**Scientific American Supplement, No. 443, June 28, 1884 eBook**

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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*.

[Illustration:  *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 2x4 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 2x6 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 2x4 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

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at the top, take pieces of 2x6 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:

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“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 deg.  F. and linseed oil at 600 deg.  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 deg.  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

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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 deg.  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

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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 deg.  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.

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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.

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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.

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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.

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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.

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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 3/4 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 | To | Total | |
|neutralize| convert |saponifi-| |
| the acid.|the ether.| cation. | 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 |
----------------+----------+----------+---------+--------+  
pre>
  
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.

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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* *floraof* *the* *carboniferous* *epoch* *andthe* *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\_{n}H\_{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 deg. 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\_{6}H\_{5}*Ho*)\_{2}H\_{2}O.
Its melting point was found to be 17.2 deg. 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 deg. 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\_{6}H\_{6}O, 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 deg. 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.

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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 phaenogamous
plants which constituted any feature in “the
coal forests” being the coniferae, and as coal
is the fossil remains of that gigantic flora which
contained phenol, I think my discovery of phenol in
the coniferae of the present day further supports,
from a chemical point of view, the views of geologists
that the coniferae 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 coniferae
of to-day, it is probable that petroleum in certain
areas has been produced from the conifers and the flora
generally of some primaeval 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—­

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C\_{n}H\_{2n2+}, C\_{n}H\_{2n-6},
  
also hydrocarbons of the C\_{n}H\_{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 coniferae 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

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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.

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[Illustration: 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]**

[Footnote 1: Lecture to the
Royal Dublin Society by Dr. Oliver J.  
 Lodge, April 2, 1884.]
  
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

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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.

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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

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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

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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.)
[Footnote 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.]  
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.
  
[Illustration: Fig. 1 and Fig. 2]
  
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 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

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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

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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 SO2 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.

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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.”

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**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*.

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[Illustration: Fig. 1]
  
[Illustration: Fig. 2]
  
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, E2, 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,
E1, 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,
E1 and E2, 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 T1 (Fig. 2) communicate through
the line to a distant station, T2, 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

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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 T1 or T2, 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, T1, the telegraph instruments
(comprising battery, B1, key, M1 and Morse receiver,
R1), the “graduating” electromagnets,
E1, and E2, the “graduating” condenser,
C1, and the “separating” condenser, C2.
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.
  
[Illustration: Fig. 3]
  
[Illustration: 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.*

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**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

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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.
  
[Illustration: FIG. 1.—­FLOAT OF SIEMENS
AND HALSKE’S MARIGRAPH.]
  
[Illustration: FIG. 2.]
  
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, s1, s2, and s3. The thickness
of w is equal to that of the three wheels, s1, s2,
and s3, 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,
s1, s2, and s3.
  
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.
  
[Illustration: FIG. 3.]
  
[Illustration: FIG. 4.]

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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,
L1, L2, and L3 communicate with the bobbins of three
electromagnets, E1, E2, and E3, 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 L1,
L2, L3, *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 deg., and for a change of current
the wheel, r, describes an angle of 60 deg., 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.
  
[Illustration: FIG. 5]
  
[Illustration: FIG. 6—­RECEIVER OF
SIEMENS AND HALSKE’S MARIGRAPH.]
  
[Illustration: FIG. 7]

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This stated, the play of the apparatus may be easily
understood. Every ten minutes a regulating clock
closes the circuit of the local pile, B2, and establishes
a contact at C. The electro-magnet, E4, 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.
  
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.*  
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**DELUNE & CO.’S SYSTEM OF LAYING UNDERGROUND CABLES.**

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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.
  
[Illustration: FIG. 1. Section of the Pipe
Open.]
  
[Illustration: 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.
  
\* \* \* \*
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**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.
  
[Illustration: 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.

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[Illustration: 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.
  
[Illustration: 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.

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(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.
  
[Illustration: ESTEVE’S AUTOMATIC PILE.]

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*Dimensions.*—­The zinc, 2, has a superficies
of 15x20 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 8x21 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 Constants and work of an element of a round Bunsen having a zinc of element, 20x30 cm. 16x20 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 = E squared/(4R
x 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.*

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**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.
  
[Illustration]
  
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.*  
\* \* \* \*
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SOME RELATIONS OF HEAT TO VOLTAIC AND THERMO-ELECTRIC ACTION OF METALS
IN ELECTROLYTES.[1]  
 [Footnote 1: Read before the
Royal Society, Nov., 1883.]
  
