No. 705,644. Patented July 29, 1902.

J. E. CARY.

ROTARY ENGINE.

(Application filed Dec. 20, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 2.

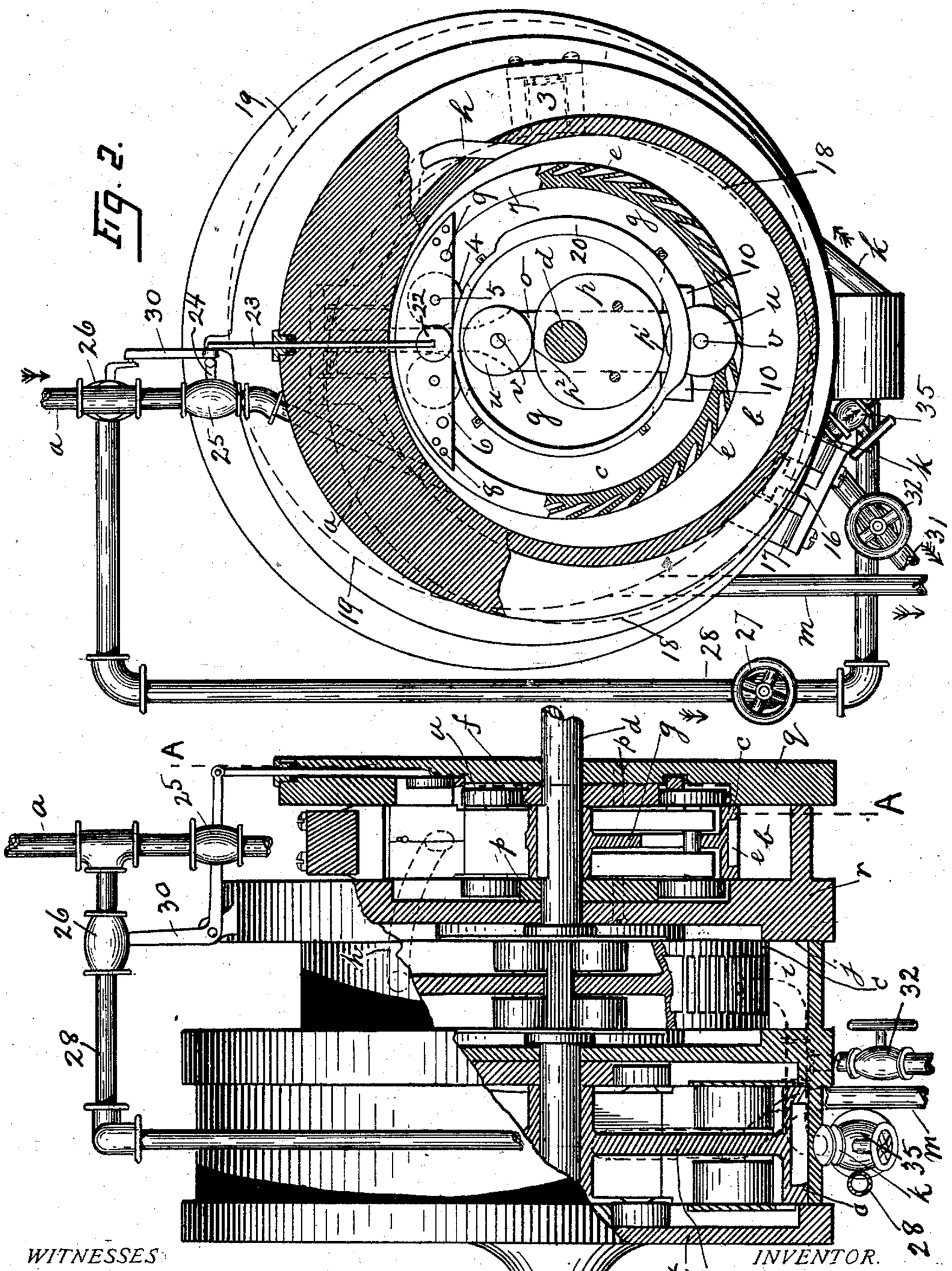

Fig. 1.

