In the "Machines approuveés par l'Académie," Vol. v, No. 350, we find a machine described by M. Du Buisson, in which an inclined plane is applied to produce the required alternate rectilinear motion. The description of the machine is introduced to contribute to an history of machinery.

The small pumps which are used on board ships, and frequently for drawing liquors, in which the action is produced by an alternate motion of the operator's hand, is composed of a cylindrical tube or pipe, having a valve at its lower extremity, which is immersed in the liquid. It is sometimes indeed constructed without any valve: in this case the effect of the machine is produced by a dextrous application of the operator's thumb, at the upper extremity of the tube. These engines also belong to this division of our work.

SECTION XVII.

To convert alternate rectilinear motion, of velocity either equable, or variable by a given law, into alternate circular motion, of velocity similar to that of the original motion, either equable, or variable according to a given law, and in the same, or in different planes of direction.

A 17.

Several of the movements described in the Section III. and VII. will also be classed in this Section.

B 17. Plate 9.

In this subject, A B in the figure represents a lever, moving on the axis C as a fulcrum, which is the centre of the semicircle D E F fixed to A B. The extremities of a chain D G H K F are attached to the points D and F of the bar A B; it is adjusted by two pins so as to allow of being lengthened or shortened as occasion may require. The chain passes over two fixed pullies G and K. Under this arrangement the alternate circular movement of the lever A B will produce the alternate rectilinear motion of the portion H of the chain, a reciprocal movement will also be afforded by this machine.

This movement has been successfully applied to a machine for cutting the tops

of piles situated below the surface of the water, and is in practice one of the most simple and effective contrivances for that purpose.

C 17.

This combination of levers in zig-zag arrangement is well known; it is applied in the contrivance of various toys for children. It has been also applied to the construction of a machine for raising sunken vessels, by Du Vivier. See Machines approuvées par l'Académie des Sciences, Vol. vi. No. 429. We also find several applications of the same movement to the construction of various machines in De Besson's work, Théatre des Instruments de Mathématiques, already spoken of; but these are all of them more or less imperfect. This author proposes to communicate the alternate circular movement by a fixed adjusting screw, this is composed of two distinct screws having their respective threads in opposite directions. The screw by its rotation produces the alternate approach and separation of two nuts fixed at the extremities of the two lower or first levers of the zig-zag arrangement. This piece of mechanism is also applicable to many other practical purposes *.

The pincers generally used for lifting or drawing up heavy bodies from the bottom of the sea, is also an application of the same principle.

The common spinning reel is an highly ingenious and useful application of this combination of levers.

In the Annales des Arts et Manufactures, Nos. 19 and 20, we find the description of a pump on a new construction, presented to the Minister of the Marine, by M. Berger.

This is a double piston pump, which seems to embrace advantages deserving attention. A report was made to the Institute on the subject of this pump by Messrs. Borg, Monge, and Lévéque; it is inserted at length in the abovementioned numbers of the Annales des Arts et Manufactures, and merits an attentive perusal. It is here asserted that the idea of this engine did not originate with

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* Several applications of this machinery may be found in the first volume of Leupold's "Theatrum Machinarum Generale." Leipsic, 1724.

M. Berger, (and to this M. Berger appears to assent) but that the merit of the invention belongs to Mr. Noble, an Englishman, whose pump on this construction was readily admitted into the British naval service, and was there substituted for the usual chain pumps. It appears that these pumps were first introduced to actual use in the Windsor Castle, a British seventy-four gun ship, in the year 1790, and that their use has been since continued with much benefit to the service. M. Berger proposes two methods for working this pump, one of which however, the reporters reject as impracticable: but they consider the other to be preferable to the crank movement adopted in the English service. The following description of the method they approve is extracted from their report:

" The principal part of the arrangement is a lozenge figured combination of " four iron bars or rods a b, b c, c d, d a, connected at their extremities by hinges " or pin-joints, so that they have free motion on them, and the component pieces " or bars can either extend or close their angles, and arrange themselves in " lozenges of different figure. This combination is represented in the figure as placed in a vertical position, so that one of the diagonals of the lozenge it composes is in an horizontal position, and supported by two bars or pillars a e, c f of equal height, in such a manner that the pin which attaches the contiguous sides of the figure shall also attach those sides to the corresponding supporting pillar. It is evident, that in this position, the other diagonal of the lozenge will be in a vertical position; this must correspond with the centre of the pump barrel and be situated accurately in the prolongation of its axis. To the upper extremity of this diagonal are attached the two rods of the lower piston, and to the other extremity are fixed those of the higher or upper piston; and the same pin which attaches the contiguous bars to that diagonal also attaches them to the piston rods.

