particles are of ultra-microscopic fineness, one of them must exist in every raindrop, nay, even in every spherule of a mist or cloud, but it is only occasionally that one can find them with the microscope. It is to such particles as these that we owe the blue of the sky, and yet they are sufficiently gross and tangible to be capable of being filtered out of the air by a packed mass of cotton-wool. Such dust as this, then, we need never be afraid of being without. Without it there could be no rain, and existence would be insupportable, perhaps impossible; but it is not manufactured in towns; the sea makes it; trees and wind make it; but the kind of dust made in towns rises only a few hundred yards or so into the atmosphere, floating as a canopy or pall over those unfortunate regions, and sinks and settles most of it as soon as the air is quiet, but scarcely any of it ever rises into the upper regions of the atmosphere at all.

Dust, then, being so universally prevalent, what do I mean by dust-free spaces? How are such things possible? And where are they to be found? In 1870 Dr. Tyndall was examining dusty air by means of a beam of light in which a spirit-lamp happened to be burning, when he noticed that from the flame there poured up torrents of apparently thick black smoke. He could not think the flame was really smoky, but to make sure he tried, first a Bunsen gas flame and then a hydrogen flame. They all showed the same effect, and smoke was out of the question. He then used a red-hot poker, a platinum wire ignited by an electric current, and ultimately a flask of hot water, and he found that from all warm bodies examined in dusty air by a beam of light the upstreaming convection currents were dark. Now, of course smoke would behave very differently. Dusty air itself is only a kind of smoke, and it looks bright, and the thicker the smoke the brighter it looks; the blackness is simply the utter absence of smoke; there is nothing at all for the light to illuminate, accordingly we have the blankness of sheer invisibility. Here is a flame burning under the beam, and, to show what real smoke looks like, I will burn also this spirit lamp filled with turpentine instead of alcohol. *Why* the convention currents were free from dust was unknown; Tyndall thought the dust was burnt and consumed; Dr. Frankland thought it was simply evaporated.

In 1881 Lord Rayleigh took the matter up, not feeling satisfied with these explanations, and repeated the experiment very carefully. He noted several new points, and hit on the capital idea of seeing what a cold body did. From the cold body the descending current was just as dark and dust-free as from a warm body. Combustion and evaporation explanations suffered their death-blow. But he was unable to suggest any other explanation in their room, and so the phenomenon remained curious and unexplained.

In this state Mr. Clark and I took the matter up last summer, and critically examined all sorts of hypotheses that suggested themselves, Mr. Clark following up the phenomena experimentally with great ingenuity and perseverance. One hypothesis after another suggested itself, seemed hopeful for a time, but ultimately had to be discarded. Some died quickly, others lingered long. In the examination of one electrical hypothesis which suggested itself we came across various curious phenomena which we hope still to follow up.[2] It was some months before what we now believe to be the true explanation began to dawn upon us. Meanwhile we had acquired various new facts, and first and foremost we found that the dark plane rising from a warm body was only the upstreaming portion of a dust-free *coat* perpetually being renewed on the surface of the body. Let me describe the appearance and mode of seeing it by help of a diagram. (For full description see *Philosophical Magazine* for March, 1884.)

Surrounding all bodies warmer than the air is a thin region free from dust, which shows itself as a dark space when examined by looking along a cylinder illuminated transversely, and with a dark background. At high temperatures the coat is thick; at very low temperatures it is absent, and dust then rapidly collects on the rod. On a warm surface only the heavy particles are able to settle—there is evidently some action tending to drive small bodies away. An excess of temperature of a degree or two is sufficient to establish this dust-free coat, and it is easy to see the dust-free plane rising from it. The appearances may also be examined by looking along a cylinder *toward* the source of light, when the dust-free spaces will appear brighter than the rest. A rod of electric light carbon warmed and fixed horizontally across a bell-jar full of dense smoke is very suitable for this experiment, and by means of a lens the dust-free regions may be thus projected on to a screen. Diminished pressure makes the coat thicker. Increased pressure makes it thinner. In hydrogen it is thicker, and in carbonic acid thinner, than in air. We have also succeeded in observing it in liquids—for instance, in water holding fine rouge in suspension, the solid body being a metal steam tube. Quantitative determinations are now in progress.

Fig. 1 shows the appearance when looking along a copper or carbon rod laterally illuminated; the paths of the dust particles are roughly indicated. Fig. 2 shows the coat on a semi-cylinder of sheet copper with the concave side turned toward the light.

It is difficult to give the full explanation of the dust free spaces in a few words, but we may say roughly that there is a molecular bombardment from all warm surfaces by means of which small suspended bodies get driven outward and kept away from the surface. It is a sort of differential

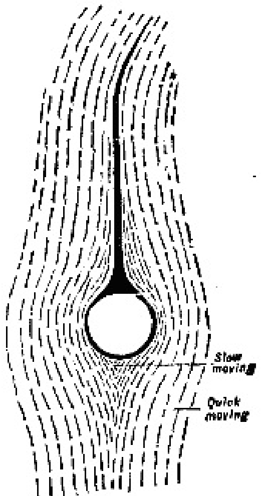


Fig. 1

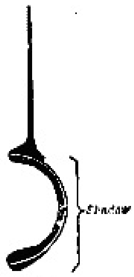


Fig. 2

bombardment of the gas molecules on the two faces of a dust particle somewhat analogous to the action on Mr. Crookes' radiometer vanes. Near cold surfaces the bombardment is very feeble, and if they are cold enough it appears to act toward the body, driving the dust inward—at any rate, there is no outward bombardment sufficient to keep the dust away, and bodies colder than the atmosphere surrounding them soon get dusty. Thus if I hold this piece of glass in a magnesium flame, or in a turpentine or camphor flame, it quickly gets covered with smoke—white in the one case, black in the other. I take two conical flasks with their surfaces blackened with camphor black, and filling one with ice, the other with boiling water, I cork them and put a bell jar over them, under which I burn some magnesium wire; in a quarter of an hour or so we find that the cold one is white and hoary, the hot one has only a few larger specks of dust on it, these being of such size that the bombardment was unable to sustain their weight, and they have settled by gravitation. We thus see that when the air in a room is warmer than the solids in it—as will be the case when stoves, gas-burners, etc., are used—things will get very dusty; whereas when walls and objects are warmer than the air—as will be the case in sunshine, or when open fireplaces are used, things will tend to keep themselves more free from dust. Mr. Aitken points out that soot in a chimney is an illustration of this kind of deposition of dust; and as another illustration it strikes me as just possible that the dirtiness of snow during a thaw may be partly due to the bombardment on to the cold surface of dust out of the warmer air above. Mr. Aitken has indeed suggested a sort of practical dust or smoke filter on this principle, passing air between two surfaces—one hot and one cold—so as to vigorously bombard the particles on to the cold surface and leave the air free.

But we have found another and apparently much more effectual mode of clearing air than this. We do it by discharging electricity into it. It is easily possible to electrify air by means of a point or flame, and an electrified body has this curious property, that the dust near it at once aggregates together into larger particles. It is not difficult to understand why this happens; each of the particles becomes polarized by induction, and they then cling together end to end, just like iron filings near a magnet. A feeble charge is often sufficient to start this coagulating action. And when the particles have grown into big ones, they easily and quickly fall. A stronger charge forcibly drives them on to all electrified surfaces, where they cling. A fine water fog in a bell jar, electrified, turns first into a coarse fog or Scotch mist, and then into rain. Smoke also has its particles coagulated, and a space can thus be cleared of it. I will illustrate this action by making some artificial fogs in a bell-jar furnished with a metal point. First burn some magnesium wire, electrify it by a few turns of this small Voss machine, and the smoke has become snow; the particles are elongated, and by pointing to the charged rod indicate the lines of electrostatic force very beautifully; electrify further, and the air is perfectly clear. Next burn turpentine, and electrify gently; the dense black smoke coagulates into black masses over an inch long; electrify further, and the glass is covered with soot, but the air is clear. Turpentine smoke acts very well, and can be tried on a larger scale; a room filled with turpentine smoke, so dense that a gas-light is invisible inside it, begins to clear in a minute or two after the machine begins to turn, and in a quarter of an hour one can go in and find the walls thickly covered with stringy blacks, notably on the gas-pipes and everything most easily charged by induction. Next fill a bell-jar full of steam, and electrify, paying attention to insulation of the supply point in this case. In a few seconds the air looks clear, and turning on a beam of light we see the globules of water dancing about, no longer fine and impalpable, but separately visible and rapidly falling. Finally, make a London fog by burning turpentine and sulphur, adding a little sulphuric acid, either directly as vapor or indirectly by a trace of nitric oxide, and then blowing in steam. Electrify, and it soon becomes clear, although it lakes a little longer than before; and on removing the bell-jar we find that even the smell of SO_2 has disappeared, and only a little vapor of turpentine remains. Similarly we can make a Widnes fog by sulphureted hydrogen, chlorine, sulphuric acid, and a little steam. Probably the steam assists the clearing when gases have to be dealt with. It may be possible to clear the air of tunnels by simply discharging electricity into the air—the electricity being supplied by Holtz machines, driven say by small turbines—a very handy form of power, difficult to get out of order. Or possibly some hydro-electric arrangement might be devised for the locomotive steam to do the work. I even hope to make some impression on a London fog, discharging from lightning conductors or captive balloons carrying flames, but it is premature to say anything about this matter yet. I have, however, cleared a room of smoke very quickly with a small hand machine.

It will naturally strike you how closely allied these phenomena must be to the fact of popular science that "thunder clears the air." Ozone is undoubtedly generated by the flashes, and may have a beneficial effect, but the dust-coagulating and dust-expelling power of the electricity has a much more rapid effect, though it may not act till the cloud is discharged. Consider a cloud electrified slightly; the mists and clouds in its vicinity begin to coagulate, and go on till large drops are formed, which may be held up by electrical action, the drops dancing from one cloud to another and thus forming the very dense thunder cloud. The coagulation of charged drops increases the potential, as Prof. Tait points out, until at length—flash—the cloud is discharged, and the large drops fall in a violent shower. Moreover, the rapid excursion to and fro of the drops may easily have caused them to evaporate so fast as to freeze, and hence we may get hail.

While the cloud was electrified, it acted inductively on the earth underneath, drawing up an opposite charge from all points, and thus electrifying the atmosphere. When the discharge occurs this atmospheric electrification engages with the earth, clearing the air between, and driving the dust and germs on to all exposed surfaces. In some such way also it may be that "thunder turns milk sour," and exerts other putrefactive influences on the bodies which receive the germs and dust from the air.

But we are now no longer on safe and thoroughly explored territory. I have allowed myself to found upon a basis of experimental fact, a superstructure of practical application to the explanation of the phenomena of nature and to the uses of man. The basis seems to me strong enough to bear most of the superstructure, but before being sure it will be necessary actually to put the methods into operation and to experiment on a very large scale. I hope to do this when I can get to a suitable place of operation. Liverpool fogs are poor affairs, and not worth clearing off. Manchester fogs are much better and more frequent, but there is nothing to beat the real article as found in London, and in London if possible I intend to rig up some large machines and to see what happens. The underground railway also offers its suffocating murkiness as a most tempting field for experiment, and I wish I were able already to tell you the actual result instead of being only in a position to indicate possibilities. Whether anything comes of it practically or not, it is an instructive example of how the smallest and most unpromising beginnings may, if only followed up long enough, lead to suggestions for large practical application. When we began the investigation into the dust-free spaces found above warm bodies, we were not only without expectation, but without hope or idea of any sort, that anything was likely to come of it; the phenomenon itself possessed its own interest and charm.

And so it must ever be. The devotee of pure science never has practical developments as his primary aim; often he not only does not know, but does not in the least care whether his researches will ever lead to any beneficial result. In some minds this passive ignoring of the practical goes so far as to become active repulsion; so that some singularly biased minds will not engage in anything which seems likely to lead to practical use. I regard this as an error, and as the sign of a warped judgment, for after all man is to us the most important part of nature; but the system works well nevertheless, and the division of labor accomplishes its object. One man investigates nature impelled simply by his own genius, and because he feels he cannot help it; it never occurs to him to give a reason for or to justify his pursuits. Another subsequently utilizes his results, and applies them to the benefit of the race. Meanwhile, however, it may happen that the yet unapplied and unfruitful results evoke a sneer, and the question: "Cui bono?" the only answer to which question seems to be: "No one is wise enough to tell beforehand what gigantic developments may not spring from the most insignificant fact."

[1]

Lecture to the Royal Dublin Society by Dr. Oliver J. Lodge, April 2, 1884.

[2]

For instance, the electric properties of crystals can be readily examined in illuminated dusty air; the dust grows on them in little bushes and marks out their poles and neutral regions, without any need for an electrometer. Magnesia smoke answers capitally.

TELEPHONY AND TELEGRAPHY ON THE SAME WIRES SIMULTANEOUSLY.

For the last eighteen months a system has been in active operation in Belgium whereby the ordinary telegraph wires are used to convey telephonic communications at the same time that they are being employed in their ordinary work of transmitting telegraphic messages. This system, the invention of M. Van Rysselberghe, whose previous devices for diminishing the evil effects of induction in the telephone service will be remembered, has lately been described in the *Journal Telegraphique* of Berne, by M.J. Banneux of the Belgian Telegraph Department. Our information is derived from this article and from others by M. Hospitalier.

The method previously adopted by Van Rysselberghe, to prevent induction from taking place between the telegraph wires and those running parallel to them used for telephone work, was briefly as follows: The system of sending the dots and dashes of the code—usually done by depressing and raising a key which suddenly turns on the current and then suddenly turns it off—was modified so that the current should rise gradually and fall gradually in its strength by the introduction of suitable resistances. These were introduced into the circuit at the moment of closing or opening by a simple automatic arrangement worked exactly as before by a key. The result, of the gradual opening and gradual closing of the circuit was that the current attained its full strength gradually instead of suddenly, and died away also gradually. And as induction from one wire to another depends not on the strength of the current, but on the rate at which the strength changes, this very simple modification had the effect of suppressing induction. Later Van Rysselberghe changed these arrangements for the still simpler device of introducing permanently into the circuit either condensers or else electro-magnets having a high coefficient of self-induction. These, as is well known to all telegraphic engineers, retard the rise or fall of an electric current; they fulfill the conditions required for the working of Van Rysselberghe's method better than any other device.

Having got thus far in his devices for destroying induction from one line to another, Van Rysselberghe saw that, as an immediate consequence, it might be concluded that, if the telegraph currents were thus modified and graduated so that they produced no induction in a neighboring telephone line, they would produce no sound in the telephone if that instrument were itself joined up in the telegraph line. And such was found to be case. Why this is so will be more readily comprehended if it be remembered that a telephone is sensitive to the changes in the strength of the current if those changes occur with a frequency of some hundreds or in some cases thousands of times *per second*. On the other hand, currents vibrating with such rapidity as this are utterly incompetent to affect the moving parts of telegraphic instruments, which cannot at the most be worked so as to give more than 200 to 800 separate signals *per minute*.

