October 20, 1913.

DRAWING

5,724

A careful search has been made this day for the original drawing or a photolithographic copy of the same, for the purpose of reproducing the said drawing to form a part of this book, but at this time nothing can be found from which a reproduction can be made.

Finis D. Morris,

Chief of Division E.

AWK

5724 Henry G. Thompson Aug. 22, 1848

Rotary Engine

Fig 1.

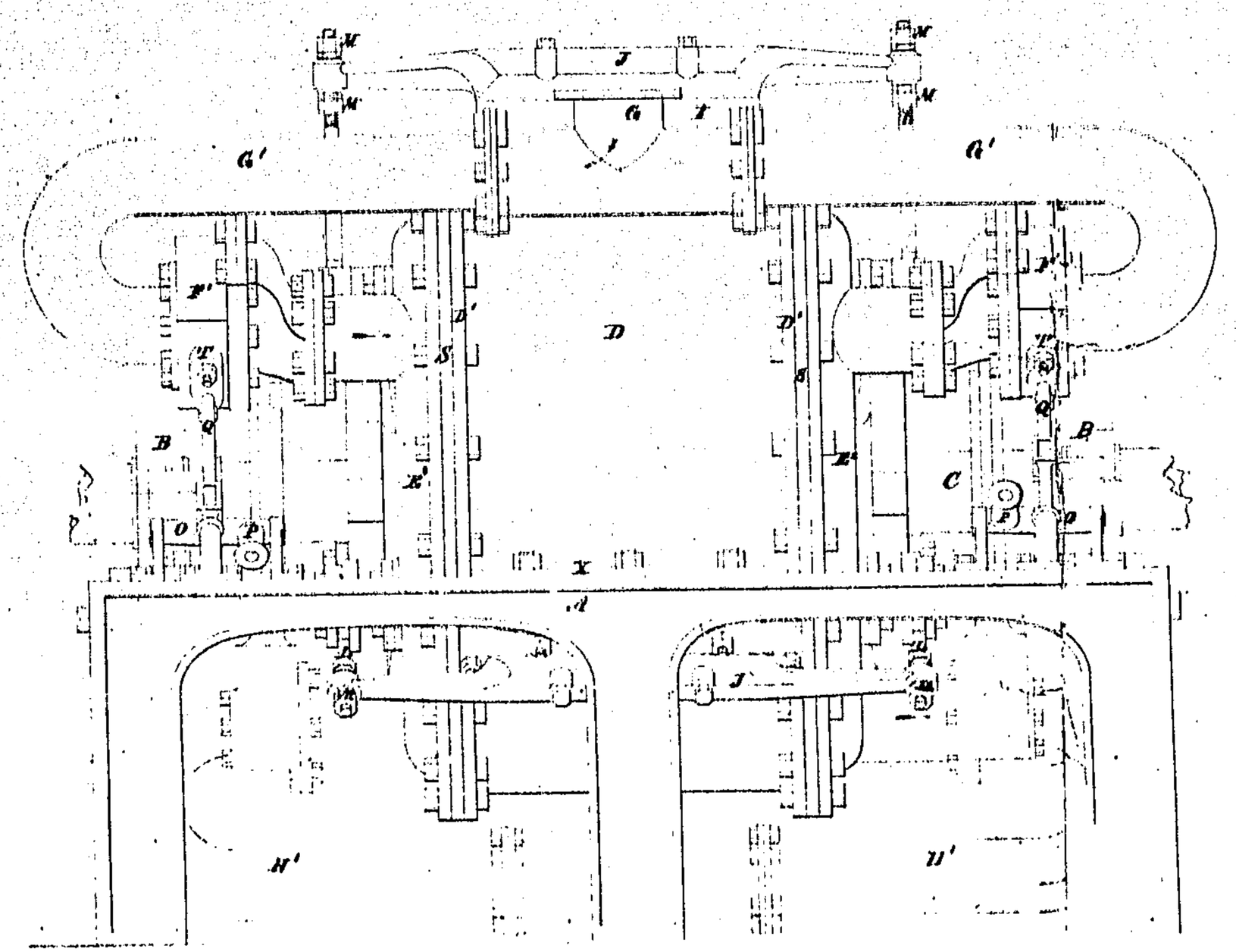
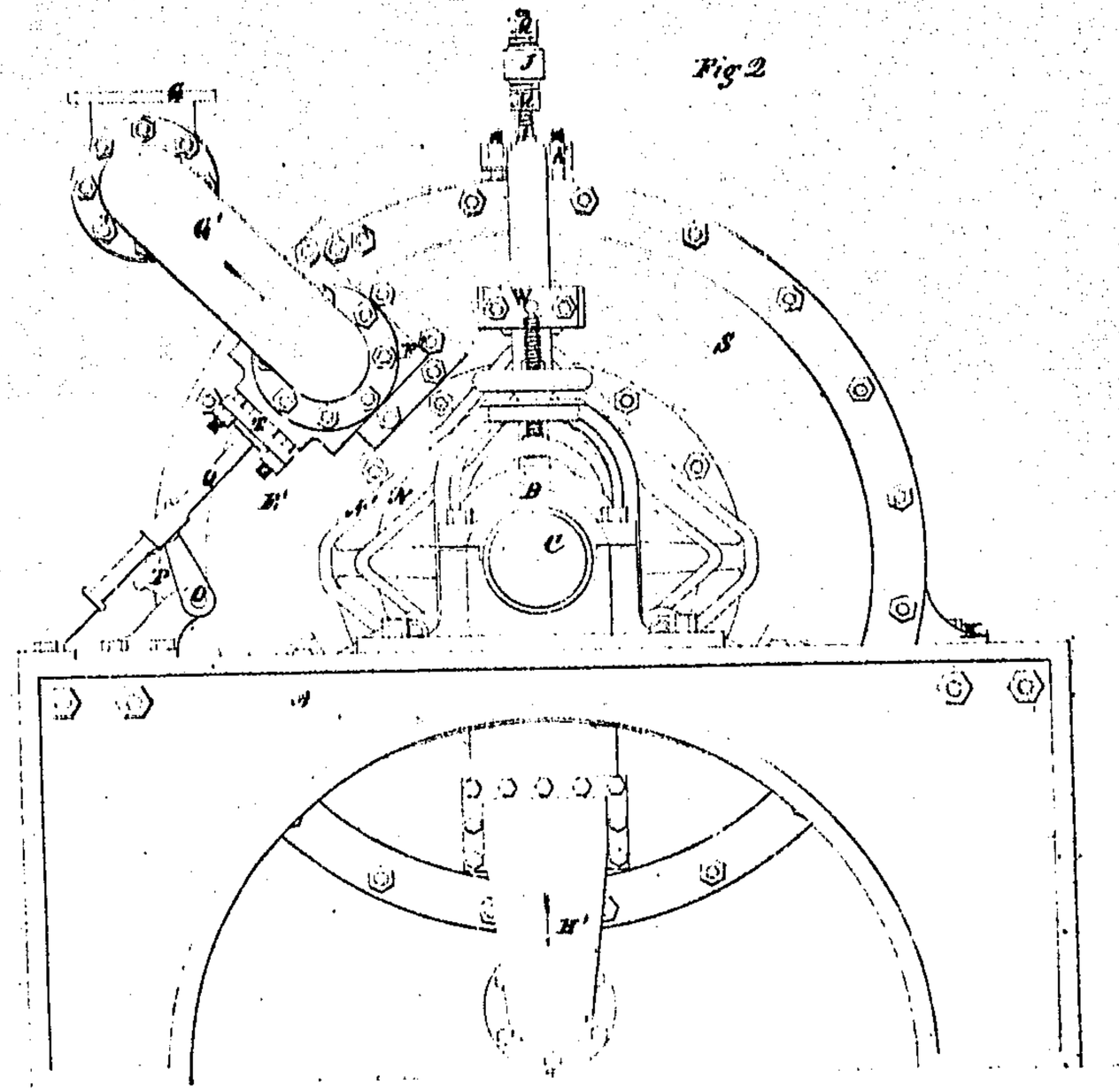


Fig 2



UNITED STATES PATENT OFFICE.

HENRY G. THOMPSON, OF NEW YORK, N. Y.

ROTARY STEAM-ENGINE.

Specification of Letters Patent No. 5,724, dated August 22, 1848.