WITNESSES

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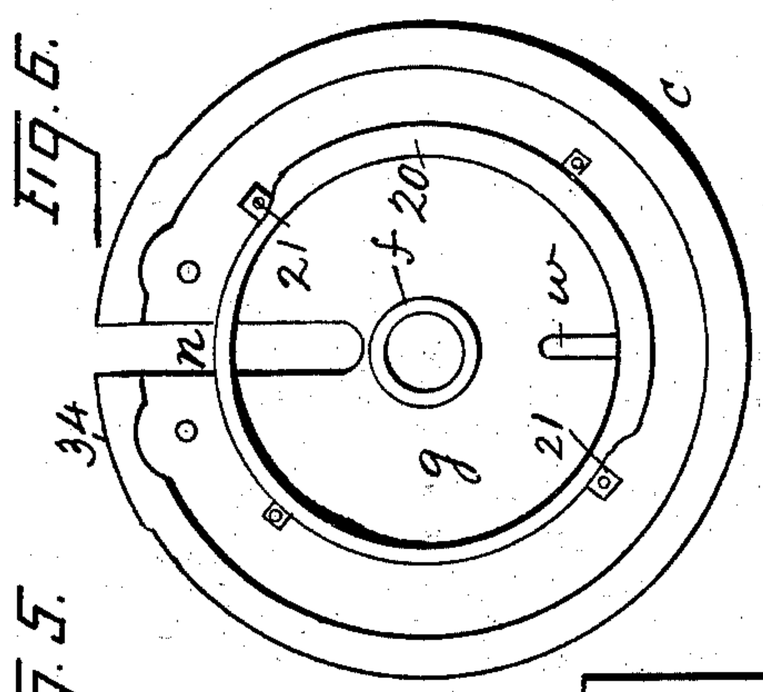

Fig. 5.

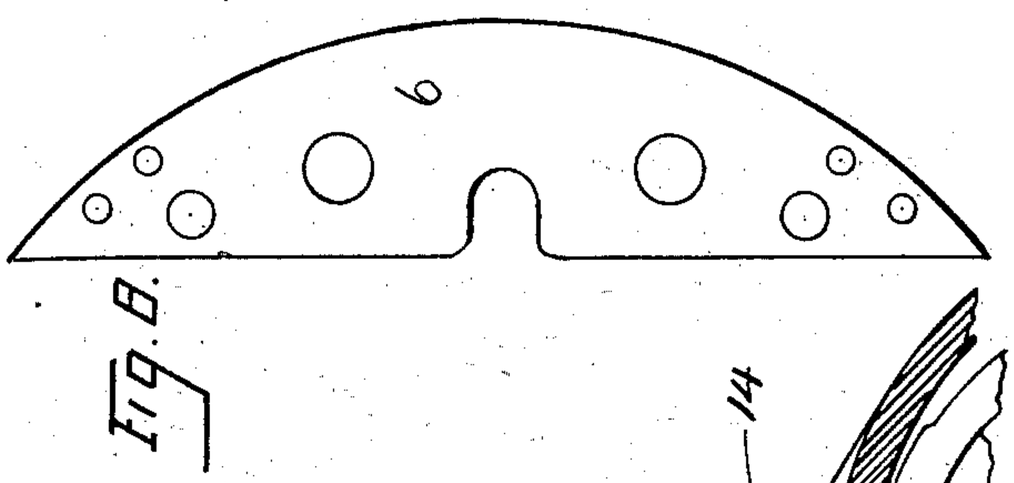

Fig. 8.