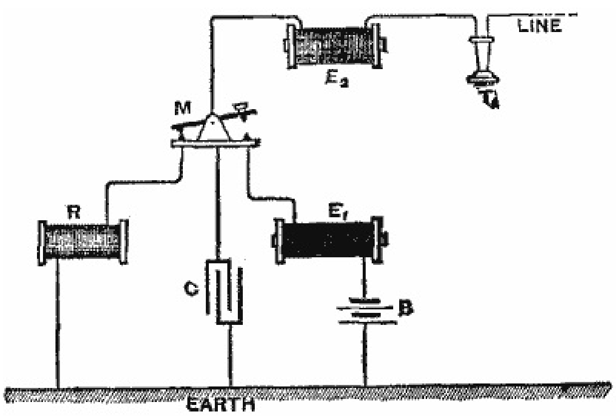


Fig. 1

The simplest arrangement for carrying out this method is shown in Fig. 1, which illustrates the arrangements at one end of a line. M is the Morse key for sending messages, and is shown as in its position of rest for receiving. The currents arriving from the line pass first through a "graduating" electromagnet, E_2, of about 500 ohms resistance, then through the key, thence through the electromagnet, R, of the receiving Morse instrument, and so to the earth. A condenser, C, of 2 microfarads capacity is also introduced between the key and earth. There is a second "graduating" electromagnet, E_1, of 500 ohms resistance introduced between the sending battery, B, and the key. When the key, M, is depressed in order to send a signal, the current from the battery must charge the condenser, C, and must magnetize the cores of the two electromagnets, E_1 and E_2, and is thereby retarded in rising to its full strength. Consequently no sound is heard in a telephone, T, inserted in the line-circuit. Neither the currents which start from one end nor those which start from the other will affect the telephones inserted in the line. And, if these currents do not affect telephones in the actual line, it is clear that they will not affect telephones in neighboring lines. Also the telephones so inserted in the main line might be used for speaking to one another, though the arrangement of the telephones in the same actual line would be inconvenient. Accordingly M. Van Rysselberghe has devised a further modification in which a separate branch taken from the telegraph line is made available for the telephone service. To understand this matter, one other fact must be explained. Telephonic conversation can be carried on, even though the actual metallic communication be severed by the insertion of a condenser. Indeed, in quite the early days of the Bell telephone, an operator in the States used a condenser in the telegraph line to enable him to talk through the wire. If a telephonic set at T_1 (Fig. 2) communicate through the line to a distant station, T_2, through a condenser, C, of a capacity of half a microfarad, conversation is still perfectly audible, provided the telephonic system is one that acts by induction currents. And since in this case the interposition of the condenser prevents any continuous flow of current through the line, no perceptible weakening will be felt if a shunt S, of as high a resistance as 500 ohms and of great electromagnetic rigidity, that is to say, having a high coefficient of self-induction, be placed across the circuit from line to earth. In this, as well as in the other figures, the telephones indicated are of the Bell pattern, and if set up as shown in Fig. 2, without any battery, would be used both as transmitter and receiver on Bell's original plan. But as a matter of fact any ordinary telephone might be used. In practice the Bell telephone is not advantageous as a transmitter, and has been abandoned except for receiving; the Blake, Ader, or some other modification of the microphone being used in conjunction with a separate battery. To avoid complication in the drawings, however, the simplest case is taken. And it must be understood that instead of the single instrument shown at T_1 or T_2, a complete set of telephonic instruments, including transmitter, battery, induction-coil, and receiver or receivers, may be substituted. And if a shunt, S, of 500 ohms placed across the circuit makes no difference to the talking in the telephones because of the interposition of the separating condenser, C, it will readily be understood that a telegraphic system properly "graduated," and having also a resistance of 500 ohms, will not affect the telephones if interposed in the place of S. This arrangement is shown in Fig. 3, where the "graduated" telegraph-set from Fig. 1 is intercalated into the telephonic system of Fig. 2, so that both work simultaneously, but independently, through a single line. The combined system at each end of the line will then consist of the telephone-set, T_1, the telegraph instruments (comprising battery, B_1, key, M_1 and Morse receiver, R_1), the "graduating" electromagnets, E_1, and E_2, the "graduating" condenser, C_1, and the "separating" condenser, C_2. It was found by actual experiments that the same arrangement was good for lines varying from 28 to 200 miles in length. A single wire between Brussels, Ghent, and Ostend is now regularly employed for transmission by telegraph of the ordinary messages and of the telemeteorographic signals between the two observatories at those places, and by telephone of verbal simultaneous correspondence, for one of the Ghent newspapers. A still more interesting arrangement is possible, and is indicated in Fig. 4. Here a separating condenser is introduced at the intermediate station at Ghent between earth and the line, which is thereby cut into two independent sections for telephonic purposes, while remaining for telegraphic purposes a single undivided line between Brussels and Ostend. Brussels can telegraph to Ostend, or Ostend to Brussels, and at the same time the wire can be used to telephone between Ghent and Ostend, or between Ghent and Brussels, or both sections may be simultaneously used.

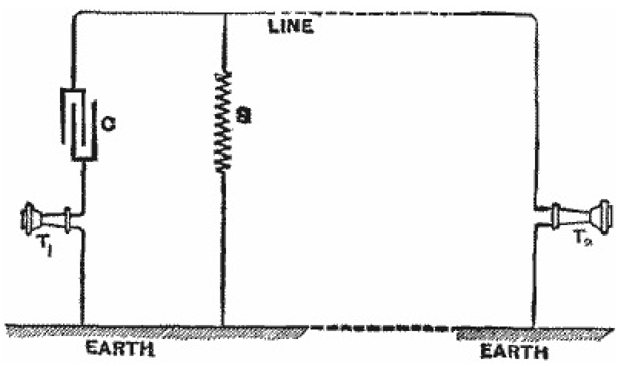


Fig. 2

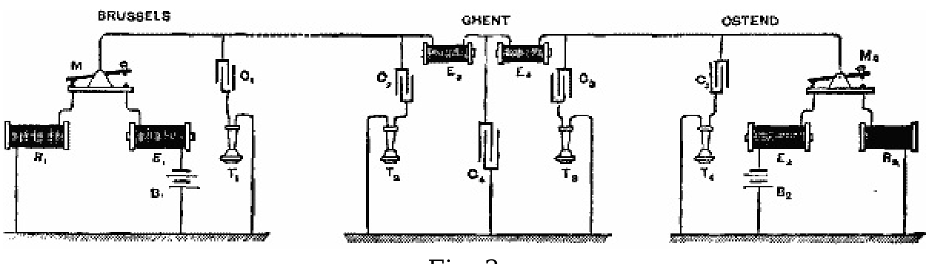


Fig. 3

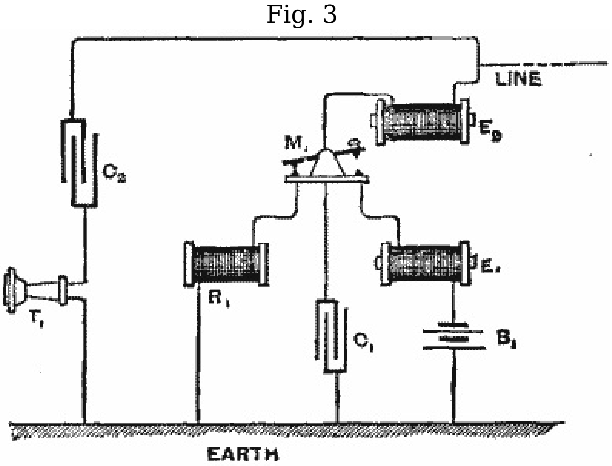


Fig. 4

It would appear, then, that M. Van Rysselberghe has made an advance of very extraordinary merit in devising these combinations. We have seen in recent years how duplex telegraphy superseded single working, only to be in turn superseded by the quadruplex system. Multiplex telegraphy of various kinds has been actively pursued, but chiefly on the other side of the Atlantic rather than in this country, where our fast-speed automatic system has proved quite adequate hitherto. Whether we shall see the adoption in the United Kingdom of Van Rysselberghe's system is, however, by no means certain. The essence of it consists in retarding the telegraphic signals to a degree quite incompatible with the fast-speed automatic transmission of telegraphic messages in which our Post Office system excels. We are not likely to spoil our telegraphic system for the sake of simultaneous telephony, unless there is something to be gained of much greater advantage than as yet appears.—*Nature*.

THE ELECTRIC MARIGRAPH.

For registering the height of the tide at every instant, hydrographic services generally adopt quite a simple marigraph. The apparatus consists in principle of a counterpoised float whose rising and falling motion, reduced to a tenth, by means of a system of toothed wheels, is transmitted to a pencil which moves in front of a vertical cylinder. This cylinder itself moves around its axis by means of a clockwork mechanism, and accomplishes one entire revolution every twenty-four hours. By this means is obtained a curve of the tide in which the times are taken for abscisses and the heights of the sea for ordinates. However little such marigraphs have had to be used, great defects have been recognized in them. When we come to change the sheet on the cylinder (and such change should be made at least once every fifteen days), there is an interruption in the curve. It is necessary, besides, to perform office work of the most detailed kind in order to refer to the same origin all these curves, which are intercrossed and often superposed in certain parts upon the original sheet. In order to render such a disentanglement possible, it is indispensable to mark by hand, at least once every twenty-four hours, upon each curve, the date of the day corresponding to it. It is equally useful to verify the exactness of the indications given by the apparatus by making readings several times a day on a scale of tides placed alongside of the float. Nine times out of ten the rise of the waves renders such readings very difficult and the control absolutely illusory.

All these conditions united, as well as others that we neglect in this brief discussion, necessitate a surveillance at every instant. The result is that these marigraphs must be installed in a special structure, very near the bank, so as to be reachable at all times, and that the indications that they give are always vitiated by error, since the operation is performed upon a level at which are exerted disturbing influences that are not found at a kilometer at sea. It were to be desired that the float could be isolated by placing it a certain distance from the shore, and transmit its indications, by meant of a play of currents, to a registering apparatus situated upon *terra firma*.

In the course of one of his lectures published in the December number (1883) of the *Elektrotechnische Zeitschrift*, Mr. Von Hefner-Alteneck tells us that such a desideratum has been supplied by the firm of Siemens & Halske. This marigraph, constructed on an order of the German Admiralty, gives the level of the sea every ten minutes with an approximation of 0.12 per cent., and that too for a difference of 8 meters between the highest and lowest sea. The apparatus consists, as we said above, of a float and registering device, connected with each other by means of a cable. This latter is formed of three ordinary conductors covered with gutta percha and surrounded with a leaden sheath, which latter is itself protected against accident by means of a strong covering of iron wire and hemp. The return is effected through the earth. We shall enter into details concerning each of these two apparatus in-succession, by beginning with the float, of which Fig. 1 gives a general view, and Fig. 2 a diagrammatic sketch. The float moves in a cast iron cylinder, having at its lower part a large number of apertures of small diameter, so that the motion of the waves does not perceptibly influence the level of the water in the interior of the cylinder. It is attached to a copper ribbon, B, whose other extremity is fixed to the drum, T. The ribbon winds around the latter in the rising motion of the float, owing to a spiral spring arranged so as to act upon the drum. The tension of this spring goes on increasing in measure as the float descends.

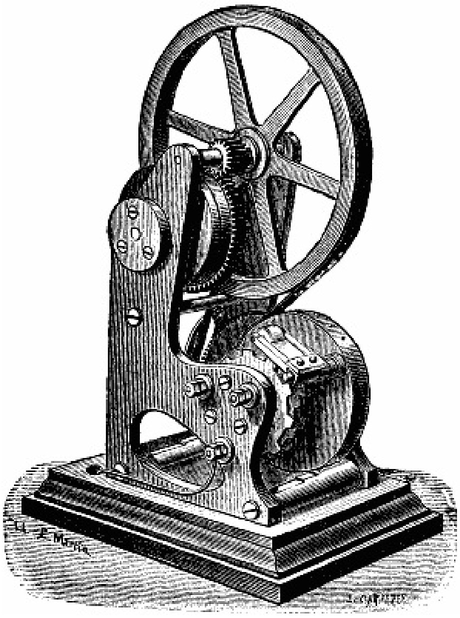


FIG. 1.—FLOAT OF SIEMENS AND HALSKE'S MARIGRAPH.

This difference in tension is utilized for balancing at every instant the weight of the ribbon unwound, and thus causing the float to immerse itself in the water to a constant degree. The ribbon, B, is provided throughout its length with equidistant apertures that exactly correspond to tappets that project from the circumference of the wheel, R. When the float moves its position, the wheel, R, begins to turn and carries along in doing so the pinion, *w*, which revolves over the toothed wheels, s_1, s_2, and s_3. The thickness of w is equal to that of the three wheels, s_1, s_2, and s_3, and a special spring secures at every instant an intimate contact between the pinion and the said wheels. These latter are insulated from each other and from the axle upon which they are keyed, and communicate, each of them, with conductors, I., II., and III. They are so formed and mounted that, in each of them, the tooth in one corresponds to the interspace in the two others. As a result of this, in the motion of the pinion, *w*, the latter is never in contact with but one of the three wheels, s_1, s_2, and s_3.

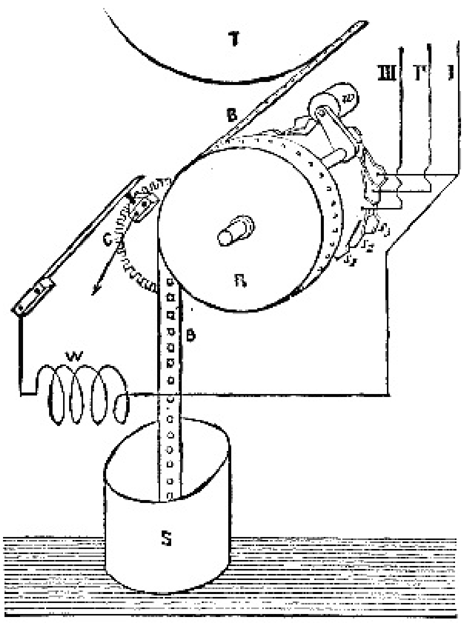


FIG. 2.

If we add that the lines, I., II., and III. are united at the shore station with one of the poles of a pile whose other pole is connected with the earth, and that w communicates with the earth through the intermedium of R, and the body of the apparatus, it is easy to see that in a vertical motion of the float in one direction we shall have currents succeeding each other in the order I., II., III., I., II., etc., while the order will become III., II., I., III., II., etc., if the direction of the float's motion happen to change.