To all whom it may concern:

Be it known that I, HENRY G. THOMPSON, of the city, county, and State of New York, have invented new and useful Improvements in Rotary Steam-Engines, and that the following is a full, clear, and exact description of the principle or character which distinguishes it from all other things before known and of the manner of making, constructing, and using the same, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1, is a front elevation of an engine on my improved plan; Fig. 2, a side elevation; Fig. 3, a vertical section taken at a plane passing through and parallel with the axis of the shaft; Fig. 4, a cross vertical section; and Fig. 5, a vertical section taken at the line (Z, Z,) of Fig. 3.

The same letters indicate like parts in all the figures.

The importance of applying steam to a rotating instead of a reciprocating piston has long been recognized, and of the almost endless attempts which have been made to attain this desired end none have so far succeeded; and indeed so unsuccessful have been these essays that among the unreflecting the idea of final success has been abandoned, not so however with those who thoroughly understand the properties of steam and the principles of mechanics. In the reciprocating engine the steam which occupies the space between the surface of the piston and the cylinder head and induction valves must of necessity be wasted at each stroke, for these spaces must be filled with steam before its elastic force can be exerted on the piston, and at the end of the stroke when the steam is discharged into the condenser or the atmosphere the steam occupying these spaces is necessarily either condensed or discharged into the atmosphere, the spaces to be again filled for a continuation of this wasting process. Again, the valves which admit and discharge the steam must be opened and closed under the pressure of the steam, thus requiring a great expenditure of power to overcome this pressure or the friction produced by it, or else complex machinery must be employed to balance the pressure, thereby wasting a nearly equal amount of steam to produce this equilibrium. But the most serious objections to the reciprocating engine are to be found in the transfer of the power from the piston to the crank shaft. As the piston approaches and passes the dead points of the crank, the pressure of the steam produces much friction on the crank pin and the journals of the crank shaft. And in addition to this is to be considered the irregularity of motion consequent on the gradual starting and stopping of the piston and the constant changes in the leverage of the crank in its rotation both of which irregularities are the sources of irregularity in the movements of the machinery impelled or driven by the engine to be overcome by the use of heavy fly wheels which add to the bulk and cost of the whole apparatus and to the friction of the moving parts by the weight of the fly wheel on the journals of its shaft; and when the fly wheel is not employed, as in boats, the bulk of the mass impelled is substituted for the fly wheel as a regulator, but as this mass is under a constant resistance its velocity is retarded during the time that the engine exerts the least force, that is in passing the dead points, and this loss of momentum, which has to be overcome at every stroke, is so much to be deducted from the effective force of the engine. This latter defect has been overcome in a measure by the use of two engines on the same crank shaft with the cranks at right angles, and what is a still nearer approximation to an equal action, three engines on the same shaft with the cranks placed relatively to one another at an angle of 120 degrees to divide the circle into three equal parts. By the use of the three in this way, it is found that the point of maximum force of the three engines on the crank shaft succeed one another so closely as to render the action nearly constant and regular, but the use of three, or even two, engines, increases the cost, the liability to derangement and the difficulty of attending and working, and hence the advantages derived from the use of them in this way is in a measure neutralized, and therefore only resorted to when other reasons induce the use of two or more engines. When however the steam is used expansively by means of what is known as the cut-off the irregularity of action of the reciprocating engine is greatly enhanced, for the moment that the supply of steam from the boiler is cut off and it begins to expand in the cylinder the impelling force gradually decreases and therefore the moment of maxi-

mum force, if the steam be cut off at less than half stroke, will be before the crank reaches its greatest leverage.

Great however as all these defects of the reciprocating engine are there is still another of great magnitude, and that is the necessity of making the parts particularly the framing, of a strength far beyond what would be requisite to sustain a constant force acting always in the same direction. The thrusts of this class of engines are first in one and then in the reverse direction—and often in oblique directions, and without any counter action or strain—and therefore these forces can only be resisted by making the parts of much greater strength. In locomotion, particularly in steam navigation, this necessity of an increased strength of the parts adds much to the weight, increases the resistance, and hence reduces the speed.