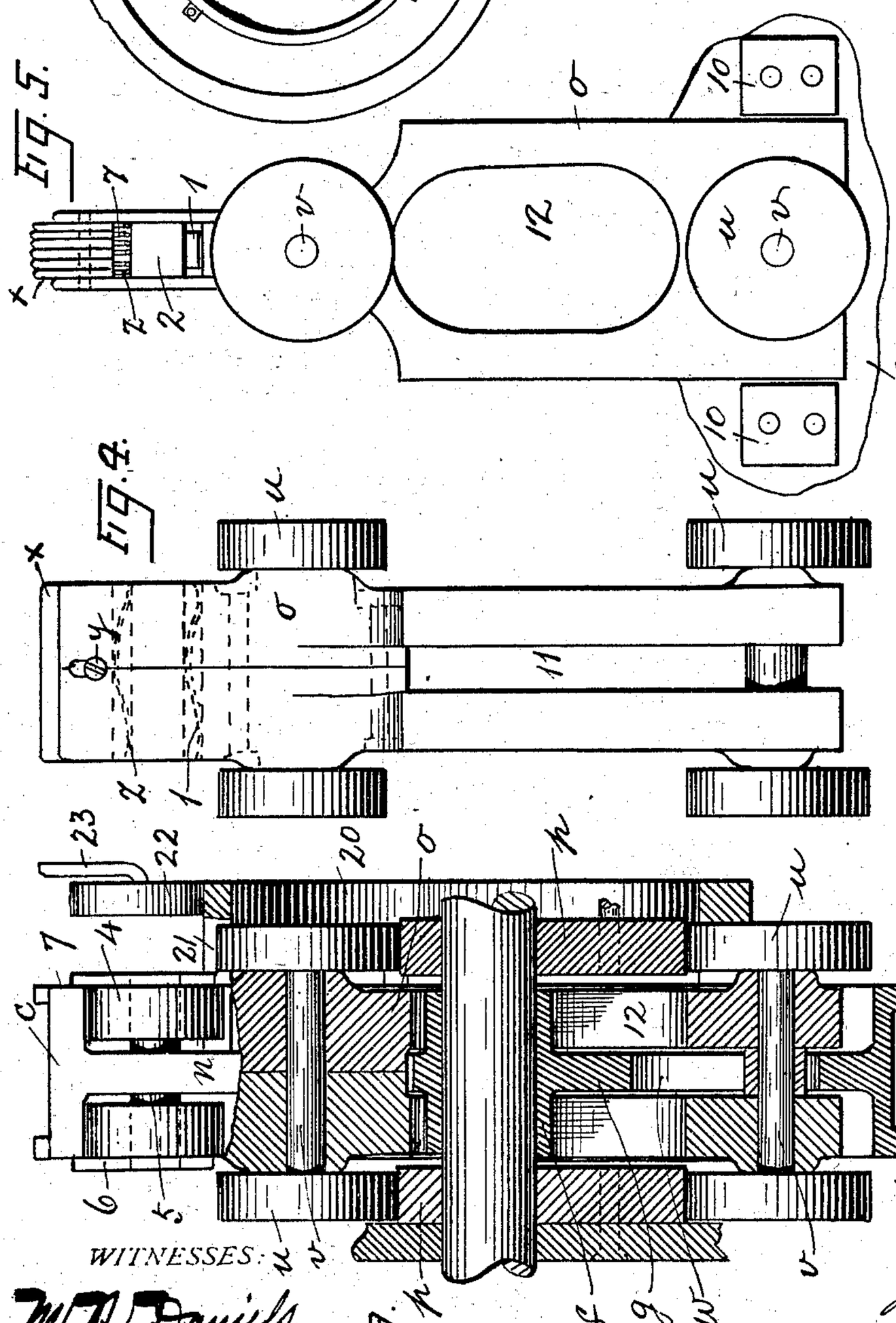

Fig. 4.

