A.D. 1781 . . . . . N° 1306.

Steam Engines.

WATT'S SPECIFICATION.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, James Watt, of Birmingham, in the County of Warwick, Engineer, send greeting.

WHEREAS His most Excellent Majesty King George the Third, by His Letters Patent under the Great Seal of Great Britain, bearing date at Westminster, the Twenty-fifth day of October, in the twenty-second year of His reign, did give and grant unto me, the said James Watt, my exors, admors, and assigns, His especial licence, full power, sole priviledge and authority, that I, the said James Watt, my exors, admors, and assigns, should and lawfully might, during the term of years therein expressed, make, use, exercise, and vend, within that part of His Majesty's Kingdom of Great Britain called England, His Dominion of Wales, and Town of Berwick upon Tweed, my Invention of "Certain New Methods of Applying the Vibrating or Reciprocating Motion of Steam or Fire Engines to produce a Continued Rotative or Circular Motion round an Axis or Centre, and thereby to give Motion to the Wheels of Mills or other Machines;" in which said recited Letters Patent is contained a proviso obliging me, the said James Watt, by an instrument in writing under my hand and seal, to cause a particular description of the nature of my said Invention, and in what manner the same is to be performed to be inrolled in His Majesty's High Court of Chancery within four calendar months next and immediately after the dateof the said Letters Patent, as in and by the said Letters Patent, relation being thereunto had, may more at large appear.

NOW KNOW YE, that in compliance with the said proviso, I, the said James Watt, do hereby declare that the nature of my said Invention, and the manner in which the same is to be performed, is particularly described and ascertained in manner and form following (that is to say):—

The fire or steam engines whose vibrating or reciprocating motions are to be converted into rotative motions by any or all of the five methods hereinafter described, may be constructed either upon the principles of the steam engines called Newcomen's fire or steam engines, (which have been hitherto most commonly used,) or more advantageously upon the principles of those newly improved steam or fire engines of my Invention, (the sole use and property of which was granted to me by His present Majesty's Royal Letters Patent, dated in the ninth year, and by an Act of Parliament made and passed in the fifteenth year of His reign); or the said engines may be constructed in any other manner or mode wherein a piston or any other part of the said steam or fire engine has a vibrating, alternating, or reciprocating motion; therefore, as for the aforesaid purpose no peculiar construction is required in those parts of the steam or fire engines which concur in and are necessary for the producing the power or active force of the engine and its vibratory or reciprocating motion, and as steam or fire engines are common and well known machines, it is not necessary to enter into any description of them, I proceed explain my newly invented methods of applying the vibrating or reciprocating motions of steam or fire engines to produce a continued rotative or circular motion round an axis or centre, and thereby to give motion to the wheels of mills and other machines, which methods are five in number, and are described as followeth:—

In the first of these methods I employ the power of the steam engine either directly or by the intervention of a lever or levers, to pull, push, or press a friction wheel or pulley against the lateral surface of a wheel fixed obliquely upon the primary axis, shaft, or wheel which is to receive the rotative motion, which lateral surface of the said oblique or inclined wheel is represented by the section of a hollow cylinder (A, B, C,) in the Drawing, No. 1, Fig. 1st), cut or sawn off at the angle of sixty-five degrees to its axis, or at any other angle which may be convenient or useful; and the said friction wheel or pulley (J) is impelled or pulled by the power of the steam engine against the said lateral surface of the inclined wheel (A, C,) in a direction which is in one way parallel to the said primary axis or shaft (D, E,) of the said obliquely cut cylinder or inclined wheel (A, C); therefore, the friction wheel (J), commencing its motion at the lowest or nearest part (C) of the said

