E02969

A KEY

TO THE

ANALYTICAL TABLE

OF

MECHANICAL MOVEMENTS.

THIRD EDITION.

MANCHESTER:

PRINTED BY LOVE AND BARTON, MARKET STREET.

1840.

ADDRESS.

THE idea of an Analytical Table of Mechanical Movements was first suggested to me by the French work of Lanz and Béttancourt, from which some of the above diagrams have been taken. The objection to the table in the former work, is the extreme minuteness of the parts, which renders it impossible to understand them without referring to the enlarged drawings; and, on the other hand, the elaborate and tedious description of the most simple arrangements.

The table now offered to the public is at least clearly engraved, and the description, though concise, will, it is trusted, be found correct and intelligible.

In the selection of diagrams, no subject has been attempted which could not be described without letters of reference, as the introduction of such would have rendered it confused. This want of letters of reference has sometimes rendered it necessary to speak of the *right*, *left*, *top*, *bottom*, and *corner* of several of the diagrams, in reference to the different parts, and caused more tautology than would otherwise have occurred. But the description of all machinery is more or less subject to this objection; and from the increased difficulty in this case, it is hoped any want of elegance in the following description will be excused.

Manchester, 1st *August*, 1831.

A KEY

TO

THE ANALYTICAL TABLE

OF

MECHANICAL MOVEMENTS.

As many of the diagrams represent such a simple arrangement, they are too obvious to require further description than their place on the table, and are therefore passed till one occurs which seems to require explanation. Thus, from fig. 1 to fig. 7 are sufficiently obvious, the first three being modifications of the pulley, and the latter various forms of parallel rules.

8. Suppose the upper pin in the slot represented in the broad part of the diagram, stationary, and the lower extremity of the piece moved in an horizontal direction, as shown by the lower dotted line, the second stud in the slot will also be moved in a straight line, guided by its connection with that part of the apparatus seen behind, and the length or amount of travers of the second point may be varied by altering its elevation.

9. Is a method of keeping the carriage of any machinery parallel, and is effected by passing bands over the loose pullies seen at each extremity of the carriage, so that the band which goes from the near low corner of

the figure, is the same as is seen at the far top corner, and the reverse; thus, as the carriage is moved back or forward on the four wheels which support it, it is prevented going faster at one end than the other.

10. Represents an arrangement in which the horizontal motion of the upper wedge is converted into perpendicular motion in the small triangular piece placed upon it, which must necessarily be elevated as the wedge is forced forward.

11. The perpendicular rod in this figure will be alternately traversed in a perpendicular direction, by the horizontal motion of the zig-zag slot, in which the pin is placed.

12. Is a method of converting a continuous fall of water into a reciprocating motion, by means of a valve at the bottom of the bucket, which opens by striking against the ground, and thereby emptying the bucket, which rises again by the action of a counter weight on the other side of the pulley, over which it is suspended.

13. Is the ingenious contrivance of the celebrated Montgolfier, generally called the Hydraulic Ram. In this apparatus, a current of water must flow through the tube, in the direction of the arrow, and escape at the lower valve, which is kept open by a weight or spring, calculated according to the current; so that when the current arrives at its speed, this valve is closed, and the momentum which the water has acquired, forces open the upper valve which leads to an air chamber above, where the portion of the water which has passed the valve is received, and thence conducted in any required

direction. As soon as the water which passes through the upper valve has come to a state of equilibrium, the stream at the arrow is necessarily at rest, and the lower valve is again opened by the spring or weight, at the same time that the valve leading to the air vessel is shut; thus by the alternate action of the two valves, a portion of the stream is raised at every stroke, and carried to a reservoir above.

14. Represents a section of the oscillating column, invented by M. Mannoury d'Ectot, for the purpose of elevating a portion of a given fall of water above the level of the reservoir or head by means of a machine, all the parts of which are absolutely fixed. It consists of an upper or a smaller tube, which is constantly supplied with water, and the lower or larger tube constructed with a circular plate in the centre of the orifice, which receives the stream from the tube above. Upon allowing the water to descend, it forms itself gradually into a cone on the circular plate, which cone protrudes into the smaller tube, so as to stop the flow of water downwards, and the regular supply continuing from above, the column in the upper tube rises until the cone on the circular plate gives way; this action is renewed periodically, and is regulated by the supply of water.

18, 19, 20, 21, 22. Represent the most simple forms of converting rectilinear motion into circular, by the fall of a weight, connected with a cylinder; the motion of a rack or chain in contact with a wheel or pinion; and the nut on a screw; or of the hand on a lever connected with a cylinder.