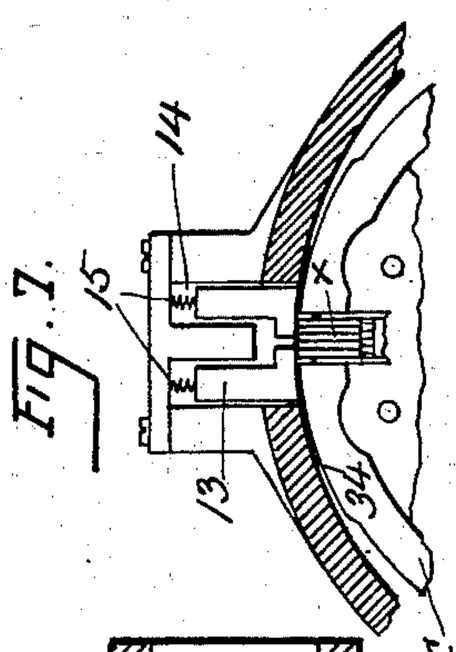

Fig. 7.

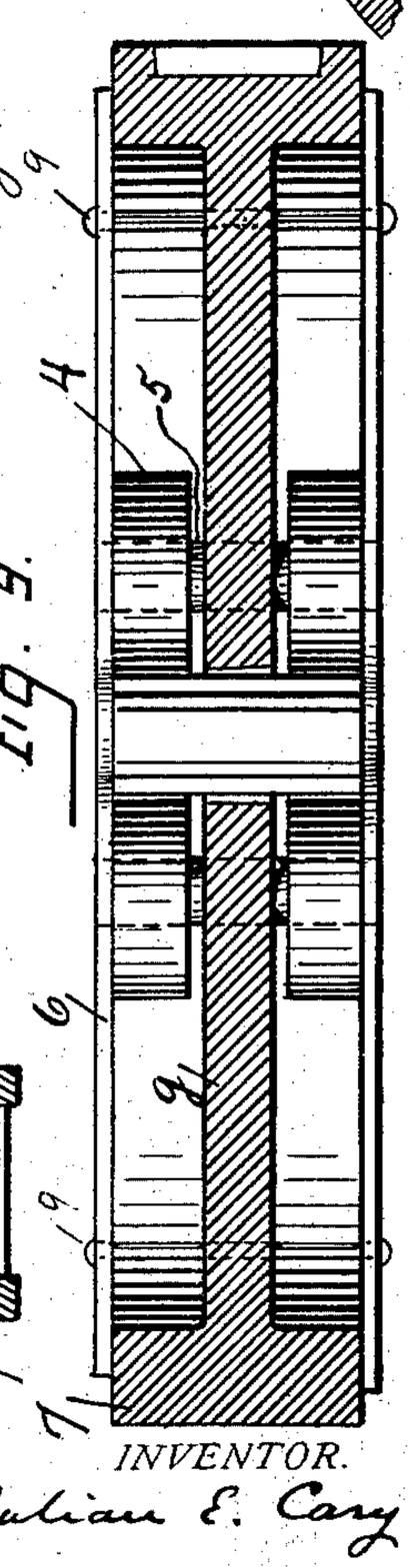

Fig. 9.

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JULIAN E. CARY, OF SAN FRANCISCO, CALIFORNIA.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 705,644, dated July 29, 1902.

Application filed December 20, 1900. Serial No. 40,583. (No model)

To all whom it may concern:

Be it known that I, JULIAN E. CARY, a citizen of the United States, residing at San Francisco, in the county of San Francisco and State of California, have invented certain new and useful Improvements in Triple-Expansion Rotary Engines, of which the following is a specification.

My invention relates to improvements in rotary engines, the object of my invention being to provide a rotary engine in which the steam may be successively expanded in a series of eccentric annular cylinders all arranged eccentrically about a common shaft, so that the several parts when assembled shall present a compact and harmonious contour in the general outline; furthermore, in such an engine to reduce the friction of the parts as much as possible; to utilize the force of the steam in the highest degree, both of its momentum and of its expansion; to provide an improved closure between the inlet and the outlet against the short-circuiting of the steam; to provide an improved form of piston-head in such an engine; to avoid back pressure of steam; to so arrange the respective pistons and cylinders that the steam shall have an uninterrupted flow through the series of cylinders and steam connections; to so arrange the pistons that the shaft shall receive impulses therefrom at substantially uniform intervals, and to so arrange the steam connections that one of the cylinders may be disconnected and the other cylinders operated in series when desired.

