(No Model.) 4 Sheets—Sheet 1.

# S. G. BROSIUS.

## ROTARY ENGINE.

No. 453,613. Patented June 9, 1891.

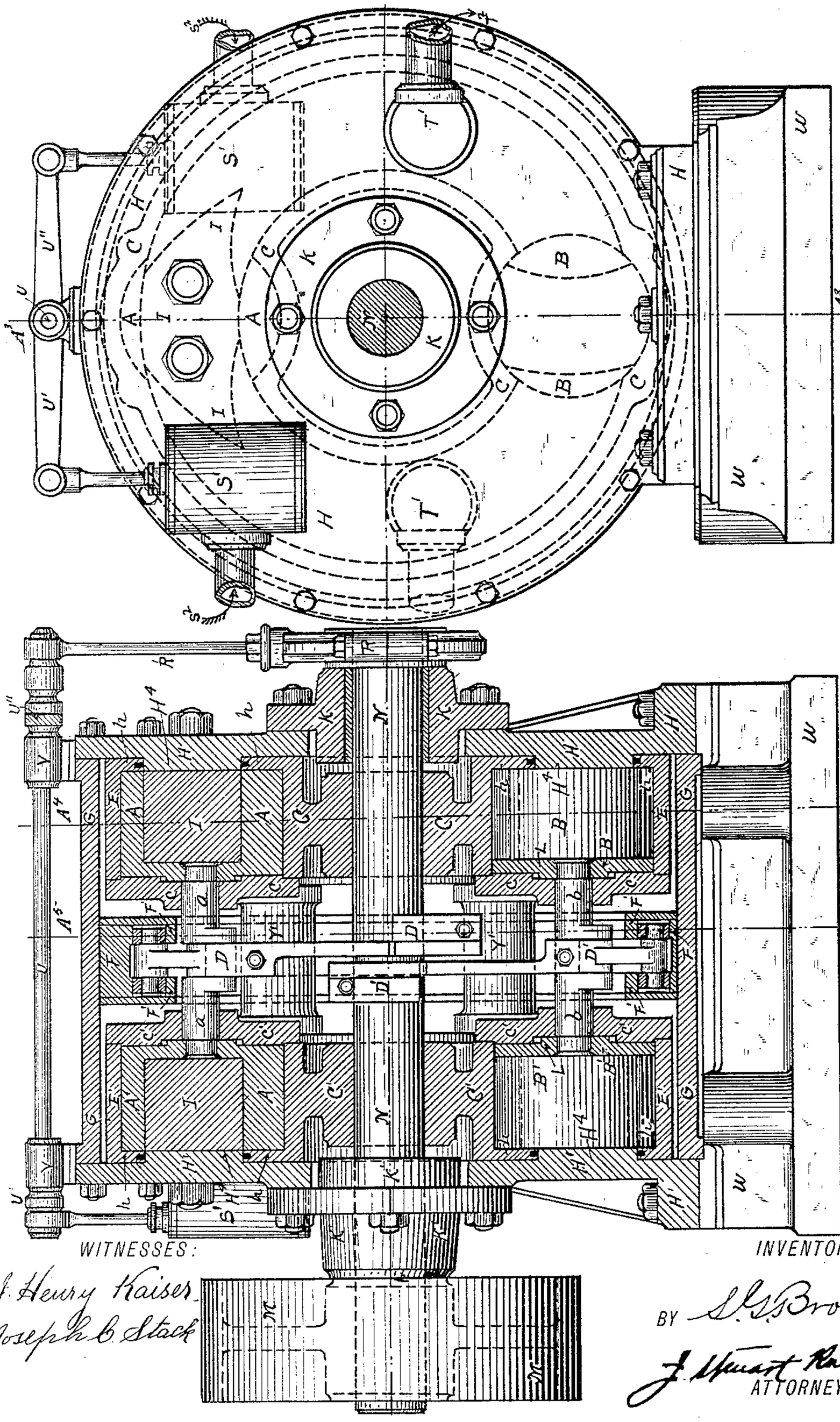

Fig. 1.

Fig. 2.

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(No Model.) 4 Sheets—Sheet 2.