23, 24. A spiral wound round a cylinder will convert the motion of the wind, or a stream, into circular motion; also the windmill.

25. Supposing the wind in the direction of the arrow, sails have been contrived to present the edge on returning towards the wind, and thus produce circular motion.

26. By protecting one-half of the sails, supported on a perpendicular shaft by means of a circular encasement of shutters, a similar effect to the last is produced, but none of these modifications are found so efficient as the old construction of the windmill.

28. Represents an arrangement for working the screw of Archimedes for raising water. The oblique shaft of this apparatus is hollow, and is revolved by a wheel below; the hollow interior is constructed in a spiral form, which being at its lower extremity immersed in the water, takes up a portion at every revolution, and conveys it in a continuous stream to the reservoir above.

29. Is generally called Barker's Mill, and is moved by the reaction of a fall of water being allowed to escape at the extremities of the four lower arms.

30, 31. Are horizontal, and overshot water-wheels.

32. Is a sectional view of the Persian wheel, said to be used in Egypt and elsewhere, for the purpose of irrigation: it consists of a hollow shaft attached to any number of floats of a curved form, at the extremity of each of which a bucket or tub is suspended. Supposing the wheel to be partly immersed in a stream of water, acting on the convex surface of the floats, a portion of water will be elevated by each float at each revolution

of the wheel, and conducted to the hollow shaft; at the same time that each of the buckets carries its amount of water to a higher level, where it is emptied by coming in contact with a stationary pin, placed in a convenient situation for the purpose of tilting it.

33. A section of a rotary steam engine, the lower aperture showing the entrance, and the upper the exit of the steam either to a condenser or otherwise; on the right of the steam entrance is a stop, which fits accurately to the revolving central part, by which the two valves on which the steam acts to turn the centre, are closed when passing; these valves must also fit accurately when open to the internal surface of the cylinder, which forms the exterior of the machine.

34. This apparatus was contrived by M. Latour. The right hand section represents a water-wheel immersed in a tub of water heated to 73° or upwards, and having its axis connected by bevils to a shaft carrying an Archimedes screw, also immersed in a separate tub of water of the natural temperature. At the lower extremity of the Archimedes screw is a tube which passes above the apparatus, and terminates immediately below the water-wheel. Supposing, therefore, that the Archimedes screw be revolved in the opposite direction to that required for raising water, atmospheric air will be regularly forced down, and into the tube at its lower extremity, whence it is conducted forward through the hot water in the other tub, where it escapes beneath the water-wheel in an increased volume, in proportion to its temperature, which is stated to have kept the machine in motion.

35. This method of passing a boat from one shore of a river to the other is common on the Rhine and elsewhere, and is effected by the action of the stream on the rudder, which carries the boat across the stream in the segment of a circle, the centre of which is the anchor which holds the boat from floating down the stream.

36. Represents a trough divided in equal parts, and supported on an axis by a frame beneath. The fall of water filling one side of the division, the trough is vibrated on its axis, and at the same time that it delivers the water the opposite side is brought under the stream and filled, which in like manner vibrates the trough back again.

37. This method of applying the direct action of the wind has frequently been proposed, and depends on the vibrating action of the sector, by the preponderance of the wind or counter weight as the wind may vary.

38. The vibrating action of the horizontal lever will raise the perpendicular piece by means of the racks and catches on its opposite sides.

39. Represents an arrangement of screws, in which the two extremes are supposed to be of the same fineness, or number of threads in the inch, but the central part which carries a moveable nut is of a different fineness, in which case the central nut will not be traversed the distance of the threads which pass through it, but the difference between the fineness of the central screw and those at the two extremities; a similar arrangement enables us to divide minutely by means of screws, with-

out such very minute or fine threads as would otherwise be required.

40. It is difficult to show the form of these sails in a single figure, but the object proposed was an universal windmill, more curious than useful.

41. Is a contrivance of the Marquis d'Ectot. The perpendicular shaft in the centre carries a circular wooden vessel, with divisions, radiating from the centre, and having a circular orifice round the shaft at the bottom. Water is admitted from above by the left hand channel, which falling in an oblique direction against the radial divisions, carries round the shaft, and finally escapes at the centre.

