All which being much more direct and expeditious than the method explained in connection with Fig. 67, the reader is recommended by all means to use this process in practice.

It was remarked above that, when the propeller is cast, the outer rim, and the intersection of the blade with the cylindrical hub, will be helices whether they be shown as such on the drawing or not. The principle of the mode of making the mould, which renders this result inevitable, may be thus described: Suppose a rigid horizontal straight-edge to be firmly secured at one end to a cylinderical socket, free to turn and also to slide upon a fixed vertical rod, surrounded by any plastic material. If we simply swing the straight-edge round, at a fixed height, without any vertical motion, the effect evidently will be to sweep or level off the irregularities, and form a plane surface. But if while turning the straight-edge be moved up or down, we shall as evidently sweep up a surface which is not plane, but depends on the relation between the two motions; and if both be uniform, it will be the helicoidal surface. The lower or acting edge of the horizontal arm, it will be readily seen, corresponds in its different positions to the edges of the steps of the winding staircase in the illustration made use of at the outset. And this relation may be and practically is attained in this way: The rod is placed in the axis of a large cylinder, or part of one (technically called a guiding iron, probably because it is made of wood), a portion being cut away so as to leave a true helical edge, upon which the outer end of the horizontal sweep rests. When the latter is rotated, then, it is also compelled to rise exactly in accordance with the pitch of the helical guide curve, and consequently sweeps up a surface literally answering to the definition of the right helicoid, as at first given.

NEW ELECTRO-MAGNETIC ENGINES.

By MARTIN EGGER, of Mariaschein, Austria.

Two oscillating beams, A and B, Fig. 1, are employed, from each of which two armatures, *a b* or *a' b'*, are suspended, so that in all four armatures are suspended above four pairs of magnets, C D E F. The arrangement is such

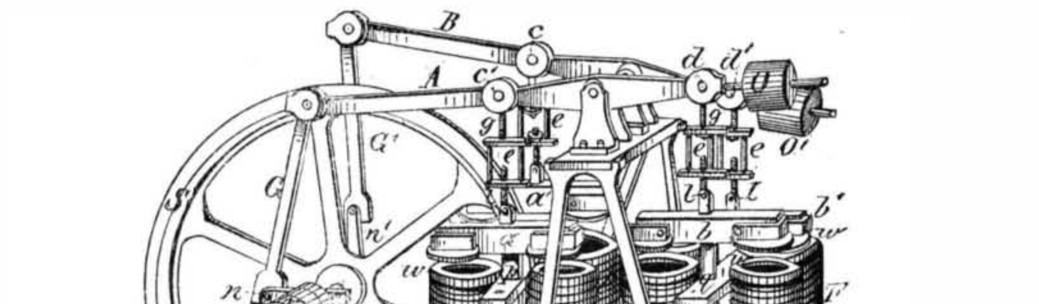

Fig. 1.

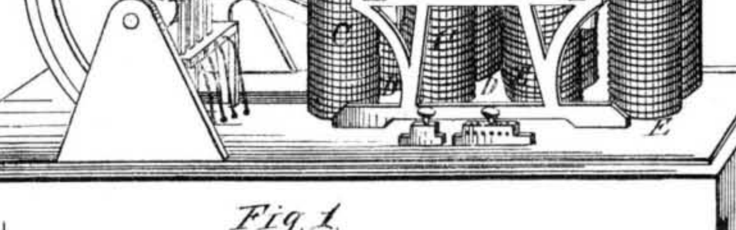

Fig. 2. Fig. 3. Fig. 4.

NEW ELECTRO-MAGNETIC ENGINE.

that the armatures are successively attracted, each by its own respective electro-magnet. The armatures are so suspended that during their reciprocating up-and-down motion they can swing on horizontal axes *c c' d d'* attached to the beams A B. Below each of the said axes a small square frame, *e*, Fig. 2, is suspended so loosely as to allow of the end of the beam going a little further down, after the armature rests on the magnet, but carrying up the armature along with it when the respective end of the beam goes upward. The frame *e* is provided with a set-screw, to enable the distance of the armature from the beam to be adjusted, which has to be done in such a manner that the armature will rest on the magnet when the respective end of the beam has nearly reached its lowest position. Each of the two beams is connected at one end with one of the two cranks *n n'* on a driving-shaft. As the oscillating center of each beam is situated between two armatures, these armatures balance each other, and the weight of the rod G or G' connecting each beam end with the crank *n* or *n'* may be counterbalanced by a weight, O or O', attached to the other end of the beam.

In order to insure the vertical movement of the armatures, each of them is provided at the bottom with a guide-piece, *p q*, sliding in a suitable guide arranged between the magnets.