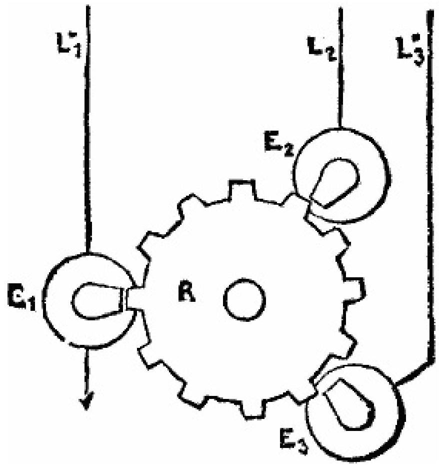


FIG. 3.

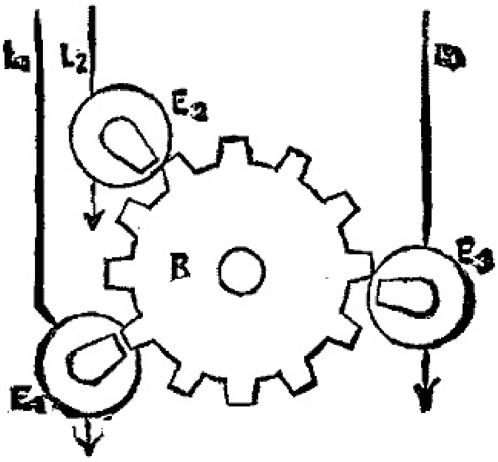


FIG. 4.

In order to understand how a variation in currents of this kind can be applied in general for producing a rotary motion in the two directions, it will only be necessary to refer to Figs. 3 and 4. The conductors, L_1, L_2, and L_3 communicate with the bobbins of three electromagnets, E_1, E_2, and E_3, whose poles are bent at right angles to the circumference of the wheel, R. There is never but one pole opposite a tooth. The distance between two consecutive poles must be equal to a multiple of the pitch increased (Fig. 3) or diminished (Fig. 4) by one-third thereof. It will be seen upon a simple inspection of the figures that R will revolve in the direction of the hands of a watch when the currents follow the order L_1, L_2, L_3, etc., in the case shown in Fig. 3, while in the case shown in Fig. 4 the rotary motion will be in the contrary direction for this same order of currents. But, in both cases, and this is the important point, the direction of rotation changes when the order in the succession of currents; is inverted. Fig. 6 gives a perspective view of the registering apparatus, and Fig. 5 represents it in diagram. It will be at once seen that, the toothed wheel, *r*, is reduced to its simplest expression, since it consists of two teeth only. The electro-magnets are arranged at an angle of 120°, and for a change of current the wheel, *r*, describes an angle of 60°, that is to say, a sixth of a circumference. The motion of r is transmitted, by means of the pinion, *d*, and the wheel, *e*, to the wheel, T. For a one-meter variation in level the wheel, T, makes one complete revolution. It is divided into 100 equal parts, and each arc therefore corresponds to a difference of one centimeter in the level, and carries, engraved in projection, the corresponding number. As a consequence, there is upon the entire circumference a series of numbers from to 99. The axle upon which the wheel, T, is keyed is prolonged, on the side opposite *e*, by a threaded part, *a*, which actuates a stylet, *g*. This latter is held above by a rod, I, which is connected with a fork movable around a vertical axis, shown in Fig. 6. The rectilinear motion of g is 5 mm. for a variation of one meter in level. Its total travel is consequently 40 mm. The sheet of paper upon which the indications are taken, and which is shown of actual size in Fig. 7, winds around the drum, P, and receives its motion from the cylinder, W. This sheet is covered throughout its length with fine prepared paper that permits of taking the imprints by impression.

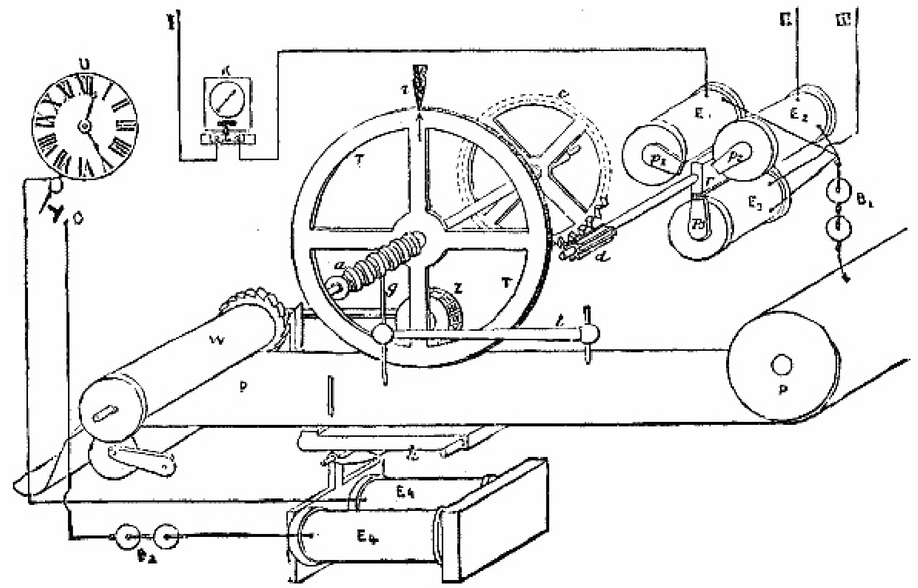


FIG. 5.

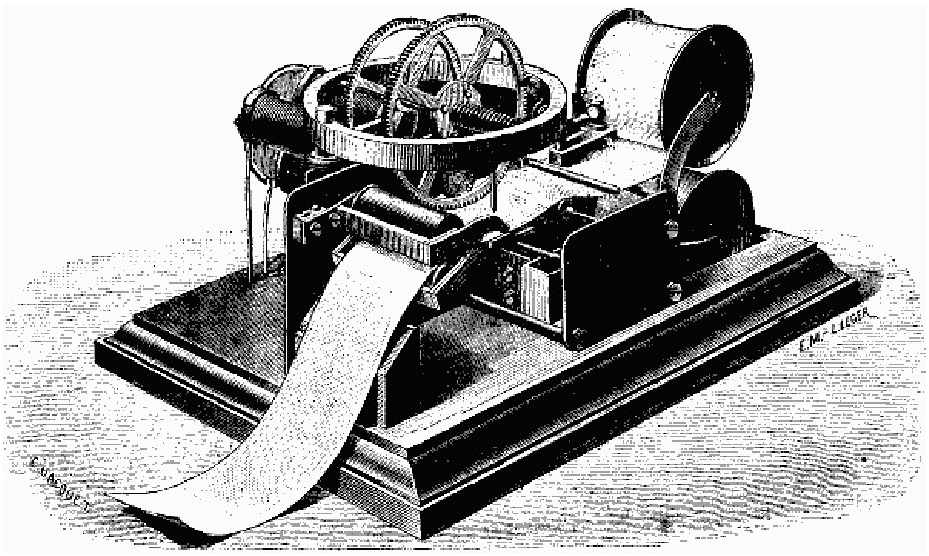


FIG. 6—RECEIVER OF SIEMENS AND HALSKE'S MARIGRAPH.

This stated, the play of the apparatus may be easily understood. Every ten minutes a regulating clock closes the circuit of the local pile, B_2, and establishes a contact at C. The electro-magnet, E_4, attracts its armature, and thus acts upon the lever, *h*, which presses the sheet of paper against the stylet in front that serves to mark the level of the lowest waters, and against the stylet, *g*, and the wheels, T and Z. In falling back, the lever, *h*, causes the advance, by one notch, of the ratchet wheel that is mounted at the extremity of the cylinder W, and thus displaces the sheet of paper a distance of 5 mm. The wheel, Z, carries engraved in projection upon its circumference the hours in Roman figures, and moves forward one division every 60 minutes. The motion of this wheel is likewise controlled by the cylinder, W.

It will be seen upon referring to Fig. 7, that there is obtained a very sharp curve marked by points. We have a general view on considering the curve itself, and the height in meters is read directly. The fractions of a meter, as well as the times, are in the margin. Thus, at the point, *a*, the apparatus gives at 3 o'clock and 20 minutes a height of tide of 4.28 m. above the level of the lowest water.

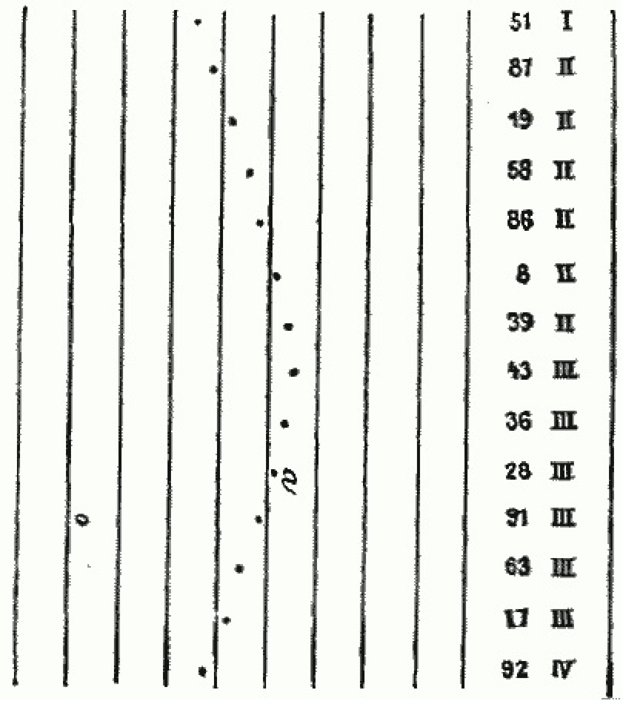


Fig. 7.

This apparatus might possibly operate well, and yet not be in accord with the real indications of the float, so it has been judged necessary to add to it the following control.

Every time the float reaches 3 meters above the level of the lowest tide, the circuit of one of the lines that is open at this moment (that of line I, for example) closes at C (Fig. 2), into this new circuit there is interposed a considerable resistance, W, so that the energy of the current is weakened to such a point that it in nowise influences the normal travel of the wheel, *r*. At the shore station, there is placed in deviation a galvanoscope, K, whose needle is deflected. It suffices, then, to take datum points upon the registering apparatus, upon the wheel, T, and the screw, *a*, in such a way as to ascertain the moment at which the stylet, *g*, is going to mark 3 meters. At this moment the circuit of the galvanoscope, K, is closed, and we ascertain whether there is a deviation of the needle.

As the sea generally rises to the height of 3 meters twice a day, it is possible to control the apparatus twice a day, and this is fully sufficient.

It always belongs to practice to judge of an invention. Mr. Von Hefner-Alteneck tells us that two of these apparatus have been set up—one of them a year ago in the port of Kiel, and the other more recently at the Isle of Wangeroog in the North Sea—and that both have behaved excellently since the very first day of their installation. We shall add nothing to this, since it is evidently the best eulogium that can be accorded them.—*La Lumiere Electrique.*

DELUNE & CO.'S SYSTEM OF LAYING UNDERGROUND CABLES.

In recent times considerable attention has been paid to the subject of laying telegraph cables underground, and various methods have been devised. In some cases the cables have been covered with an armor of iron, and in others they have been inclosed in cast-iron pipes. For telephonic service they are generally inclosed in leaden tubes. What this external envelope shall be that is to protect the wires from injury is a question of the highest importance, since not only the subject of protection is concerned, but also that of cost. It is therefore interesting to note the efforts that are being made in this line of electric industry.

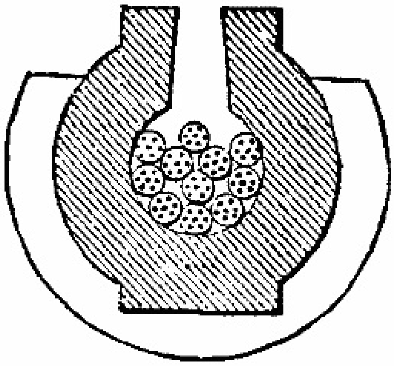


FIG. 1. Section of the Pipe Open.

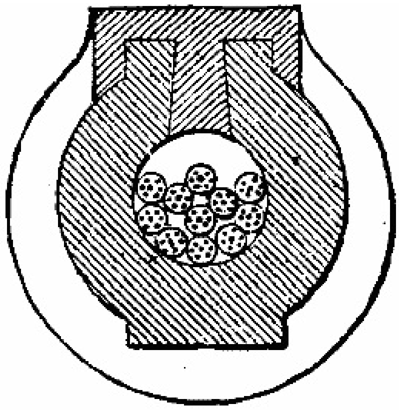


FIG. 2. Section of the Pipe Closed.

Messrs. Delune & Co. have recently taken out a patent for an arrangement consisting of pipes made of beton. The annexed cuts, borrowed from *L'Electricite*, represent this new system. The pipes, which are provided with a longitudinal opening, are placed end to end and coupled with a cement sleeve. The cables are put in place by simply unwinding them as the work proceeds, and thus all that traction is done away with that they are submitted to when cast iron pipes are used. When once the cables are in place the longitudinal opening is stopped up with cement mortar, and in this way a very tight conduit is obtained whose hardness increases with time. The value of the system therefore depends, as in all cement work, on the care with which the manufacturing is done.

Experiments have been made with the system at Toulouse, by the Minister of Post Offices and Telegraphs, and at Lyons, by the General Society of Telephones. Here, as with all similar questions, no opinion can be pronounced until after a prolonged experience. But we cannot help setting forth the advantages that the system offers. These are, in the first place, a saving of about 50 per cent. over iron pipe, and in the second, a better insulation, and consequently a better protection of the currents against all kinds of disturbance, since a non-conducting mass of cement is here substituted for metal.

ELECTRICITY APPLIED TO HORSE-SHOEING.

"There is nothing new but what has been forgotten," said Marie Antoinette to her milliner, Mdlle. Bertin, and what is true of fashion is also somewhat so of science. Shoeing restive horses by the aid of electricity is not new, experiments thereon having been performed as long ago as 1879 by Mr. Defoy, who operated with a small magneto machine.

But the two photographs reproduced in Figs. 1 and 2 have appeared to us curious enough to be submitted to our readers, as illustrating Mr. Defoy's method of operating with an unruly animal.

