In the explanation of his own theory he makes another assumption, which we hardly think will be borne out. That is to say, "His theory supposes the existence of large masses of iron occurring with inorganic carbon in the heart of the earth, and this supposition is said to be "in conformity with the hypothesis of Laplace on the formation of the earth." Laplace's nebular theory, here referred to, amounts to this. At some period in the infinitely remote past the globe had no existence as such. The matter composing it existed in space, but at such a high temperature that it was not merely liquid but a gas. Everything of which the earth is now composed—iron, gold, granite, as well as water and air—existed only in the form of incandescent vapor.

In the course of ages this mass of gaseous matter gradually cooled, and the globe assumed first the form of a ball of melted matter surrounded by dense clouds; then it became covered with a solid crust, the clouds gradually disappeared, and the earth assumed its present form. This theory, startling at first, becomes more plausible as our knowledge increases, and if not itself the final explanation of globe formation, is at least a long stride toward accurate knowledge. From the experience men have gained in the operations of smelting and other processes requiring intense heat, we are enabled to predict with great certainty what would be the state of things during the gradual condensation of the globe from a gas to a solid. And the knowledge thus gained leads us to the conclusion that it is extremely improbable that carbon could exist in the earth in a solid state. Every one knows what would be the effect of exposing white-hot carbon to the atmosphere. It would burn rapidly and disappear. Metallurgists will understand further that if a limited amount of air were supplied to a number of combustible bodies, the carbon would burn first. Sulphur, phosphorus, white-hot iron, zinc, and many other substances, all burn, that is, they all use up the oxygen of the atmosphere. But it is well known that charcoal is used to smelt iron, that is to say, when heated iron and heated charcoal are placed in contact with a limited amount of oxygen, such as is contained in hæmatite and other good ores, the iron gives up its oxygen to the carbon, and we get as results metallic iron and carbonic acid gas. Carbonic acid gas is always formed when carbon is burnt in the air. It is the same with most other materials. The carbon would extract from them all the oxygen they contained, and would be transformed into gas. It may be said that carbon in the center of the earth would be protected from the atmosphere and would have no chance of burning. Our contention is, that it would never get into the center of the earth. Remember that the whole material of the earth is in a state of vapor. As this gradually cooled, carbon and iron among other things would separate as solid or liquid masses at more than a white heat. And it is impossible to suppose that the carbon would not immediately seize upon all the oxygen surrounding it and be instantly converted into the permanent gas, carbonic acid.

Further, Mendeleef assumes that water could penetrate soil which was sufficiently hot to keep iron in a melted state. If the water could creep down a crevice to the melted iron, it is certain that steam could escape by the same passage, and the heat generated by the neighborhood of the masses of melted iron would certainly cause every particle of water to disappear long before it would come in contact with the iron itself.

If there was not sufficient organic life in the Silurian and Devonian periods to supply the materials for the formation of petroleum; if carbon and iron could exist in a melted state in the center of the earth and could reach that position before the carbon was completely oxidised and converted into gas; if water could penetrate the intensely heated soil without being transformed into vapor and restored to the atmosphere; if water could come in contact with heated iron or carbon, it is possible that petroleum might be formed through the combination of these materials. But it is evident that this involves too many suppositions to be worthy of great confidence, and until we have obtained more facts we must content ourselves either with the older theory or with the statement that we know nothing about the origin of this important commodity.—*The Ironmonger.*

Arrow Poison.