42. Represents three bevil wheels geering into each other, that on the left being fast on the horizontal shaft, that on the right loose, and the upper one loose on the perpendicular shaft, which is held to the horizontal shaft by a circular hole at the common centre of the bevils. Supposing the two bevils on the horizontal shaft to be revolved in opposite directions at equal velocities, by means of the drum beneath, the upper bevil would be revolved on a stationary centre; but supposing the band which revolves the right hand bevil, to be removed into one of the smaller pullies, with which it is connected, the speed of the two lower bevils will no longer remain the same, and the top bevil will partake of two motions, one round its own centre, and another round the centre of the horizontal shaft.

43. Is an arrangement of parts, by which alternate circular motion is produced in the central wheel. The

axis of this wheel moves in an horizontal slot, in which it can be traversed, and thereby put into geer with either of the other wheels as seen in the upper figure. The lower figure is a section of the apparatus, showing two drums on the axis of the exterior wheels, and two intermediate drums, the whole of which are geered together by an endless band, which keeps them and the exterior wheels in uniform motion, when it is imparted by the handle, seen in the upper figure. On the axis of the two interior drums are fixed eccentrics, or small pieces, which bearing upon the axis of the central wheel, alternately traverse it in the before-mentioned slot from one of the exterior wheels to the other, thereby reversing its motion, and causing it to describe the curve indicated by dotted lines in the upper figure.

44, 45. Are modifications by which the rectilinear motion of a piston rod is converted into circular motion, as shown by the dotted lines.

46. Revolutions of the central wheel will produce, by means of the projections on its surface, either rectilinear motion in the shaft supported by friction pullies above, or circular motion by its action on the crank to the left.

47. Is a drill moved by pressing on the horizontal piece which is connected to the drill by bands, which, when the drill is once set in motion, keep it alternately revolving by the action of the hand.

48 to 51. Are obvious modifications ranging themselves under this head.

52. Represents the ordinary arrangement for lifting

stampers by circular motion, commonly used for pounding flint, pressing seed, &c.

53 to 55. Are various methods of producing perpendicular motion from circular.

56. Is a section of a traverse motion produced by the revolution of the pinion, which is guided in a perpendicular slot in the framing, shown by the dotted lines.

57. Is an example of a cam, eccentric, or tappet piece, by which any rectilinear traverse may be produced, and varied in speed or amount according as its shape is varied.

58, 59. Are alternate traverse motions, produced by the revolution of the pinions, shown in the middle of the figures.

60. Represents a machine for driving piles, in which the circular motion of the central perpendicular shaft is converted into alternate perpendicular motion, in the weight on the left. The principal contrivance by which the weight is relieved when at its highest elevation, is effected by the progressive increase of the coils of rope on the central shaft, which press on a small lever seen to the right hand, and disengage the upper part of the shaft, and allow the weight to run down; the upper part of the shaft being again re-connected as soon as the rope has run off.

61. Is a modification of the last machine, the upper part, or drum, which receives the rope, being permitted to slide loose on the perpendicular shaft, on which it revolves at the upper part, but being carried along with the shaft on the lower part; the lower drum is fast to the shaft, and is constructed with a spiral surface, cal-

culated to raise the upper drum as it fills with rope, and thereby bringing it on to the loose part of the shaft where the weight is allowed to fall.

62. Is an arrangement for producing two different amounts of traverse motion from the circular motion of the wheel; the larger at the weight, and the less at the horizontal bar beneath.

63. Represents a metallic plate with radiating slots cut in it, and the dotted lines represent slots cut in a similar plate at the back. Suppose bolts or rods passed through the aperture made by the intersection of the slots, they will be held stationary while the two metallic plates remain at rest, but if either of the plates are revolved, the bars or bolts will be traversed in the direction of the straight slots.

64, 65, 66. Are modifications of traverse motion, the latter having the horizontal bar held to the ratchet wheel by the small spring on the right.

67. Supposing the fly wheel in this figure to revolve, a rectilinear motion will be imparted to the perpendicular shaft; this arrangement was used as a parallel motion by Cartwright in his steam engine.

68. Represents an horizontal cylinder, having two reverse threads or grooves cut on it, which necessarily intersect twice in every revolution. Under this arrangement a point inserted in the groove will be traversed from end to end, at a speed dependent on the revolution of the cylinder.

69. Is the late Mr. White's proposed method for pumping by rotatory motion. The wheel carrying a

rope connected with the pump rod, is placed loose on a revolving shaft, which shaft carries a fixed projection, taking into a vibrating catch attached to the wheel near the circumference, so that in the position here shown, the wheel and rope are carried along with the shaft: but as soon as the vibrating catch comes in the position shown by the dotted lines to the right, it is relieved by striking against a fixed stud, and the wheel being thereby liberated, the weight of the pump rods carries it back till again caught by the projection from the shaft.