The motion of the engine takes place as follows: First, one of the four pairs of magnets—C, for instance—attracts one of the four armatures, *a*, and thus causes one of the two beams, A, to move downward with one end, and thus pushes downward one of the two cranks, *n*, which was situated to the left, and therefore rotates the crank-shaft through ninety degrees, arrangement being made so that each electro-magnet exerts its power while the crank on which it indirectly acts is situated between the dead-points. As the two cranks are arranged at an angle of ninety degrees to each other, the second crank *n'* will now be situated to the left horizontally, and therefore between the dead-points. Then a second pair of magnets, D, attracts the armature *a'* suspended at the reverse end of the second beam B', which, through its connecting-rod G', turns the second crank *n'* through another ninety degrees. The first crank *n* will now be situated horizontally to the right, and the third pair of electro-magnets E, attracting the third armature *b* suspended at the other end of the first beam A, this end goes downward, thus causing the other end to rise and draw up the first crank *n* through ninety degrees. The second crank *n* will now be situated horizontally to the right, and when the fourth armature C is now attracted by the fourth pair of magnets F, the other end of the second beam D, and therefore the second crank *n'* connected to it, will be drawn up through ninety degrees. The first crank *n* will now be situated horizontally to the left, and the whole proceedings will be repeated, as above explained.

In this way the alternate attraction of the four armatures will cause an uninterrupted rotation of the crank-shaft, on which a flywheel, S, may be arranged.

The commutator may also be arranged on the crank-shaft. It may be constructed of contact-springs, gliding over a surface alternately conducting and non-conducting, as seen in Fig. 3, or an arrangement may be used by which contact devices may be alternately dipped into mercury, serving as a conductor, as shown in Fig. 4. In the first case the commutator is constructed as follows: On a cylinder, K, of non-conducting material, such as bone, wood, or vulcanite, four metallic plates, three of which, y^1 y^2 y^3, are visible in Fig. 3, are arranged in a row, but alternately around the circumference of the cylinder, so that each occupies rather more than ninety degrees of the circumference. These metal plates are in metallic contact with each other as well as with a metal disk, *r*, fixed to one end of the cylinder, and a contact-spring, *s*, rests on the said metal disk, and is connected with the positive pole of the circuit. Four contact-springs, *t t' t'' t'''*, rest on the circumference of the cylinder, and are each connected with one end of the wire of one of the four pairs of magnets, the other ends of the said wires being connected with the negative pole of the circuit. The entire arrangement is made so that each contact-spring alternately touches a metal plate on the cylinder, and is therefore brought into the circuit, and remains in contact until the next contact-spring is brought into the circuit, and for a moment later, so that the entire circuit is never entirely broken at any moment, but is merely passed over from one electro-magnet to the other. The non-conducting parts of the cylinder are marked with the letters z' z'' z''' z^{iv}.

When mercury is to be used as a conducting material, the commutator may be constructed as follows: Instead of the above-mentioned cylinder, a set of four cams, b^2, Fig. 4, non-conducting material, may be employed, which are so arranged that alternately one of the four contact-springs, d^2, is dipped, by the pressure of its respective cam, into a vessel, Q, containing mercury, and with which the positive pole of the circuit is always in connection. In this case, also, the arrangement is such that each contact-spring, and therefore the magnet connected with it, does not come out of the circuit until another magnet has been brought into the circuit by its respective contact-spring.

In order to receive any shock that might be occasioned by the armatures dropping on the pole ends of the magnets, rings, *w w*, of india rubber or leather may be arranged thereon.

Without departing from the substance of this invention, the electro-magnets may be provided with hollow iron cylinders, placed over the coils.

It is evident that, instead of two oscillating beams, with four armatures and magnets, three beams, with six armatures and magnets, or four beams, with eight armatures and magnets, may be employed. When using three oscillating beams, the cranks may be arranged at an angle of sixty degrees to each other, or with four beams at an angle of forty-five degrees.

THE ELECTRIC CANDLE.

THE value of electricity as a source of artificial light has always been recognized, and its utilization has frequently been attempted. The great obstacle, however, which has hitherto prevented the practical attainment of this object is the difficulty of subdividing an electric current, and producing a number of lights from one main source. This subdivision of the current, as it flows from the generator, has several times been attempted, and in some cases—experimentally, at least—it has been attended with success. The fine carbon points were, however, quickly consumed when burnt in contact with oxygen, and thin platinum wires melted as soon as they began to give a perfect light, and, so far as we are aware, no system of subdivision of electricity has come into practical operation.

About the first who attempted to solve the problem was M Lodyghin, of St. Petersburg, who, some few years since, used a vacuum, burning the carbon out of contact with the oxygen of the atmosphere. The details of his apparatus, however, were imperfectly worked out, and failure resulted.