inclined wheel (A, C,) continues to move in the aforesaid direction nearly parallel in one way to the primary shaft or axis (D, E,) and thereby obliges the inclined wheel (A, C,) and the primary axis (D, E,) to turn round or revolve on their centre until the highest or most distant part (A) of the said oblique surface of the inclined wheel (A, C,) comes into contact with the said friction wheel (J), at which point or time the working beam (P, P,) or other moving part of the steam engine has moved the length of its stroke, and is disposed to return by the common or other machinery used for that purpose, and the inclined wheel or obliquely cut cylinder (A, B, C,) has made one half of a revolution on its axis; and the rotative motion of the said inclined wheel (A, B, C,) is continued in the same direction through the other half revolution by means of the descent of the heavy arch (G) which was raised by the power of the steam engine at the same time with the friction wheel (J), and which during the returning motion of the working beam of the steam engine acts upon the inclined wheel (A, C,) on the opposite side of the primary axis (D, E,) by means of a second friction wheel (H), which is carried by a double lever or carriage (G, F,) whose center of motion is at (K), and to the one end of which the heavy arch (G) or any other weight is attached or suspended, and the velocity which the matter of the wheel or cylinder (A, B, C,) has acquired serves to continue its rotative motion past the points (A and C) where neither the steam engine nor the weight (G) have much action upon it, and when the point (C) has again come into contact with or has passed the friction wheel (J), the steam engine again commences its action, and the motion is continued as has been recited; and the mill-work or other machinery which is required to be wrought by this machine is put in motion by the said primary axis, or by the oblique or inclined wheel, or by means of wheels connected with them in the usual manner. This method of producing a rotative motion by means of a friction wheel acting against the lateral surface of a wheel inclined to its axis, admits of many varieties in its mode of application, for I fix the primary axis or shaft either perpendicular or horizontal, or at any other angle of inclination to the horizon which may be required, and I use one or more friction wheels, and I increase or diminish the angle of inclination of the oblique wheel to the primary axis, as the case may require. As therefore I cannot herein represent all those varieties, I have hereunto annexed a Drawing or delineation and description of one of the best (which is applicable to the moving of corn and other similar mills), which Drawing is delineated in its true proportions, according to a scale of one-fourth of an inch for each foot of the real machine, being one forty-eighth part of the real size; but it must be

remembered that I make the machines larger or lesser, and vary the proportions of their parts, as their uses may require. To shew the easiest method of connecting the said new machinery with the piston of the steam or fire engine, on whatever principle it may be otherwise constructed, I have delineated in red the piston and cylinder of a Newcomen's steam engine (as being the most commonly used). And as the same mode of connection serves equally for all the four following methods herein described, I have not repeated the Drawing of the said steam engine, but have only delineated the parts which in these methods connect the new machinery with the old.

My second method of producing the aforesaid rotative motion consists in applying the power of the steam engine to pull, push, or press a friction wheel or wheels against the external or internal circumference of a circular, oval, or double spiral wheel fixed upon an axis or shaft, in such manner that the said axis or shaft shall not pass through the center of the said circular, oval, or double spiral wheel, but shall be fixed nearer to one side of the circumference than to the other, which, therefore, I denominate an excentric wheel, and the said action of the steam engine and of the said friction wheel or wheels upon or against the circumference of the said excentric wheel causes it to make one half of a revolution, and its motion is continued through the other half revolution by the descent of a weight fixed to or acting upon the said excentric wheel or its shaft, or acting upon another excentric wheel (fixed to the same shaft) by means of a friction wheel or wheels. This second method also admits of several varieties in its application, of which I have hereunto annexed a delineation of two of the best, shewing the action of the steam engine on the external and also on the internal circumference of excentric wheels, which Drawings are delineated and set forth according to their true proportions by a scale of one-fourth of an inch for each foot of their real size; but the said machines are also made larger or lesser, and the proportions of there parts varied according to the uses for which they are required. The excentric wheel whose external circumference is acted upon by the steam engine by means of friction wheels is moved as follows (see the Drawing No. 2, Fig. 1st):—The steam engine pulls up the frame (H, D, L,) with the friction wheel (F, G,) against the external circumference of the excentric wheel A, B, which causes it to revolve on its axis towards D, until the point A of the excentric wheel comes to be in the middle between the points of contact of two friction wheels F, G, (with the excentric wheel, and the point B has attained the summit of its motion, then the steam engine ceases to act, and the velocity acquired by the excentric wheel A, B, carries its point B beyond the summit, and the gravity of the

unballanced part of the excentric wheel, which is made equal to half the power of the steam engine, or greater or lesser as may be necessary, causes the excentric wheel to perform the other half revolution, by which motion it pulls down the frame H, D, L, and the end (J) of the steam engine's working beam, and the point B having past its lowest place, the engine begins to act as before. The action of the steam engine on the internal circumference of an excentric wheel is described as follows:—When the engine pulls up the frame D, E, (see the annexed Drawing, No. 2, Fig. 3d,) with the friction wheel C, the latter is pressed against the internal circumference of the excentric wheel at H, by which means the wheel is turned round half a revolution, and the point B becomes the vertex; then the engine ceases to act, and the weight of the wheel descending causes it to continue to revolve in the same direction, and compleats the revolution in like manner as has just been described.