The defects above pointed out, with others not necessary to enumerate, would be avoided, or in a great measure modified, by the application of the steam to a rotating body, provided by such application other defects, more formidable, do not arise. In theory this mode of application is unquestionably the best, although the want of practical success has led even writers on the steam engine to advance, as theoretical objections notions that will not for a moment stand the test of sound reasoning. So long as science admits as a law that gaseous bodies exert an equal force in all directions, so long will the application of the force of steam to a rotating body be theoretically better than applied to a reciprocating body. All the impediments to this better mode of application are of a practical nature—to these have my mind been directed, and by the nature of my improvements I believe they have in a great measure been overcome.

In my improved engine the rotating wheel to which I attach four pistons, works within a stationary cylinder the steam chamber (or what corresponds with the steam cylinder of the reciprocating engine) being formed between the inner periphery of the stationary cylinder and the outer periphery of the rotating piston wheel, and the pistons are each formed by projections from the periphery of this wheel, the outer lines of such projections being two opposite tangents with a radial groove between them to receive the metal packing which consists of two radial side pieces having their inner faces beveled inward, and a middle piece which is forced outward by springs or other packing so that when forced outward it shall force the side pieces out against the disks of the stationary wheel and the periphery of the cylinder. When four pistons are used there are three stops that slide radially through apertures in the periphery of the cylinder and bear on the periphery of the rotating piston wheel. The stops form abutments to resist the steam when acting against the pistons—they are moved in and out by two cams of a form corresponding with the form of the periphery of the piston wheel, and attached to the same shaft so that as the piston wheel rotates these stops or steam abutments shall be moved in and out to follow the pistons and yet form steam tight joints.

On each side of the cylinder, that is at each end, there is an annular pipe in connection with the steam pipe and condenser, and each of these annular pipes communicates with the steam chamber by means of three steam ports, that is one for each stop or abutment and these ports are so located that those leading from one of the pipes shall open into the steam chamber on one side of each stop and those at the other end of the cylinder shall communicate with the chamber on the other side of the stops. In this way there will always be one port on each side of each stop and as many at each end of the cylinder as there are stops. The two annular pipes are connected each by branch pipes with the steam pipe and with the exhaust pipe, and in the branch pipes there are sliding or throttle valves so that either of the annular pipes can be made to connect with the steam or the exhaust pipe to reverse the motion of the piston wheel. By means of these annular pipes the steam ports are always in connection with the steam, and so the exhaust ports with the condenser or the atmosphere, so that as the piston wheel rotates the steam is admitted and discharged by the simple passage of the pistons by the steam and exhaust ports thus dispensing with the use of separate valves for this purpose.

The nature of the first part of my invention consists in the use of four or more pistons on the piston wheel and three or more stops or abutments and steam and exhaust ports in the cylinder—that is to say four pistons and three stops with an equal number of steam and exhaust ports, or more in that proportion, the steam ports being arranged on one side of the pistons and the exhaust ports on the other that the rotation of the pistons may open and close them alternately to admit and discharge the steam.

The nature of the second part of my invention consists in having all the steam ports connected at one and the same time with the steam pipe and all the exhaust ports with the condenser, so that the engine will take steam and exhaust from all of these in succession by the mere rotation of the pistons, thus avoiding the necessity of separate valves, and this part of my invention also consists in connecting all the ports with the steam pipe and also with the exhaust pipe, the said steam pipe and the said exhaust pipe being each provided with

purpose of giving a slight play to the steps the rods (L) are connected with the cross purpose of giving a slight play to the stops above and below.

There are three ports (E^1) (D^2) on each side passing through the heads of the cylinder, those on one side are lettered (E^1) and those on the other side are represented in Fig. 4 of the drawings by dotted lines lettered (D^2). Supposing the piston wheel to be rotating in the direction of the arrow A^3, the ports (E^1) are each in front of one of the sliding stops or abutments and are, in that condition, the steam ports which admit the steam to impel the pistons in the direction indicated—at the same time the ports (D) back of the stops, and made through the other head of the cylinder, act as exhaust ports to discharge the steam into the atmosphere or into a condenser. In this way it will be seen that with the use of four pistons on one wheel, and three steam stops or abutments in the cylinder, with the appropriate and corresponding number of steam and exhaust ports, the steam is at all times acting on an amount of piston surface equal to two of the pistons; at times, that is when one of the pistons is passing one of the stops, the steam is acting on nearly the entire surface of two pistons while the fourth is neutral, and in other positions the steam acts on the entire surface of one piston and on portions of two others, making the whole equal to the surface of two pistons, so that there is always a constant and equal pressure of steam on the piston wheel which must of necessity produce a constant and regular motion.