70. Is a modification of 67, the amount of traverse being varied by the size of the wheels.

71. Represents Mr. White's ingenious method of converting circular to rectilinear motion, by the revolution of the internal wheel, which being one half the diameter of the circular rack in which it geers, any point on its circumference will describe a straight line. This arrangement has been applied to the piston rod of small steam engines.

72. Is a combination, moved by the circular eccentric to the left, which revolves on the small centre in the upper part, and thereby traverses the levers with which it is connected.

73. Is a form of eccentric for producing an uniform traverse.

74. In this figure the ratchet wheel is fixed on the shaft seen in the centre; but the spur wheel, to which a clip is attached, runs loose on the same shaft, so that its rotatory motion will only act on the rack into which it geers in one direction, namely, when the click holds on

the ratchet.—At the back of the spur wheel is another similarly arranged, with a click and a ratchet wheel, and geering into the opposite rack, which is not on the same plane. Thus the alternate traverse of the perpendicular rack-piece will produce continuous circular motion in the shaft which carries the wheels.

75. The pinion having motion on its axis, as also liberty to traverse in the slot, shown by dots, the large double rack will be revolved back and forward on its centre, according to the interior or exterior position of the pinion, and the band shown at the periphery of the large rack will produce an alternate rectilinear traverse.

76. Is an arrangement by which the inclined disk or plate, by circular motion, produces an alternate traverse in the horizontal shaft to the left.

77, 78. Are modifications of 67 and 70.

79. Represents a revolving perpendicular shaft, carrying two balls which vibrate on levers, supported on a common centre above; these balls being acted on by the centrifugal force, fly out according to the velocity of the shaft. On the upper part of the shaft is placed a loose collar, connected to the opposite ends of the levers which carry the two balls, which by their position either elevate or depress the loose collar, and regulate the valve on the right, with which it is connected;—this arrangement is generally used to regulate the supply of steam to engines.

80. Is a sectional plan and elevation of Leslie's tide mill. On the central shaft are fixed four spiral wings, which fit as near as possible to the inner circle, seen in the plan.

Above the casing in which the wings move is another case, having opposite doors which alternately open inwards, to receive the tide at the ebb or flow; and below the part in which the wings move is a case, also arranged with doors, which open outwards to allow the water to escape after it has acted on the spiral wings. These doors are alternately shut and opened by the ebb and flow of the tide, at the same time with the reverse doors in the case above.

81, 82, 83. Are various traverse motions produced from circular motion.

84. This arrangement, (patented by E. Cartwright,) was for converting the motion of a piston rod into circular motion. Supposing the perpendicular rod to the right of the piston rod, counterbalanced by the weight over the pulley above, its motion will necessarily vibrate the horizontal lever with which the pulley is connected, and the lever will impart continuous circular motion to the larger wheel, by means of the crank to which it is attached.

85. Marcel Cardinet contrived this apparatus as an amusement for four people, seated at the extremity of each arm, who, by pulling the ropes connected with the crank of the smaller wheel, produced to themselves a rotatory motion round the centre of the larger fixed wheel. The whole framing of the arms being supported on an axis below.

86, 87, 88. Are various arrangements for transferring circular motion, by means of endless bands, in which

the speed is necessarily varied, in the proportion of the diameters.

89. Circular motion transferred by spur wheels.

90. Supposing an uniform motion to be imparted to the small pinion, which is allowed to traverse in the slot cut in the fixed bar which supports it, the oval wheel will be revolved at a variable velocity, according to the several parts of its periphery, which come into geer with the pinion.

91. One of the oval wheels being driven at an uniform speed, will produce a regularly varying speed in the other.

92. Where circular motion is required to be transferred in a direction not parallel to the driver, bevil wheels are generally used as in this example.

93. The circular motion of a screw transferred to a bevil wheel, commonly called a worm wheel, is one of the most efficient modes of reducing speed.

94. Represents a plan and elevation of a wheel constructed with a succession of inclined planes or teeth, on which the small rollers on the periphery of the smaller wheel act, and thereby transfers circular motion in a right angle direction.

95. Either of the two wheels being driven at an uniform speed, will produce variable motion in the other wheel, according to the different diameters which come in contact.

96. The same variable speed as in the last figure, is produced by means of a decreasing spiral, called a fusee, carrying a band or chain, which, acting on the progressive diameters, varies the speed accordingly.

97. Is an arrangement producing the same effect as the last; the spiral teeth on the right hand cone being driven by an uniform motion from one on the left.