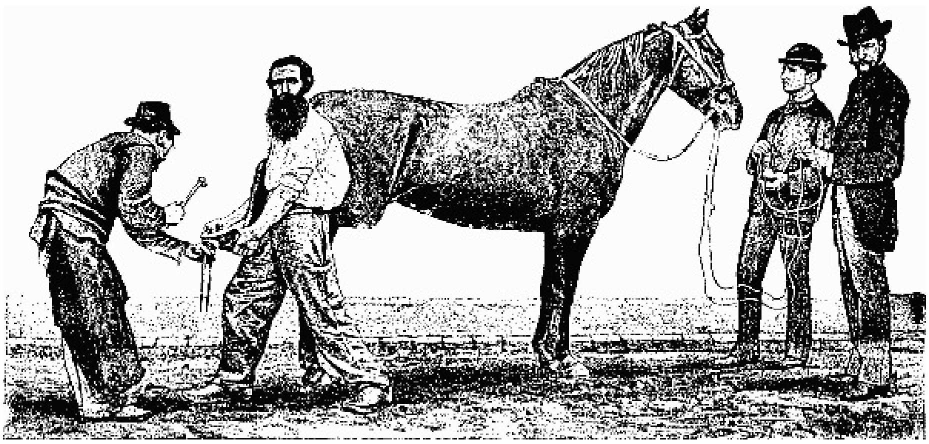


FIG. 1.—THE HORSE RECEIVING THE CURRENT.

The battery used was a small Grenet bichromate of potash pile, which was easy to graduate on account of the depth to which the zinc could be immersed. This pile was connected with the inductor of a small Ruhmkorff coil, whose armature was connected with a snaffle-bit placed in the horse's mouth.

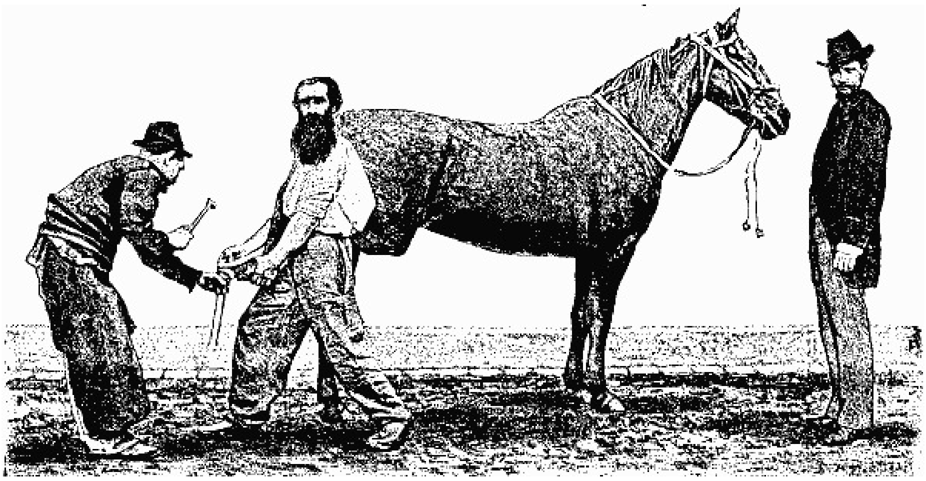


Fig. 2.—THE HORSE CONQUERED.

This bit was arranged as follows (Fig. 3): The two conductors, which were uncovered for a length of about three centimeters at their extremity, were placed opposite each other on the two joints of the snaffle, and about five or six centimeters apart. The mouth-pieces of the bit had previously been inclosed in a piece of rubber tubing, in order to insulate the extremities of the conductors and permit the recomposition of the current to take place through the animal's tongue or palate.

Each of the bare ends of the conductors was provided, under a circular brass ligature, with a small damp sponge, which, surrounding the mouth-piece, secured a perfect contact of each end of the circuit with the horse's mouth.

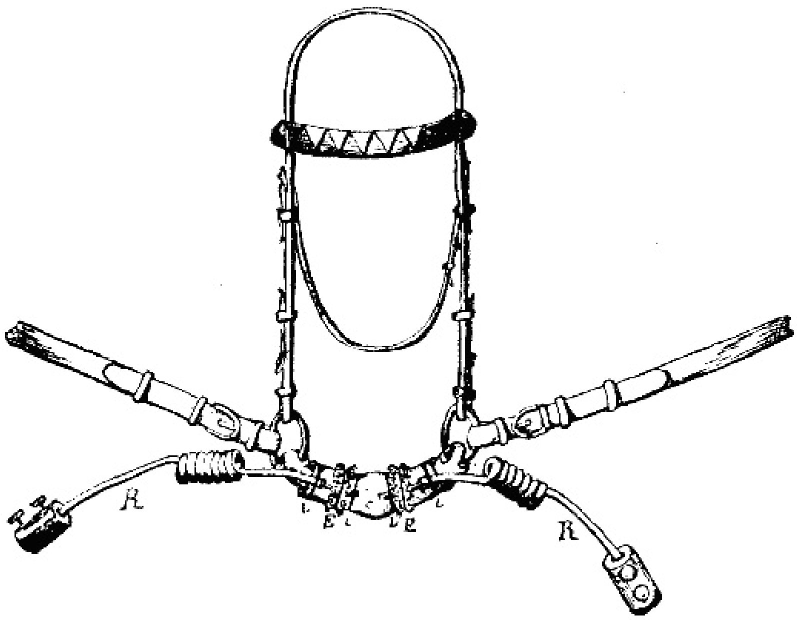


Fig. 3.—ARRANGEMENT OF THE BIT

The horse having been led in, defended himself vigorously as long as an endeavor was made to remove his shoes by the ordinary method, but the current had acted scarcely fifteen seconds when it became possible to lift his feet and strike his shoes with the hammer.

The experimenter having taken care during this experiment to place the bobbin quite near the horse's ear, so that he could hear the humming of the interrupter, undertook a second experiment in the following way: Having detached the conductors from the armature, he placed himself in front of the horse (as shown in Fig. 2), and began to imitate the humming sound of the interrupter with his mouth. The animal at once assumed the stupefied position that the action of the current gave him in the first experiment, and allowed his feet to be lifted and shod without his even being held by the snaffle.

The horse was for ever after subdued, and yet his viciousness and his repugnance to shoeing were such that he could only be shod previously by confining his legs with a kicking-strap.

It should be noted that the action of the induction coil, mounted as this was, was very feeble and not very painful; and yet it was very disagreeable in the mouth, and gave in this case a shock with a sensation of light before the eyes, as we have found by experimenting upon ourselves.

From our own most recent experiments, we have ascertained the following facts, which may guide every horse-owner in the application of electricity to an animal that is opposed to being shod: (1) To a horse that defends himself because he is irritable by temperament, and nervous and impressionable (as happens with animals of pure or nearly pure blood), the shock must be administered feebly and gradually before an endeavor is made to take hold of his leg. The horse will then make a jump, and try to roll over. The jump must be followed, while an assistant holds the bridle, and the action of the current must be at once arrested. After this the horse will not endeavor to defend himself, and his leg may be easily handled.

(2) Certain large, heavy, naturally ugly horses kick through sheer viciousness. In this case, while the current is being given it should be gradually increased in intensity, and the horse's foot must be seized during its action. In most cases the passage of a current through such horses (whose mucous membrane is less sensitive) produces only a slightly stupefied and contracted position of the head, accompanied with a slight tremor. The current must be shut off as soon as the horse's foot is well in one's hand, and be at once renewed if he endeavors to defend himself again, as is rarely the case. It is a mare of this nature that is represented in the annexed figures.

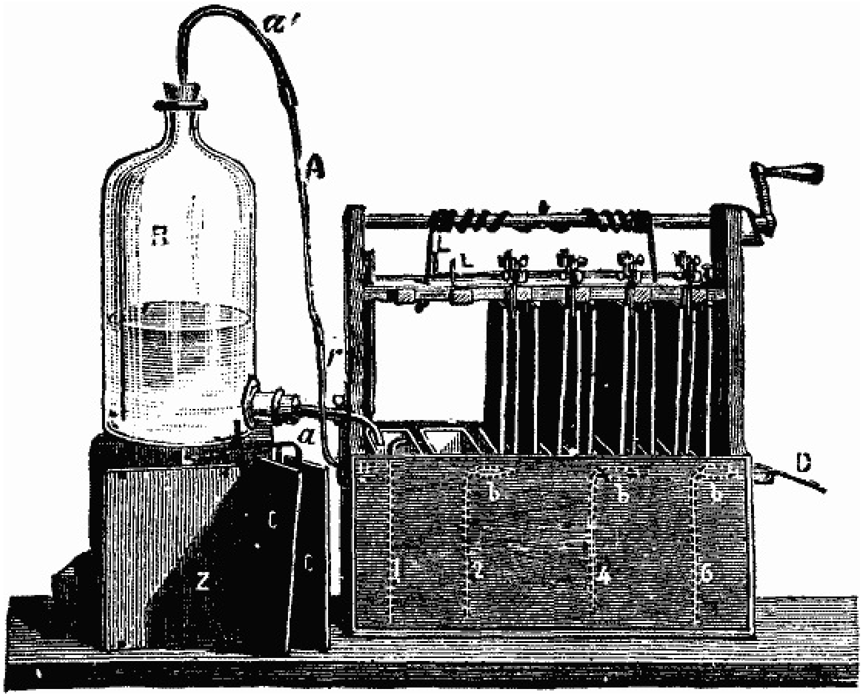
We know that this same system has been applied for bringing to an abrupt standstill runaway horses, harnessed to vehicles; but knowing the effect of a sudden stoppage under such circumstances, we believe that the remedy would prove worse than the disease, since the coachman and vehicle, in obedience to the laws of inertia, would continue their motion and pass over the animals, much to their detriment.—*Science et Nature*.

ESTEVE'S AUTOMATIC PILE.

Mr. Esteve has recently devised a generator of electricity which he claims to be energetic, constant, and always ready to operate. The apparatus is designed for the production of light and for actuating electric motors, large induction bobbins, etc.

We give a description of it herewith from data communicated by its inventor.

The accompanying cut represents a battery of 6 elements, with a reservoir, R, for the liquid, provided at its lower part with a cock for allowing the liquid to enter the pile. The vessels of the different elements are of rectangular form. At the upper part, and in the wider surfaces of each, there are two tubes. The first tube of the first vessel receives the extremity of a safety-tube, A, whose other extremity enters the upper part of the reservoir, R. This tube is designed for regulating the flow of the liquid into the pile. When the cock, *r*, is too widely open, the liquid might have a tendency to flow over the edges of the vessel; but this would close the orifice of the tube, A, and, as the air would then no longer enter the reservoir, R, the flow would be stopped automatically. The second tube of the first vessel is connected with a lead tube, 1, one of the extremities of which enters the second vessel. The other tubes are arranged in the same way in the other vessels. The renewal of the liquids is effected by displacement, in flowing upward from one element over into another; and the liquids make their exit from the pile at D, after having served six times. The electrodes of the two first elements are represented as renewed in the cut, in order to show the arrangement of the tubes.



ESTEVE'S AUTOMATIC PILE.

Dimensions.—The zinc, 2, has a superficies of 15×20 centimeters, and is cut out of the ordinary commercial sheet metal. It may be turned upside down when one end has become worn away, thus permitting of its being entirely utilized. The negative electrode is formed of four carbons, which have, each of them, a superficies of 8×21 centimeters. These four carbons are less fragile and are more easily handled than two having the same surface. Their arrangement is shown at the left of the figure. They are fixed to a strip of copper, *a*, to which is soldered another strip, L, bent at right angles. There are thus two pairs of carbon per element, and these are simply suspended from a piece of wood, as shown in the figure. Upon this wooden holder will be seen the two strips, LL, that are designed to be put in contact with the zinc of the succeeding element by means of pinchers that connect the electrodes with one another. This arrangement permits the pile to be taken apart very quickly.

Charging, Work, and Duration of the Pile.—The inventor has made a large number of experiments with solutions of bichromate of potash of various degrees of saturation, and has found the following to give the best results:

Bichromate of potash.	1	kilogramme.
Sulphuric acid	2	liters.
Water	8	"

When a larger quantity of the salt is used, crystallization occurs in the pile.

	Constants and work of an element having a zinc of 16×20 cm.	Constants and work of a round Bunsen element, 20×30 cm.
Volts.	1.9	1.8
Resistance.	0.05	0.24
Work disposable in the external circuit.	1.839 k.	0.344 k.

The work disposable in the external circuit is deduced from the formula:

$$T = \frac{E^2}{(4R \times 9.81)}$$

It will be seen that an element thus charged gives as much energy as 5.3 large Bunsen elements.

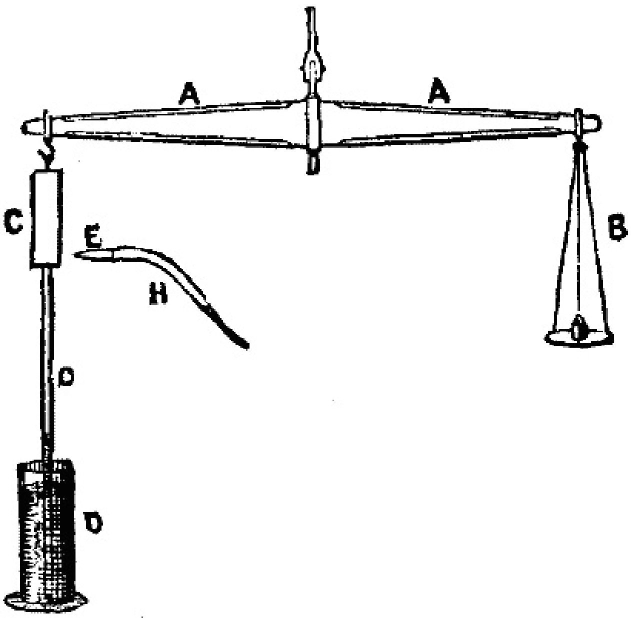
The battery is charged with 10 liters of solution, and is capable of furnishing for 5 hours a current of 7 amperes with a difference of potential of 9 volts at the pile terminals. The work, according to the formula (EI)/*g*, equals 6.422 kilogram-meters; with a feebler resistance in the external circuit it is capable of producing a current of 19 amperes for an hour and an half. In this case the resistance of the external circuit equals the interior resistance of the pile. Upon immersing the electrodes in new liquid, and with no resistance in the external circuit, the current may reach 100 amperes. On renewing the liquids during the operation of the pile, a current of 7 amperes is kept up if about a liter of saturation per hour be allowed to pass into the battery. For five hours, then, only 5 liters are used instead of the 10 that are necessary when the liquid is not renewed while the pile is in action.—*La Nature*.

WOODWARD'S DIFFUSION MOTOR.

The energy produced by the phenomena of diffusion is exhibited in lecture courses by placing a bell glass filled with hydrogen over a porous vessel at whose base is fixed a glass tube that dips into water. The hydrogen, in diffusing, enters the porous vessel, increases the internal pressure, and a number of bubbles escapes from the tube. On withdrawing the bell glass of hydrogen, the latter becomes diffused externally, a lower pressure occurs in the porous vessel, and the level of the water rises.

The arrangement devised by Mr. C.J. Woodward, and recently presented to the Physical Society of London, is an adaptation of this experiment to the production of an oscillating motion by alternations in the internal and external diffusion of the hydrogen.