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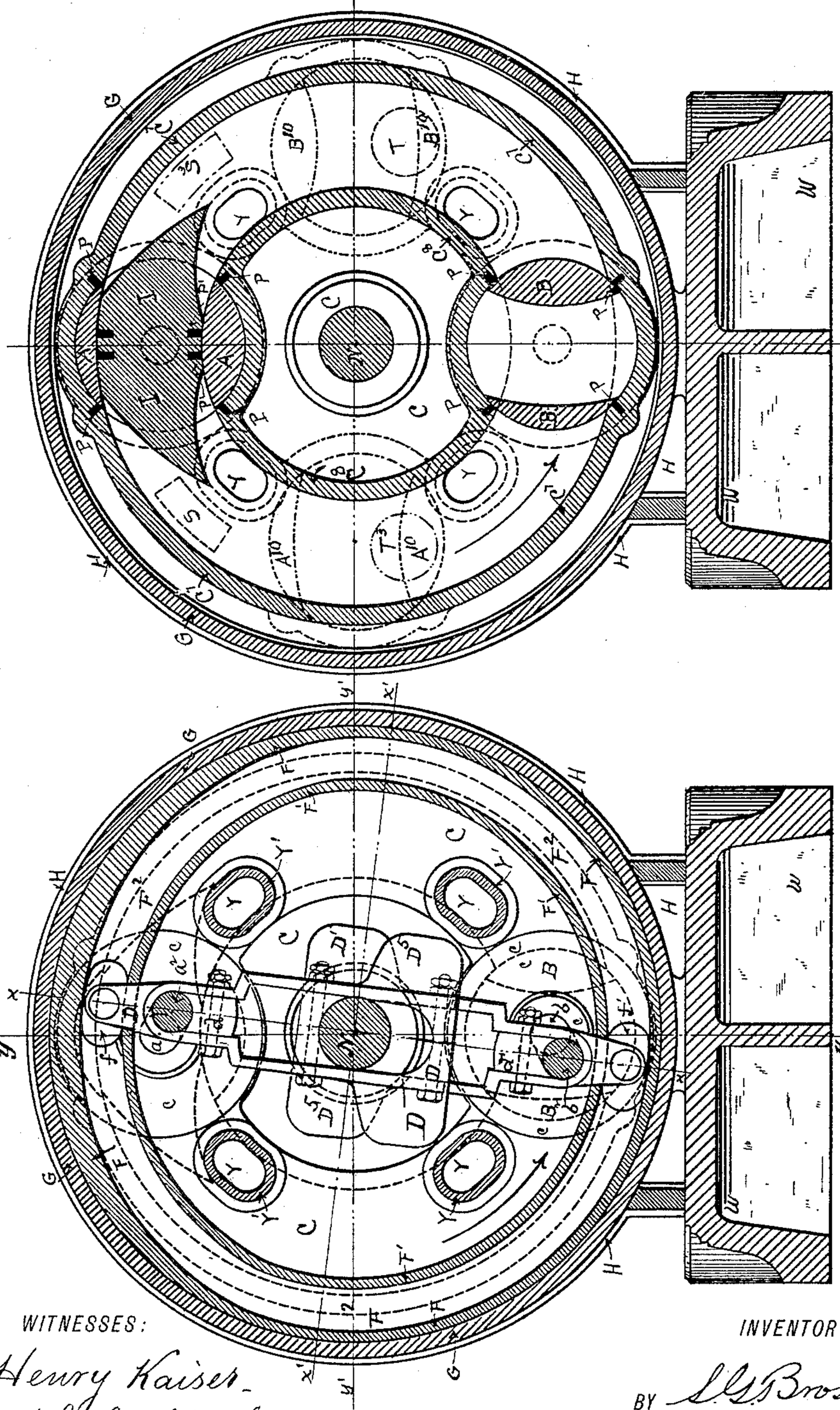

Fig. 3.



Fig. 4.

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(No Model.) 4 Sheets—Sheet 3.

# S. G. BROSIUS.

## ROTARY ENGINE.

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Fig. 5

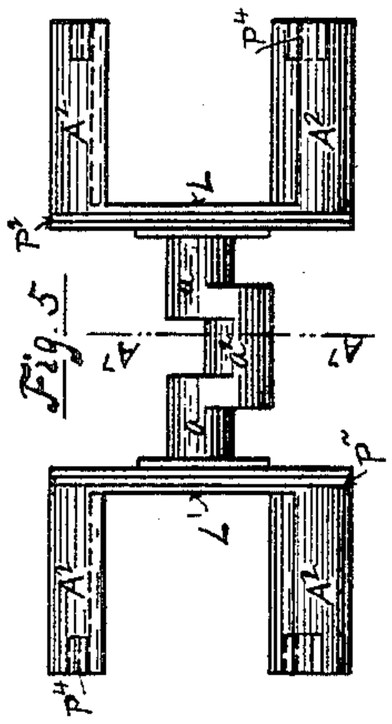

Fig. 14.

