bustion. All the gases, except carbonic acid, generated, including the malaria, are combustible, and will add fuel to the flame.

It may, also, be objected, that the air is damp. This is so. But the water is in the form of vapor, and not liquid, hence the thousand degrees of caloric are not required to convert the water into steam. This vapor, passing over the glowing carbon, would be decomposed, and, by no means, diminish the the intensity of the combustion, but rather increase it.

The advantages of this operation are manifest. In the first place, the offensive matters are burned up, and not allowed, as now, to be diffused through the air. By this process there will be a constant downward tendency of the foul airs to flow into the sewers, wherever generated, whether from the surface of the streets, or in dwellings, or outhouses. Like the water, they will all flow off into the sewers, and be drawn up into the furnaces. The tendency, now, is to accumulate and rise up as the quantity increases, and flow into the dwellings, instead of flowing from them. The sewers themselves are now centers of the foulest emanations, as any one may convince himself by experimenting on the air over the water holes at the corners of the streets.

It is feared by some, that the immense production of carbonic acid, and other noxious products produced by the manufactories of New York, may demand, sooner or later, their removal from the city. These fears, probably, have their origin in the analysis of the air in the great cities of England. They certainly have not arisen from the analysis of the air of New York. The cases of English cities and New York are very different. In the first place, the kinds of manufactories of New York are small or null in those materials which most load the atmosphere of some English cities. In the next place, we have a very different atmosphere. While theirs is moist, and loaded with vapors, ours is comparatively dry, and will not sustain them. Although immense volumes of carbonic acid are raised into the air, yet the winds, in a few minutes, will transport them to distant places.

This principle may be applied with much benefit to private dwellings. If the dwelling is furnished with a furnace, the air for combustion could be drawn from the lowest place on the premises, and the supply of air would come from the upper portions of the house, creating a tendency to ventilate the dwelling by pure air drawn from above. The cellars of private buildings might be connected with the sewers, and when the draft was strong; the stagnant air drawn out and fresh air supplied.

It might be objected, that circumstances might occur, when the air could not be drawn from the sewers from obstructions or from their being full. Then the usual source could be employed by removing the jacket, and the dampers in the tube be shut. Where the tubes are employed, and too small for the supply from accumulations of water in them, the furnace could be connected with the reservoirs for surface water at the corners of the streets. But the furnaces, generally, are in operation only in the daytime. Still, if the sewers are thoroughly aerated three times in twenty-four hours, no harm could result, certainly none when they are kept pure for twelve hours, and that in the hottest portion of the twenty-four.

Hotels might draw their air from the same source to their ranges and furnaces, and their premises supplied with pure air.

The only facts we have observed in examining the *literature* of sewers, that relates to this matter, are the following: A proposition was made, in London, to connect the sewers with the chimneys of manufactories, above the fires, which the owners objected to, from its diminishing the draft. In Paris, when the sewers become so foul that the workmen cannot enter them with safety, they have movable chimneys, which they put over the holes in the streets, and, by building a fire in the chimneys, draw out the foul air. This involves our principle, which we have discovered since the above was written.

It may be objected that insuperable difficulties would arise in putting the above views in practice. That difficulties would arise, is probable, but, that they are insuperable to the engineering talent of New York, we do not believe. We imagine the expense of the various efforts now put forth for a partial success, if rightly directed, would achieve a perfect and permanent relief from malarial influences, and would supply the now most miasmatic districts with pure air.

WHAT IS ENERGY?

[Balfour Stewart in Nature.]

It has been shown in a former article (See SCIENTIFIC AMERICAN, page 360, Vol. XXII.), that energy, or the power of doing work, is of two kinds; namely, energy due to actual motion, and that due to position. We ended that article by supposing a stone shot vertically upwards had been caught at the summit of its flight and lodged on the top of a house; and this gave rise to the question, What has become of the energy of the stone? To answer this we must learn to regard energy, not as a quality, but rather as a thing.