M. Kosloff then took up M. Lodyghin's idea, and in time succeeded in producing an efficient means of subdividing the electric light. By forming the holders for the carbon points of a special metal, and producing the light in a vacuum lamp, excellent results were produced.

M. Kosloff's apparatus was exhibited in London in May, 1874, and some very successful trials were made with it, and reported upon by us at the time. It does not, however, appear that this invention went beyond the phase of experiment, at least in England, although it was an invention of great promise. Hence, wherever electricity has been utilized, as in lighthouses and for signalling or other purposes, the constant shortening of the carbon points by combustion has to be compensated for, and followed up by clockwork, so that the necessary distance between the points is preserved as nearly uniform as possible.

It has remained for another Russian man of science—M. Paul Jablochkoff, who was formerly in the Russian military service—to demonstrate in practice the feasibility of subdividing the electric current. He has worked out his results in the form of an electric candle, which governs the production of the electric light, and supersedes the ordinary clockwork arrangement. By it he has, moreover, demonstrated the possibility of obtaining several lights from a single source of electricity.

The first practical trial of this system was made two weeks ago at the Magasins du Louvre, and the experiments were attended with perfect success. The Marengo Hall was the apartment lighted, and six electric candles were sufficient to shed around a very bright light, which was softened by being transmitted through oval glass globes. Some idea of the comparative value of gas and the electric light under notice may be formed when we state that the Marengo Hall is ordinarily illuminated by means of one hundred argand gas burners of the largest size. The cause of the wide difference between this and other electric lights lies in the fact that electricity plays, so to speak, only a secondary part in producing the light. The light is principally the result of the combustion of the refracting material, which occupies in the electric candle the same position as does wax or tallow in ordinary candles.

The electric candle, as originally designed by M. Jablochkoff, consisted of what may be termed a double wick and a surrounding material. The wick consisted of two carbon points, about four inches long, embedded parallel to each other in an insulating substance, by which also they were separated from each other. This material, which was consumed as well as the double wick, was composed of several ingredients, forming a combination known only to the inventor. Each of the carbon points terminated at the bottom in a small metal tube into which the conducting wires were led. With these candles a series of experiments was some time since carried out by a War Office Committee of Royal Engineers at Chatham. It was then demonstrated as one result that the system gave fifty per cent. greater power of light than had ever before been obtained from any electric light. The next development of the electric candle by M. Jablochkoff was to denude it of its outer casing, leaving merely the double wick with a strip of the insulating compound between the carbon points, which terminated at the bottom in metallic tubes, as before. It was with the electric candle in this form that the hall at the Magasins du Louvre was illuminated, as previously stated. In either case only one electrical machine is needed to produce a number of lights. The positive and negative wires are led from the machine, and branch wires are simply conducted from them at the necessary points to the candles. In this way M. Jablochkoff succeeded in getting as many as eight candles to burn at the same time in the circuit of a single machine of the ordinary kind, with alternating currents.

Arrangements are being made in England to light up one of the East and West India Dock Company's docks in London upon M. Jablochkoff's system, so that the loading and unloading of ships may be carried on by night as well as by day when desirable. Experiments were to have been primarily made in order to test the system, but since the exhibition of the electric candle at the Louvre, M. Jablochkoff has still further improved his system, so that the experiments have been postponed for the completion of the details of the improvement. In the new form of candle the inventor dispenses with the carbon points which constituted the wick, and uses only the outer surrounding material answering to the tallow of an ordinary candle. We have already seen that this compound—to which M. Jablochkoff has given the name of "kaolin," which substance enters largely into its composition—consumes at the same rate as the carbon points. From this material alone M. Jablochkoff now produces results superior in many respects to those which he previously obtained. One point of superiority consists in the fact that he is now enabled to produce as many as fifty constant and uniform lights from a single machine of the ordinary kind, as was recently stated in a paper brought before the Academy of Sciences, in Paris, by M. Dumas. In short, M. Jablochkoff appears to have satisfactorily solved the question of dividing up the electric light by a method capable of practical application, of insuring perfect steadiness in the light so divided, and of distributing throughout a building lights of varying degrees of intensity. The results point to a very wide application of the system, which appears to possess special advantages for the lighting up of theatres and other large buildings.—*London Times.*

HEAT.

IN a recent lecture at the Royal Institution, Prof. Tyndall, with the aid of the thermo-electric pile and the galvanometer, illustrated the consumption of heat in the conversion of crystals into a solution, salt consuming more heat in the process than sugar, and saltpeter more than common salt. This illustration was continued with alcohol and ether, showing the consumption of heat in the vaporization of liquid. Water, placed under the air pump in company with sulphuric acid, which consumed the vapor of the water, could be frozen in that way. A simple experiment of this kind was shown: A glass vessel containing water was connected by a