My invention therefore resides in the novel construction, combination, and arrangement of parts for the above end, hereinafter fully specified, and particularly pointed out in the claims.

In the accompanying drawings, Figure 1 is a side elevation of the engine, broken away in parts to show the interior. Fig. 2 is a section on the line A A of Fig. 1. Fig. 3 is an enlarged section diametrally through the rotating wheel and through the center of the piston. Fig. 4 is a front view of the piston detached. Fig. 5 is a side view of the same. Fig. 6 is a reduced side view of the wheel. Fig. 7 is a detail to show the gate. Fig. 8 is a side view of a strap, and Fig. 9 is a section of the wheel just below the straps and looking outward.

Referring to the drawings, *a* represents the feed-pipe for the high-pressure steam or other pressure fluid, said pipe *a* entering the cylindrical chamber *b* at the periphery of the latter and obliquely thereto, as shown in Fig. 2. The pressure fluid thus impinges obliquely upon the rim of a wheel *c*, fixedly mounted on a shaft *d*. Said rim is provided with oblique pockets *e* to receive the impact of the steam or other motive fluid and is connected with the hub *f* of the wheel by a thin web *g*. Thus the wheel is driven partly by the impact of the high-pressure steam. The partly-expanded steam escapes by means of a conduit *h*, leading to the steam-chamber *i* of a second cylinder *j*, where it is permitted to expand further, and from thence it passes by a conduit *k* to the chamber of a third cylinder *l*, from which it exhausts by means of an outlet *m*. The construction of the parts in each of these three cylinders is substantially the same, with the exceptions hereinafter pointed out, and therefore the description of the first will suffice for the other two.

The wheel *c* has a radial cut therein, as shown at *n*, extending from the circumference to a point near the hub to receive a piston *o*, which rotates with said wheel and also reciprocates longitudinally as it rotates in the cylinder. In order to control this longitudinal reciprocation, there are provided two cams *p*, fixedly secured the one to the outer cover *q* of the first cylinder and the other to the casing *r*, which forms the casing of the first cylinder and the cover of the second cylinder. In like manner the corresponding cams of the second cylinder are secured the one to the other side of said cover *r* and the other to the casing *s*, which forms the casings for both the second and the third cylinders, and the corresponding cams of the third cylinder are secured the one to the other side of the casings and the other to the cover *t* of said third cylinder. All of these cams necessarily have circular apertures to permit the shaft *d* to pass therethrough. The piston *o* is operated by said cams *p* through the medium of rollers *u* on shafts *v*, carried by the piston, said rollers riding on said cams, and the wheel *c* is slotted, as at *w*, to permit the rear shaft *v* to pass therethrough and reciprocate longitudinally with the piston *o*.

The piston-head *x* is formed of thin plates

of metal secured in a recess in the end of the piston by means of a bolt *y* through slotted holes to permit of longitudinal movement, each of said plates being forced outward by independent springs *z*. By this construction the outer face of the piston-head is permitted to assume a curved form corresponding to the concave curvature of the cylindrical chamber *b*. Moreover, the end of each plate which comes in contact with the eccentric surface of the cam is rounded to avoid friction. Said piston-head *x* as a whole is forced outward by means of a spring 1, acting against a block 2, between which block and the plates are the springs *z*.

The piston transmits the thrust of the steam to the wheel *c* by means of rollers 4 on shafts 5, secured in straps 6. Said straps are secured to the sides of the rim 7 of the wheel by means of studs 8 and are also secured to each other and to the web of the wheel by means of bolts 9. Said rollers roll against the end of the piston. At the other end the piston slides between guides 10, bolted on opposite sides of the web *g*. It may, however, move between rollers in the manner already described for the end carrying the piston-head. The piston *o* is forked, as shown at 11, to pass on both sides of the web, and each part of the fork is slotted, as shown at 12, to pass over the shaft *d* and the hub *t* of the wheel.