The chemist has always taught us to regard quantity or mass of matter as unchangeable, so that amid the many bewildering transformations of form and quality which take place in the chemical world, we can always consult our balance with a certainty that it will not play us false. But now the physical philosopher steps in and tells us that energy is quite as unchangeable as mass, and that the conservation of both is equally complete. There is, however, this difference between the two things—the same particle of matter will always retain the same mass, but it will not always retain the same energy

As a whole, energy is invariable, but it is always shifting about from particle to particle, and it is hence more difficult to grasp the conception of an invariability of energy than of an invariability of mass. For instance, the mass of our luminary always remains the same, but its energy is always getting less.

And now to return to our question—What has become of the energy of the stone? Has this disappeared? Far from it; the energy with which the stone began its flight has no more disappeared from the universe of energy, than the coal, when we have burned it in our fire, disappears from the universe of matter. But this has taken place: the energy has changed its form and has become spent or has disappeared as energy of actual motion, in gaining for the stone a position of advantage with regard to the force of gravity.

If we study this particular instance more minutely, we shall see that during the upward flight of the stone its energy of actual motion becomes gradually changed into energy of position, while the reverse will take place during its downward flight, if we now suppose it dislodged from the top of the house. In this latter case the energy of position with which it begins its downward flight is gradually reconverted into energy of actual motion, until at last, when the stone reaches the ground, it has the same amount of velocity, and, therefore, of actual energy, which it had at first.

Let us now revert, for a moment, to the definition of energy, which means the power of doing work, and we shall see at once how we may gage numerically the quantity of energy which the stone possesses, and in order to simplify matters, let us suppose that this stone weighs exactly one pound. If, therefore, it has velocity enough to carry it up one foot, it may be said to have energy enough to do one unit of work, inasmuch as we have defined one pound raised one foot-high to be one unit of work; and in like manner if it has velocity sufficient to carry it 16 feet high, it may be said to have an energy equivalent to 16 units of work, or foot-pounds, as those units are sometimes called.

Now, if the stone be discharged upwards with an initial velocity of 32 feet per second, it will rise 16 feet high, and it has therefore an energy represented by 16. But if its initial velocity be 64 feet per second it will rise 64 feet high before it turns, and will therefore have energy represented by 64. Hence we see that by doubling the velocity the energy is quadrupled, and we might show that by tripling the velocity the energy is increased nine times. This is expressed in general terms by saying that the energy or quantity of work which a moving body can accomplish varies as the square of its velocity. This fact is well known to artillerymen, for a ball with a double velocity will penetrate much more than twice as far into an obstacle opposing its progress.

Let us now take the stone or pound-weight having an initial velocity of 64 feet per second, and consider the state of things at the precise moment when it is 48 feet high. It will at that moment have an actual velocity of 32 feet per second, which, as we have seen, will represent 16 units of work. But it started from the ground with 64 units of work in it; what, therefore, has become of the difference—or 48 units? Evidently it has disappeared as actual energy; but the stone, being 48 feet high, has an energy of position represented by 48 units; so that at this precise moment of its flight its actual energy (16), plus its energy of position (48), are, together, equal to the whole energy with which it started (64).

Here, then, we have no annihilation of energy, but merely the transformation of it from actual energy into that implied by position; nor have we any creation of energy when the stone is on its downward flight, but merely the re-transformation of the energy of position into the original form of actual energy.

We shall presently discuss what becomes of this actual energy after the stone has struck the ground; but, in the meantime, we would repeat our remark how intimate is the analogy between the physical and the social world. In both cases we have actual energy and energy of position, the only difference being that in the social world it is impossible to measure energy with exactness, while in the mechanical world we can gage it with the utmost precision.

Proteus-like, this element, energy, is always changing its form; and hence arises the extreme difficulty of the subject, for we cannot easily retain a sufficient grasp of the ever-changing element to argue experimentally regarding it. All the varieties of physical energy may, however, be embraced under the two heads already mentioned; namely, energy of actual motion and of position.

We have chosen the force of gravity, acting upon a stone shot up into the air, as our example; but there are other forces besides gravity. Thus, a watch newly wound up is in a condition of visible advantage with respect to the force of the main spring; and as it continues to go it gradually loses this energy of position, converting it into energy of motion. A cross-bow bent is likewise in a position of advantage with respect to the spring of the bow; and when its bolt is discharged, this energy of position is converted into that of motion. Thus, again, a meteor, a railway train, a mountain torrent, the wind, all represent energy of actual visible motion; while a head of water may be classed along with a stone at the top of a house as representing energy of position. The list which represents visible energy of motion and of position might be extended indefinitely; but we must remember that there are also invisible molecular motions, which do not the less exist because they are invisible.