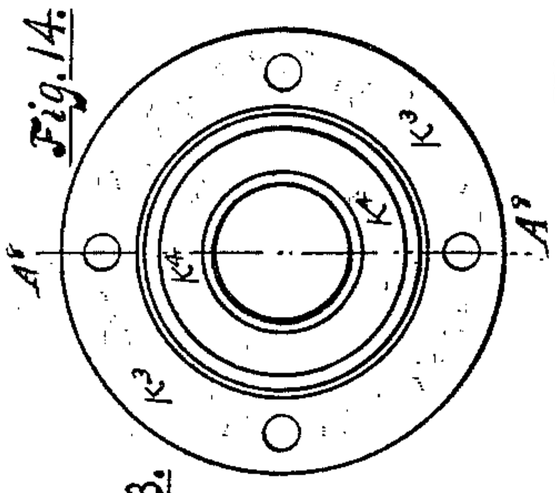

Fig. 15.

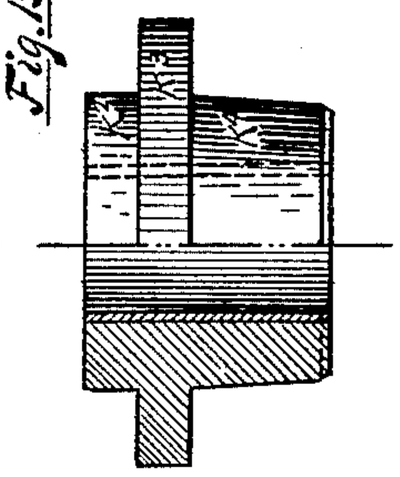

Fig. 8.

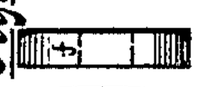

Fig. 9.

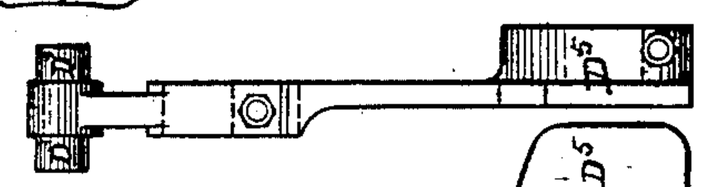

Fig. 11.

Fig. 10.

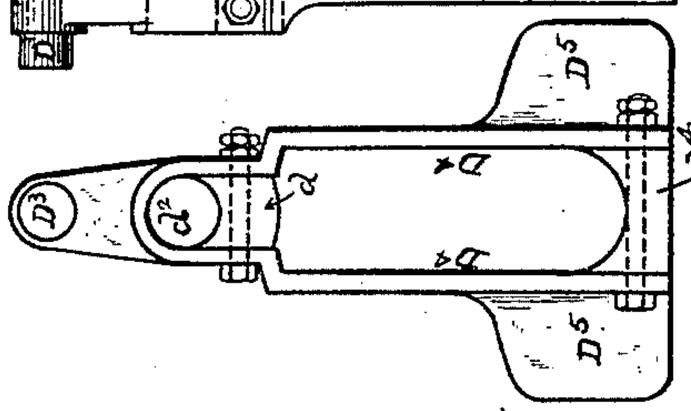

Fig. 6.

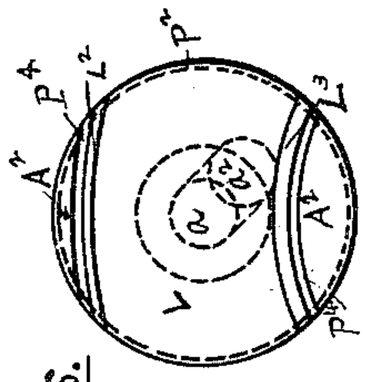

Fig. 7.

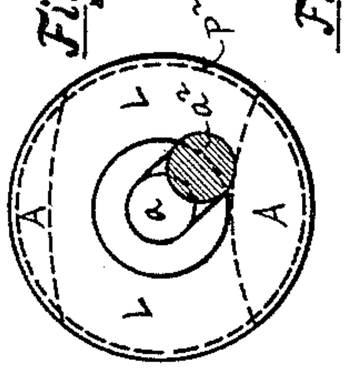

Fig. 13.