All the ports (D^2) open into an annular pipe (E^1) on one side, and the ports (E^3) on the other side into a like pipe (E^2). These annular pipes are secured to the heads (S, S,) of the cylinder by flanges and screw bolts or in any other desired manner, and they are both connected with the steam pipe (G) by means of a branch pipe (G^1), the two ends of the branch pipe being connected with the annular pipes by means of valve boxes (F^1, F^1,) provided with sliding or throttle valves (not seen in the drawings) operated by the valve stems (Q, Q,) that pass through stuffing boxes (T, T,) and operated by the arm of a rock shaft (O) that has a handle (P,). In like manner these annular pipes are both connected with the exhaust pipe (H,) by means of a branch pipe (H^1) also provided with valves (U, U,) the stems of which are attached to screws (R) by means of loops (R^1) that pass around the main shaft so that by a screw nut (R^2,) the valves can be operated. By this arrangement it will be seen that by closing the valve in the branch steam pipe that leads to the annular pipe (E^2) on one side and closing the valve in the exhaust branch pipe on the opposite side that leads to the annular pipe (E^2) all the ports on one side will be in connection with the steam pipe and will therefore be the steam ports, while all the ports on the other side will be in connection with the exhaust pipe and therefore will act as exhaust ports; but by reversing these valves this condition of things will be reversed and therefore the action of the engine will be reversed. Another advantage resulting from this arrangement is that as all the ports are on one side and are constantly in connection with the steam and the others with the exhaust pipe the steam will be admitted to, and discharged from, the engine by the passage of the pistons over the ports during their rotation, hence the rise of steam and exhaust valves are entirely dispensed with, and no more steam will be exhausted than has been employed for the working of the piston, this being due to the fact that the ports are closed by the passage of the pistons over them.

From the foregoing it will be obvious that instead of using four pistons and three stops or abutments and a corresponding number of steam and exhaust ports, that these numbers may be increased so long as the number of pistons exceeds the number of stops, there being always a steam and an exhaust port for each stop, one on each side thereof. And that instead of the annular pipes for connecting each set of ports either with the steam pipe or with the exhaust that this may be done by a separate chamber for each port, the chambers of one entire set of ports being connected by branch pipes into one; and when so connected by chambers and branch pipes instead of admitting steam on one side of the cylinder and exhausting on the other side, all the ports may be placed on one side, or on the periphery of the cylinder; in short any variation may be made in this part of the arrangement so long as the principle of this part of my invention is retained, which principle consists in having all the steam ports in connection with the steam pipe at one and the same time, and in like manner with the exhaust ports, and also in having the steam and the exhaust ports on opposite sides of the steps or abutments—that is the one set in front and the other behind the stops. And also in having the two sets of ports connected by branch pipes with the steam and with the exhaust pipes so that by the use of valves in these pipes the direction of motion of the engine may be readily reversed.

It is to be observed also that instead of cam grooves for working the sliding stops, cam fillets embraced by the sliding rods attached to the stops may be substituted, or surface cams may be used with the ends of the rods adapted thereto and kept thereon by the tension of springs, but these modifications will be clearly understood by engi-

two valves to shut off on either side for the purpose of reversing the action of the engine.

The third part of my invention consists in operating or sliding the steam stops or abutments by means of cams corresponding in form with the periphery of the piston wheel and attached to the shaft thereof so that as the piston wheel rotates the stops shall be made to move in and out and rest on the periphery of the piston wheel and thus save the steam which would be wasted if the cam were of a different form.

And, finally my invention consists in forming the pistons on the wheel by projections from its periphery produced by opposite tangent or curved lines, when this is combined with packing plates let into a groove between the two tangents or curved lines of each piston, the said packing plates consisting of two side pieces and a middle one, the latter being beveled at the ends to correspond with equal bevels on the inner face of the end ones so that when the middle one is forced out by elastic packing or springs within to force its outer face against the inner periphery of the steam chamber, it shall at the same time force the others against the sides and periphery thereof and thus render the joint steam tight.