The apparatus, represented herewith, consists of a scale beam about three feet in length that supports at one end a scale pan and weights, and, at the other, a corked porous vessel that carries a glass tube, *c*, which dips into a vessel containing either water or methylic alcohol. Three or four gas jets, one of which is shown at E, are arranged around the porous vessel, as close as possible, but in such a way as not to touch it during the oscillation of the beam. These gas jets communicate with a gasometer tilled with hydrogen, the bell of which is so charged as to furnish a jet of sufficient strength. Experience will indicate the best place to give the gas jets, but, in general, it is well to locate them at near the center of the porous vessel when the beam is horizontal.



It is now easy to see how the device operates. When the hydrogen comes in presence of the porous vessel it becomes diffused therein, and the pressure exerted in the interior then produces an ascent. When the bottom of the porous vessel gets above the jets, the internal diffusion ceases and the hydrogen becomes diffused externally, the internal pressure diminishes, and the vessel descends. The vessel then comes opposite the jets of hydrogen and the same motion occurs again, and soon indefinitely. The work produced by this motor, which has purely a scientific interest, is very feeble, and much below that assigned to it by theory. In order to obtain a maximum, it would be necessary to completely surround the porous vessel each time with hydrogen, and afterward remove the jets to facilitate the access of air. All the mechanical arrangements employed for obtaining such a result have failed, because the friction introduced by the maneuvering parts also introduces a resistance greater than the motor can overcome. There is therefore a waste of energy due to the continuous flow of hydrogen; but the apparatus, for all that, constitutes none the less an original and interesting device.—*La Nature*.

SOME RELATIONS OF HEAT TO VOLTAIC AND THERMO-ELECTRIC ACTION OF METALS IN ELECTROLYTES.[1]

By G. GORE, F.R.S., LL.D.

The experiments described in this paper throw considerable light upon the real cause of the voltaic current. The results of them are contained in twenty tables; and by comparing them with each other, and also by means of additional experiments, the following general conclusions and chief facts were obtained.

When metals in liquids are heated, they are more frequently rendered positive than negative in the proportion of about 2.8 to 1.0; and while the proportion in weak solutions was about 2.29 to 1.0, in strong ones it was about 3.27 to 1.0, and this accords with their thermo-electric behavior as metals alone. The thermo-electric order of metals in liquids was, with nearly every solution, whether strong or weak, widely different from the thermo-electric order of the same metals alone. A conclusion previously arrived at was also confirmed, viz., that the liquids in which the hot metal was thermo-electro-positive in the largest proportion of cases were those containing highly electro-positive bases, such as the alkali metals. The thermo-electric effect of *gradually* heating a metal in a liquid was sometimes different from that of *suddenly* heating it, and was occasionally attended by a reversal of the current.

Degree of strength of liquid greatly affected the thermo-electric order of metals. Increase of strength usually and considerably increased the potential of metals thermo-electro-negative in liquids, and somewhat increased that of those positive in liquids.

The electric potential of metals, thermo-electro-positive in weak liquids, was usually about 3.87 times, and in strong ones 1.87 times, as great as of those which were negative. The potential of the strongest thermo-electric couple, viz., that of aluminum in weak solution of sodic phosphate, was 0.66 volt for 100° F. difference of temperature, or about 100 times that of a bismuth and antimony couple.

Heating one of the metals, either the positive or negative, of a voltaic couple, usually increased their electric difference, making most metals more positive, and some more negative; while heating the second one also usually neutralized to a large extent the effect of heating the first one. The electrical effect of heating a voltaic couple is nearly wholly composed of the united effects of heating each of the two metals separately, but is not however exactly the same, because while in the former case the metals are dissimilar, and are heated to the same temperature, in the latter they are similar, but heated to different temperatures. Also, when heating a voltaic pair, the heat is applied to two metals, both of which are previously electro-polar by contact with each other as well as by contact with the liquid; but when heating one junction of a metal and liquid couple, the metal has not been previously rendered electro-polar by contact with a different one, and is therefore in a somewhat different state. When a voltaic combination, in which the positive metal is thermo-negative, and the negative one is thermo-positive, is heated, the electric potential of the couple diminishes, notwithstanding that the internal resistance is decreased.

Magnesium in particular, also zinc and cadmium, were greatly depressed in electromotive force in electrolytes by elevation of temperature. Reversals of position of two metals of a voltaic couple in the tension series by rise of temperature were chiefly due to one of the two metals increasing in electromotive force faster than the other, and in many cases to one metal increasing and the other decreasing in electromotive force, but only in a few cases was it a result of simultaneous but unequal diminution of potential of the two metals. With eighteen different voltaic couples, by rise of temperature from 60° to 160° F., the electromotive force in twelve cases was increased, and in six decreased, and the average proportions of increase for the eighteen instances was 0.10 volt for the 100° F. of elevation.

A great difference in chemical composition of the liquid was attended by a considerable change in the order of the volta-tension series, and the differences of such order in two similar liquids, such as solutions of hydric chloride and potassic chloride, were much greater than those produced in either of those liquids by a difference of 100° F. of temperature. Difference of strength of solution, like difference of composition or of temperature, altered the order of such series with nearly every liquid; and the amount of such alteration by an increase of four or five times in the strength of the liquid was rather less than that caused by a difference of 100° F. of temperature. While also a variation of strength of liquid caused only a moderate amount of change of order in the volta-tension series, it produced more than three times that amount of change in the thermo-electric tension series. The usual effect of increasing the strength of the liquid upon the volta-electromotive force was to considerably increase it, but its effect upon the thermo-electro-motive force was to largely decrease it. The degree of potential of a metal and liquid thermo-couple was not always exactly the same at the same temperature during a rise as during a fall of temperature; this is analogous to the variations of melting and solidifying points of bodies under such conditions, and also to that of supersaturation of a liquid by a salt, and is probably due to some hinderance to change of molecular movement.

The rate of ordinary chemical corrosion of each metal varied in every different liquid; in each solution also it differed with every different metal. The most chemically positive metals were usually the most quickly corroded, and the corrosion of each metal was usually the fastest with the most acid solutions. The rate of corrosion at any given temperature was dependent both upon the nature of the metal and upon that of the liquid, and was limited by the most feebly active of the two, usually the electrolyte. The order of rate of corrosion of metals also differed in every different liquid. The more dissimilar the chemical characters of two liquids, the more diverse usually was the order of rapidity of corrosion of a series of metals in them. The order of rate of simple corrosion in any of the liquids examined differed from that of chemico-electric and still more from that of thermo-electric tension. Corrosion is not the cause of thermo-electric action of metals in liquids.

Out of fifty-eight cases of rise of temperature the rate of ordinary corrosion was increased in every instance except one, and that was only a feeble exception—the increase of corrosion from 60° to 160° F. with different metals was extremely variable, and was from 1.5 to 321.6 times. Whether a metal increased or decreased in thermo-electromotive force by being heated, it increased in rapidity of corrosion. The proportions in which the most corroded metal was also the most thermo-electro-positive one was 65.57 per cent. in liquids at 60° F., and 69.12 in the same liquids at 160° F.; and the proportion in which it was the most chemico-electro-positive at 60 F. was 84.44 per cent, and at 160° F. 80.77 per cent. The proportion of cases therefore in which the most chemico-electro-negative metal was the most corroded one increased from 15.56 to 19.23 per cent, by a rise of temperature of 100° F. Comparison of these proportions shows that corrosion usually influenced in a greater degree chemico-electric rather than thermo-electric actions of metals in liquids. Not only was the relative number of cases in which the volta-negative metal was the most corroded increased by rise of temperature, but also the average relative loss by corrosion of the negative to that of the positive one was increased from 3.11 to 6.32.

The explanation most consistent with all the various results and conclusions is a kinetic one: That metals and electrolytes are throughout their masses in a state of molecular vibration. That the molecules of those substances, being frictionless bodies in a frictionless medium, and their motion not being dissipated by conduction or radiation, continue incessantly in motion until some cause arises to prevent them. That each metal (or electrolyte), when unequally heated, has to a certain extent an unlike class of motions in its differently heated parts, and behaves in those parts somewhat like two metals (or electrolytes), and those unlike motions are enabled, through the intermediate conducting portion of the substance, to render those parts electro-polar. That every different metal and electrolyte has a different class of motions, and in consequence of this, they also, by contact alone with each other at the same temperature, become electro-polar. The molecular motion of each different substance also increases at a different rate by rise of temperature.

This theory is equally in agreement with the chemico-electric results. In accordance with it, when in the case of a metal and an electrolyte, the two classes of motions are sufficiently unlike, chemical corrosion of the metal by the liquid takes place, and the voltaic current originated by inherent molecular motion, under the condition of contact, is maintained by the portions of motion lost by the metal and liquid during the act of uniting together. Corrosion therefore is an effect of molecular motion, and is one of the modes by which that motion is converted into and produces electric current.

In accordance with this theory, if we take a thermo-electric pair consisting of a non-corrodible metal and an electrolyte (the two being already electro-polar by mutual contact), and heat one of their points of contact, the molecular motions of the heated end of each substance at the junction are altered; and as thermo-electric energy in such combinations usually increases by rise of temperature, the metal and liquid, each singly, usually becomes more electro polar. In such a case the unequally heated metal behaves to some extent like two metals, and the unequally heated liquid like two liquids, and so the thermo-electric pair is like a feeble chemico-electric one of two metals in two liquids, but without corrosion of either metal. If the metal and liquid are each, when alone, thermo-electro-positive, and if, when in contact, the metal increases in positive condition faster than the liquid by being heated, the latter appears thermo-electro-negative, but if less rapidly than the liquid, the metal appears thermo-electro-negative.

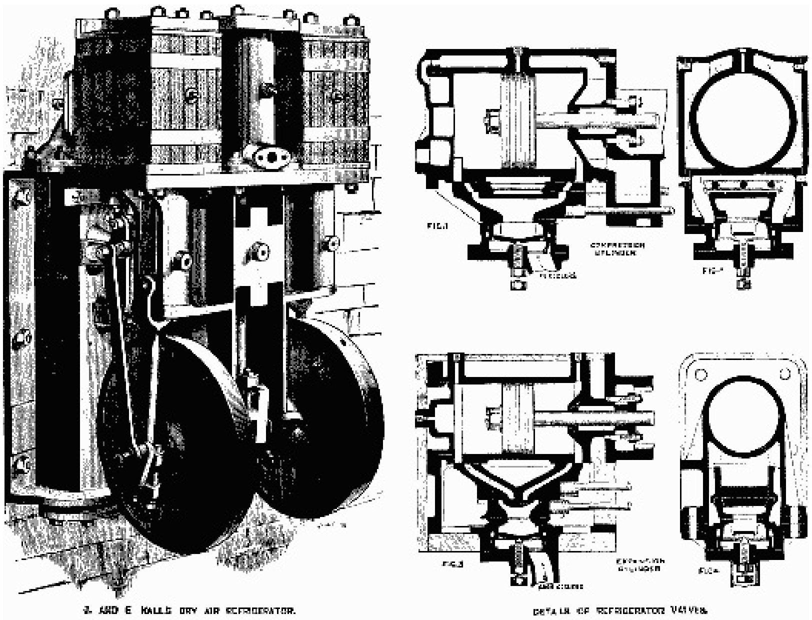
As also the proportion of cases is small in which metals that are positive in the ordinary thermo-electric series of metals only become negative in the metal and liquid ones (viz., only 73 out of 286 in weak solutions, and 48 out of the same number in strong ones), we may conclude that the metals, more frequently than the liquids, have the greatest thermo-electric influence, and also that the relative largeness of the number of instances of thermo-electro-positive metals in the series of metals and liquids, as in the series of metals only, is partly a consequence of the circumstance that rise of temperature usually makes substances—metals in particular—electro-positive. These statements are also consistent with the view that the elementary substances lose a portion of their molecular activity when they unite to form acids or salts, and that electrolytes therefore have usually a less degree of molecular motion than the metals of which they are partly composed.

The current from a thermo-couple of metal and liquid, therefore, may be viewed as the united result of difference of molecular motion, first, of the two junctions, and second, of the two heated (or cooled) substances; and in all cases, both of thermo- and chemico-electric action, the immediate true cause of the current is the original molecular vibrations of the substances, while contact is only a static permitting condition. Also that while in the case of thermo-electric action the sustaining cause is molecular motion, supplied by an external source of heat, in the case of chemico-electric action it is the motion lost by the metal and liquid when chemically uniting together. The direction of the current in thermo-electric cases appears to depend upon which of the two substances composing a junction increases in molecular activity the fastest by rise of temperature, or decreases the most rapidly by cooling.

[1]

Read before the Royal Society, Nov., 1883.

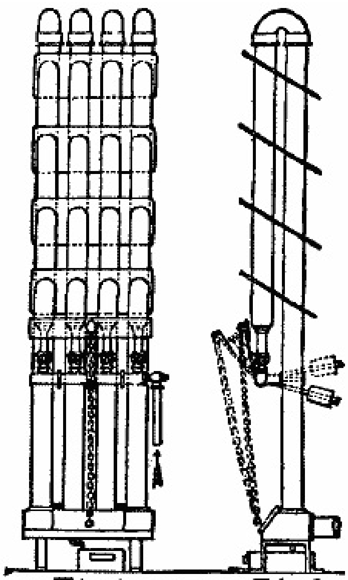
AIR REFRIGERATING MACHINE.



IMPROVED AIR REFRIGERATING MACHINE.

Messrs. J. & E. Hall, Dartford, exhibit at the International Health Exhibition, London, in connection with a cold storage room, two sizes of Ellis' patent air refrigerator, the larger one capable of delivering 5,000 cubic feet of cold air per hour, when running at a speed of 150 revolutions per minute; and the smaller one 2,000 cubic feet of cold air per hour, at 225 revolutions per minute. The special features in these machines are the arrangement of parts, by which great compactness is secured, and the adoption of flat slides for the compressor, instead of the ordinary beat valves, which permits of a high rate of revolution without the objectionable noise which is caused by clacks beating on their seats. The engraving shows the general arrangement of the apparatus. Figs. 1 to 4 show details of the compression and expansion valves, which are ordinary flat slides, partly balanced, and held up to their faces by strong springs from behind. The steam, compression, and expansion cylinders are severally bolted to the end of a strong frame, which though attached to the cooler box does not form part of it, the object being to meet the strains between the cylinders and shaft in as direct a manner as possible without allowing them to act on the cooler casting. Each cylinder is double acting, the pistons being coupled to the shaft by three connecting rods, the two outer ones working upon crank pins fixed to overhung disks, and the center one on a crank formed in the shaft. The slide valves for all the cylinders are driven from two weigh shafts, the main valve shaft being actuated by a follow crank, and the expansion and cut off valves from the crosshead pin of the compressor. The machines may be used either in the vertical position as exhibited, or may be fixed horizontally; and it is stated that the construction is such as to admit of speeds of 200 and 300 revolutions per minute respectively for the larger and smaller machines, under which conditions the delivery of cold air may be taken at about 7,000 and 2,600 cubic feet per hour. Messrs. Hall also make this class of refrigerator without the steam cylinder, and arranged to be driven by a belt from a gas engine or any existing motive power.

