difference of the circumferences of the two portions A and E of the roller; and it will also be evident that the difference may be made small at pleasure.

The description of a double capstern, produced by an application of this principle will be found in vol. xix, page 305 of Les Annales des Arts et Manufactures.

SECTION IV.

To convert a given direct and equable rectilinear motion, or the velocity of which varies by a given law, into alternate circular motion of velocity similar to that of the moving power, either equable or variable by a given law; and in the same, or in different directions.

(A 4.)

IF direct rectilinear motion be converted into direct circular motion by any of the arrangements pointed out in Section 3rd, all the examples shewn in Section 9 will apply to this section.

(B 4.)

It has been proposed by M. Perrault, of the Royal Academy of Sciences (Recueil des Machines approuvées par l'Académie des Sciences, Vol. i. Nos. 9 and 10,) to apply the fall of water as a mover for a pendulum clock. Without pledging our judgement as to the usefulness or merit of his machine, we shall explain the organization he has adopted for converting the rectilinear direction of the moving power into an alternate circular motion.

Water is made to fall, as at c in the figure, into the vessel d, which is constructed to turn or swing on an axis m, and is divided in the middle into two equal parts by a partition. When the base of this vessel is in an horizontal position, the water falls so as to divide itself equally by the partition before mentioned, and in any inclined position the whole quantity of falling water will be received by that side of the vessel which is elevated. In the position shewn by the figure, this entire quantity is received by the side b of the vessel; when that side of the vessel becomes full, it turns on its axis in the direction of that side, and descends till it reaches and rests on the stop or support f, pouring out, by this change of position, the

quantity of water which produced the motion. The opposite side fills in its turn, and brings the vessel into its first position, resting on the support g; and the operation is repeated.

(C 4.)

Problem.—*To convert alternate circular motion into direct rectilinear motion.*

Let A B of this figure be a lever turning about on an axis C, and F G an upright bar, which is at liberty to rise and fall easily; and having a strait ratchet on each of its longitudinal edges. D E, D E are two small levers turning on pivots at D and D, and have their other extremities E E, turned so as to engage in the teeth of the ratchet already mentioned. The alternate circular motion of the lever A B will operate to raise the bar F G. M. Perrault, of the Royal Academy of Sciences, has applied a piece of mechanism of much similitude to this, to the construction of an engine for raising heavy weights. It will be found in the Recueil des Machines approuvées par l'Academie, Vol. i. No. 1.

(D 4.)

A boat at anchor in the middle of a river, if held by a cable of sufficient length, will move alternately from one bank of the river to the other, by means of its rudder; furnishing an instance of alternate circular motion from direct rectilinear: this is a well known contrivance, and is of frequent application.

(E 4.)

A sector of a circle surmounted with a sail, forming together a combination, the centre of gravity of which shall be situated considerably below the centre of oscillation, by means of the application of a counterpoising weight, will swing to and fro continually, with an alternate circular motion produced from the impulsion of the wind upon the sail: this mode of applying the direct action of the wind has been often proposed, and many models constructed on this principle may be found in the Conservatory of Machines of Paris; and in the work of M. Alexander Bailey, which includes the description of machines presented

to the Society for the Encouragement of Arts and Manufactures of London: the application of this contrivance as a first mover to an hydraulic machine by M. Merryman, will be found in vol. i. page 154.

All machines which are applied to the purposes of raising water by means of an oscillatory or alternate circular motion, communicated to the machine by any power whatever, and which is applied to them exteriorily, as are those for instance which are described in the Journal des Mines, No. 66, may be placed in this fourth class.

The Bulletin de la Société d'Encouragement, for August, 1811, No. 86, contains a description of a machine termed an Hydraulic Pendulum, by its inventor M. Boitias. M. Molard, in a report upon this machine, made by him to the Society in December 1808, and which is contained in the 54th Number of the work above mentioned, makes the following observation:—" With respect to the hydraulic pendulum, this machine must not be confounded with a contrivance under the same name, described by Belidor, for the purpose of raising water. It is a simple pendulum which receives its oscillatory movement by means of the current of a river, and with the additional aid of a counterpoising weight.

To produce this effect, the author has placed a float board of considerable size, and mounted on a supporting pivot, at the lower extremity of the pendulum; it alternately assumes the vertical and horizontal position. In the first it dips into the current and obeys its pressure; in the second it obeys the effect of the counterpoising weight, which brings it back to the position from which it set out, in order to commence another oscillation."

SECTION V.