Lovers of the weird and ghastly will be gratified by the perusal of the account of the poisoned arrow manufacture as carried on by the Samoan islanders, and related to the Fellows of the Linnæan Society by the Rev. Thomas Powell. An old chief of Efat—one of the Sandwich Islands—thus reveals the mystery of the poison craft to his son Pomare. The initiated, distinguished by wearing the *os femoris* of a pig inserted between the arm and armlet, watch for the death of a sufferer laid low by any acute disease which may be accompanied by delirium. They note the place of his burial, and six months afterwards open his grave by stealth. From thence they carry the large bones of both extremities, and the parietal bones of the skull. Of these, by sundry sawing, polishing, and scraping, they make the points of spears and arrows. For a saw they use the spines of a large echinus, of which they need a goodly quantity, as the edge is soon worn out Three plants are pressed into service for the poison—the toto, the putu, and the fanuamamala. The most virulent is the toto, a large tree. When cut, a white milk exudes, which causes blindness; its sap introduced into the circulation causes death. A band of freebooters once landed on the western end of Efat. Proceeding eastward, they came to a place called Mole, where the inhabitants prepared for them an inhospitable reception. There was an enclosure of water on the beach, which, at low tide, served both for drinking and for bathing. The people dried some toto leaves and strewed them in the water. No sooner landed, the invaders rushed into the cooling lake. Immediately they were thrown into convulsive agonies. Those who only bathed in the impregnated water became blind, whilst those who drank, died. These three plants, the toto being chief, carefully picked and desiccated, were pounded in a mortar with a wooden pestle made of the ara. Next a species of holothuria was taken from the lagoon, put into a leaf of *colocasia Indica*, and placed in the shade till it became a putrid liquid, to which the powder was added in sufficient quantity to form a thin paste. One last ingredient was *na lel*, or wasp food, and the villanous concoction was worked up with the expressed juice of an old cocoa-nut, stirred for a month at intervals till the mass became a dark cloudy oil, which, when bottled and preserved for twelve months, was fit for use. Great precautions were employed in applying the poison to the tips of spears and arrows. Every trace of moisture was got rid of by careful drying in the smoke. The poison, taken internally, was always fatal. When received into the system on the spear point, recovery might be effected by making instantaneous free incisions in different parts of the body, to allow the escape of the poisoned blood. Whenever fatal the same symptoms followed—convulsions, lock-jaw, death. Tetanus was one of the invariable results. Imagine the old Samoan noting the grave for which delirium had found an occupant, exhuming the fever corpse to barb his weapons with the poisoned bones; then, with a skill and patience which no modern pharmacist could surpass, mixing, evaporating, and perfecting his vile compound.—*Chemist and Druggist.*

How the French Workman Lives.

The French laborer probably gets more for his wages than any other. His food is cheaper and more nourishing. His bouillon is the liquid essence of beef at a penny per bowl. His bread at the restaurant is thrown in without any charge, and is the best bread in the world. His hot coffee and milk is peddled about the streets in the morning at a sou per cup. It is coffee, not slops. His half bottle of claret is thrown in at a meal costing twelve cents. For a few cents he may enjoy an evening's amusement at one of the many minor theaters, with his coffee free. Sixpence pays for a nicely cushioned seat at the theater. No gallery gods, no peanuts, pipe, smoke, drunkenness, yelling or howling. The Jardin des Plantes, the vast galleries and museums of the Louvre, Hotel Cluny, palace of the Luxembourg and Versailles, are free for him to enter. Art and science hold out to him their choicest treasures at small cost, or no cost at all. French economy and frugality do not mean that constant retrenchment and self-denial which would deprive life of everything which makes it worth living for. Economy in France, more than in any other country, means a utilization of what America throws away, but it does not mean a pinching process of reducing life to a barren existence of work and bread and water.

PRACTICAL MECHANISM.

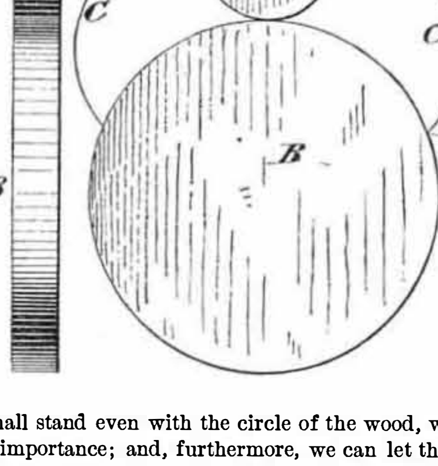
BY JOSHUA ROSE, M.E.

NEW SERIES—NO. XXXV.

CURVES FOR GEAR WHEEL TEETH.

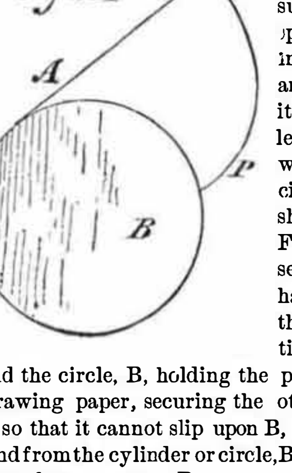
An epicycloid may be described or generated by a point in the circumference of a circle that rolls, without slip, upon the circumference of another circle. Hence to produce this curve, take two pieces of wood, having circular edges, A and B in Fig. 243, and bore a parallel hole obliquely in A to receive the tightly fitting and hard piece of pencil shown at P in the Fig. 243, which is to serve as a tracing point. It should be made to protrude well through the wood, be filed even with the circular edge of the same, and brought to a point by filing from the back and on the two sides. By adopting this plan of sharpening the pencil point we ensure

Fig. 243.