Between the inlet *a* and the outlet *h* there is provided a closure for the annular chamber *b*. This closure in the first cylinder comprises two independent gates 13, sliding in ways 14 and pressed down upon the wheel *c* by means of independent springs 15. In the second cylinder a single gate 3 is used, having a bearing-surface sufficiently wide to completely cover each one of the pockets *e*. In the gate 16 for the third cylinder the bridge is adjusted by means of removable plates 17.

The three cylinders are located about the shaft eccentrically, so that the pistons will reach the point of greatest exposure—that is to say, the point where the cross-sections of the respective cylinders are the largest in area—in such an order of succession that their movements may establish a counterbalance and at the same time give a series of impulses to the shaft at substantially uniform intervals.

Since in each cylinder the gate is placed at the narrowest portion of the annular steam-chamber, the point of maximum steam-pressure in each cylinder will be diametrally opposite to the gate of said cylinder. This is also indicated in Fig. 2, where the dotted line 18 represents the eccentric of the second cylinder and the dotted line 19 represents the eccentric of the third cylinder. It will be seen that the third gate follows the second gate at about the same angle that the second follows the first, and therefore also the points of maximum pressure follow at the same intervals. Also the pistons are arranged in such a manner with reference to each other that each piston has a slight lead in its own cylinder ahead of the relative position of the piston in the preceding cylinder, so that before the exhaust is reached in the preceding cylinder the inlet has been passed in the next succeeding cylinder, thereby providing an open steamway, as a common pipe connection, between the several cylinders. By this form of construction I am able to secure a continuous flow of the steam or other motive fluid from the original inlet to the final outlet. By this arrangement of cylinders and pistons I gain an advantage in overcoming the friction incident upon having the impulses only on one side of the shaft, and a counterpoise is established by having these points of highest pressure of the different cylinders upon the shaft distributed at different points around it, thereby gaining a greater efficiency with a given amount of steam.

An important feature of my invention resides in the means for avoiding the objectionable back pressure of the steam confined between the exhaust and the gate when the piston has passed the exhaust. This is accomplished by placing a small raised surface *p'* on the periphery of the cams *p* at the point where they act on the rollers *u* to operate the pistons *o*, so as to withdraw the ends of said pistons out of contact with the eccentric surface of the cylinder between the exhaust and the gate and by correspondingly flattening, as at p^2, the surface of the cam at a point nearest to the gate.

In addition I may provide means for depressing the gate against its springs while the piston is passing the gate. This means is shown in Figs. 6 and 7 and comprises a raised cam-surface 34 upon the wheel *c* before and after the cut *n* therein.

20 is a cam-ring secured on the wheel *c* by legs 21 and operating a roller 22, attached to a rod 23, actuating a bell-crank lever 24 to control a valve 25 in the feed-pipe *a* to admit or shut off steam at the proper points in the revolution of the wheel.

I sometimes desire to drive the third cylinder or low-pressure cylinder direct and independently of the other cylinders. For this purpose I provide a pipe 28, leading from the pipe *a* to the third cylinder and normally closed by a cock 27. A valve 26 in said pipe is operated simultaneously with the valve 25 in the pipe *a* by means of a bell-crank lever 30. In this case a separate exhaust is required for the second cylinder. This exhaust-pipe is shown at 31 and is provided with a valve 32, which is closed normally when the three cylinders are operated in series. The conduit *k* is also provided with a cut-off 35 to close said conduit when the third cylinder is operated independently of the other two.

I claim—

1. In a rotary engine, the combination of an expansion-chamber, a revolving body, a shaft and rotating piston, said piston com-

prising a head and extension-arm, said head containing thin laminations and a flexible material supporting said laminations and enabling them to act independently, a roller for actuating said extension-arm longitudinally and an eccentric cam for controlling said roller, substantially as described.

2. In a rotary engine, an expansion-chamber, a revolving body, a shaft supporting said body, a rotary piston, which comprises a head and a lever-arm, said head being provided with thin laminations and an individual yielding mechanical support therefor, said lever-arm being elongated sufficiently to be used in transmitting propelling power at points on opposite sides of the shaft, substantially as described.