98. Suppose the small warve or pulley on the right to be the driver, the larger wheel with an internal rack, and the concentric wheel within, will be driven in opposite directions by the bands as represented; and at the same time impart motion to the intermediate pinion on the left, both round its own centre, and also round the common centre of the circular rack and concentric wheel.

99. This arrangement is commonly called the sun and planet wheels, and was first extensively applied, if not invented, by the celebrated James Watt. Two spur wheels are held in geer by a strap or connecting rod from their respective centres; the one being fast on a shaft, and the other fast to the connecting rod which proceeds from the beam on the left, the vibration of which carries round the fly wheel at the same time that the fixed spur wheel on the connecting rod is revolved round the spur wheel into which it geers.

100. Is a plan in which the application of a spiral fusee varies the traverse of a carriage according to the diameters on which the band acts.

101. An arrangement for conveying circular motion to distinct parts of the same shaft.

102. Is the universal joint, generally attributed to Dr. Hook, by means of which the rotatory motion of a shaft may be conveyed out of the straight line, without breaking its continuity.

103. Suppose the spur wheel which geers into the perpendicular rack to be revolved by the handle on the right, the rack will be moved at the same time that the bevils will revolve the cylinder with which the horizontal bevil is connected, and a regular spiral line will be described on the surface of the cylinder, by the projecting point connected with the lower part of the rack.

104. Is Mr. Roberts's ingenious contrivance, to prove that carriages do not present more friction at a great velocity than at a less, if that velocity be once obtained. The upper part of the figure represents a loaded waggon, supported on the surface of a wheel, and connected to an indicator constructed with a spiral spring, showing the amount of force required to keep the waggon stationary when the large wheel on which it rests is put in motion. The waggon being loaded, it was found that the number of revolutions of the large wheel did not vary the effect on the indicator, but that the amount of weight placed in the waggon immediately varied the position of the pointer of the indicator; thus proving, that the friction of any carriage on a road does not increase with the speed, but by its weight only.

105. Is a modification of what is generally called the mangle-wheel, in which the uniform revolution of the pinion, which passes from one side of the large wheel to the other, by means of the opening at the left, produces an alternate back and forth revolution of the larger wheel.

106. Represents a method of producing a small tra-

verse in the upper bar, by means of an oblique groove in the periphery of a revolving wheel.

107. Is a front and side view of a machine used for polishing mirrors, in which process it is desirable to vary the direction of the rubbing as much as possible. The handle seen on the right turns a crank to which is attached the perpendicular bar carrying a ratchet wheel; this bar is guided by the pins seen in the horizontal bar below. To the ratchet wheel is attached the glass to be polished, which is revolved along with it at every revolution of the crank, by means of a dog or click piece which proceeds from a smaller crank on the same axis as the crank which vibrates the perpendicular bar.

108. Is a method of converting equable circular motion into variable circular motion, by means of the curved groove with which the pointer is connected.

109. Represents a contrivance proposed by M. Breguet, for regulating the velocity of machinery: the lower wheel being driven in the direction of the dart, carries those above in succession, but the axis of the centre wheel is supported in an elastic piece which is fixed at its lower extremity, and acts as a curb or brake on the top wheel, whenever the speed or force of the lowest wheel carries the axis of the centre wheel out of a straight line through the three centres.

110. Let the train of wheels be in the proportion of 2, 1, 2, 4, and the sliding part over the second 2 and the 4 fixed at any eccentric points on the respective wheels; the revolution of the wheels will cause the bar to describe curved lines which may be varied according

to the position of the points to which the bar is attached.

111. Suppose the upper part of this figure to represent the sails of an horizontal mill, or any sufficient moving power to revolve the shaft which carries the spiral or worm below, and the shaft coupled immediately below the sails so as to allow of a small vibration, thereby allowing the spiral or worm to act on only one wheel at a time.—At the back of these wheels, and on the same shafts, are placed pullies, over which a rope is passed, carrying a bucket at each extremity, one of which is elevated at the same time that the other is lowered, by the alternate action of the worm on the opposite wheels. In the centre, and immediately below the worm, is placed a vibrating piece, against which the bucket strikes in its ascent, and which, by means of an arm connected with the step in which the worm shaft is supported, traverses the worm from one wheel to the other, by which means the bucket which has delivered its water is again lowered at the same time that the opposite one is elevated.

112. Is an arrangement of spur wheels running loose on their respective shafts, with which they can be connected by clutch boxes, so that the relative speed of the driver and the driven can be varied according to the proportion of the wheels which are connected to the shafts.