My third method of producing the said rotative motion is by means of a rod or rods D, B, (see the Drawing No. 3, Fig. 1st,) one end (D) of which is attached or suspended to the end of the working beam of the steam engine, and the other end (B) to any point of a wheel (A, E, B, F,) of a circular or any other form, which wheel is fixed at one end of a shaft or axis (C), so that by the revolution of the said wheel and the said axis (C), the said latter point of fixture or attachment (B) shall describe a circle round the centre of the said axis, the diameter of which circle shall be equal to the extent of the stroke of the point of the engine's working beam, to which the end D is attached, and the said wheel (A, E, B, F,) is made so much heavier on one side (E, B, F,) of the centre than upon the other side (A) that the said unballanced weight (E, B, F,) shall have an action in its descent equal to one half of the power of the steam engine which works the machine, or more or less, as required; or, in place of putting the weight in the wheel (A, B, F,) itself, it is put upon a lever or other wheel, fixed to the said shaft (C, C,) in any other part, or is fixed in any other manner which may serve to make the wheel continue its motion during the return of the piston of the steam engine; and this machine is used as follows:—When the point or pin (B) which connects the rod (D, B,) with the wheel is a little on either side of the lowest part of its revolution, the steam engine pulls the rod (D, B,) and thereby obliges the wheel to make one half of a revolution, and the unbalanced weight (E, B, F,) of the wheel, or such other weight as acts upon it during the return of the steam engine, makes the wheel compleat its revolution, as has been already recited in the above methods. This third method also admits of several varieties in the mode of execution,

for the wheel is sometimes placed so as to turn vertically (as in the Drawing), and sometimes to turn horizontally, and also at other inclinations to the horizon, and the balancing weight is also placed in various situations. I have therefore delineated only one of the most simple and perfect of these methods in the Drawing No. 3 hereunto annexed, which is laid down by the same scale with the other Drawings of the preceding methods; but the size of the machine must be greater or lesser, and the proportions of its parts varied according to its use.

My fourth method of producing the aforesaid rotative motion consists in employing two steam engines to produce a rotative motion in one and the same axis or shaft by any of the aforesaid three preceding methods, or by that which is herein-after described; and in applying these two steam engines in such manner that the second engine shall begin to act when the first engine has made the said shaft revolve upon its axis one-third part of a revolution or thereabouts, and consequently by the action of both the engines the shaft makes two-third parts of a revolution, and its motion is continued through the remaining one-third part of the revolution, by the action of a weight properly placed, by which means the rotative motion is maintained in a more equal manner than can be done by a single steam engine. I also apply this method to move two seperate or distinct shafts or axles, which are connected in their action by wheel-work or otherwise, so that they both must revolve the same number of turns in the same time. As this fourth method must admit of many varieties in its application to any or all of the three preceding or the following methods, all which may be easily understood by explaining its application to one of them, I have only delineated in the Drawing No. 4 its application to the third method, as being the most simple, and I have laid down the said Drawing according to the same scale with the others. The motion of this machine is explained as under. The pin (G) of the connecting rod B, G, (see Drawing No. 4, Fig. 2d,) having past its lowest point, the working beam B ascends by the power of the steam engine to which it belongs, and by its action on the pin G, through the rod B, G, causes both the wheels and their common axis to revolve until the end of the rod B, G, arrives at the point (C), at which time the end of the rod (A, C,) (which is attached to the further wheel) is arrived at the point K, (that is, a point of the further wheel directly behind K in this view,) and the centre of gravity of the weight or heavy sides of the wheels G, J, C, has passed its vertex or highest part at F, and begins to descend towards K, the rod B, G, continues to act upon the wheels until it arrives at F, where it ceases to

act, and the motion is continued only by the gravity of the heavy side of the wheels or by any other properly disposed weight, until the point C of the further wheel has past its lowest place and comes into the position directly behind G, when the steam engine belonging to the rod A, C, begins to act and continues the motion until it arrives again at C, when the revolution is completed and the rod B acts as before; the heavy sides of the wheels or any other weight used to continue the motion ought to be equal to one-half of the power of one of the engines, but may be greater or lesser as suits.

