

upper end of the upright piece CD. The alternate circular movement communicated to the extremity of AB, by the action of a person seated at that point, and which tends alternately first to elevate it by the sudden action of the feet downwards on the ground on which they are then placed, and afterwards to produce its descent, by the effect of their gravity. These movements are communicated conversely to a person seated at the opposite extremity, whose action similarly exerted, tends continually to encrease the oscillations of the machine.

## SECTION XX.

*To convert a given alternate circular movement, of uniform velocity, or which is variable by a given law, into an alternate movement in a given curve, of velocity similar to that of the original movement, uniform, or variable by a given law, and in the same, or in different planes of direction.*

### A 20.

ALL the movements described in Section X, will afford solutions of this problem.

### B 20.

This is a turning engine by which screws of any description may be made, without centres. It is the invention of M. Grandjean, of the Royal Academy of Sciences; and is described in the "Machines approuvées par l'Academie," vol. v. 1729, No. 336.

" This engine is composed of a firm supporting frame or stand AB, and two  
 " upright pieces or puppets PQ; these have instead of centre points, two collars  
 " ST, which receive the mandrill FH, whose terminations are conically pointed;  
 " FH carries the piece R which is to be cut, and also the pulley G which re-  
 " ceives the band GO attached to the treadle O. The puppet Q carries an  
 " iron arm I, to which is attached in I a square HK, also of metal, one ex-  
 " tremity of which presses on the point H of FH, and consequently tends to  
 " press it from H towards F. The point F is supported upon a piece E, which  
 " is moveable upon an axis D, at the extremity D of which, the piece DC is

“ set upon a square ; and in a groove formed in this piece there runs a sliding  
 “ piece  $N$  to which the band  $NO$  is attached, and thence passes to the treadle  $O$ .  
 “ This understood, it will be evident that when the foot is applied to the  
 “ treadle, it will produce the rotation of  $FH$ , and will also lower the piece  $DC$ ,  
 “ that this motion of  $DC$  will cause the advance of  $FH$  from  $F$  towards  $H$  in  
 “ a quantity which will be always reciprocally proportional to the distances  $DN$   
 “ of the sliding piece  $N$  from the centre of motion  $D$  ; and the piece  $N$  being  
 “ moveable, it may be adjusted or placed in any required situation or distance :  
 “ hence it will result that during a revolution the axes will advance whatever  
 “ quantity may be required, and consequently if the cutting tool be applied at  
 “  $R$ , any required screw may be produced, as was proposed.

“ If a spiral or screw be required, the thread of which shall become gradually  
 “ closed or finer, it will be only necessary to take off the piece  $DC$  and substi-  
 “ tute for it the piece  $DNC$ , figure 2, the periphery  $NVC$  of which is a curve  
 “ in which the radii  $DN$ ,  $DV$ ,  $DC$  increase as the thread of the screw to be  
 “ cut is required to close ; thus, each point of the curve, as  $C$ ,  $V$ ,  $N$ , &c. will  
 “ successively perform the office of an arm or lever of different length, continu-  
 “ ally substituted for the arm  $DN$ , figure 1, which will produce an unequal  
 “ retrograde motion of  $FH$  towards  $H$ , and consequently the thread of the re-  
 “ quired screw will be gradated as the radii  $DC$ ,  $DV$ ,  $DN$ .”

## C 20.

M. Clairault is the author of a memoir included in those of the Academy of Sciences for 1734, in which he proposes the solution of several important problems.

One of these has for its object the determination of the curve  $MON$ , upon which if the square  $MCN$  be moved always in contact, its vertex  $C$  shall be always in the given curve  $EC$ .

The required movement of the square may be given by an alternate circular movement, which by the solution of the problem will be converted into an alternate movement in the given curve  $EC$ .

## D 20.

In this plate, the figure on the right represents a front elevation, and the

figure on the left a side elevation of the subject. The same letters of reference are placed as usual to the corresponding parts of the machine in both figures.

These figures represent the machine used for rifling gun barrels, in the Royal Arsenal at Versailles.

*A A* are two upright timbers placed perpendicularly upon the lower or ground framing *B*, and the cap piece *C C* attaches the upper ends of the upright timbers; the whole composes a frame work, the firmness of which is farther secured by the auxiliary pieces *D* and *E*.

*G* is a cylindrical roller on the axis of which is placed the toothed wheel *H*, and this is driven by the pinion *I*; the moving power is applied to a winch set on the axis of the pinion.

*a b c d* is a carriage which slides vertically in the frame *A A B C C*; two ropes *e e* are fixed to the upper cross framing of the carriage, they pass over two fixed pulleys attached to the cap *C*, and are afterwards coiled on the roller *G*; another cord *f* is attached to the middle of the lower cross framing of the carriage, passes over a fixed pulley to the lower piece *B* of the principal frame, and then returns; and is coiled also upon the roller *G*, but in a contrary direction to that of the cords *e e*.

The carriage carries an iron cylinder *g h*; the extremity *g* of which rests upon a block of metal, fixed in the middle of the upper surface of the lower cross piece of the carriage; it passes through an aperture formed in the middle of the upper cross piece, and terminates in *h* by an auger or other boring tool suited to the operation. The iron cylinder *g h* carries a pulley *m*, at a point nearly equidistant from the upper and lower cross pieces of the carriage.

A cord *n o p q* is fixed to the cap in the point *n*, passes over the fixed pulley *o* placed near the middle of one of the vertical or side frames of the carriage, passes entirely round the horizontal pulley *m*, and afterwards over a vertical pulley *p* placed opposite to the pulley *o* in the other side frame of the carriage, and terminates in *q*, where it sustains the weight *N*, which operates to keep the cord in an uniform degree of tension.

If the moving power act by an alternate circular movement, that movement