113. Represents a face wheel with ratchet teeth, which is moved by the alternate horizontal motion of the shaft to the right.

114. Is the dead beat escapement used by M. Amant: the balance vibrates on the small centre to the right, and allows one pin of the wheel to escape at each vibration.

115. The vibrating action of the horizontal lever in the upper part of the figure will produce a continuous revolution in the wheel beneath, by means of the two catches, one of which is acting on the wheel while the other is gathering a tooth.

116. Is Arnold's free escapement. The small centre on the left being the point of vibration of the balance, and the horizontal spring that which holds the ratchet wheel; when the small point on the balance centre is vibrating downwards, it passes a small spring which is held at its opposite extremity, near the screw head on the right hand, at the same time that the indented part on the circle round the balance centre holds a tooth of the ratchet; but on the return of the balance the same point again comes in contact with the small spring, which resting against a stop at the extremity of the spring which presses on the two top teeth of the ratchet, relieves them, and allows a tooth to escape at the same time that the indented part of the balance is on the return to receive it.

117. Is a modification of 115, in which the vibrating motion of the oblique lever acts by means of catches on the wheel, and elevates the weight beneath.

118. Is a plan of the crown-wheel escapement, in which the perpendicular sides of the ratchet teeth precede in the revolution of the wheel, and alternately act on the two pallets, which are carried on the verge or axis, which passes across the crown-wheel. These pallets are set at an angle of about 90°, so that when one pallet is impelled by a tooth of the wheel, and has

escaped, the other pallet comes in contact with a tooth of the wheel on the opposite side; thus the motion of the wheel vibrates the pallets, and the vibration of the pallets regulates the velocity of the wheel.

119. Is the dead beat escapement by Graham: each of the teeth of this wheel is formed with an inclined plane, and the verge or axis of the balance is furnished with one-half of a cylinder of steel, resembling the letter C, facing towards the wheel, at every vibration of which a tooth is received or liberated.

120, 121. Are arrangements for drawing a rope by means of a vibrating lever, connected with a catch which gathers a tooth of the ratchet wheel at every vibration, thereby revolving the shaft on which the rope is coiled.

122. This arrangement, like 107, is used for polishing mirrors, where it is essential that the friction should not be repeated in the same line. The ropes which go round the central pulley are fast to the two perpendicular shafts, and the square mirror is fixed to the pulley—thus by the back and forth motion of one of the shafts, the mirror is caused to describe irregular curves on every part of its surface.

123. These nippers have been used for holding rough timber, in sawing mills, and are closed by the action of the two wheels on the rack segments.

124. The simplest manner of communicating alternate circular motion of a limited extent.

125, 126. Are arrangements by which spiral lines may be described on revolving cylinders. The nut which is seen on the horizontal screw in the first figure, is attached

to a carriage, on which is seen an arm, fastened by two screws; at the extremity of this arm is an horizontal piece, with a slot held at its opposite extremity by a long screw rod, which also moves along with the carriage. Thus, supposing the bevils to be put in motion, the slot piece would be traversed, and the small pointer, which is seen against the shaft of the horizontal bevil, would remain stationary; but if the slot piece be placed in an oblique direction by means of the screw rod to the right, the pointer will be traversed along the shaft, and describe a spiral line thereon. In a like manner the pointer in 126 is traversed by the screw movement carrying the carriage which supports it.

127. The horizontal shaft in this figure revolving in one direction will produce an alternate revolution in the perpendicular shaft, the teeth in the horizontal wheel being partly removed so as to take into only one of the smaller wheels at once.

128. Supposing the upper circle to represent a section of two drums close to each other, and running in opposite directions, the endless band, which passes over the carrier pulley below, will impart motion to the horizontal warve at the lower end of the perpendicular screw, which is supported by the upper and lower arms, but carries the central piece as a moveable nut; to this nut is connected a fork which at each extreme of its traverse vibrates the weighted lever, and thereby passes the endless band from one drum to the other, and reverses the revolution of the screw.

129. Is Graham's dead beat escapement for second

pendulums in clocks, which is still one of the most perfect.

130. The horizontal shaft carries two bevils, which are loose, and furnished with clicks, which take into the two reverse ratchet wheels attached to the same shaft, and the bevil above geers into both. Supposing an alternate revolution to be given to the horizontal shaft, a continuous motion will be imparted to the bevil above.

131. The projections on the circular part to the right, will by its revolution cause regular vibrations of the lever with which they come in contact, as in the well-known trip hammer.