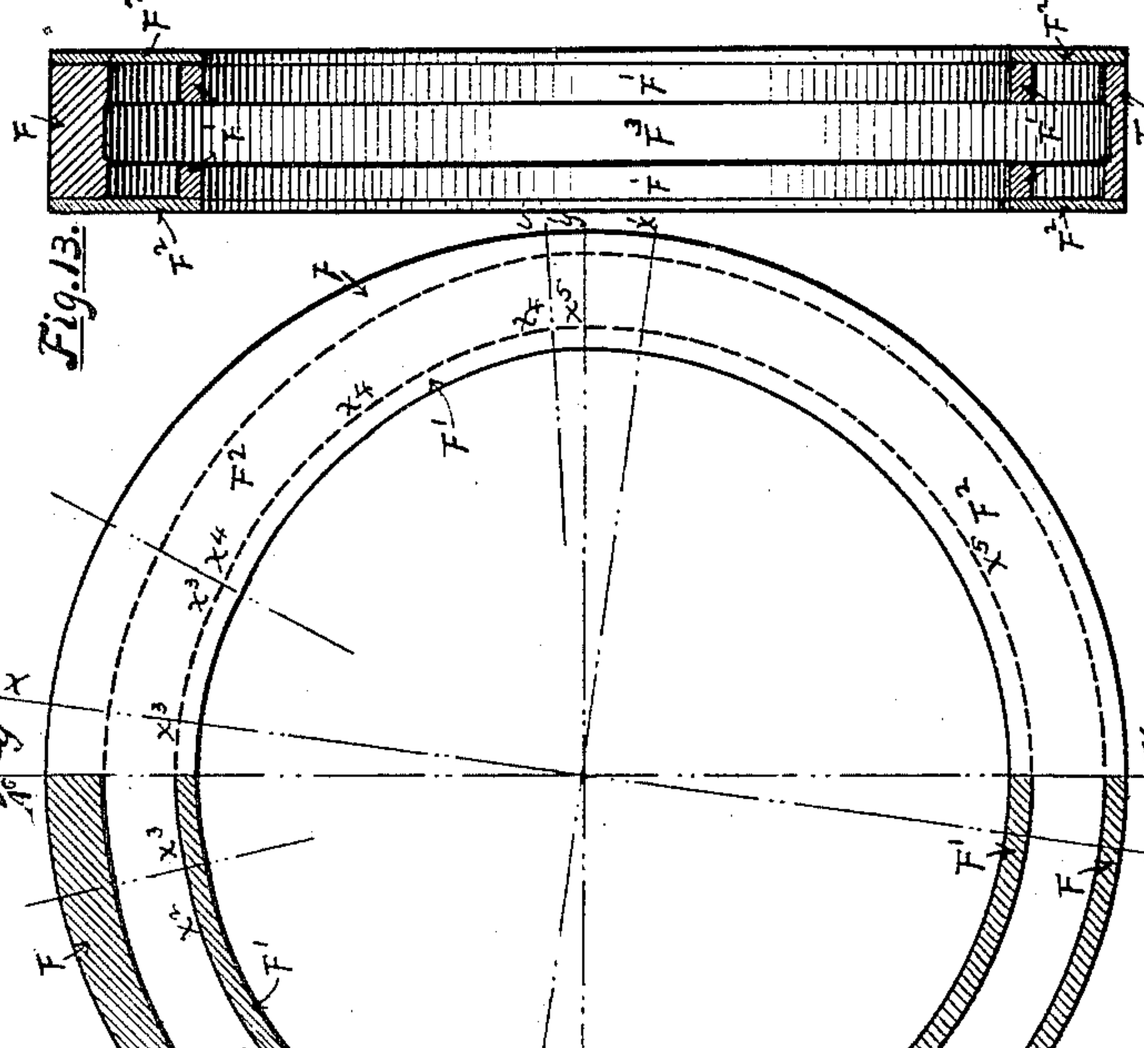

Fig. 12.



Fig. 16.

