SECTION III.

To convert a given direct, and equable rectilinear motion, or the velocity of which varies by a given law, into direct 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.

THE re-acting engine of Segner gives a direct solution of the problem ; and Mour's centrifugal machine, noticed by Euler, in the Memoirs of the Academy of Berlin, for the year 1751, gives a solution of the inverse problem ; both these, therefore, class themselves in this Section.

(A 3.)

A cylinder having a motion on its axis, and a rope winding on its surface, gives a general solution of this, and the inverse problem. The arrangement is sufficiently familiar to render a more detailed description unnecessary.

(B 3.)

The cord used in the preceding movement is here superseded by an endless chain furnished with projecting teeth, which engage in a toothed wheel, affixed to the end of the cylinder.

(C 3.)

A NUT AND SCREW.

If the nut of a screw be fixed, and the screw be turned within it, the screw will have a motion which is composed of its own rotation on its axis, and the conversion to direct rectilinear motion. Thus it is used in the arts to penetrate hard substances—to draw or force them together—to lift heavy burthens—and in some of the tools of watchmaking, as drills. The axis of the drill is so placed that its ends are supported by two screws, the nuts of which are confined or held between the puppets of a lathe. The two screws being turned by this means in opposite directions, communicate to the drill the required rectilinear motion. Another method, which is much to be preferred, is to support the drill by two steel cylinders which pass through the puppets of the lathe, and close to these are placed two screws, the nuts of which are also held by the same puppets. The heads of the screws are in this case of sufficient size to press against the ends of the two cylinders which support the axis of the drill; and when turned in opposite directions gives to the drill the required motion, and in a more steady manner than was afforded by the preceding method.

If the screw be turned without being suffered to change its place, the nut must not be allowed to turn, but to have liberty to move in the longitudinal direction of the screw, and in this case the circular and rectilinear movements are divided, and a direct solution of the problem is obtained: the circular movement being converted into rectilinear. A rotatory motion of the screw may also be produced by giving the nut a rectilinear motion, but the friction of this motion is so considerable that it is seldom practised.

It is frequently required to hold a screw and its nut together, so that no change of their relative positions may take place by accident, carelessness of workmen, or by any violent motion or shock which might be produced by the machine; this is effected in a very simple manner by means of a second nut, which screws close upon that which is required to be fixed; the first nut is thus continually pressed forward in the longitudinal direction of the screw by the second nut, and the friction between the first nut and the screw, being as already observed, very great, the action exerted is not sufficient to overcome the resistance; the re-action of the nut, which is pressed upon, operates upon the tightening nut, and the resistance encreasing with the pressure, they both become fixed.

The screw is one of the mechanical powers of the most general use in the arts; there are few in which it is not rendered useful, and it varies its character of usefulness: sometimes having relation to the mechanical composition of the instrument, sometimes to the purpose for which it is to be used.

An arrangement of two screws placed parallel to each other is frequently used to produce the parallel motion of a plane of considerable length.

Presses for different purposes are constructed on this principle. In the 4th volume of the machines approved by the Academy of Sciences we find the application of the screw to the construction of a press, proposed by M. Jacques Le Maire: the editor of that work observes, that this method of applying the screw is extremely ingenious, that it would be found useful in a great diversity of ways, and will produce the most striking effects. He states M. Le Chevalier De Ville to be the inventor, who employed it for the purpose of forcing barricadoes: and has shewn the method of application in his treatise entitled—" Traité de Fortifications de l'attaque et de la defense des places," page 228, plate 37. Printed at Lyons 1629. Descriptions of it will also be found in other works.

If two threads be cut on the same cylinder in opposite directions, they will move two nuts at the same time, also in opposite directions.

(D 3.)

A method of converting circular into rectilinear motion with an extremely low velocity has been discovered by M. Prony. It is by means of this contrivance that we are enabled to avoid the necessity of using screws of an unusually fine thread, to procure a slow adjusting motion. The disadvantages arising from the use of such screws were formerly very great; the rapid wear and consequent inaccuracy of the usual micrometers was an instance of the ill consequences produced by that circumstance. It is also capable of many other practical and useful applications. The original idea of the inventor is extremely simple and elegant.