One of the best known of these molecular energies is radiant light and heat—a species which can traverse space with the enormous velocity of 186,000 miles a second.

Although itself eminently silent and gentle in its action it is, nevertheless, the parent of most of the work which is done in the world, as we shall presently see when we proceed to another division of our subject. In the mean time we may state that radiant light and heat are supposed to consist of a certain undulatory motion traversing an etherial medium which pervades all space.

Now, when this radiant energy falls upon a substance, part of it is absorbed, and in the process of absorption is converted into ordinary heat. The undulatory motion which had previously traversed the thin ether of space has now become linked with gross palpable matter, and manifests itself in a motion which it produces in the particles of this matter. The violence of this rotary or vortex-like motion will thus form a measure of the heat which the matter contains.

Another species of molecular energy consists of electricity in motion. When an electric current is moving along a wire, we have therein the progress of a power moving the light with enormous velocity, and, like light, silent in its operation. Silent, we say, if it meets with no resistance, but exceedingly formidable if it be opposed; for the awe-inspiring flash is not so much the electricity itself as the visible punishment which it has inflicted on the air for daring to impede its progress. Had there been a set of stout wires between the thunder-cloud and the earth, the fluid would have passed into the ground without disturbance.

The molecular energies which we have now described may be imagined to represent motion of some sort not perceived by the outward eye, but present, nevertheless, to the eye of the understanding, they may therefore be compared to the energy of a body in visible motion, or actual energy as we have termed it.

But we have also molecular energies which are more analogous to the energy of position of a stone at the top of a cliff.

For instance, two bodies near one another may be endowed with a species of energy of position due to opposite electrical states, in which case they have a tendency to rush together, just as a stone at the top of a cliff has a tendency to rush to the earth. If the two bodies be allowed to rush together this energy of position will be converted into that of visible motion, just as when the stone is allowed to drop from the cliff its energy of position is converted into that of visible motion.

There is finally a species of molecular energy caused by chemical separation. When we carry a stone to the top of a cliff, we violently separate two bodies that attract one another, and these two bodies are the earth and the stone. In like manner when we decompose carbonic acid gas into its constituents we violently separate two bodies that attract one another, and these are carbon and oxygen. When, therefore, we have obtained in a separate state two bodies, the atoms of which are prepared to rush together and combine with one another, we have, at the same time, obtained a kind of energy of molecular position analogous on the small scale to the energy of a stone resting upon the top of a house, or on the edge of a cliff on the large or cosmical scale.

Preservation of Freestone.

The *Hub*, a Bostoncotemporary, in discoursing on the above subject, remarks that many methods have been adopted to preserve brown stone, and a number of patents have been taken out for preparations for this purpose.

In regard to the cause of the scaling of the brown stone so much used of late in this country, it would seem to be chiefly due to its porosity, whereby it absorbs water, which, in freezing beneath the surface, splits it apart by the expansion which water undergoes at temperatures below 39° Fah. This force of expansion is very powerful, as is shown by the rupture of water pipes, which so often burst in cold weather. It is frequently the case that these pipes do not crack until the temperature moderates and melts the cylinders of ice contained therein, and this has given rise to the delusion that it is the thawing which bursts them.