My fifth method of producing the aforesaid rotative motion delineated in the Drawing No. 5, hereunto annexed) is performed by means of a toothed wheel E (Fig. 1st), fixed upon the end of the shaft or axis F, which is to receive the rotative motion, which wheel E is acted upon and made to revolve by means of a second toothed wheel D, of an equal or greater or lesser diameter, which is firmly fixed to or connected with a rod A, B, (the other end of which is attached or hung to the working beam B, C, of the steam engine or is otherwise connected with the piston of the said engine,) in such manner that the said wheel D cannot turn round on its own axis or centre, and by means of a pin A, which is fixed to or in the centre of the wheel D, and enters into a groove or circular channell in the large wheel (G, G, or by any other proper means) the wheel D is confined, so that it cannot recede from the wheel E, but can revolve or turn round the wheel E without turning on its own axis or centre, and the motion is performed as follows:—The wheel D being nearly in the position of the prick't circle H, H, and so that its centre shall be a little towards either side of the perpendicular line passing through the centre F, the steam engine by means of the connecting rod B, A, pulls the wheel D upwards, and as its teeth are locked in the teeth of the wheel E, and it cannot turn on its own axis, it cannot rise upwards without causing the wheel E to turn round upon its axis F; when the wheel D is raised so high that its lower edge is come into contact with the upper edge of the wheel E, the engine has compleated its stroke upwards, the piston of the engine is disposed to return, and the wheel continuing to turn round in virtue of the motion it had acquired, it carries the wheel D past the vertex or highest part, and the gravity of the wheel D, or of the connecting rod A, B, or of any other weight connected with them, causes the wheel D to descend on the other side of the wheel E, and thereby continues the motion it had imprest upon it, whereby the wheel D completes its revolution round E; and when the two wheels D and E have equal numbers of teeth, the wheel E makes two revolutions on its axis for each stroke of the engine; and in order that the

said motion may be more regular, I fix to or upon the shaft or axis F, M, L, (Fig. 2d,) or to or upon some other wheel or shaft to which it gives motion, a heavy wheel or flyer to receive and continue the motion communicated to it by the primary movement.

And be it remembered, that in all cases were heavy wheels or swift motions are not otherwise necessary to the uses to which any of the four preceding methods herein described may be applied, a flyer or heavy rotative motion should be applied to them to equalize their motion. In Fig. 3d & 4th, I have delineated the application of this method to a wheel C, C, fixed upon the primary axis, and having teeth upon its inside circumference which is acted upon by the wheel E in the manner which has just been recited, but as the wheel E has only half the number of teeth that the wheel C, C, has, the wheel C, C, will make only one revolution for every two strokes of the engine. The Drawings of this fifth method are also delineated according to a scale of one-fourth of an inch for every foot of the real size of the machine. Fig. 1st and 2d are adapted to a stroke of six feet long, and Fig. 3d and 4th to a stroke of three feet long; but I make the machines larger or lesser, and also make such variations in their structure as may serve to accomodate them to their use, as I alter the proportional diameters of the two wheels, and I place the primary axis either horizontally, perpendicularly, or inclined, and I make the wheels of an eliptical, oval, or other form, and sometimes in place of the wheel D, I use a straight row of teeth or pins fix't to the connecting rod A, B, which take hold of the teeth of the said wheel E and cause it to revolve, some point of the connecting rod being guided by a pin moving in a groove, so as to keep the teeth or pins always engaged in the teeth of the wheel E, and also to keep the teeth of the wheels always engaged in another; instead of the wheel G, G, and its groove, I use a strap of leather, or a link of iron, or other proper material (such as is drawn at J, K, which embraces the axis M or F, and the pin A, and connects them together and keeps them at their proper distance from each other, and I also make the two wheels E and D without any teeth, but with rough surfaces, so that D turns E by the friction of their circumference alone.