It will be understood that, in order to alter the angles which the bars of the figure form with each other, and so extend or reduce the dimensions of the diagonals, the two supporting pillars a e, c f must have liberty of motion. They are therefore set on a cross piece on the joints e, f to which they are attached by a pin, and have thus a movement of rotation in the same plane as that in which the bars of the arrangement are situated.

The construction and disposition of this mechanism being understood, it will appear that by causing the horizontal angles of the figure to approach each other, the upper angle is made to rise, while the lower angle is by the same action, made to descend in the same quantity; and if on the contrary, the horizontal angles of the figure are made to recede from each other or encrease their distance, the upper angle will descend while the lower angle will rise; thus the action of the pistons is produced. It will be seen, that in this arrangement the maximum range of each piston is equal to the side of the figure; the action of the pump does not however require the maximum range of the pistons, nor indeed would it be possible to obtain it in practice; it being necessary for that end that the supporting pillars should vary very little from a vertical position. M. Berger considers the best dimensions for the figure to be about 22. 2 inches in each side, and that 18 inches will allow sufficient range for each of the pistons.

In this action of the pistons it will be understood, that given points in the sides of the figure are elevated and depressed proportionally, so that the range of each piston, and the vertical path of any given point in one of the sides of the figure, are constantly in the ratio of the distance of the point of suspension of the piston, and the point from which it acts, from that centre of motion of the lozenge which is situated at the extremity of the contiguous supporting pillar. The horizontal line which joins the middle of the lower ends, will therefore be elevated or depressed a quantity equal to one-half the range of each piston. M. Berger transmits the action of the moving power directly to an arm placed on this line by the following arrangement:—Each lower piece of the figure is perforated in its middle by an iron axle, to these are fixed two naves of wood of about 3. 75 inches in length, the projecting portion of each axis is cylindrical, and receives a small metal roller having a flanch or projecting shoulder on its outer end; these rollers support a frame which encloses the lozenge, which passes into longitudinal openings made in the side pieces of the frame, and the whole is firmly held together by nuts, as in the modes of fastening practiced in coach building. The length of the openings in the sides of the frame are determined by the range which may be required for the pistons. To the middle of each of these sides is fixed an axis: it is necessary that these should be accurately centred, or placed

accurately opposite to each other, having to perform the office of a single axis passing through the entire width of the frame; these axes pass through the sides of the frame of a set of lever handles which encompass the whole machine, nearly resembling the arrangement of working handles by which the common fire-engine is put in action. The axis of motion of the set of lever handles is supported by two upright pillars C D, the arm which works the lozenge is divided at one-third of its length by the arm of the enclosing frame.

It will be evident that under this arrangement, if the power of men be applied to the bars it will operate to raise or depress the frame, because the flanched rollers passing through the openings in its sides will allow the alternate opening and closing of the lozenge frame, and thus effect the required action of the pistons. It will also be seen that the extent of the motion of the frame will be but one-half that of the pistons, and that the men whose action is directed on the bars, will have to perform a motion through the same space only, as that traversed by the pistons, which will act in a perfectly equal and simultaneous manner, and in the reverse direction. Lastly, the piston rods will preserve the same vertical positions, because those points of the lozenge frame to which they are attached, describe in equal times, two equal and similar curves in vertical planes: these are placed back to back, having their concave sides in opposite direction; those points therefore can only follow the direction of their common tangent, which is vertical.

The statement respecting the range of the pistons being double that of the frame by which they are worked, should not be understood as strictly correct, for in the organization of the engine which we have described, it will become rather greater, from the effect of the rotation of the supporting bars a e, c f, because, by that rotation the horizontal diagonal constantly preserves its horizontal position, during its elevations and depressions; this circumstance is however rather advantageous to the general effect of the engine than otherwise.

In the figure D 17, we have omitted the frame which encloses the lozenge frame, and we have shewn but a small portion of the lever handle g i; upon one side of the portion shewn in the plate, a curved groove n m k is cut, into which the axis n passes, which is fixed to one of the lower sides of the lozenge; and