3. In a rotary engine, the combination of an expansion-chamber, a shaft, a revolving body, a piston which comprises a head and extension-arm, said head being provided with laminations having individual independent supports, said extension-arm passing beyond the axis of motion, a roller-bearing near the piston-head through which propelling power is transmitted to the revolving body, and a bearing on the opposite side of the center of motion through which a reciprocal propelling power is transmitted from the extension-arm of the piston, substantially as described.

4. In a rotary engine, the combination of an annular cylinder having an eccentric wall, a piston, rollers carried thereby at a fixed distance from each other, and a cam between said rollers for reciprocating said piston through the medium of said rollers, said cam being suitably shaped to permit both of said rollers to remain in contact with said cam throughout the entire revolution of the piston, thus providing a positive control of the piston in both directions by the cam, substantially as described.

5. In a rotary engine, the combination of an annular cylinder having an eccentric wall, a rotating piston, rollers carried thereby substantially at a fixed distance from each other, and a cam between said rollers for reciprocating said piston through the medium of said rollers, said cam being suitably shaped to permit both of said rollers to remain in contact with said cam substantially on opposite sides of the cam in the revolution of the piston, thus providing a positive control of the piston in both directions by the cam, substantially as described.

6. In a rotary engine, the combination of a cylinder having an inlet and an outlet, a rotating shaft extending longitudinally through the cylinder, a wheel secured to, and rotating with said shaft, having a wide rim and a thin web, said wheel having a radial cut therein, straps secured to the sides of the rim, rollers axially mounted in said straps on both sides of said web and adjacent to said cut, a piston reciprocating in said cut and bearing against said rollers, and a cam for reciprocating said piston, substantially as described.

7. In a rotary engine, an annular expansion-chamber, with an inlet and an outlet, a shaft, a rotary piston, a revolving wheel or drum whose periphery forms a wall of said chamber, said wall being provided with pockets and being suitably removed from the inlet that the jet of steam may have an uninterrupted flow thereby and also give a free discharge of steam from the pocket at the beginning of the impact in said pocket for the purpose of giving clearance, substantially as described.

8. In a rotary engine, a cylinder, an expansion-chamber with inlet and outlet contained therein, a piston, a revolving body whose periphery forms a wall of the expansion-chamber, impact-pockets, said revolving body being suitably disposed in said cylinder so that when in rotation the jet of the motive fluid from the inlet shall have a free admission into said expansion-chamber independently of the position or operation of the pockets, as shown and described.

9. An engine with an annular expansion-chamber, a revolving body, a piston supported by said body, a shaft on which said body is mounted, an inlet and an outlet in combination with a series of impact-pockets arranged along the periphery of the revolving body in said chamber, said pockets having their front and rear walls alined with the inflowing jet of steam for the purpose of obtaining the full force of the impact in the direction of rotation, as shown and described.

10. In a rotary engine, an expansion-chamber having an inlet and an outlet, a rotating piston, a shaft, a revolving body mounted upon said shaft, whose periphery forms the convex wall of said expansion-chamber, said convex wall being provided with a series of impact-pockets conformed with their front and rear walls at an angle corresponding in pitch with that of the inflowing jet of motive fluid, as shown and specified.

11. In a rotary engine, an annular expansion-chamber having an inlet and an outlet, a rotating wheel whose periphery forms a wall of said chamber, a shaft supporting said wheel, a piston carried thereby, a resiliently-yielding gate, and means operating at each revolution of the shaft for depressing the gate while the piston passes from any desired point between the outlet and gate to any desired point at or near the inlet, to open a steamway and permit the escape of the residual steam in a forward direction thereby avoiding back pressure due to the compression of residual steam, substantially as described.

12. In a rotary engine, a cylinder having an inlet and an outlet, a wheel rotating in the cylinder eccentric with respect thereto and having a point of closure therewith, a shaft supporting said wheel, a piston carried thereby, and means operating at each revolution of the shaft for separating, from contact with each other, the concave wall of the cylinder and the corresponding face of the piston-head

while the piston passes a portion of the cylinder adjacent to the closure whereby free circulation of the steam at that part is permitted and back pressure due to compression or vacuum is avoided, substantially as described.