A GAS RADIATOR AND HEATER.



A GAS RADIATOR AND HEATER.

There is now being introduced into Germany a gas radiator and heater, the invention of Herr Wobbe. It consists, as will be seen in engraving above, of a series of vertical U-shaped pipes, of wrought iron, 50 millimeters (2 inches) in diameter. The two legs of the U are of unequal length; the longer being about 5 feet, and the shorter 3 feet (exclusive of the bend at the top). Beneath the open end of the shorter leg of each pipe is placed a burner, attached to a horizontal gas-pipe, which turns upon an axis. The object of having this pipe rotate is to bring the burners into an inclined position—shown by the dotted lines in Fig. 2—for lighting them. On turning them back to the vertical position, the heated products of combustion pass up the shorter tube and down the longer, where they enter a common receptacle, from which they pass into the chimney or out of doors. Surrounding the pipes are plates of sheet iron, inclined at the angle shown in Fig. 2. The object of the plates is to prevent the heated air of the room from passing up to the ceiling, and send it out into the room. To prevent any of the pipes acting as chimneys, and bringing the products of combustion back into the room, as well as to avoid any back-pressure, a damper is attached to the outlet receptacle. The heated gas becomes cooled so much (to about 100° Fahr.) that water is condensed and precipitated, and collects in the vessel below the outlet. Each burner has a separate cock, by which it may be kept closed, half-open, or open. To obviate danger of explosion, there is a strip of sheet iron in front of the burners, which prevents their being lighted when in a vertical position; so that, in case any unburned gas gets into the pipes, it cannot be ignited, for the burners can only be lighted when inclined to the front. In starting the stove the burners are lighted, in the inclined position; the chain from the damper pulled up; the burners set vertical; and, as soon as they are all drawing well into the tubes, the damper is closed. If less heat is desired, the cocks are turned half off. It is not permissible to entirely extinguish some of the burners, unless the unused pipes are closed to prevent the products of combustion coming back into the room. The consumption of gas per burner, full open, with a pressure of 8/10, is said to be only 4-3/8 cubic feet per hour.

CONCRETE WATER PIPES.

Concrete water pipes of small diameter, according to a foreign contemporary, are used in parts of France, notably for water mains for the towns of Coulommiers and Aix-en-Provence. The pipes were formed of concrete in the trench itself. The mould into which the concrete was stamped was sheet iron about two yards in length. The several pipes were not specially joined to each other, the joints being set with mortar. The concrete consisted of three parts of slow setting cement and three parts of river sand, mixed with five parts of limestone debris. The inner diameter of the pipes was nine inches; their thickness, three inches. The average fall is given at one in five hundred; the lowest speed of the current at one foot nine inches per second. To facilitate the cleaning of the pipes, man-holes are constructed every one hundred yards or so, the sides of which are also made of concrete. The trenches are about five feet deep. The work was done by four men, who laid down nearly two hundred feet of pipe in a working day; the cost was about ninety-three cents per running yard. It is claimed as an advantage for the new method that the pipes adhere closely to the inequalities of the trench, and thus lie firmly on the ground. When submitted to great pressure, however, they have not proved effective, and the method, consequently, is only suitable for pipes in which there is no pressure, or only a very trifling one.

THE SELLERS STANDARD SYSTEM OF SCREW THREADS, NUTS, AND BOLT HEADS.

SCREW THREADS.					NUTS.						BOLT HEADS.					
Diam. of Screw.	Threads per inch.	Diameter at root of Thread.	Area of Bolt at root of Thread.	Width of Flat.	Short Diam. Rough	Short Diam. Finish.	Long Diam. Rough.	Long Diam. Rough.	Thick ness Rough.	Thick ness Finish	Short Diam. Rough	Short Diam. Finish.	Long Diam. Rough.	Long Diam. Rough.	Thick ness Rough.	Thick ness Finish
1/4	20	.185 13/64	.026	.0062	1/2	7/16	37/64	7/10	1/4	3/16	1/2	7/16	37/64	7/10	1/4	3/16
5/16	18	.240 15/64	.045	.0074	19/32	17/32	11/16	10/12	5/16	1/4	19/32	17/32	11/16	10/12	19/64	1/4
3/8	16	.294 19/64	.067	.0078	11/16	5/8	51/64	63/64	3/8	5/16	11/16	5/8	51/64	63/64	11/32	5/16
7/16	14	.344 11/32	.092	.0089	25/32	23/33	9/10	1 7/64	7/16	3/8	25/32	23/32	9/16	1 7/64	25/64	3/8
1/2	13	.400 13/32	.125	.0096	7/8	13/16	1	1 15/64	1/2	7/16	7/8	13/16	1	1 15/64	7/16	7/16
9/16	12	.454 29/64	.161	.0104	31/32	29/32	1 1/8	1 23/64	9/16	1/2	31/32	29/32	1 1/8	1 23/64	31/64	1/2
5/8	11	.507 33/64	.201	.0113	1 1/16	1	1 7/32	1 1/2	5/8	9/16	1 1/16	1	1 7/32	1 1/2	17/32	9/16
3/4	10	.620 5/8	.301	.0125	1 1/4	1 3/16	1 7/16	1 49/64	3/4	11/16	1 1/4	1 3/16	1 7/16	1 49/64	5/8	11/16
7/8	9	.731 47/64	.419	.0138	1 7/16	1 3/8	1 21/32	2 1/32	7/8	13/16	1 7/16	1 3/8	1 21/32	2 1/32	23/32	13/16
1	8	.837 27/32	.550	.0156	1 5/8	1 9/16	1 7/8	2 19/64	1	15/16	1 5/8	1 9/16	1 7/8	2 19/64	13/16	15/16
1 1/8	7	.940 15/16	.693	.0178	1 13/16	1 3/4	2 5/32	2 9/16	1 1/8	1 1/16	1 13/16	1 3/4	2 5/32	2 7/16	29/32	1 1/16
1 1/4	7	1.065 1 1/16	.890	.0178	2	1 15/16	2 5/16	2 53/64	1 1/4	1 3/16	2	1 15/16	2 5/16	2 53/64	1	1 3/16
1 3/8	6	1.160 1 5/32	1.056	.0208	2 3/16	2 1/8	2 17/32	3 3/32	1 3/8	1 5/16	2 3/16	2 1/8	2 17/32	3 3/32	1 3/32	1 5/16
1 1/2	6	1.284 1 9/32	1.294	.0208	2 3/8	2 5/16	2 3/4	3 23/64	1 1/2	1 7/16	2 3/8	2 5/16	2 3/4	3 23/64	1 3/16	1 7/16
1 5/8	5 1/2	1.389 1 25/64	1.515	.0227	2 9/16	2 1/2	2 31/32	3 5/8	1 5/8	1 9/16	2 9/16	2 1/2	2 31/32	3 5/8	1 9/32	1 9/16
1 3/4	5	1.491 1 31/64	1.746	.0250	2 3/4	2 11/16	3 3/16	3 57/64	1 3/4	1 11/16	2 3/4	2 11/16	3 3/16	3 57/64	1 3/8	1 11/16
1 7/8	5	1.616 1 39/64	2.051	.0250	2 15/16	2 7/8	3 13/32	4 5/32	1 7/8	1 13/16	2 15/16	2 7/8	3 13/32	4 5/32	1 15/32	1 13/16
2	4 1/2	1.742 1 23/32	2.301	.0277	3 1/8	3 1/16	3 5/8	4 27/64	2	1 15/16	3 1/8	3 1/16	3 5/8	4 27/64	1 9/16	1 15/16
2 1/4	4 1/2	1.962 1 31/32	3.023	.0277	3 1/2	3 7/16	4 1/16	4 61/64	2 1/4	2 3/16	3 1/2	3 7/16	4 1/16	4 61/64	1 3/4	2 3/16
2 1/2	4	2.176 2 11/64	3.718	.0312	3 7/8	3 13/16	4 1/2	5 31/64	2 1/2	2 7/16	3 7/8	3 13/16	4 1/2	5 31/64	1 15/16	2 7/16
2 3/4	4	2.426 2 27/64	4.622	.0312	4 1/4	4 3/16	4 29/32	6	2 3/4	2 11/16	4 1/4	4 3/16	4 29/32	6	2 1/8	2 11/16
3	3 1/2	2.629 2 5/8	5.428	.0357	4 5/8	4 9/16	5 3/8	6 17/32	3	2 15/16	4 5/8	4 9/16	5 3/8	6 17/32	2 5/16	2 15/16
3 1/4	3 1/2	2.879 2 7/8	6.509	.0357	5	4 15/16	5 13/16	7 1/16	3 1/4	3 3/16	5	4 15/16	5 13/16	7 1/16	2 1/2	3 3/16
3 1/2	3 1/4	3.100 3 3/32	7.547	.0384	5 3/8	5 5/16	6 7/32	7 39/64	3 1/2	3 7/16	5 3/8	5 5/16	6 7/32	7 39/64	2 11/16	3 7/16
3 3/4	3	3.317 3 5/16	8.614	.0413	5 3/4	5 11/16	6 21/32	8 1/8	3 3/4	3 11/16	5 3/4	5 11/16	6 21/32	8 1/8	2 7/8	3 11/16
4	3	3.567 3 9/16	9.993	.0413	6 1/8	6 1/16	7 3/32	8 41/64	4	3 15/16	6 1/8	6 1/16	7 3/32	8 41/64	3 1/16	3 15/16
4 1/4	2 7/8	3.798 3 51/64	11.329	.0435	6 1/2	6 7/16	7 9/16	9 3/16	4 1/4	4 3/16	6 1/2	6 7/16	7 9/16	9 3/16	3 1/4	4 3/16
1	3	1			7	13	31	3	1	7	7	13	31	3	7	7

4 [illegible]/2	2 [illegible]/4	4.028	4 [illegible]/32	12.742	.0454	6 [illegible]/8	6 [illegible]/16	7 [illegible]/32	9 [illegible]/4	4 [illegible]/2	4 [illegible]/16	6 [illegible]/8	6 [illegible]/16	7 [illegible]/32	9 [illegible]/4	3 [illegible]/16	4 [illegible]/16
4 3/4	2 5/8	4.256	4 1/4	14.226	.0476	7 1/4	7 3/16	8 13/32	10 1/4	4 3/4	4 11/16	7 1/4	7 3/16	8 13/32	10 1/4	3 5/8	4 11/16
5	2 1/2	4.480	4 31/64	15.763	.0500	7 5/8	7 9/16	8 27/32	10 49/64	5	4 15/16	7 5/8	7 9/16	8 27/32	10 49/64	3 13/16	4 15/16
5 1/4	2 1/2	4.730	4 47/64	17.570	.0500	8	7 15/16	9 9/32	11 23/64	5 1/4	5 3/16	8	7 15/16	9 9/32	11 23/64	4	5 3/16
5 1/2	2 3/8	4.953	4 61/64	19.267	.0526	8 3/8	8 5/16	9 23/32	11 7/8	5 1/2	5 7/16	8 3/8	8 5/16	9 23/32	11 7/8	4 3/16	5 7/16
5 3/4	2 3/8	5.203	5 13/64	21.261	.0526	8 3/4	8 11/16	10 5/32	12	5 3/4	5 11/16	8 3/4	8 11/16	10 5/32	12 3/8	4 3/8	5 11/16
6	2 1/4	5.423	5 27/64	23.097	.0555	9 1/8	9 1/16	10 19/32	12 15/16	6	5 15/16	9 1/8	9 1/16	10 19/32	12 15/16	4 9/16	5 15/16

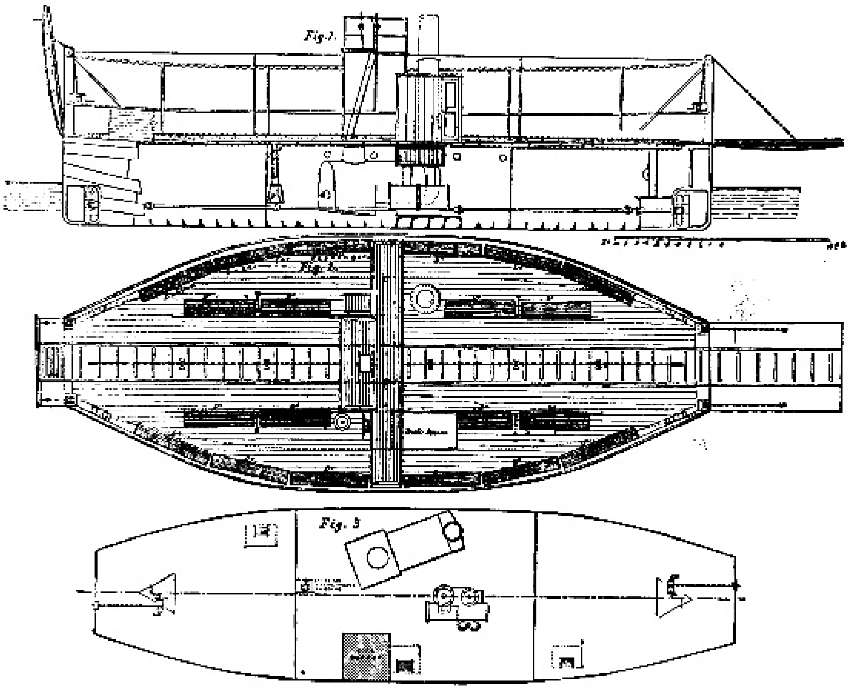
Original table

The dimensions given for diameter at root of threads are also those for diameter of hole in nuts and diameter of lap drills. All bolts and studs 3/4 in. diameter and above, screwed into boilers, have 12 threads per inch, sharp thread, a taper of 1/16 in. per 1 inch; tap drill should be 9/64 in. less than normal diameter of bolts.

The table is based upon the following general formulæ for certain dimensions:

Short diam. rough nut or head	= 11/2 diam. of bolt + 1/8.
Short diam. finished nut or head	= 11/2 diam. of bolt + 1/16.
Thickness rough nut	= diameter of bolt.
Thickness finished nut	= diameter of bolt - 1/16.
Thickness rough head	= 1/2 short diameter.
Thickness finished head	= diameter of bolt - 1/16.

AN ENGLISH RAILWAY FERRY BOAT.



AN ENGLISH RAILWAY FERRY BOAT.