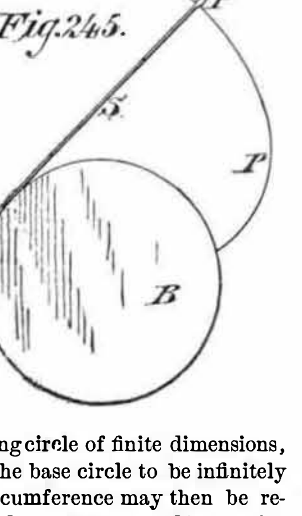
that it shall stand even with the circle of the wood, which is of great importance; and, furthermore, we can let the point protrude well, enabling us to see distinctly the operation of the point and place to any mark upon the base circle, B. Lay the radial face of the base circle, B, upon a sheet of drawing paper and, while holding it in a fixed position, take the piece, A, and placing its perimeter in contact with that of B, and pressing the two together to avoid slip, revolve A around B. The point, P, will then mark upon the paper the epicycloidal curve, C C. In this operation A (the moved circle) is called the generating circle and B (the stationary circle) the base circle. It will readily be perceived that the shape of the curve thus traced will vary with the size of the generating circle, but the properties of the curve will remain the same. If the diameter of the generating circle, A, be supposed to be infinite, than a portion of its circumference may be represented by a straight line, such as A in Fig. 244, and if this straight line be made to roll upon the circumference of a circle, as shown in Fig. 244, then the curve traced will be involute, P. In practice a piece of flat spring steel, such as a piece of clock spring, is used for tracing involutes. It may be of any length, but at one end it should be filed so as to leave a scribing point that will come close to the base circle or line, and have a short handle, as shown in Fig. 245, in which S represents the piece of spring, having the point, P′, and the handle, H. The operation is to bend the spring around the circle, B, holding the point, P′, in contact with the drawing paper, securing the other end of the piece of steel, so that it cannot slip upon B, and allowing the steel to unwind from the cylinder or circle, B. The point, P′, will mark the involute curve, P.

Fig. 244.



Another way to mark an involute is to use a piece of twine in place of the spring and a pencil instead of the tracing point; but this is not so accurate, unless, indeed, a piece of wood be laid on the drawing board and the pencil held firmly against it. In tracing any of these curves a hard pencil is necessary to obtain a fine line, and it is best to go over the operation twice, and if then the curve is a fine and not a double line, it is a proof of correctness.

Fig. 245.



Returning now to a generating circle of finite dimensions, we will suppose the radius of the base circle to be infinitely extended. A portion of its circumference may then be represented by a straight line, and the curve traced by a point in the circumference of the generating circle as it rolls upon the base line is termed a cycloid. Thus in Fig. 246, B is a portion of a base circle of infinite diameter, A is the generating circle, and C C is the cycloidal curve traced by the point, D, when A is rolled along B. If now we suppose the line, B, to represent a rack, it will be obvious that the part of the cycloid which meets B at one end is suitable for the face on one side of the tooth, and the part at the end is suitable for the other side of the tooth.

Fig. 246.

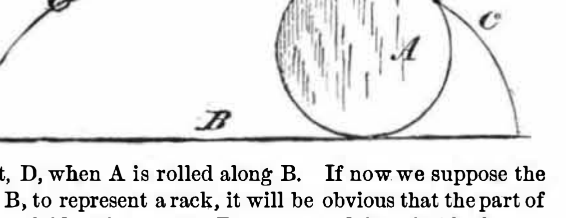
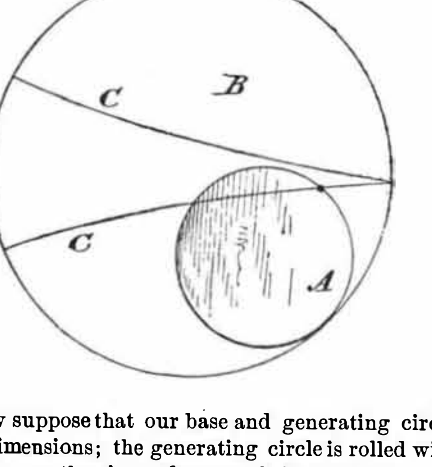


Fig. 247.