Be it remembered, that though I have described all these motions as derived or produced from the motion of the end of the working beam of the steam engine, they may also be derived from the vibrating motion of any other part of the steam or fire engine which is found convenient; the end of the working beam appears at present to be the best adapted for that purpose; any or all of these methods admit of the machines being moved with rotative

motions in either direction, that is, either right-hand ways or left-hand ways about, according as the motion is commenced in either of these directions respectively.

In witness whereof, I have hereunto set my hand and seal, the Thirteenth day of February, in the year of our Lord One thousand seven hundred and eighty-two.

JAMES (L.S.) WATT.

Signed, sealed, and delivered (being first duly stampt), by the within-named James Watt, in the presence of

N. BENNETT,
Clerk to Mr. Davis,
of Penryn.

BENJ. COLLETT,
Servant to Mr. Davis.

AND BE IT REMEMBRED, that on the Thirteenth day of February, in the year of our Lord 1782, the aforesaid James Watt came before our said Lord the King in His Chancery, and acknowledged the Specification aforesaid, and all and every thing therein contained and specified, in form above written. And also the Specification aforesaid was stampt according to the tenor of the Statutes made in the sixth year of the reign of the late King and Queen Wm and Mary of England, and so forth, and in the seventeenth year of the reign of this Majesty King George the Third.

DAVIS, Extra.

Inrolled the Twenty-third day of February, in the year of our Lord One thousand seven hundred and eighty-two.

LONDON:
Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1855.

A.D.1781. OCT.25. Nº1.306.
WATT'S SPECIFICATION.

(1 SHEET)

Drawing Nº1. relative to the First Method.

