and by this means a circular movement may be converted into alternate rectilinear movement, with any required modification of velocity or direction.

This piece of mechanism is extremely simple of construction, is practicable on a scale of reduced dimensions, and is capable of numerous useful applications, of which we shall give selected examples.

SECTION IX.

To convert direct circular motion, of uniform velocity, or which varies by a given law, into alternate circular motion, of velocity either equable, or variable by a given law, and in the same, or in different directions.

THE arrangements, shewn in the articles E 7, U 7, B 7′, E 7′, G 7′, H 7′, I 7′, K 7′, L 7′, M7′, may also be considered as examples of the required conversion.

A 9.

A is a wheel with waved teeth, and which communicates an alternate circular movement to the bent lever P S R. The method of constructing these curved teeth may be seen in the memoir of M. Deparcieux, to the Academy of Sciences, which we have already mentioned. There is no reciprocal action in this piece of mechanism.

B 9.

This is a remarkable instance of the preceding example, in which there is but one wave or curve. An application of it may be found in the Repertory of Arts and Manufactures, vol. iii, page 220; in the specification of a patent granted to William Fulton, &c. for a method of working pumps; and in Les Annales des Arts et Manufactures, vol. xxii, page 325.

A groove of this figure may be described on the surface of a cylinder, and if the extremities of two levers be introduced to it, an alternate motion may then be transmitted to four pumps at once, under an arrangement by which two of them shall be elevated while the other two shall be depressed.

In Leupold's work—Theatrum Machinarum Hydraulicarum, vol. i, we find an application of this contrivance to the raising water by means of two buckets. He places the mechanism shewn in B 9, near the upper extremity of a vertical axis, which turns constantly in the same direction, by the action of a fall of water upon the float-boards of an horizontal water wheel. A piece of wood placed vertically in the prolongation of the axis, supports a long horizontal beam, which presents the precise appearance of a balance, of which the supporting vertical piece will represent the suspension, and the horizontal beam the arms. The beam carries a bucket at each extremity, and is supported upon the mechanism exhibited in the article B 9, by friction rollers. The rotation of the shaft of the water wheel will communicate an oscillatory movement to the horizontal arm, and the two buckets will, by their alternate action, raise the water from a reservoir to an higher level.

C 9.

In this figure we have an elevation of the subject in the upper figure, and a plan in the lower figure, with corresponding letters of reference.

The memoir of M. Deparcieux (see A 7) furnishes the methods of describing a curve a m n p, which is grooved, and fixed to a lever A B which is at liberty to turn freely upon an axis which passes through its extremity A; if we suppose 1. That the wheel M has an equable rotatory motion on its centre, 2.—That the pin p fixed to a point on the surface of the wheel M, shall work in the groove which forms the curve a m n p, this curve may be of such a figure that the lever A B shall make oscillations which will fulfil one of the following conditions:—1. That the arcs described by any point of the bar A B, shall be described with an equable velocity; 2.—That the velocity shall vary by a given law; 3.—That it shall not be the arc itself, but rather the chord of that arc which shall traverse with an equable velocity, or varying by a given law.

The curve described in the present figure, is of a nature to satisfy the first of these three conditions.

D 9.

We have in this figure also a plan and elevation of the subject, with their corresponding letters of reference.

The curve a m n p may also be fixed on the surface of the wheel M, and in such a manner that the equable circular motion of the wheel M shall communicate to the lever A B an oscillatory movement which may fulfil one of the three conditions stated in the foregoing example, by means of a pin p fixed in the lever, aud which acts in the groove of the curve a m n p. The subject of that, and the preceding article, are capable of various useful applications in the solution of a great number of curious problems.

If the alternate circular motion of the lever be considered, all such motions will be arranged in this place; but if a grooved bar be fixed on the chord of the described arc, the intersection of that groove, with a longitudinal groove made in the lever, will present an open space in which a point may be inserted which shall have an alternate rectilinear movement; and in this case, the two motions C 9 and D 9 will be classed in Section 7. The same will be the case if the movement be that of a weight suspended from the extremity of a bar, by means of a rope which passes over a fixed pulley. Lastly, if an alternate circular movement be communicated to the wheel M, the same motions will then be arranged in the 17th and 19th Sections.

The movement D 9 has been applied to the construction of a watch escapement by M. Volet. (Machines approuvées par l'Academie Royale, Vol. vii. No. 450.)

E 9.

A cylinder A furnished with cams or curved projecting pieces, has a movement of rotation on its axis, and operates to raise the hammer B, which is suspended on an axis at C. This motion is too well known to need many illustrative examples.

F 9.

The upper of these figures is an elevation of the subject, the lower a plan, with the same letters of reference to each figure.

This gives an inverse solution of the problem in Section IX. A is the lower extremity of the shaft of a large wheel or fly, on which is fixed the ratchet wheel

B. CC is a wheel fitted on the shaft of the fly, by its friction, and carries a click-piece q, which acts upon the ratchet wheel by means of a spring.