132. Supposing the horizontal bevil above to run with a uniform speed, and the two other bevils to be loose on the horizontal shaft, to which the central coupling is connected by a rib or otherwise, either of the perpendicular bevils, being connected to the shaft by means of the coupling, will revolve it, but in opposite directions. Connected to the coupling is a lever similar to that in 111, which alternately puts the coupling into geer with the opposite bevils, as the bucket suspended from the pulley comes in contact, and acts on the horizontal lever beneath.

133. Is an example of coupling, by which the revolution of the upper shaft may be transferred to the shaft below, by bringing the pin on the loose wheel in contact with that on the shaft by means of the lever.

134. Is a modification of 133, having the coupling on the same shaft.

135. A simple combination, converting circular into reciprocating rectilinear motion.

136. The horizontal beam above being vibrated, and the drum to which the right hand cord is attached being placed loose on the axis of the fly wheel, the click which takes into the first ratchet will produce a continuous revolution in the wheel.

137. The regular curved form towards the right in the upper part of the figure being constructed, and the three wheels being put in uniform motion by the pinion at the left, and perpendicular and horizontal lines of an equal length carried to the surface of the first and third wheel, will, on being passed over the figure, describe curved lines on the wheels. These lines may afterwards be constructed as a machine, to produce the original figure to any extent, as shown in the diagram.

138. Is a combination by which a series of concentric curved lines may be described on the square surface attached to the lower wheel, by means of a point proceeding from the upright part to the right, which is traversed by the upper wheel at the same time that the square surface is revolved by the lower.

139. Is a modification of 137.

140. Represents a plan and elevation of an instrument for drawing curved lines from a design. The upper figure represents an elevation of a rule, having the first and third points below attached to it, and clipt or held by a similar piece carrying the second point: this second point passes through a slot in the lower rule, which is allowed to slide freely in the clips, but drawn toward the

right hand extremity by means of a spiral spring and band. Supposing the second point to be firmly fixed as a centre, and the third point to be passed over the outline of the face in the plan, a curved line will be produced; and if the centre be placed on the profile, a succession of similar curves may be produced by varying the position of the profile, all of which will be common to the centre.

141. Is a plan of another instrument for producing curved lines round the centre of the larger wheel, which curves may be varied by varying the proportion of the first and third wheels.

142. Is a method of enlarging a curved line.

143. Is a section of a cylinder, in which the cutting tool, for the purpose of boring, is traversed by means of the screw above.

144. Is a combination of levers called the Pentagraph, for transferring outlines on an enlarged or reduced scale. One of the longer levers must have a fixed fulcrum, the other long lever carrying a point to be passed over the outline. It is also requisite that the fixed point, the repeating point, which is on one of the shorter levers, and the tracer, should be in a line.

145. Is a machine proposed by M. Grandjean for cutting screws, in which the piece to be cut is traversed by means of the bent lever on the left, which is acted on by the same treadle which gives the rotatory motion.

146 and 147. Are combinations, by which spirals are produced by worm or screw movements.

148. Shows the action of a curved line in vibrating the lever which rests on its face.

149. Is an arrangement for the brush movement of a machine for dressing warps, in which the revolution of the crank on the right, combined with the inclined plane on which the small roller to the left is supported, produces the brushing motion on the warp, which is represented at the dotted horizontal line.

150. Represents a revolving drum, having a worm at the extremity of its axis which takes into a wheel freely supported by the two horizontal rods at the back, and connected at an eccentric point on its surface to the fast framing; by this arrangement the drum is traversed endways, back and forth at every revolution of the wheel. The right hand figure is a section of the wheel shaft and rods.

151. Is another plan for brushing the warp similar to 149, in which the contact of the brushes is effected by the cam pieces beneath the longer lever, while the brushing action is given by the perpendicular lever from below.

152. Is an arrangement which produces a traverse motion from the vibration of the upper lever.

153. Is the well-known parallel motion of the steam engine, by which the circular motion of the end of the beam is converted into perpendicular motion in the piston rod.

154. Represents an arrangement proposed by Mr. Noble for working ship pumps; the perpendicular centre being connected with the piston rod, and the lever from the left acting on the combination of levers, forming the square at the top.

155. Is a combination of wheels running loose on the

respective shafts, which will produce a variety of speeds in a similar manner to 112.

156, 157. Are simple forms of transferring circular to rectilinear motion.