Let us now suppose that our base and generating circles have finite dimensions; the generating circle is rolled within instead of upon the circumference of the base circle, and a point upon the periphery of the generating circle will then describe a curve called an hypocycloid. Thus, in Fig. 247, B represents a bore forming the base circle, and A a cylindrical piece of wood forming the generating circle. Then a point at the periphery of A would, upon rolling A within B, describe the hypocycloidal curve, C C. Now though in the four cases here given the curves produced by the prescribed mechanical means are called by different names, yet, as the conditions are the same, it is the same general curve throughout, and is known as the cycloid. If we consider the case of Fig. 243 as positive, then that of Fig. 244 is negative, that of Fig. 246 is neutral, and that of Fig. 247 infinite.

To demonstrate that, by the application of these curves, motion from one wheel to another may be communicated with as much uniformity as by frictional contact of the circumferential surfaces, let A B, in Fig 248, represent two plain disk wheels which are at liberty to revolve about their

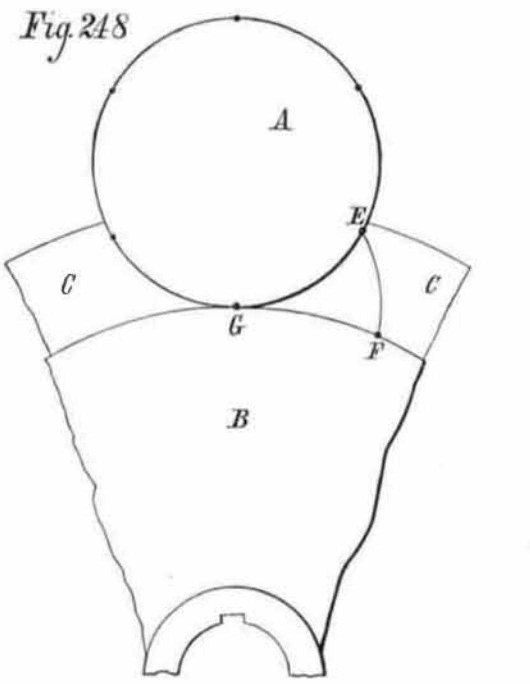


Fig. 248

fixed centers, and let C C represent a margin of stiff white paper attached to B, so as to revolve with it. Now suppose that rotary motion to A and B commenced when the point, E (where a tracing point or pencil is attached), in conjunction with the point, F, formed the point of contact of the two wheels, and continued until the points, E and F, had arrived at their respective positions, as shown in the figure. The pencil at E will have described upon the margin of stiff paper the small portion of the epicycloid denoted by F E, and as this movement took place by the contact of the circumferences of the wheels it is evident that the arc, G F, must be equal to the arc, G E. The conclusion, therefore, is that the motion of the wheel, B, would be communicated uniformly to the wheel, A. Again, if we suppose a series of these small portions of epicycloids, as shown at E F in Fig. 249, to be arranged at equal distances around the wheel, B, and a series of points set up at equal and corresponding points around A, which we will call the pinion, then the wheel, B, in revolving in the direction from G to F, would impart a continuous and uniform motion to the pinion, A.

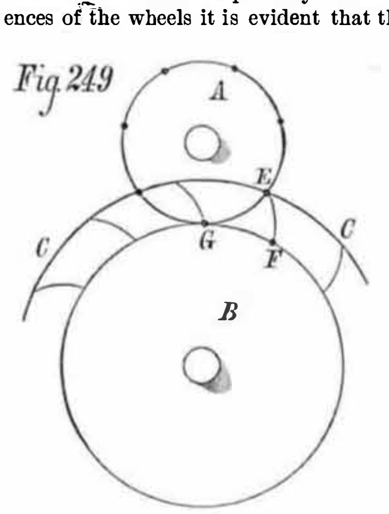


Fig. 249

In Fig. 250 is shown a similar case applied to a rack and an internal wheel. The line, B, with the series of short curves, which are portions of cycloids struck with the gene-

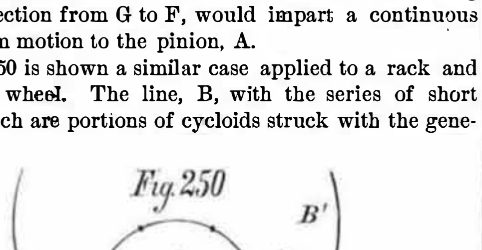


Fig. 250

rating circle, A, representing the rack, B', with its small portions of hypocycloids representing an internal wheel, or more strictly the elements of one. In our figure the generating circle, A, is drawn half the diameter of the base circle, B, and consequently the hypocycloids are straight radial lines, which will not be the case where these two proportions are different, although the practical construction would remain the same. It will be seen that, by the arrangement of curves and points shown in our two figures, rotary motion may be either transmitted or converted into a plane motion, but it will be noted that this arrangement would transmit the motion in one direction only. To enable it to operate in both directions we have but to add another set of portions of cycloids, as shown in Fig. 251, and we shall have arrived at an elementary form of gearing, known as the wheel and lantern.