A B is an axis or spindle divided into three portions a b, c d, e f. The two screws ab, e f, are of the same thread: they pass through the two fixed supports C D, in each of which there is a nut; the spindle has an horizontal motion, and at each revolution of the screw moves over a space equal to one of its threads; the portion c d, is formed into another screw, the thread of which may either be a little finer or a little coarser than that of the screws a b, e f, and the difference may be small at pleasure. A nut M is introduced, in which the threads of a micrometer are fixed: this nut being checked by the block E F, is not at liberty to turn with the spindle A B, which it would otherwise do: but at each revolution of the spindle moves a space equal to one of its own threads, its rate of motion is therefore compounded of the actual and relative advance of the spindle A B: so that it really moves but the amount of the difference between those motions.

This is M. Prony's simple and ingenious solution of this problem.

In practice it will be found difficult to make the two screws a b, and e f, so accurately alike, that there shall be no resistance in the nuts: one of these might however be omitted, that portion of the spindle being in that case made plain or cylindrical.

(E 3.)

A spiral winding about a cylinder, and exposed to a current of air or water, will convert the rectilinear motion of those fluids into a circular motion. The spiral of Archimedes may be considered as the inverse of this problem *.

The process of constructing this spiral may be found in the collection of machines approved by the Academy of Sciences of Paris, vol 7, No. 479. This method is there proposed by M. Dubost, for the construction of a mill upon the Rhone. In volume v, No. 338, of the same work, M. Du Quet proposed it for the construction of a machine intended to raise sunken vessels. It is also applied to the operation of turning the common jack used in our kitchens, by means of the current of air which continually passes through the chimney; and to other machines for the purposes of the log instrument, for measuring the progress of maritime vessels †.

(F 3.)

Vertical water wheels, with plane floats.

(G 3.)

Horizontal water wheels, with curved floats.

(H 3.)

Over-shot water wheels.

M. Borda in a memoir on water wheels, printed in the Memoirs of the Academy

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* The theory of the screw of Archimedes may be seen in L'Hydrodynamique de Daniel Bernoulli. A memoir by Pitot, in the memoirs of the Academy of Sciences for 1736;—another by Euler, in the memoirs of the Imperial Academy of Petersburgh, vol. v. for the year 1754.—A work by P. Belgrado, entitled "Theoria cochleæ Archimedis; ab Observationibus, Experimentis et Analyticis rationibus ducta, 1767."—The premium of the Berlin Academy in 1765, adjudged to M. Jean Frederic Hon-nerol;—and the work of Paucton, on the Theory of the Archimedian screw.

† See Theatrum Machinarum de Leupold, vol. i. plate 51. Theatrum machinarum novum, &c. per Gregorium Andream Bocklerum, 1662, fig. 81, 82.—Designs for Wind and Water Mills, &c. by Jacques de Strada, published by Octave de Strada. Frankfort, 1617, fig. 49.

of Sciences of 1767, has given many important calculations on the subject, shewing the most effective mode of applying the moving powers to such wheels, and their effects under different circumstances; and closes his memoir with the following reflections on the practical application of his researches.

OF VERTICAL WHEELS WITH PLANE AND INCLINED FLOATS.

Such wheels are capable of producing the half of the maximum effect, if the floats moving in their channel exactly occupy the whole passage, allowing no particle of the water to escape without communicating to them its excess of velocity; but it is necessary to allow a small space sufficient to avoid the collission of the floats with the bottom and sides of the channel; although this at the same time allows a portion of water to escape which has not exerted any action. It is difficult to determine the diminution of effect produced from this cause, since it depends more or less on accuracy of workmanship; but it seldom happens that the practical effect of such wheels is more than three-eighths of the maximum effect,, although in theory it may be considered equal to one half.

OF HORIZONTAL WHEELS WITH PLANE FLOATS.

These wheels do not lose by a great deal so much of the action of the water as the preceding ones, and should consequently be preferred where the quantity of the fall, or other circumstances will allow the equal choice. They have also the advantage of being susceptible of a considerable encrease of their velocity according to its required action on the machinery to which it is applied, instead of the constant velocity of one half of that of the current, which suits the maximum effect of vertical wheels.

OF HORIZONTAL WHEELS WITH CURVED FLOATS.

These wheels have not the advantages over those of the preceding form which theory assigns them: because in practice it is nearly impossible that the whole of the water should enter the curves—conform to their figure—and leave them