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 deg. 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.

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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 deg. to 160 deg. 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 deg. 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 deg. 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 deg. 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.

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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 deg. to 160 deg.
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 deg. F., and 69.12
in the same liquids at 160 deg. F.; and the proportion
in which it was the most chemico-electro-positive
at 60 F. was 84.44 per cent, and at 160 deg.
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 deg.
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.

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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.
  
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**AIR REFRIGERATING MACHINE.**

[Illustration: 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.
  
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**A GAS RADIATOR AND HEATER.**

[Illustration: Fig. 1 & Fig. 2 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

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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 deg. 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.
  
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**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

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

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
| |
| SCREW THREADS. |
|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|
| | | | | |
| Diam. |Threads | Diameter | Area of | Width |
| of | per | at root of | Bolt at | of |
| Screw. | inch. | Thread. | root of | Flat. |
| | | | Thread. | |
|\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_\_\_|\_\_\_\_\_\_\_|
| | | | | | |
| 1/4 | 20 | .185 | 13/64 | .026 | .0062 |
| 5/16 | 18 | .240 | 15/64 | .045 | .0074 |
| 3/8 | 16 | .294 | 19/64 | .067 | .0078 |
| 7/16 | 14 | .344 | 11/32 | .092 | .0089 |
| 1/2 | 13 | .400 | 13/32 | .125 | .0096 |
| 9/16 | 12 | .454 | 29/64 | .161 | .0104 |
| 5/8 | 11 | .507 | 33/64 | .201 | .0113 |
| 3/4 | 10 | .620 | 5/8 | .301 | .0125 |
| 7/8 | 9 | .731 | 47/64 | .419 | .0138 |
| | | | | | |
| 1 | 8 | .837 | 27/32 | .550 | .0156 |
| 1-1/8 | 7 | .940 | 15/16 | .693 | .0178 |
| 1-1/4 | 7 | 1.065 | 1- 1/16 | .890 | .0178 |
| 1-3/8 | 6 | 1.160 | 1- 5/32 | 1.056 | .0208 |
| 1-1/2 | 6 | 1.284 | 1- 9/32 | 1.294 | .0208 |
| 1-5/8 | 5-1/2 | 1.389 | 1-25/64 | 1.515 | .0227 |
| 1-3/4 | 5 | 1.491 | 1-31/64 | 1.746 | .0250 |
| 1-7/8 | 5 | 1.616 | 1-39/64 | 2.051 | .0250 |
| | | | | | |
| 2 | 4-1/2 | 1.742 | 1-23/32 | 2.301 | .0277 |
| 2-1/4 | 4-1/2 | 1.962 | 1-31/32 | 3.023 | .0277 |
| 2-1/2 | 4 | 2.176 | 2-11/64 | 3.718 | .0312 |
| 2-3/4 | 4 | 2.426 | 2-27/64 | 4.622 | .0312 |
| | | | | | |
| 3 | 3-1/2 | 2.629 | 2- 5/8 | 5.428 | .0357 |
| 3-1/4 | 3-1/2 | 2.879 | 2- 7/8 | 6.509 | .0357 |
| 3-1/2 | 3-1/4 | 3.100 | 3- 3/32 | 7.547 | .0384 |
| 3-3/4 | 3 | 3.317 | 3- 5/16 | 8.614 | .0413 |
| | | | | | |
| 4 | 3 | 3.567 | 3- 9/16 | 9.993 | .0413 |
| 4-1/4 | 2-7/8 | 3.798 | 3-51/64 | 11.329 | .0435 |  
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 formulae
for certain dimensions:
  
 Short diam. rough nut or head = 11/2 diam.
of bolt + 1/8.  
 " 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.**

[Illustration: 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

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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:

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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.

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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.

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That the machine so built might traverse the water
as well as air.
  
\* \* \* \*
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**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.
  
[Illustration: 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.
  
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**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.

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[Footnote 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.]  
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.

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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 deg. 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.

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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 deg.
C. or -459 deg. 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 deg. or 300 deg. 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 deg..
  
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.

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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.
  
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**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 antennae
and legs gray. The females are larger than the
males, and have shorter antennae. 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 larvae 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.”

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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 larvae
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 larvae before they enter
the bark, or for preventing the beetles depositing

**Page 55**

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.

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[Illustration: 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 deg., 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.

**Page 57**

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.*  
\* \* \* \*
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