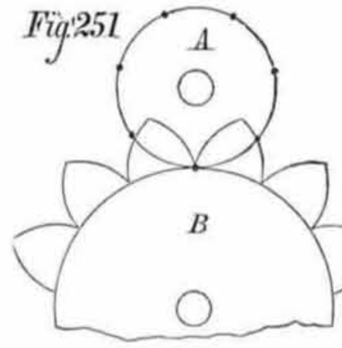


Fig. 251

To render this device useful in practice all that remains is to increase the points to a suitable diameter, making them into rungs possessing the requisite strength. This will necessitate a diminishing of the teeth (to afford space for the rungs to fall into) by the same amount we have added to the points, or, strictly speaking, by rather more, since it is necessary to allow a little for irregularity in the workmanship and to permit of the free passage of the rungs. Fig. 252 represents this process carried out. A B represents the wheel, as before, C C the primitive teeth, as in Fig. 251; and by setting the points of a pair of compasses to a trifle more than the radius of the rung, and marking off a number of points of that distance from the curves, C C, we are enabled to trace out the same curves; that is to say, teeth adapted to work correctly with and allow space for those rungs.

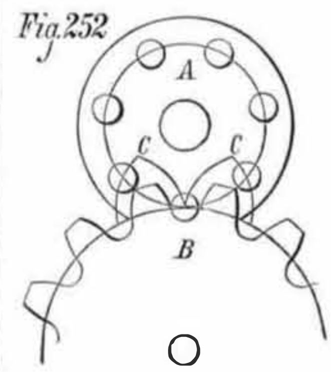


Fig. 252

It is considered as established that the correct form to be given to the teeth of a wheel that is to drive or be driven by a lantern, trundle, or wallower (which are synonymous terms) must be epicycloidal with the curves generated by the rolling of a circle whose diameter is the same as that of the lantern, measured at the centers of the pins or rungs, which diameter represents, in this case, the pitch circle; the teeth being first drawn out as if the rungs were points, and then diminished by curves drawn parallel to the first, but set back, as it were, so as to make room for the full size of the rung and allowing a small portion for clearance. It is obvious, however, that such method of communicating rotary motion is unsuited to the transmission of much power, because the pins in the pinion, A, would be considerably weaker than the teeth in the wheel, B, and the pins would soon wear away from the small amount of wearing surface they possess.

Let us now suppose that instead of points we have radial

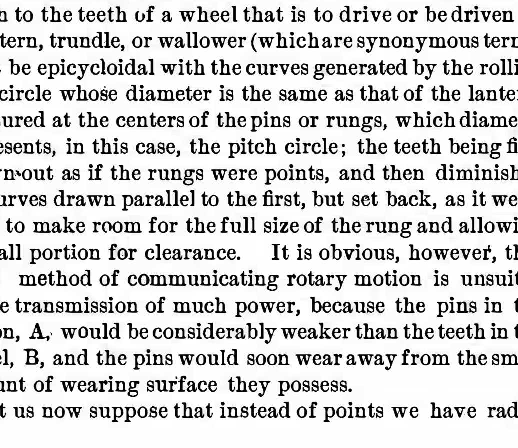


Fig. 253

lines, representing the surfaces of projecting radial ribs, arranged at equal distances around the plane of the disk, A, as in Fig. 253. To determine the shape of the teeth of the wheel, B, to work with those lines, we take a circle, C, in the figure of half the diameter of A, and cause it to roll along in contact with the internal circumference of A, and a tracing point at its circumference will draw radial lines upon A, but the circumstances will not be altered if we suppose these three circles to be movable about their fixed centers and let the centers be in a straight line; and if under these latter circumstances we suppose motion to be imparted to these three circles, through frictional contact of their perimeters, a point on the circumference of C would trace epicycloids upon the revolving plane of B and hypocycloids upon that of A. The latter being a radial line, and therefore the proper curve for the teeth of these two primitive wheels, will be epicycloidal for B and hypocycloids, or radial lines, for A, as shown in the figure. Now let us render these teeth, which are adapted to work with radial lines, capable of practical use, by allowing for the thickness of the ribs, of which the radial lines represented the surface: or, in other words, let us proportion the strength, which we do by increasing the width of the radial lines on A, so as to represent the thickness of the ribs, and striking the epicycloidal curves with the same generating circle, but those formed with C rolling in one direction nearer to the roots of those struck when it rolled in the other, so as to reduce the thickness of the tooth to permit of the passage, between the teeth, of the radial arms, and we shall find that we have arrived at the form of teeth shown in Fig. 254.