158. The horizontal piece which crosses the whole diagram represents one side of a pair of pincers, which open at the small circle in the middle, and the lower parallel side is seen holding the right hand circle between the jaws. At the back of these pincers is shown a square sliding piece, which can be moved by means of the lever above. On this piece are placed two pins, which acting on the indented parts of the lower side of the pincers, open or shut them according to the direction of traverse given by the lever above.

159, 160. Are modifications of parallel perpendicular motion, produced from alternate circular motion.

161. Represents an arrangement for giving motion to a sieve, by moving it backward and forward in the guides seen on each side, at the same time that they are moved in a cross direction by the pendulum on the right.

162. Front and side views of a French machine, for rifling gun barrels; the motion being given to the handle or winch, the sliding carriage which moves perpendicularly in the side guides, is elevated or lowered by the inclined rope in the left hand figure, at the same time that a rotatory motion is given to the perpendicular boring tool by another band passing round the horizontal warve, and held tight by means of the weight.

163. Shows a combination of levers, by which rectilinear motion may be transferred.

164. The upper part represents a spring, by means of which the band is kept tight during its action on the cylinder, which it passes over from the treadle beneath.

165. Is an arrangement for regulating the speed of the moving wheel to the left, which carries the governor on the upright shaft to the right; to the sliding part of this governor are connected two racks, which geer into the small spur wheels seen on each side of the upright shaft; the same wheels take into horizontal racks which are respectively attached to the broad flat surfaces immediately below them; thus by the vibration of the governor, which depends on the speed of the first mover, the broad flat pieces are carried out or withdrawn, and the amount of resistance caused by their passing through the air, increased or diminished.

166. Is the invention of the late Mr. White, which he calls the dinamometer, the object being to determine the amount of power required to give rotatory motion to any given piece of mechanism. The upper figure shows a hooped piece carrying two bevils; the same is also shown revolving freely on the middle of the horizontal shaft in the figure below. On this shaft are seen two bevils which geer into those carried by the hoop piece; one of these is fast to the horizontal shaft, and the other runs loose. Supposing then, the hooped piece in the lower figure to be held stationary, and motion given to either of the side wheels, it will be imparted through the horizontal bevils to the opposite wheel; but on the other hand, if the hooped part is not held stationary, it will revolve on the shaft along with the wheel which is

put in motion, and the amount of power required to hold the hooped piece stationary, will be the same as the amount transmitted from the first wheel. Thus a band attached to the periphery of the hoop will indicate the power, by the amount of weight required to keep it stationary.

167. Is an arrangement of levers for dressing the warp, similar to fig. 151, the vibration of the bell cranks on the right and left, producing the requisite movements of the brushes, and the dotted lines showing the position of the warp.

168. One of the most simple parallel motions.

169, 170. Two arrangements for producing circular motion by the hands or feet.

171. Is a similar arrangement to 71, by which the rectilinear motion of a piston rod is converted to circular motion, for which the late Mr. White received a medal from Buonaparte, in 1801.

172, 173. Are examples of alternate rectilinear motion produced from circular.

174. Is another arrangement for producing an alternate traverse in a revolving cylinder, similar to fig. 150. The flange piece seen to the right hand, on the shaft of the larger cylinder, takes into a groove in the smaller one, which also revolves slowly on its axis, and necessarily traverses the larger shaft at every revolution.

175. Represents an arrangement of parts similar to 143, for traversing the cutter of a boring machine.

176. Is a section of a screw movement for adjusting the centre of a lathe.

177. Is an application of the governor for regulating the supply of water to wheels. The horizontal wheel is fixed to the revolving shaft, which receives motion from the water-wheel, the speed of which is calculated to place the balls in the position here represented; but should it increase, and thereby raise the sliding piece, a projection from the left of the shaft would strike against the part of the arm immediately above, and traverse the coupling on the horizontal shaft below, into geer with the left hand bevil, which, being connected with the shaft, depresses the shuttle of the water-wheel, and reduces the speed; but should the speed be insufficient, and the balls collapse, the same projection would strike against the other arm immediately beneath it, and the bevil on the right would be connected with the shaft, and turn it in an opposite direction, thereby raising the shuttle for a greater supply of water.

178. This is a useful governor for pumping engines, in which the work is suddenly varied; the solid piston here represented fits loosely in the cylinder, which is filled with water. When the passage on the right hand is shut, the water is compelled to escape through the space between the piston and the cylinder, and thus work is thrown on the engine; but supposing the governor to resume its proper position, the valve in this side passage is opened, and the piston traverses without resistance.

LOVE AND BARTON, PRINTERS, MARKET-STREET, MANCHESTER.