13. In a rotary engine an annular expansion-chamber having an inlet and an outlet, a revolving wall which constitutes a wall of the said chamber, a piston moving with said wall, a shaft supporting said wall in combination with a resiliently-yielding gate, and means operating at each revolution of the shaft for depressing said gate for the purpose of obtaining an unobstructed passage of the steam and piston, substantially as described.

14. In a rotary engine the combination of an annular expansion-chamber having an inlet and an outlet, a rotating piston, a revolving body moved by said piston, a shaft supporting said revolving body with a gate applied so as to close the recess between the outlet and inlet and means for holding said gate open while the piston passes from the gate or a point near thereto, to the inlet or a point near thereto for the purpose of overcoming vacuum, substantially as described.

15. In a rotary engine an expansion-chamber having an inlet and an outlet, a point of closure between said inlet and outlet, a rotating piston, a revolving body supporting said piston, a shaft on which said revolving body is mounted, the walls of said expansion-chamber being suitably conformed and the piston suitably operated so that an escape for the back pressure of the motive fluid shall be provided as the piston passes from the outlet toward the point of closure, substantially as described.

16. In a rotary engine the combination of an expansion-chamber having an inlet and an outlet, a means for establishing a closure in said expansion-chamber between said inlet and outlet, a rotating piston, a revolving body supporting said piston, a shaft supporting said revolving body, and means provided whereby the motive fluid or air may freely pass between the piston-head and the walls of the expansion-chamber as said piston passes from the point of closure toward the inlet, for the purpose of overcoming vacuum, substantially as described.

17. A rotary engine having two or more annular cylinders having a common shaft and separated only by party-walls thus forming one compact body, said cylinders being connected to be operated in series as a compound engine, being provided with means for dividing the series to form two primary or high-pressure cylinders, an independent cut-off valve for each primary cylinder, and valve-actuating mechanism suitably arranged for controlling said valves in unison and operative when the series of engines is divided, substantially as described.

18. In a rotary engine two or more circular expansion-cylinders with suitable inlets and outlets, the necessary rotating pistons, a shaft arranged in common for the rotating pistons, means for rotating said pistons with said shaft, two of said cylinders being contained between their vertical walls to form a compact body, said cylinders being connected so as to be operated in series as a compound engine and means for disconnecting said series when desired, a primary live-steam way connecting with the high-pressure chamber of the said series and a second live-steam way connected to a second of the chambers of the series, and a cam device, arranged, when the said series are disconnected, to control the passage of the motive fluid through each of the said steamways simultaneously, substantially as described.

19. In a rotary engine, the combination of an annular expansion-chamber, a rotating piston supported by a shaft and rotating in said chamber, the head of said piston carrying thin laminations and individual metallic springs for pressing said laminations outwardly against the concave wall of the chamber, substantially as described.

20. In a rotary engine, comprising an annular cylinder having an inlet and an outlet, a shaft and a piston rotating on said shaft, the head of the piston comprising a block, a spring for pressing outwardly said block, thin plates of metal and individual springs interposed between said blocks and plates, substantially as described.

21. A rotary engine comprising two cylinders contained between three vertical walls, each cylinder being provided with concave and convex annular walls, and all constituting one compact body, with a horizontal shaft common to the cylinders, said cylinders being provided with the necessary pistons and being connected in series so as to be operated as a compound engine, and means for disconnecting when desired, having also an auxiliary live-steam way to a low-pressure cylinder and a cam on the common shaft for controlling the passage of steam in the latter steamway and in the steamway to the original high-pressure cylinder in unison, substantially as described.

In witness whereof I have hereunto set my hand in the presence of two subscribing witnesses.

JULIAN E. CARY.

Witnesses:
O. C. PRATT,
FRANCIS M. WRIGHT.