The illustrations above represent a double screw steam ferry boat for transporting railway carriages, vehicles, and passengers, etc., designed and constructed by Messrs. Edwards and Symes, of Cubitt Town, London. The hull is constructed of iron, and is of the following dimensions: Length 60 ft.; beam 16 ft.; over sponsons 25 ft. The vessel was fitted with a propeller, rudder, and steering gear at each end, to enable it to run in either direction without having to turn around. The boat was designed for the purpose of working the train service across the bay of San Juan, in the island of Puerto Rico, and for this purpose a single line of steel rails, of meter gauge, is laid along the center of the deck, and also along the hinged platforms at each end. In the engraving these platforms are shown, one hoisted up, and the other lowered to the level of the deck. When the boat is at one of the landing stages, the platform is lowered to the level of the rails on the pier, and the carriages and trucks are run on to the deck by means of the small hauling engine, which works an endless chain running the whole length of the deck. The trucks, etc., being on board, the platform is raised by means of two compact hand winches worked by worm and worm-wheels in the positions shown; thus these two platforms form the end bulwarks to the boat when crossing the bay. On arriving at the opposite shore the operation is repeated, the other platform is lowered, and the hauling engine runs the trucks, etc., on to the shore. With a load of 25 tons the draught is 4 ft.

The seats shown on the deck are for the convenience of foot passengers, and the whole of the deck is protected from the sun of that tropical climate by a canvas awning. The steering of the vessel is effected from the bridge at the center, which extends from side to side of the vessel, and there are two steering wheels with independent steering gear for each end, with locking gear for the forward rudder when in motion. The man at the wheel communicates with the engineer by means of a speaking tube at the wheel. There is a small deck house for the use of deck stores, on one side of which is the entrance to the engine room. The cross battens, shown between the rails, are for the purpose of horse traffic, when horses are used for hauling the trucks, or for ordinary carts or wagons. The plan below deck shows the arrangement of the bulkheads, with a small windlass at each end for lifting the anchors, and a small hatch at each side for entrance to these compartments. The central compartment contains the machinery, which consists of a pair of compound surface condensing engines, with cylinders 11 in. and 20 in. in diameter; the shafting running the whole length of the vessel, with a propeller at each end. Steam is generated in a steel boiler of locomotive form, so arranged that the funnel passes through the deck at the side of the vessel; and it is designed for a working pressure of 100 lb. per square inch. This boiler also supplies steam for the small hauling engine fixed on the bulkhead. Light to this compartment is obtained by means of large side scuttles along each side of the boat and glass deck lights, and the iron grating at the entrance near the deck house. This boat was constructed in six pieces for shipment, and the whole put together in the builders' yard. The machinery was fixed, and the engine driven by steam from its own boiler, then the whole was marked and taken asunder, and shipped to the West Indies, where it was put together and found to answer the purpose intended.—*Engineering*.

[For The Scientific American.]

THE PROBLEM OF FLIGHT, AND THE FLYING MACHINE.

As a result of reading the various communications to the Scientific American and Supplement, and *Van Nostrand's Engineering Magazine*, including descriptions of proposed and tested machines, and the reports of the British Aeronautical Society, the writer of the following concludes:

That, as precedents for the construction of a successful flying machine, the investigation of some species of birds as a base of the principles of all is correct only in connection with the species and habits of the bird; that the *general mechanical principles* of flight applicable to the *operation* of the *same unit* of wing in *all* species are alone applicable to the flying machine.

That these principles of *operation* do not demand the principles of *construction* of the bird.

That as the wing is in its stroke an arc of a screw propeller's operation, and in its angle a screw propeller blade, its animal operation compels its reciprocation instead of rotation.

That the swifter the wing beat, the more efficient its effect per unit of surface, the greater the load carried, and the swifter the flight.

That the screw action being, in full flight, that of a screw propeller whose axis of rotation forms a slight angle with the vertical, the distance of flight per virtual "revolution" of "screw" wing far exceeds the pitch distance of said "screw."

That consequently a bird's flight answers to an iceboat close hauled; the wing *force* answering to the *wind*, the wing *angle* to the *sail*, the bird's *weight* to the leeway fulcrum of the *ice*, and the passage across direction of the *wing* flop to the fresh *moving* "inertia" of the wind, both yielding a maximum of force to bird or iceboat.

That the speed of *reciprocation* of a fly's *wing* being equivalent to a *screw rotation* of 9,000 per minute, proves that a *screw* may be run at this speed without losing efficiency by centrifugal vacuum.

That as the *object* of wing or screw is to mount upon the inertia of the particles of a mobile fluid, and as the rotation of steamship propellers in water—a fluid of many times the inertia of air—is *already* in *excess* of the highest speed heretofore tried in the propellers of moderately successful flying machines, it is plain that the speed employed in *water* must be many times exceeded in *air*.

That with a *sufficient* speed of rotation, the supporting power of the inertia of air must *equal* that of *water*.

That as mere speed of rotation of propeller *shaft*, minus blades, must absorb but a small proportion of power of engine, the addition of blades will not cause more resistance than that actually encountered from inertia of air.

That this must be the measure of load lifted.

That without *slip* of screw, the actual *power* expended, will be little in *excess* of that required to support the machine in *water*, with a slower rotation of screw.

That in case the same *power* is expended in water or air, the only difference will lie in the sizes and speed of engines or screws.

That the *greater* the speed, the *less* weight of engine, boiler, and screw must be, and the stronger their construction.

That, in consequence, solid metal worked down, instead of bolts and truss work, must be used.

That as the bird wing is a screw in action, and acts *directly* between the inertias of the load and the air, the position and operation of the screw, to the load, must imitate it.

That, in consequence, machines having wing planes, driven *against* one inertia of air by screws acting in the line, of flight against another inertia of air, lose fifty per cent. of useful effect, besides exposing to a head wind the cross section of the stationary screw wing planes and the rotating screw discs; and supporting the dead weight of the wing planes, and having all the screw slip in the line of flight, and carrying slow and heavy engines.

That as a result of these conclusions, the supporting and propelling power should be expressed in the rotation of screws combining both functions, the position of whose planes of rotation to a fixed horizontal line of direction determines the progress and speed of machine upon other lines.

That the whole weight carried by the screws should be at all times exactly below the center of gravity of the plane of support, whether it be horizontal or inclined.

That while the *permanently* positioned weight, such as the engines, frame, holding screws, etc., may be rigidly connected to or around the screw plane of support, the variable positioned weight, such as the passenger and the car, should be connected by a *flexible joint* to the said plane of support.

Consequently, the car may oscillate without altering its weight position under center of supporting plane, thus avoiding an involuntary alteration of speed or direction of flight.

That to steer a machine so constructed, it is merely necessary to move the point of attachment of car to *machine* proper, out of the center of plane of support in the desired direction, and thus cause the plane of support or rotation of propellers to incline in that direction.

That the reservoir of power, the boiler, etc., should be placed in the *car*, and steam carried to engines through joint connecting car with machine.

That at present material exists, and power also, of sufficient lightness and strength to admit of a machine construction capable of a limited successful flight in any fair wind and direction.

That such *machine* once built, the finding of a *power* for long flights will be easy, if not already close at hand in *electricity*.

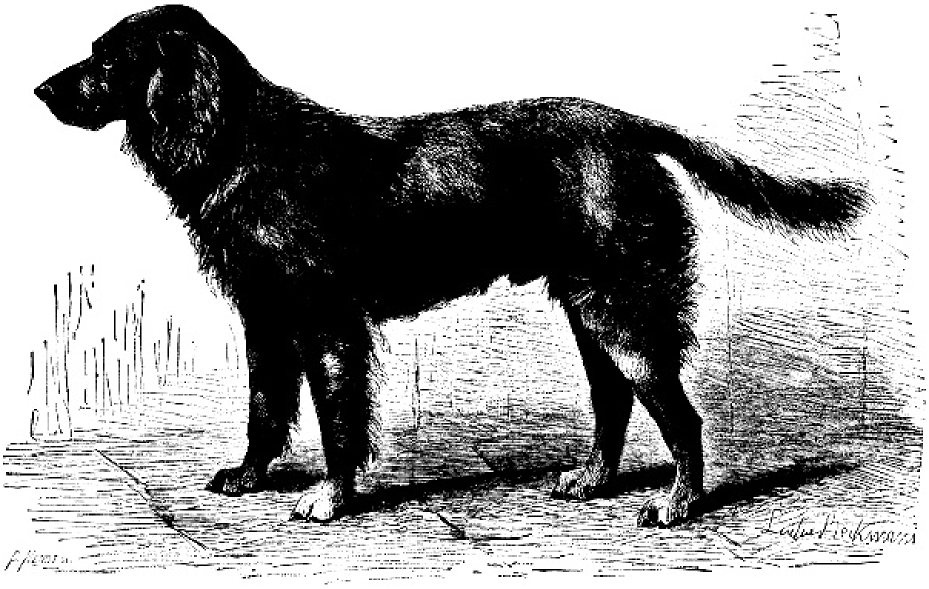
That the *easiest* design for such *actual machine* should be adopted, leaving the adaptation of the principles involved to the making of more perfect machines, to a time after the success of the *first*.

That such design may be a propeller, and its engine at each end of a steel frame tube, supporting tube horizontally, a car to be supported by a universal joint from center of said tube, and the joint apparatus movable along the tube or a short distance transverse to it, to alter position of center of gravity.

That the machine so built might traverse the water as well as air.

THE LONGHAIRED POINTER MYLORD.

Pointers are trained to search for game, and to indicate that they have found the same by standing motionless in front of it, and, when it has been shot, to carry the game to the huntsman. Several kinds of pointers are known, such as smooth, longhaired, and bushyhaired pointers. The smoothhaired pointers are better for hunting on high land, whereas the longhaired or bushyhaired dogs are better for low, marshy countries, crossed by numerous streams, etc. Mylord, the dog represented in the annexed cut taken from the *Illustrirte Zeitung*, is an excellent specimen of the longhaired pointer, and is owned by Mr. G. Borcher, of Braunschweig, Germany.



THE LONGHAIRED POINTER, "MYLORD."

The longhaired pointer is generally above the medium size, powerful, somewhat longer than the normal dog, the body is narrower and not quite as round as that of the smoothhaired dog, and the muscles of the shoulders and hind legs are not as well developed and not as prominent. The head and neck are erect, the head being specially long, and the tail is almost horizontal to the middle, and then curves upward slightly. The long hair hangs in wavy lines on both sides of his body. The expression of his face is intelligent, bright, and good-natured, and his step is light and almost noiseless.

The pointer is specially valuable, as it can be employed for many different purposes; he is an excellent dog for the woods, for the woodsman and hunter who uses only one dog for different kinds of game. The intelligence of the German pointer is very great, but he does not develop as rapidly as the English dog, which has been raised for generations for one purpose only. The German pointer hunts very slowly, but surely. It is not difficult to train this dog, but he cannot be trained until he has reached a certain age.

LUNAR HEAT.

By Professor C.A. YOUNG.

One of the most interesting inquiries relating to the moon is that which deals with the heat she sends us, and the probable temperature of her surface. The problem seems to have been first attacked by Tschirnhausen and La Hire, about 1700; and they both found, that even when the moon's rays were concentrated by the most powerful burning-lenses and mirrors they could obtain, its heat was too small to produce the slightest perceptible effect on the most delicate thermometers then known. For more than a hundred years, this was all that could be made out, though the experiment was often repeated.

It was not until 1831 that Melloni, with his newly-invented "thermopile," [1] succeeded in making the lunar heat sensible; and in 1835, taking his apparatus to the top of Vesuvius, he obtained not only perceptible, but measurable, results, getting a deviation of four or five divisions of his galvanometer.

Others repeated the experiment several times between this time and 1856, with more or less success; but, so far as I know, the first quantitative result was that obtained in 1856 by Piazzi Smyth during his Teneriffe expedition. On the top of the mountain, at an elevation of ten thousand feet, he found that the moon's rays affected his thermopile to the same extent as a standard candle ten feet away. Marie Davy has since shown that this corresponds to a heating effect of about 1/1300 of a Centigrade degree.

The subject was resumed in 1868 by Lord Rosse in Ireland; and a long series of observations, running through several years, was made by the aid of his three-foot reflector (not the great *six*-foot instrument, which is too unwieldy for such work). The results of his work have, until very recently, been accepted as authoritative. It should be mentioned that, at about the same time, observations were also made at Paris by Marie Davy and Martin; but they are generally looked upon merely as corroborative of Rosse's work, which was more elaborate and extensive. Rosse considered that his results show that the heat from the moon is mainly *obscure, radiated* heat; the *reflected* heat, according to him, being much less in amount.

A moment's thought will show that the moon's heat must consist of two portions. First, there will be *reflected solar heat*. The amount and character of this will depend in no way upon the temperature of the moon's surface, but solely upon its reflecting power. And it is to be noted that moon-*light* is only a part of this reflected radiant energy, differing from the invisible portion of the same merely in having such a wave-length and vibration period as to bring it within the range of perception of the human eye.

The second portion of the heat sent us by the moon is that which she emits on her own account as a warm body—warmed, of course, mainly, if not entirely, by the action of the sun. The amount of *this* heat will depend upon the temperature of the moon's surface and its radiating power; and the temperature will depend upon a number of things (chiefly heat-absorbing power of the surface, and the nature and density of the lunar atmosphere, as well as the supply of heat received from the sun), being determined by a balance between give and take. So long as more heat is received in a second than is thrown off in the same time, the temperature will rise, and *vice versa*.

It is to be noted, further, that this second component of the moon's thermal radiance must be mainly what is called "obscure" or dark heat, like that from a stove or teakettle, and characterized by the same want of penetrative power. No one knows why at present; but it is a fact that the heat-radiations from bodies at a low temperature—radiations of which the vibrations are relatively slow, and the wave-length great—have no such power of penetrating transparent media as the higher-pitched vibrations which come from incandescent bodies. A great part, therefore, of this contingent of the lunar heat is probably stopped in the upper air, and never reaches the surface of the earth at all.

Now, the thermopile cannot, of course, discriminate directly between the two portions of the lunar heat; but to some extent it does enable us to do so indirectly, since they vary in quite a different way with the moon's age. The simple *reflected* heat must follow the same law as moonlight, and come to its maximum at full moon. The *radiated* heat, on the other hand, will reach its maximum when the average temperature of that part of the moon's surface turned toward the earth is highest; and this must be some time after full moon, for the same sort of reasons that make the hottest part of a summer's day come two or three hours after noon.

The conclusion early reached by Lord Rosse was that nearly all the lunar heat belonged to the second category—dark heat *radiated* from the moon's warmed surface, the *reflected* portion being comparatively small—and he estimated that the temperature of the hottest parts of the moon's surface must run as high as 500° F.; well up toward the boiling-point of mercury. Since the lunar day is a whole month long, and there are never any clouds in the lunar sky, it is easy to imagine that along toward two or three o'clock in the lunar afternoon (if I may use the expression), the weather gets pretty hot; for when the sun stands in the lunar sky as it does at Boston at two P.M., it has been shining continuously for more than two hundred hours. On the other hand, the coldest parts of the moon's surface, when the sun has only just risen after a night of three hundred and forty hours, must have a temperature more than a hundred degrees below zero.