It has been theorized that the decay of the stone is due in part to the corrosive action of the sulphuric acid which exists in the atmosphere of large cities, proceeding from the coal there burned. Even if this theory be correct, the acid could not affect the stone unless absorbed into its pores with moisture. Stop these pores therefore, and the decay will be arrested. For this purpose the journal from which we condense this article recommends the varnish known as "Permanent Wood Filling." It says oil has been used on walls of brick and stone, but it soaks away before drying, and leaves but little at the surface where it is most needed, while the "Filling," being more viscid, remains in the surface pores until it hardens and closes them forever. This article, like most modern discoveries, was known in principle before the Christian era, and if Sextus Tarquin had not scowled on the gypsy we might perhaps have found in the sibylline books the formula for its preparation. It is at least certain that the asphaltum, which enters into its composition, was used by the Egyptians to preserve their dead, by impregnating the bandages in which they wrapped the bodies to make mummies; and after a trial of four thousand years, we are justified in calling this species of dry pickle *permanent*. In the fossil gums, moreover, which are also used in its composition, we find insects and leaves which have been handed down to us from antediluvian times, and which would indicate the preserving qualities of those gums. Is it not probable that if frail organic remains have been thus preserved by its ingredients, that they will as well protect a hard stone wall? To us it seems that nothing can be more durable than a surface composed of the elastic "Filling," closing the pores of the stone, and the silicous cells of the latter guarding the "Filling" from abrasion. The motives of reformers are often assailed, but the principles of natural philosophy are here in question and not the principles of men.

Improvement in Pumps.

The object of this invention is to so construct a pump for the use of ships and railways, and for domestic purposes, that the lower valve and seat, A, Fig. 1, may be taken out without taking up the pump.

It results from this construction that ships' pumps may be used without a strainer, as whatever may be drawn through the pipe into the barrel may be easily removed. This class of pumps most frequently clogs at the strainer, necessitating loss of time, often in cases of great emergency when minutes lost are lives lost.

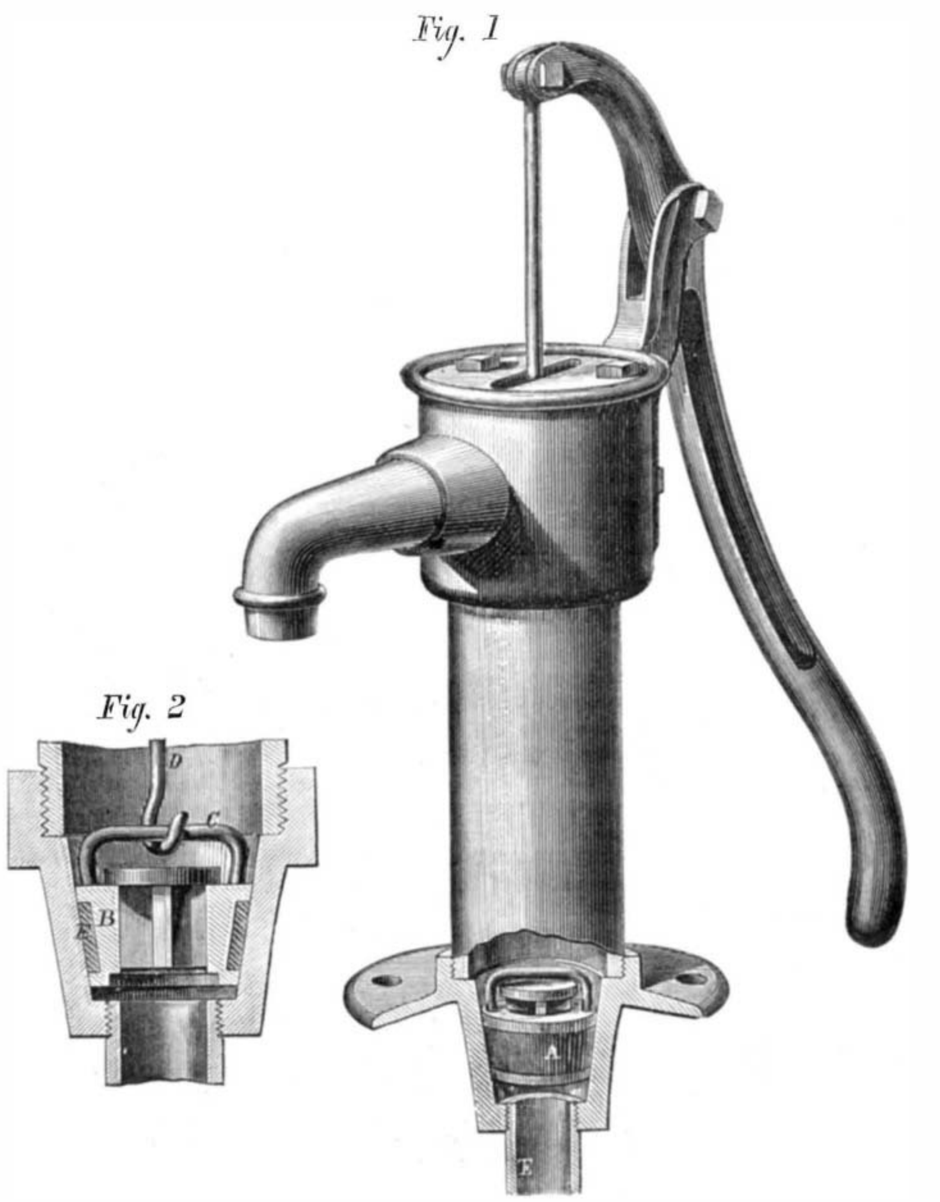
For railways also the pump offers advantages, as the valve may be placed below the reach of frost, and be as readily removed for cleaning or repair as though it were near the surface.