To convert a given direct and equable rectilinear motion, or the velocity of which varies by a given law, into a direct curvlinear motion of velocity similar to that of the moving power, either equable, or variable by a given law, and in the same, or in different directions.

DIRECT rectilinear motion may be converted into direct circular motion by the methods exhibited in Section III.; and the arrangements shewn in Section X. will afford examples of the required conversion.

SECTION VI.

To convert a given direct, and equable rectilinear motion, or the velocity of which varies by a given law, into an alternate curvlinear motion, of velocity similar to that of the moving power, either equable or variable by a given law, and in the same, or in different directions.

DIRECT rectilinear motions may be converted into direct circular motions by any of the arrangements exhibited in Section III.; and then the examples of Section II. will afford instances of the required conversion.

SECTION VII.

To convert direct circular and equable circular motion, or the velocity of which varies by a given law, into alternate rectilinear motion of velocity similar to that of the moving power either equable, or variable by a given law, and in the same, or in different directions.

(A 7.)

LET A B D E, plate 2, be a wheel which is at liberty to revolve on its axis in the direction indicated by the letters A B D E with an uniform velocity;

m n is an index which is obliged to observe the same direction, while the extremity m follows the figure of a curve drawn on the surface of the wheel; the other extremity n, is also required to make a determined number of back and forward motions of given extent; and returning with each revolution of the wheel to the same point from which the motion commenced, and this with a velocity either uniform, or which varies by a given law, or which is even entirely arbitrary.

If the ratio of the velocities be uniform, or if they follow given laws, the curves which will be thus described will be determinate and easy of construction. On this subject a memoir of M. Deparcieux may be consulted on the mechanical methods of describing those curves which occur in the construction of machines intended to move levers or balance wheels. It is printed in the memoirs of the Royal Academy of Sciences for 1747.

If the ratio of the velocities be arbitrary, a solution of the problem may be afforded by a great variety of curves; and by rectilinear polygons as well as by curved. Rectilinear polygons afford angles too acute—curvlinear ones are therefore to be preferred.

The application of this problem is of considerable use in the art of turning.

(B 7.)

This is a particular case of the subject of the last problem, in which at each revolution of the wheel we obtain but a single alternate stroke, aud that an uniform motion. The curve being proportional and all its diameters equal, that circumstance is rendered advantageously available by subjecting the motion of the rule or bar a b, to the curve, by means of two metal pins n m, which are fitted with friction rollers, against which the curve acts through its whole course.

The pieces which carry the threads in the bobbins of the silk-throwing machine of M. Vaucanson, are put in motion by an application of this curve. It is also used in different hydraulic engines to afford an uniform motion to the pistons of pumps.

In the 23rd number of Les Annales des Arts et Manufactures, we find the description of a new spinning-wheel by Mr. Antis, an Englishman, for which

the Society for the Encouragement of Arts, &c. of London awarded a premium to that gentleman.

C 7. Plan and Elevation.

Let A B C in the plan of the figure represent a plate of metal, through the thickness of which are cut the grooves or channels a b, c d, &c.: behind the plate A B C, and close to it, let us suppose a second plate N M (shewn in the elevation or upper figure); in this plate is cut, also through its thickness, the spiral channel indicated in the plan of the figure by the double dotted line, and described on the same principles as the curve of the preceding figure B 7: it is evident that if the small cylindrical pins r s pass through the intersections which the spiral will form with the channels a b, c d, &c. and the hinder plate be made to move, all the cylindrical pins will approach to, or recede from the centre by an equal distance. Now if the bent arms s n be added to those cylindrical pins forming radii to the circle, and their lengths be such that their extremities n shall terminate in the circumference of a circle concentric to the plate; it is evident that these extremities n of the arms, will in every position, whether advancing to, or receding from the centre, also be situated in the circumference of a circle concentric to the same circle. Two pieces of mechanism similar to this may be arranged one over the other, as is shewn in the elevation of the figure; and the extremities n of the bent arms may be connected so as to compose a kind of cylinder whose diameter may be encreased or diminished at pleasure by the rotatory motion of the spiral plates before described. This ingenious arrangement is adopted in England, in the construction of lathes, and in other machines in which it is occasionally required to alter the relation which the moving power bears to the resistance, and where it is necessary to effect this with quickness and facility. Other applications of this contrivance may be found in the Repertory of Arts and Manufactures, vol. xvii.; which contains the specification of a patent obtained by R. Brayshay—" for a machine for the purpose of gaining an increased speed and power to all mechanical operation by land and water:" dated October 30th 1801; and No. lxxi of Les Annales des Arts, &c. by R O'Reilly.