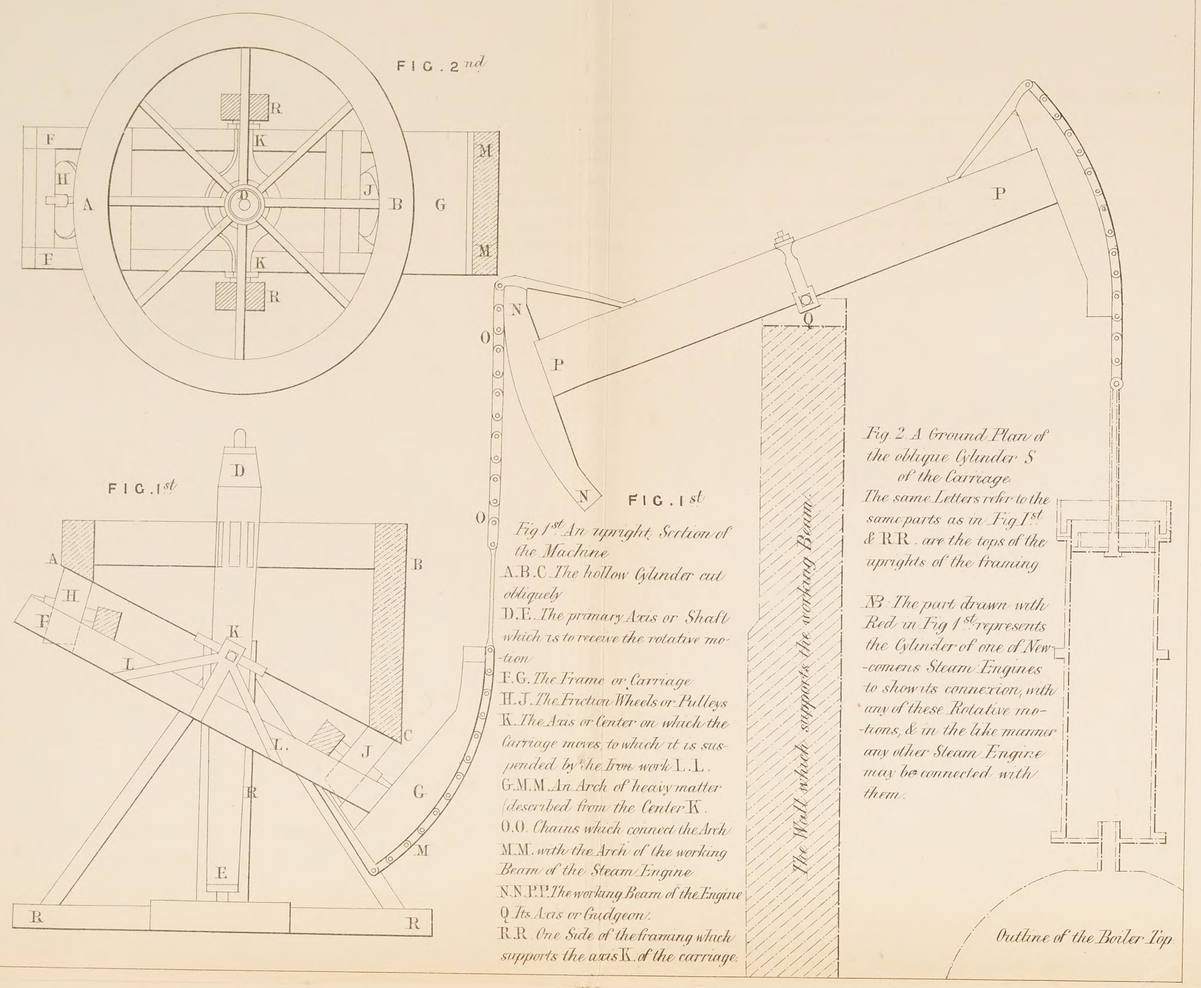


Fig 1st An upright Section of the Machine
A.B.C. The hollow Cylinder cut obliquely
D.E. The primary Axis or Shaft which is to receive the rotative motion
F.G. The Frame or Carriage
H.J. The Friction Wheels or Pulleys
K. The Axis or Center on which the Carriage moves, to which it is suspended by the Iron work L.L.
G.M.M. An Arch of heavy matter described from the Center K.
O.O. Chains which connect the Arch M.M. with the Arch of the working Beam of the Steam Engine
N.N.P.P. The working Beam of the Engine
Q. Its Axis or Gudgeon.
R.R. One Side of the framing which supports the axis K. of the carriage.

Fig 2 A Ground Plan of the oblique Cylinder S of the Carriage.
The same Letters refer to the same parts as in Fig 1st & R.R. are the tops of the uprights of the framing.

NB. The part drawn with Red in Fig 1st represents the Cylinder of one of New-comens Steam Engines to show its connexion, with any of these Rotative motions, & in the like manner any other Steam Engine may be connected with them.

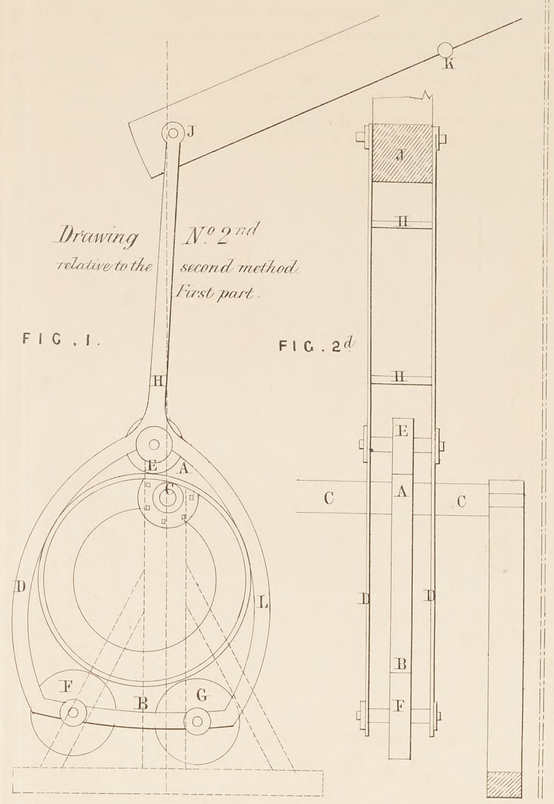
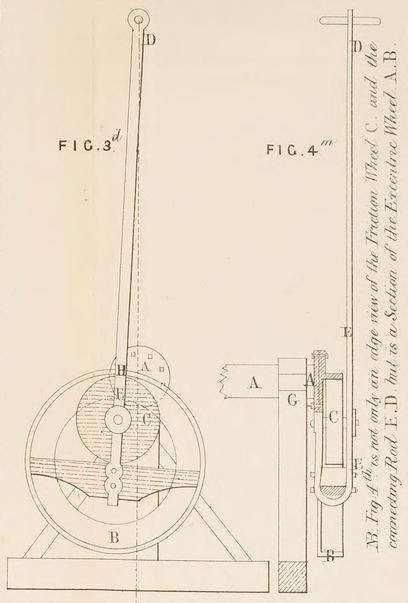