The improvement consists in providing the valve seat, B, Fig. 2, with a bail, C, with which a hook, D, attached to a cord or formed upon the end of a rod, engages, and the valve seat and valve may be withdrawn and taken out at the top of the pump.

The valve seat is made tapering, to fit a similarly shaped recess at the bottom of the barrel of the pump, the wedging action being sufficient to hold it in place when the pump is in action, but offering but little resistance when the valve is desired to be removed. It also has a leathern packing, E.

The valve may be taken out of a ship's pump made in this way, all obstructions removed, the valve again replaced, and the pump put in operation, within five minutes from the stoppage of the pump.

Patented, through the Scientific American Patent Agency, July 27, 1869, by John W. Williams, of Syracuse, N. Y., whom address for further particulars.



WILLIAMS' IMPROVED PUMP FOR SHIP AND RAILWAY USE.

Mack's Patent Circulator.

Our engravings illustrate a new apparatus for the generation of steam, for which the inventor claims the merits of safety, economy, and freedom from incrustation, and which, therefore, will attract the attention of steam engineers and consumers.

Fig. 1 is a perspective view, and Fig. 2 a cross section, showing its construction. It will be seen that the boiler proper is mounted upon a circulator attachment, the object of which is to prevent the intense heat of the fire acting upon the boiler proper, and to present a thin body of water to the heat, which, by its constant circulation, will bring every particle of the water in the upper boiler over the immediate action of the fire, thereby rendering the boiler a reservoir for water and steam, and preventing violent commotion from extra heat in the boiler, wherein the steam and water will become distinctly separated, so as to leave the steam perfectly dry. It is also claimed that incrustation is likewise prevented, as the constant motion of the water in the circulator prevents deposits accumulating on it. The water enters the circulator from the bottom of the boiler to the lowest part of the circulator by the tubes, D, on each side, moving around the bars or stays, till both streams meet on the top or crown of the circulator, and enter the boiler by the pipe, E, at or near the water line.

B and C are the outer and inner plates of the circulator, between which are the stays or angle irons, A. B can be made of stronger and better material, or if made of copper, it will surpass iron for withstanding the effects of the heat.

Thus the water comes from the boiler at about the lowest point through two large tubes, and descends and enters the circulator at the lowest point of the same on opposite sides, thence passing around the bars (which are placed to guide the course of the water) on both sides, till they meet on the top or crown, where they enter by a tube back to the boiler again near the water line, where the steam and water become silently separated, the steam ascending, the water descending, to be again returned back through the circulator.