Lord Rosse's later observations modified his conclusions, to some extent, showing that he had at first underestimated the percentage of simple reflected heat, but without causing him to make any radical change in his ideas as to the maximum heat of the moon's surface.

For some time, however, there has been a growing skepticism among astronomers, relating not so much to the correctness of his measures as to the computations by which he inferred the high percentage of obscure radiated beat compared with the reflected heat, and so deduced the high temperature of lunar noon.

Professor Langley, who is now engaged in investigating the subject, finds himself compelled to believe that the lunar surface never gets even comfortably warm—

because it has no blanket. It receives heat, it is true, from the sun, and probably some twenty-five or thirty per cent. more than the earth, since there are no clouds and no air to absorb a large proportion of the incident rays; but, at the same time, there is nothing to retain the heat, and prevent the radiation into space as soon as the surface begins to warm. We have not yet the data to determine exactly how much the temperature of the lunar rocks would have to be raised above the absolute zero (-273° C. or -459° F.) in order that they might throw off into space as much heat in a second as they would get from the sun in a second. But Professor Langley's observations, made on Mount Whitney at an elevation of fifteen thousand feet, when the barometer stood at seventeen inches (indicating that about fifty-seven per cent. of the air was still above him), showed that rocks exposed to the perpendicular rays of the sun were not heated to any such extent as those at the base of the mountain similarly exposed; and the difference was so great as to make it almost certain that a mass of rock not covered by a reasonably dense atmosphere could never attain a temperature of even 200° or 300° F. under solar radiation, however long continued.

It must, in fact, be considered at present extremely doubtful whether any portion of the moon's surface ever reaches a temperature as high as -100°.

The subject, undoubtedly, needs further investigation, and it is now receiving it. Professor Langley is at work upon it with new and specially constructed apparatus, including a "bolometer" so sensitive that, whereas previous experimenters have thought themselves fortunate if they could get deflections of ten or twelve galvanometric divisions to work with, he easily obtains three or four hundred. We have no time or space here to describe Professor Langley's "bolometer;" it must suffice to say that it seems to stand to the thermopile much as that does to the thermometer. There is good reason to believe that its inventor will be able to advance our knowledge of the subject by a long and important step; and it is no breach of confidence to add that so far, although the research is not near completion yet, everything seems to confirm the belief that the radiated heat of the moon, instead of forming the principal part of the heat we get from her, is relatively almost insignificant, and that the lunar surface now never experiences a *thaw* under any circumstances.

Since the superstition as to the moon's influence upon the wind and weather is so widespread and deep seated, a word on that subject may be in order. In the first place, since the total heat received from the moon, even according to the highest determination (that of Smyth), is not so much as 0.00001 of that received from the sun, and since the only hold the moon has on the earth's weather is through the heat she sends us (I ignore here the utterly insignificant atmospheric *tide*), it follows necessarily that her influence *must* be very trifling. In the next place, all carefully collated observations show that it *is* so, and not only trifling, but generally absolutely insensible.

For example, different investigators have examined the question of nocturnal cloudiness at the time of full moon, there being a prevalent belief that the full moon "eats up" light clouds. On comparing thirty or forty years' observations at each of several stations (Greenwich. Paris, etc.), it is found that there is no ground for the belief. And so in almost every case of imagined lunar meteorological influence. As to the coincidence of weather changes with changes of the moon, it is enough to say that the idea is absolutely inconsistent with that progressive movement of the "weather" across the country from west to east, with which the Signal Service has now made us all so familiar.

Princeton, April 12, 1884.

[1]

> Probably most of our readers know that the thermopile consists of a number of little bars of two different metals, connected in pairs, and having the ends joined in a conducting circuit with a galvanometer. If, now, one set of the junctures is heated more than the other set, a current of electricity will be generated, which will affect the galvanometer. The bars are usually made of bismuth and antimony though iron and German silver answer pretty well. They are commonly about half or three-quarters of an inch long, and about half as large as an ordinary match. The "pile" is made of from fifty to a hundred such bars packed closely, but insulated by thin strips of mica, except just at the soldered junctions. With an instrument of this kind and a very delicate galvanometer, Professor Henry found that the heat from a person's face could be perceived at a distance of several hundred feet. There is however, some doubt whether he was not mistaken in respect to this extreme sensitiveness.

APPLE TREE BORERS.

The apple tree borers have destroyed thousands of trees in New England, and are likely to destroy thousands more. There are three kinds of borers which assail the apple tree. The round headed or two striped apple tree borer, *Saperda candida*, is a native of this country, infesting the native crabs, thorn bushes, and June berry. It was first described by Thomas Say, in 1824, but was probably widely distributed before that. In his "Insects Injurious to Fruit," Prof. Saunders thus describes the borer:

"In its perfect state it is a very handsome beetle, about three-quarters of an inch long, cylindrical in form, of a pale brown color, with two broad, creamy white stripes running the whole length of its body; the face and under surface are hoary white, the antennæ and legs gray. The females are larger than the males, and have shorter antennæ. The beetle makes its appearance during the months of June and July, usually remaining in concealment during the day, and becoming active at dusk. The eggs are deposited late in June and during July, one in a place, on the bark of the tree, near its base. Within two weeks the young worms are hatched, and at once commence with their sharp mandibles to gnaw their way through the outer bark to the interior. It is generally conceded that the larvæ are three years in reaching maturity. The young ones lie for the first year in the sapwood and the inner bark, excavating flat, shallow cavities, about the size of a silver dollar, which are filled with their sawdust-like castings. The holes by which they enter being small are soon filled up, though not until a few grains of castings have fallen from them. Their presence may, however, often be detected in young trees from the bark becoming dark colored, and sometimes dry and dead enough to crack."

On the approach of winter, it descends to the lower part of its burrow, where it remains inactive until spring. The second season it continues its work in the sapwood, and in case two or three are at work in the same tree may completely girdle it, thus destroying it. The third year it penetrates to the heart of the tree, makes an excavation, and awaits its transformation. The fourth spring it comes forth a perfect beetle, and lays its eggs for another generation.

THE FLAT-HEADED BORER.

The flat-headed apple tree borer, *Chrysobothris femorata*, is also a native of this country. It is a very active insect, delights to bask in the hot sunshine; runs up and down the tree with great rapidity, but flies away when molested. It is about half an inch in length. "It is of a flattish, oblong form, and of a shining, greenish black color, each of its wing cases having three raised lines, the outer two interrupted by two impressed transverse spots of brassy color dividing each wing cover into three nearly equal portions. The under side of the body and legs shine like burnished copper; the feet are shining green." This beetle appears in June and July, and does not confine its work to the base of the tree, but attacks the trunk in any part, and sometimes the larger branches. The eggs are deposited in cracks or crevices of the bark, and soon hatch. The young larva eats its way through the bark and sapwood, where it bores broad and flat channels, sometimes girdling and killing the tree. As it approaches maturity, it bores deeper into the tree, working upward, then eats out to the bark, but not quite through the bark, where it changes into a beetle, and then cuts through the bark and emerges to propagate its kind. This insect is sought out when just beneath the bark, and devoured by woodpeckers and insect enemies.

Another borer, the long-horned borer, *Leptostylus aculifer*, is widely distributed, but is not a common insect, and does not cause much annoyance to the fruit grower. It appears in August, and deposits its eggs upon the trunks of apple trees. The larvæ soon hatch, eat through the bark, and burrow in the outer surface of the wood just under the bark.

PROTECTION AGAINST BORERS.

The practical point is, What remedies can be used to prevent the ravages of the borers? The usual means of fighting the borers is, to seek after them in the burrows, and try to kill them by digging them out, or by reaching them with a wire. This seems to be the most effectual method of dealing with them after they have once entered the tree, but the orchardist should endeavor to prevent the insects from entering the tree. For this purpose, various washes have been recommended for applying to the tree, either for destroying the young larvæ before they enter the bark, or for preventing the beetles depositing their eggs. It has been found that trees which have been coated with alkaline washes are avoided by beetles when laying their eggs. Prof. Saunders recommends that soft soap be reduced to the consistency of a thick paint, by the addition of a strong solution of washing soda in water, and be applied to the bark of the tree, especially about the base or collar, and also extended upward to the crotches where the main branches have their origin. It should be applied in the evening of a warm day, so that it may dry and form a coating not easily dissolved by the rain. This affords a protection against all three kinds of borers. It should be applied early in June, before the beetles begin to lay their eggs, and again in July, so as to keep the tree well protected.

Hon. T.S. Gold, of Connecticut, at a meeting of the Massachusetts State Board of Agriculture, in regard to preventing the ravages of the borer, said:

"A wash made of soap, tobacco water, and fresh cow manure mingled to the consistency of cream, and put on early with an old broom, and allowed to trickle down about the roots of the tree, has proved with me a very excellent preventive of the ravages of the borer, and a healthful wash for the trunk of the tree, much to be preferred to the application of lime or whitewash, which I have often seen applied, but which I am inclined to think is not as desirable an application as the potash, or the soda, as this mixture of soft soap and manure."

J.B. Moore, of Concord, Mass., at the same meeting said, in regard to the destruction of the borer:

"I have found, I think, that whale oil soap can be used successfully for the destruction of that insect. It is a very simple thing; it will not hurt the tree if you put it on its full strength. You can take whale oil soap and dilute until it is about as thick as paint, and put a coating of it on the tree where the holes are, and I will bet you will never see a borer on that tree until the new crop comes. I feel certain of it, because I have done it."

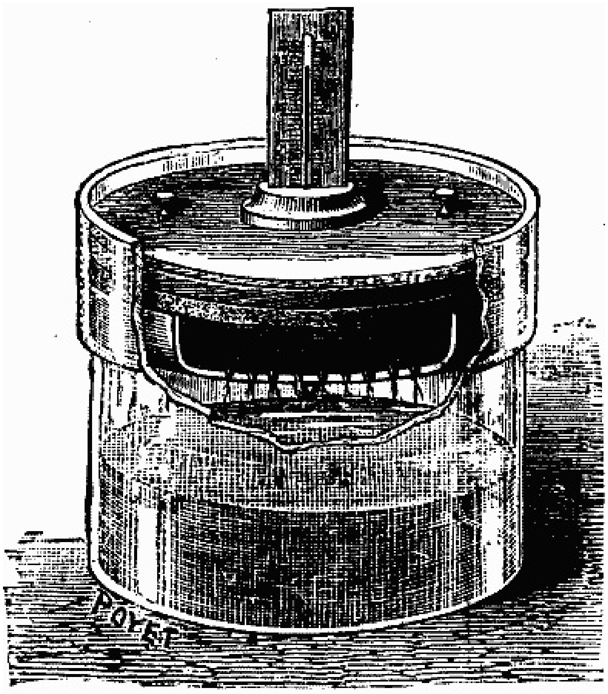
For borers, tarred paper 1 or 2 feet wide has been recommended to be wrapped about the base of the trunk of the tree, the lower edge being 1 or 2 inches below the surface of the soil. This prevents the two-striped borer from laying its eggs in the tree, but would not be entirely effectual against the flat-headed borer, which attacks any part of the trunk and the branches. By the general use of these means for the prevention of the ravages of the borers, the damages done by these insects could be brought within very narrow limits, and hundreds of valuable apple trees saved.

H. REYNOLDS, M.D.

Livermore Falls, Me.

KEFFEL'S GERMINATING APPARATUS.

The apparatus represented in the annexed cut is designed to show the quality of various commercial seeds, and make known any fraudulent adulterations that they may have undergone. It is based upon a direct observation, of the germination of the seeds to be studied.



KEFFEL'S GERMINATING APPARATUS.

The apparatus consists of a cylindrical vessel containing water to the height of 0.07 m. Above the water is a germinating disk containing 100 apertures for the insertion of the seeds to be studied, the germinating end of the latter being directed toward the water. After the seeds are in place the disk is filled with damp sand up to the top of its rim, and the apparatus is closed with a cover which carries in its center a thermometer whose bulb nearly reaches the surface of the water.

The apparatus is then set in a place where the temperature is about 18°, and where there are no currents of air. An accurate result is reached at the end of about twenty or twenty-four hours. As the germinating disk contains 100 apertures for as many seeds, it is only necessary to count the number of seeds that have germinated in order to get the percentage of fresh and stale ones.

The aqueous vapor that continuously moistens all the seeds, under absolutely identical conditions for each, brings about their germination under good conditions for accuracy and comparison. If it be desired to observe the starting of the leaves, it is only necessary to remove the cover after the seeds have germinated.

This ingenious device is certainly capable of rendering services to brewers, distillers, seedsmen, millers, farmers, and gardeners, and it may prove useful to those who have horses to feed, and to amateur gardeners, since it permits of ascertaining the value and quality of seeds of every nature.—*La Nature*.

MILLET.

The season is now at hand when farmers who have light lands, and who may possibly find themselves short of fodder for next winter feeding, should prepare for a crop of millet. This is a plant that rivals corn for enduring a drought, and for rapid growth. There are three popular varieties now before the public, besides others not yet sufficiently tested for full indorsement—the coarse, light colored millet, with a rough head, Hungarian millet, with a smooth, dark brown head, yielding seeds nearly black, and a newer, light colored, round seeded, and later variety, known as the golden millet.

Hungarian millet has been the popular variety with us for many years, although the light seeded, common millet is but slightly different in appearance or value for cultivation. They grow in a short time, eight weeks being amply sufficient for producing a forage crop, though a couple of weeks more would be required for maturing the seed. Millet should not be sown in early spring, when the weather and ground are both cold. It requires the hot weather of June and July to do well; then it will keep ahead of most weeds, while if sown in April the weeds on foul land would smother it.

Millet needs about two months to grow in, but if sowed late in July it will seem to "hurry up," and make a very respectable showing in less time. We have sown it in August, and obtained a paying crop, but do not recommend it for such late seeding, as there are other plants that will give better satisfaction. Golden millet has been cultivated but a few years in this country, and as yet is but little known, but from a few trials we have been quite favorably impressed with it. It is coarser than the other varieties, but cattle appear to be very fond of it nevertheless. It resembles corn in its growth nearly as much as grass, and, compared with the former, it is fine and soft, and it cures readily, like grass, and may be packed away in hay mows with perfect safety. It is about two weeks later than the other millets, and consequently cannot be grown in quite so short a time, although it may produce as much weight to the acre, in a given period, as either of the other more common varieties. A bushel of seed per acre is not too much for either variety of millet.—*N.E. Farmer*.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

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