Fig 1st A View of a Circular excentric Wheel seen in the direction of its Shaft or Axis
A.B. The Excentric Wheel C. Its Shaft or Axis E.F.G. Friction Wheels
H.D.L. A Frame of Iron, by which the friction Wheels are suspended to & connected with J.K. one end of the Working Beam of the Steam Engine
Fig 2nd An Edge view of the excentric Wheel.
The same letters relate to the same parts as in Fig 1st

Second part of Nº 2nd



NB. Fig 4th is not only an edge view of the Friction Wheel C. and the connecting Rod E.D. but is a Section of the Excentric Wheel A.B.

Fig 3d & 4th Represent the Application of the second method to the internal circumference of an Excentric Wheel.
Fig 3d View of the Excentric Wheel in the direction of its Shaft
A. The end of Axis or Shaft which is behind the Wheel
A.B. The Excentric Wheel. C. The friction Wheel which is connected with the working Beam of the Steam Engine by means of the Rod E.D. which is suspended to the working Beam by the end D
Fig 4th Edge View of the Excentric Wheel & its Shaft &c.

All these Drawings are delineated by a Scale of one fourth of an Inch for each Foot of the real size of the Machines.

Drawing Nº3.
Relative to the Third method

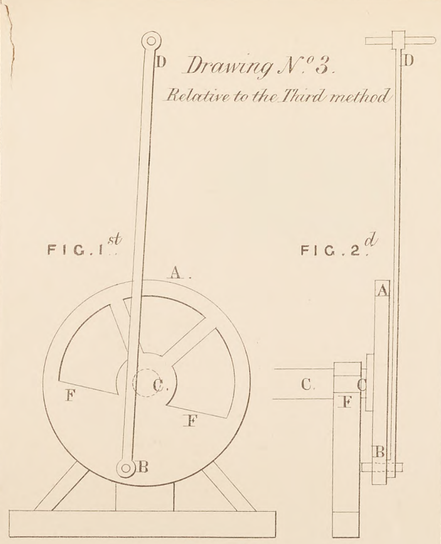
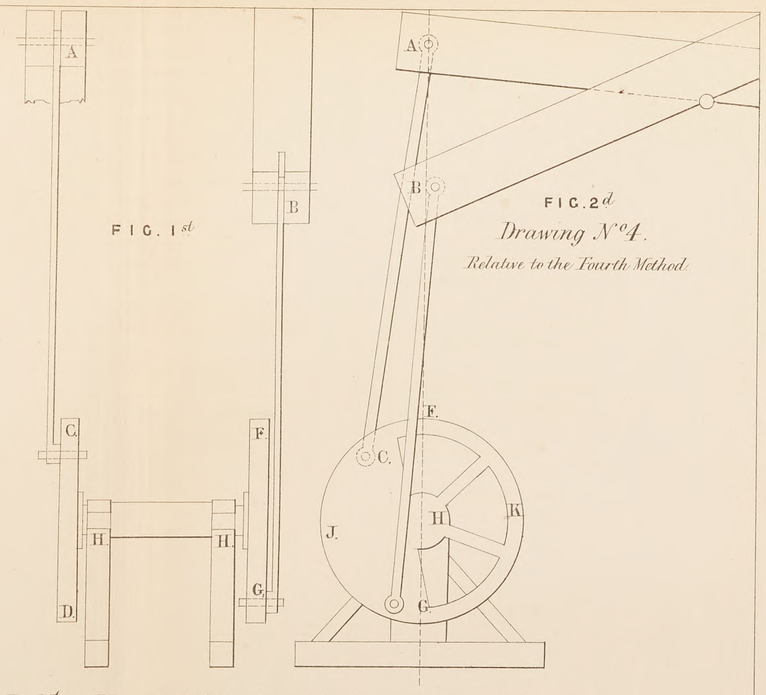


Fig 1st Front view of the Primary Rotative Wheel.
A.B. The Wheel C. Its Center or Axis.
E.B.F. The heavy side of the Wheel B. The point of attachment of the Rod B.D. which connects the wheel with the working Beam of the Steam Engine
D. The end of the Rod which is attached to the working Beam.
Fig 2d An Edge view of the Wheel & its Shaft &c.