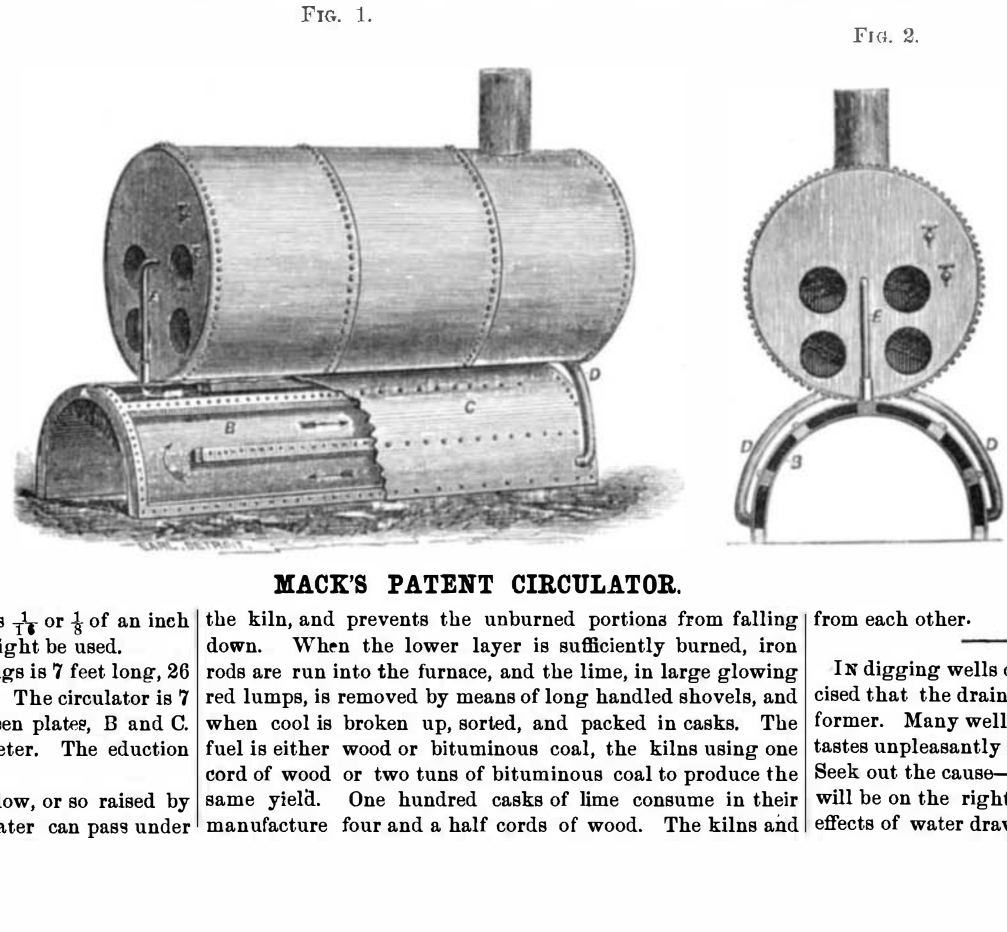
The longitudinal bars, around which the currents move in the circulator, may be placed so as not to exclude the water entirely from the fire-plate, as they are only to guide the same in its course, therefore they do not require to be riveted like the outer edges. Rings or washers might be placed to raise the bars $\frac{1}{16}$ or $\frac{1}{8}$ of an inch from the plate, or hollow or fluted bars might be used.

The boiler represented in the engravings is 7 feet long, 26 inches in diameter, and has 21 3-inch flues. The circulator is 7 feet long, having $1\frac{1}{4}$ in. water space between plates, B and C. The feed pipes, D, are each $2\frac{1}{2}$ in. in diameter. The eduction pipe or tube, E, is $1\frac{3}{4}$ in. in diameter.

The bars or stays should be made hollow, or so raised by small washers under them that the water can pass under them—they are merely to guide the current of water in its course.

Patented by W. B. Mack, November 11, 1869. All communications relative to purchase of rights, etc., should be addressed to D. B. and H. M. Duffield, Jefferson avenue, corner of Griswold street, Detroit, Mich.

FIG. 1. FIG. 2.



MACK'S PATENT CIRCULATOR.

Lime Burning.