Now although the formation of teeth that shall enable any two wheels in a set to work practically correctly together is a subject not as yet under consideration, yet it is proper to here point out that a wheel having teeth of the form of those upon A, in Fig. 14, can only work in gear with one having the form of those upon B, and *vice versa*, and that, although these two forms of teeth were struck with the same generating circle, yet neither two of the wheels B and two of A will work together. We may, however, by means of the employment of another generating circle, carry the process a step further forward and form teeth that will do so. Then we

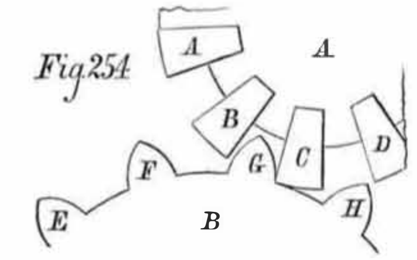


Fig. 254

have in Fig. 255 the same two wheels shown in Fig. 254, with the shape of the teeth in that figure shown at D D and D D. We now introduce a second generating circle, shown in Fig. 255 at E E, and of half the diameter of B, and by rolling it outside of A a point on its circumference will mark or add to the teeth shown on A at D, the epicycloidal curves, G and H, G being marked with the circle, E, rolled in one direction, and H, with it rolling in the other direction, care being, of course, taken to let the tracing point start at each operation of tracing from the exact edge or corner line of the teeth or marks at D. So likewise, with the teeth upon

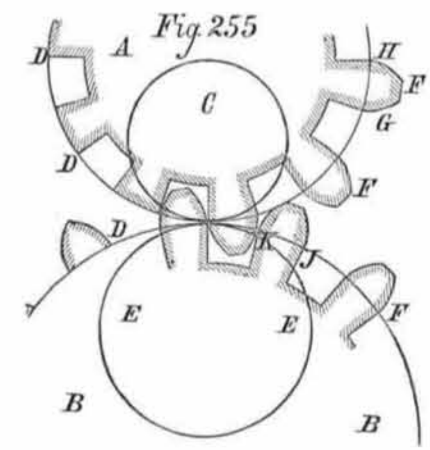


Fig. 255

B, we place our generating circle in contact with the inside of the circle of B and bring the tracing point on its circumference exactly even with the face of the tooth at the pitch line, and then rolling the generating circle will trace a line representing the flank, as, for example, at J in the Fig. 255; then by going through the same operation, rolling the generating circle in the other direction, we mark lines on the other side of the tooth, as shown at K. Thus by the introduction of our last generating circle we have added epicycloidal faces to the teeth on A, shown at D, and hypocycloidal flanks to the teeth on B, shown at J K: giving us the form of tooth shown on the respective wheels at F, the circles forming A and B now representing the pitch lines of their respective wheels, the form of tooth thus arrived at being epicycloidal with hypocycloidal or radial flanks.

How Scorpions Sing.

At the September meeting of the London Entomological Society, Mr. J. Wood-Mason announced the discovery of singing organs in scorpions. He procured two large living scorpions; these, when fixed face to face and goaded into fury, at once commenced to beat the air with their palps and simultaneously to emit sounds which were most distinctly audible. It resembled the noise made by scraping a stiff tooth brush with one's fingernails. The singing apparatus is developed on each side of the body, the scraper upon the flat outer face of the basal joint of the palp-fingers, and the rasp on the equally flat and produced inner face of the corresponding joint of the first pair of legs. The former was thickly beset with stout, conical, sharp and curved spinules; the latter studded with minute tubercles shaped like the top of mushrooms. The sounds were produced by these parts being quickly rubbed together, friction in a dead specimen producing the same sound.

THE American export of petroleum has increased wonderfully within the last four years, until, to-day, there is scarcely a civilized spot on the face of the globe to which this cheapest of all illuminators is not shipped. The wells of Pennsylvania and West Virginia have yielded in all about 80,000,000 barrels, which has a value of nearly four hundred million dollars at the seaboard.—*British Trade Journal*

INSTEAD of the time-honored millstones, chilled iron rolls are beginning to be used in England for the purpose of reducing wheat and other kinds of grain.