The enrolled drawing is colored.



Drawing Nº4.
Relative to the Fourth Method.

Fig 1st An Edge view of the two Wheels & a longitudinal one of their Shaft or Axis.
A. & B. parts of the Working Beams of the two Steam Engines. C.D.F.G. Edge views of the wheels. H.H. Their common Axis supported at H.H. A.C. B.G. Rods which connect the wheels to the working Beams of their respective Engines.
Fig 2nd Front view of the Wheel F.G. (the other wheel C.D. being hid by F.G. in this view)
A.B. Part of the working Beams of the two Steam Engines. A.C. The connecting Rod of the further wheel C.D. B.G. The connecting Rod of the nearest Wheel (J.F.G.)
H. The center of the Wheels and of their Shaft or Axis C.J.G. The heavy side of both Wheels.

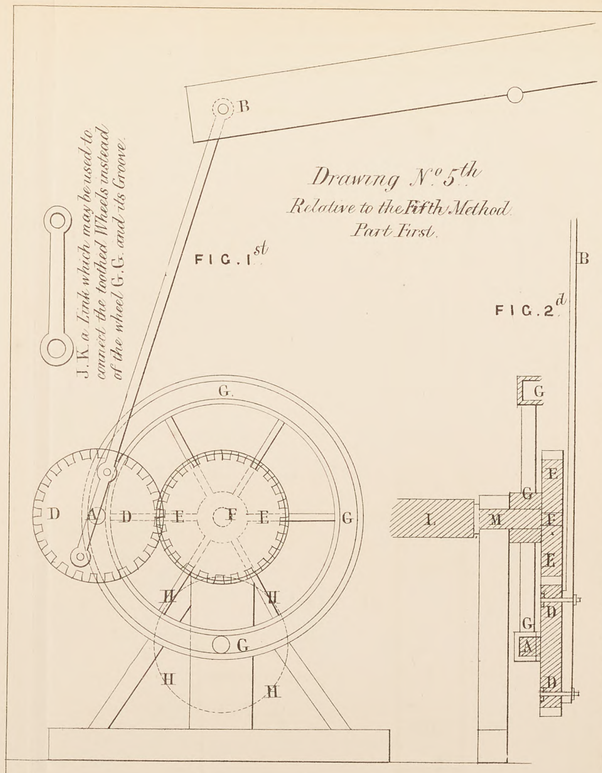


Fig 1st Front view of the Machine B. Part of the working Beam of the Steam Engine. C. Its Gudgeon or Axis. D.D. A toothed Wheel fixt to the Connecting Rod A.B which without turning upon its own center revolves round the toothed wheel E.E. which is fixt upon the Primary Rotative axis F. and which is made to turn round by the teeth of D.D.
A a Pin projecting from the Backside of D.D which being guided by the Groove G.G. keeps the toothed wheels always in contact.
Fig 2d Edge view of the Machine.

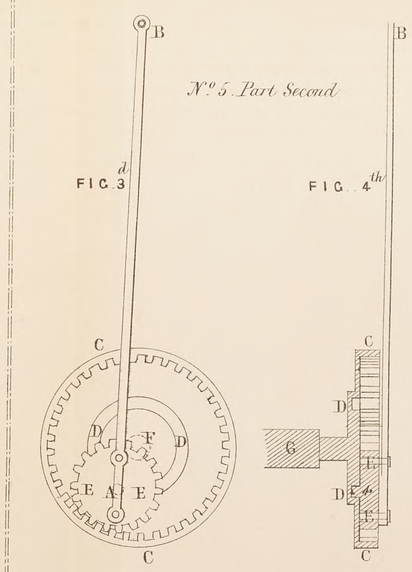


Fig 3d Front view of the application of the Fifth method to a Rotative wheel having teeth on its internal circumference.
C.C. The Rotative wheel which is made to turn round by the action of the wheel E.E within it.
E.E. a Wheel fixt to the connecting Rod A.B. The Pin A keeps the two wheels always in contact by moving in the Groove D.D.
Fig 4. A Section of the Machine through its Axis.

Drawn on Stone by Maltby & Sons.

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Printers to the Queen's most Excellent Majesty. 1855.