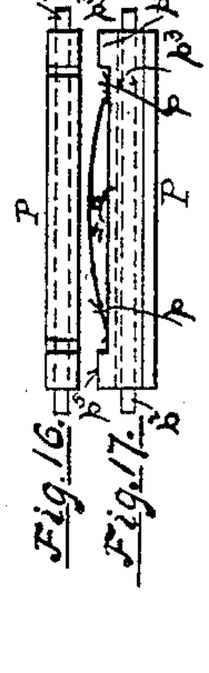

Fig. 17.



Fig. 18.

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(No Model.) 4 Sheets—Sheet 4.

# S. G. BROSIUS.

## ROTARY ENGINE.

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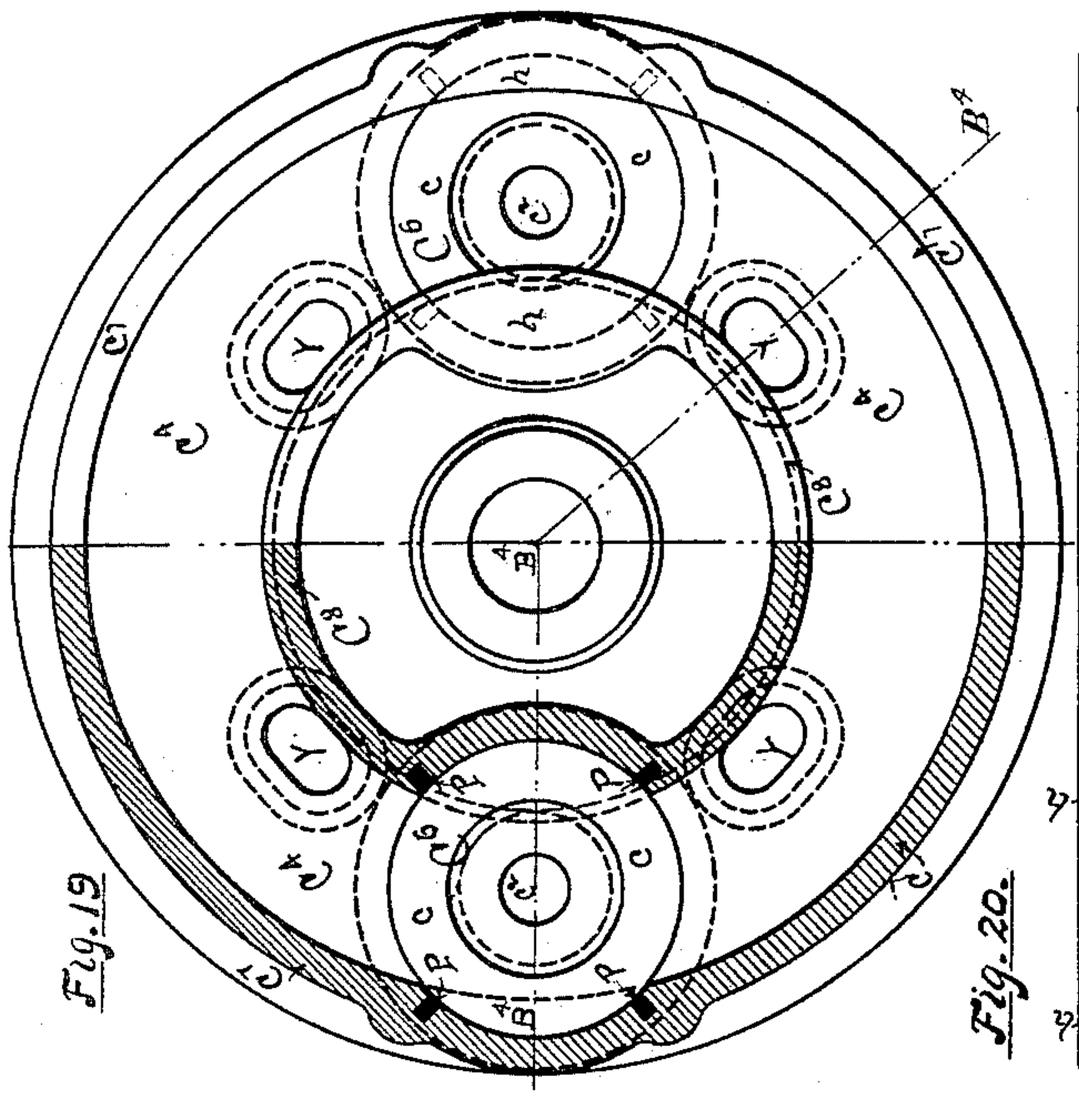