"The limestone quarries at Rockland," says the *Architectural Review*, "near the mouth of Penobscot Bay, Me., are at present worked on a more extensive scale than ever before. The old fashioned kiln for burning the limestone has been entirely superseded by the patent perpetual kiln, and a large amount of capital is invested in the business. The kilns are situated on the shore of a peninsula, and are built at the foot of a bank and at the head of a wharf. The kilns are constructed with walls of thick granite and lined with fire-brick, being eighteen feet square and thirty feet deep, narrowing towards the lower part. Each kiln will hold from one hundred and fifty to two hundred casks of lime, and a charge of limestone rock and fuel is burned in from seven to eight hours, and is drawn three or four times a day, according to the character of the rock. The lime, it is stated, swells in the kiln, and prevents the unburned portions from falling down. When the lower layer is sufficiently burned, iron rods are run into the furnace, and the lime, in large glowing red lumps, is removed by means of long handled shovels, and when cool is broken up, sorted, and packed in casks. The fuel is either wood or bituminous coal, the kilns using one cord of wood or two tuns of bituminous coal to produce the same yield. One hundred casks of lime consume in their manufacture four and a half cords of wood. The kilns and the fuel are covered by large sheds, the buildings for a pair of kilns occupying an area of seventeen thousand square feet.

Heat From Electric Currents.

Professor Tyndall, in a recent lecture, pointed out how the metal zinc is virtually "burnt" or made to enter into combination with oxygen, in the cells of the Grove's battery; the consequence is, that the temperature of the liquid in the battery cells is raised. If both ends of the battery be joined by a very short, thick copper wire, a definite amount of heat is produced in the cells; but if a thin platinum wire be placed in the circuit, so that the said wire shall be made red hot by the current, there is no additional creation of heat, for the temperature gained in the wire is compensated for by less heat generated in the battery cells. He also explained, that when an electrical current raises the temperature of a wire, it thereby creates increased resistance to its own passage through the wire, for the cooler the metal the more freely does the current pass. To illustrate this, Professor Tyndall passed a current from a forty-cell Grove's battery through a fine platinum wire, rather more than a yard long; the result was, that the wire became red-hot. He then took this red-hot wire by its two ends, with the current still passing through it, and held it so that it hung in a curve like the letter U, and he let the bottom part of the U-curve sink slowly into a glass vessel full of water. The result was, that the water quenched the redness of the wire, wherever the wire was immersed, and the current then passed more freely through the cooled portions; this, of course, increased the heating action of the current upon those portions of wire which were not immersed in the water, so that they became white hot, and, after glowing brilliantly for a time, were fused by the intense heat. The lecturer explained how some metals conduct electricity better than others. For this purpose, he joined up short lengths of platinum wire and silver wire of the same thickness, so as to form one long wire, and then he passed a powerful galvanic current through the whole arrangement; the platinum lengths then became white hot because of the resistance they offered to the passage of the electricity, but the silver lengths remained quite cold and dark, because their good conducting power permitted the current to pass freely. In this lecture he also showed how two wires, through which a current of galvanic electricity is passing, will, when free to move, visibly attract or repel each other, according to the direction of the current through each. An electrified wire will also attract or repel the electric arc produced by the passage of an electrical current between two carbon points. To illustrate this, Professor Tyndall placed a little lump of silver in a hollow on the top of the lower carbon of the electric lamp. When the upper carbon was permitted to touch the silver, the current soon made the metal boil, and when the carbons were separated a little, a brilliant arc of bright green silver vapor extended between the points. A bright image of this arc was projected upon the screen, by means of the lenses of the lamp, and when a wire, through which a galvanic current was passing, was brought near the arc, it was seen to attract it in a remarkable manner. In fact, it could be made to draw the arc of luminous vapor so far on one side as to break it, and to extinguish the light altogether. Professor Tyndall also called attention to the fact, that when frictional or galvanic electricity is passed through one wire, it will induce currents of electricity in another wire lying near, but not touching the first one. He placed one flat coil of insulated wire on the top of another flat coil of insulated wire; then, on passing the discharge from a Leyden jar through the first coil, the electrical current produced in the second one was so strong, that it set fire to gun cotton placed between the terminals of the secondary coil. In another experiment, he showed that these effects may be produced when the two coils are a considerable distance apart, and he repeated the experiment, after first separating the two coils to the distance of eight or nine inches from each other.

IN digging wells or sink-holes great care should be exercised that the drainage from the latter does not affect the former. Many wells are poisoned in this way. The water tastes unpleasantly; which is a proof that it is unhealthy. Seek out the cause—suspect that it is the sink-hole, and you will be on the right track. Many families suffer from the effects of water drawn from wells affected by sinks.