In the accompanying drawings (A) represents the frame which may be made as represented or in any form desired to suit the purpose to which such engines may be applied. To this frame is properly secured the stationary hollow cylinder (D) by means of flanges (X X) cast on the periphery thereof. The ends of the cylinder are provided with flanges (D^1 D^1) to which are secured, by bolts, in the usual manner, the heads or disks (S, S,) through holes in the centers of which passes the main shaft (C) that has its bearings in boxes (B, B,) on the frame, the holes in the heads (S, S,) of the cylinder being provided with stuffing boxes (V, V,) to prevent the escape of steam, should any pass between the cylinder heads and the rotating piston within. The inner periphery of the cylinder should be as nearly a perfect cylinder as can be, and to it is to be accurately fitted the rotating pistons (Y, Y, Y, Y,) four in number that project at equal distances apart from the circle of the piston wheel (F) on the shaft (C); these pistons are formed each by two opposite tangents to the circle of the wheel, the two tangents not being projected however far enough to meet, but leaving a concentric space between them of greater width than the thickness of the stops to be presently described, the line of this concentric space coinciding with the inner periphery of the cylinder. The tangential lines forming the pistons should however run by a gradual curve into the concentric line uniting the two that they may pass the stops with the more facility, although in the drawings these lines are represented as forming angles at their intersection. A longitudinal radial groove is cut out of each piston and in the middle thereof in which is fitted the metallic packing (Z, z, z_2) formed in three parts. The part (Z) has its outer edge formed to fit the inner periphery of the cylinder and it rests on springs (a, a,) at the bottom of the groove so that it is at all times forced out against the periphery of the cylinder with its ends beveled inward so that its inner edge is the largest; and at each end there is a piece (z) which runs down to a greater depth than the piece (Z) and fitted to grooves in the projecting rims (b) of the piston wheel, the inner faces of these two pieces are beveled the reverse of the ends of the main part, so that when the main part is forced out, by the springs, against the periphery of the cylinder the bevels on the ends thereof will carry the end pieces also against the periphery of the cylinder and at the same time force them laterally against the heads of the cylinder, thus insuring steam tight joints on all three of the sides. Instead of the springs, elastic packing of any kind may be substituted to force out the metallic packing of the pistons.

The steam is prevented from passing between the rims of the piston wheel and the heads of the cylinder by means of metallic packing rings (c^1 c^1) fitted to annular grooves in the cylinder heads, the said rings being forced in contact with the rim of the wheel at all times by elastic packing or any other known mode of forcing out metallic packing,—in short other packing may be substituted for the rings.

The cylinder is provided with three steam stops or abutments (I, I, I,) that slide radially in slots made for that purpose in the cylinder, and at equal distances apart. The heads of the cylinder are grooved out as at (A^1, A^1,) to receive the ends of the stops or abutments which slide therein with joints packed in the usual way, and outside of the cylinder the stops are each surrounded by a stuffing box (K,) to prevent the escape of steam. For the purpose of operating these stops they are each attached to a cross head (J,) connected at the ends with rods (L L) (that slide in guides (W, W,) attached to the frame) and provided at the lower end with rollers (d, d,) that run in cam grooves (N,) made in two wheels (N^1) attached to and carried by the main shaft (C,), and the form of these cam grooves must so correspond with the form of the periphery of the piston wheel that as it (the piston wheel) rotates the lower edge of the sliding stops or abutments shall follow and be always in contact with the periphery of the piston wheel to insure steam tight joints. For the

neers and therefore it is simply necessary to mention them.

What I claim as my invention, and desire to secure by Letters Patent, is—

Sliding the steam stops or abutments in and out by a cam or cams outside corresponding in form with the periphery of the piston wheel, that the said stops or abutments may follow the undulations of the periphery of the piston wheel and remain in contact therewith during the entire rotation, substantially as described, thus avoiding the loss of steam and the loss of the action of the steam which takes place when the cam is not thus formed, in this class of rotary engines, or the injurious effects on the piston and the stops or abutments when forced out by the periphery of the piston wheel.

HENRY G. THOMPSON.

Witnesses:
C. W. M. KELLER,
A. P. BROWNE.