The alternate circular motion of the wheel C transmits to the fly and the shaft A a direct circular motion in the same direction; but the wheel C will only act during the half of its oscillation. An application of this motion by White, may be seen in the report of Messrs. Prony and Molard, adverted to at H 7.

G 9.

This is another application of the movement described in the preceding article, P Q is a lever having an alternate circular motion, which it communicates to the wheel C, by means of the rope a b c d e, the proper tension of the rope is produced by the weight P, or by a spring. The wheel C is fitted on the axis A of the fly-wheel N, by its friction only; on the end of the axis of the fly-wheel is fixed a ratchet wheel shewn in the figure, and in which the click-piece α acts, the click being fixed on the wheel C. Under this arrangement, the alternate circular motion of C will cause the fly-wheel N to revolve constantly in the same direction.

An application of this movement is described in the "Bibliothéque Britanique," vol. vi, article "Arts," in an account of a patent granted to T. Bingen, for a method of producing a rotatory motion, by the action of an alternate movement in any direction, and which may be afforded by the power of steam or any other principle. The editor subjoins some observations on fly-wheels.

H 9. Plate 7.

A B is a lever which is capable of an alternate circular motion about the axis C: c d is an arm which has a free motion on its extremity c; its other extremity d is fixed to the toothed wheel E, which works with a similar wheel F set on the axis of the fly-wheel N; on the reverse side of the wheels E and F, is an arm e f which preserves the constant distance of the wheel E from the centre of the fly-wheel; the alternate circular movement of the lever A B elevates and depresses the wheel F, but this could not take place unless the wheel F revolved on its centre. According to the arrangement of the machine the actual movement may be either direct or alternate; but the inertia of the fly-wheel operates to render it direct and nearly equable: a reciprocal action takes place, when the machine has commenced its movement. This mechanism is adopted in steam engine work—a description of it occurs in Prony's Architecture Hydraulique, part ii, page 118.

It will be observed, that notwithstanding the two wheels E and F are of the same diameter, the fly-wheel N makes two revolutions for each oscillation of the lever, which prevents the necessity of using fly-wheels of the large dimensions required to produce the same effect in the usual construction.

I 9.

The following is a description of a rotatory motion, for which a patent was obtained in England by Edmund Cartwright. This rotatory motion is communicated by steam, and its velocity may be encreased at pleasure, without the assistance of wheel-work.

A B represents the side elevation of the upper part of the framing which incloses the boiler, the cylinder, the fly-wheel, and all the acting parts of the engine; an axis crosses this framing, on which the pulley or wheel C revolves; a chain passes over this wheel and is attached to the upper end T of the piston rod; (the wheel C receives an alternate circular motion by the action of the piston and its counterpoising weight P;) the wheel C carries a lever handle D, which by means of the arm K communicates with the lever F, placed horizontally on the top, or at the side of the boiler. Another axis, which may be placed either above, below or at the side of the first, passes through the fly-wheel G, and carries at its other extremity a lever handle H, which communicates with the horizontal lever F by means of the arm I, as before described of the wheel C by means of the arm K.

It is evident that when the wheel C is made to revolve by the action of the piston T, the arm D which is fixed on its axis, will cause the fly-wheel G to revolve also, the wheels G and C being connected with the same lever F. If C therefore be moved alternately in the direction a b and b a by the action of the piston, and its counterpoise P; and if the lever D of the wheel C moves in the same direction, the lever H of the fly-wheel will perform the same alternate movement, unless it should be (as it ought) of such length as that at the termination of its arc of rotation, it is at liberty to pass beyond it; which in fact, produces the complete rotation of the fly-wheel.

If the lever D of the wheel C be so disposed, as that when it revolves in any quantity not exceeding one entire revolution, it shall pass from e to a, by f, or in the direction traversed by a given point of the wheel C, then D will cause two vibrations of the lever for one stroke of the piston, and the fly-wheel G will in the same time make two revolutions. Further, if the diameter of C be so determined that it shall complete one revolution and a half for each stroke of the piston, and retrograde the same quantity, the lever F will receive three vibrations for each stroke of the piston rod. Lastly, if the wheel C be of such a diameter that it shall make two direct, and two retrograde revolutions for each stroke of the piston rod, the lever F will then make four vibrations, and the fly-wheel four revolutions.

It thus appears that the fly-wheel may revolve with any given velocity, without the aid of any combination of wheel work.

K 9.

This figure represents the common treadle. If we suppose the lever arm of the fly-wheel to be connected with the end of the lower lever or treadle, by an inflexible arm, the relation between the component parts of the treadle, and the effect or action become determinate, which, in a certain degree, is not the case when the arm is flexible; we will suppose the following data:—1. The length of the lower lever.—2. Its centre of rotation.—3. The value of the arc which it will describe at each oscillation.—4. The position of the centre of the fly-wheel with respect to the centre of rotation of the lower lever, the length of the upper or shorter lever, and that of the longer and inflexible arm, are known quantities. To determine their value, place the treadle or lower lever in its two extreme positions, the higher and the lower points of its vibrations, and draw right lines from the centre of the fly-wheel to the extremity of the treadle in