Fig. 19

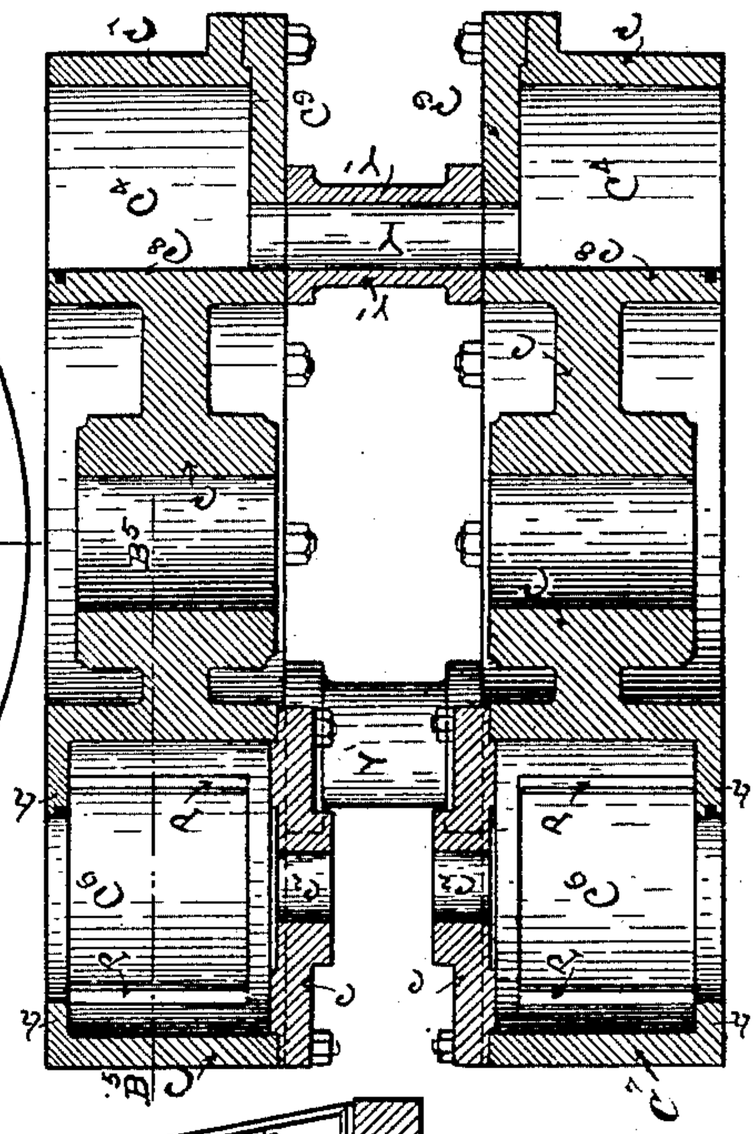

Fig. 20.

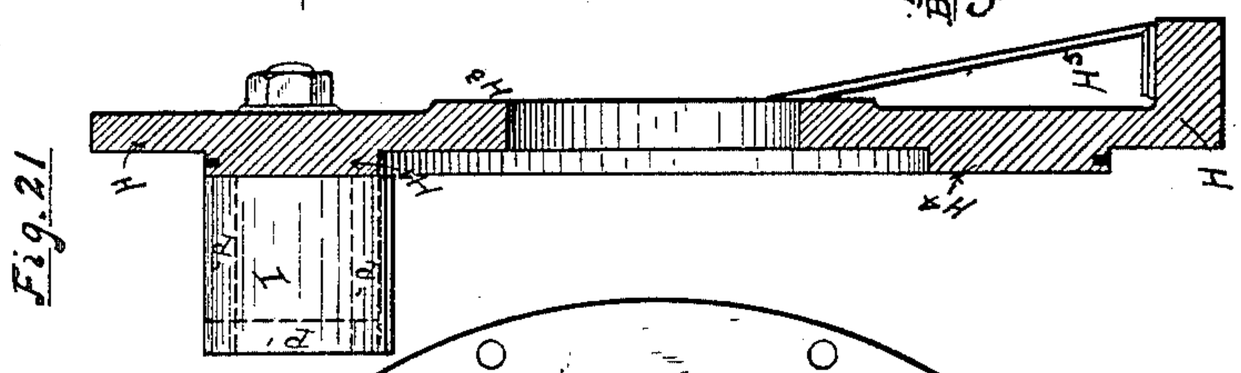

Fig. 21

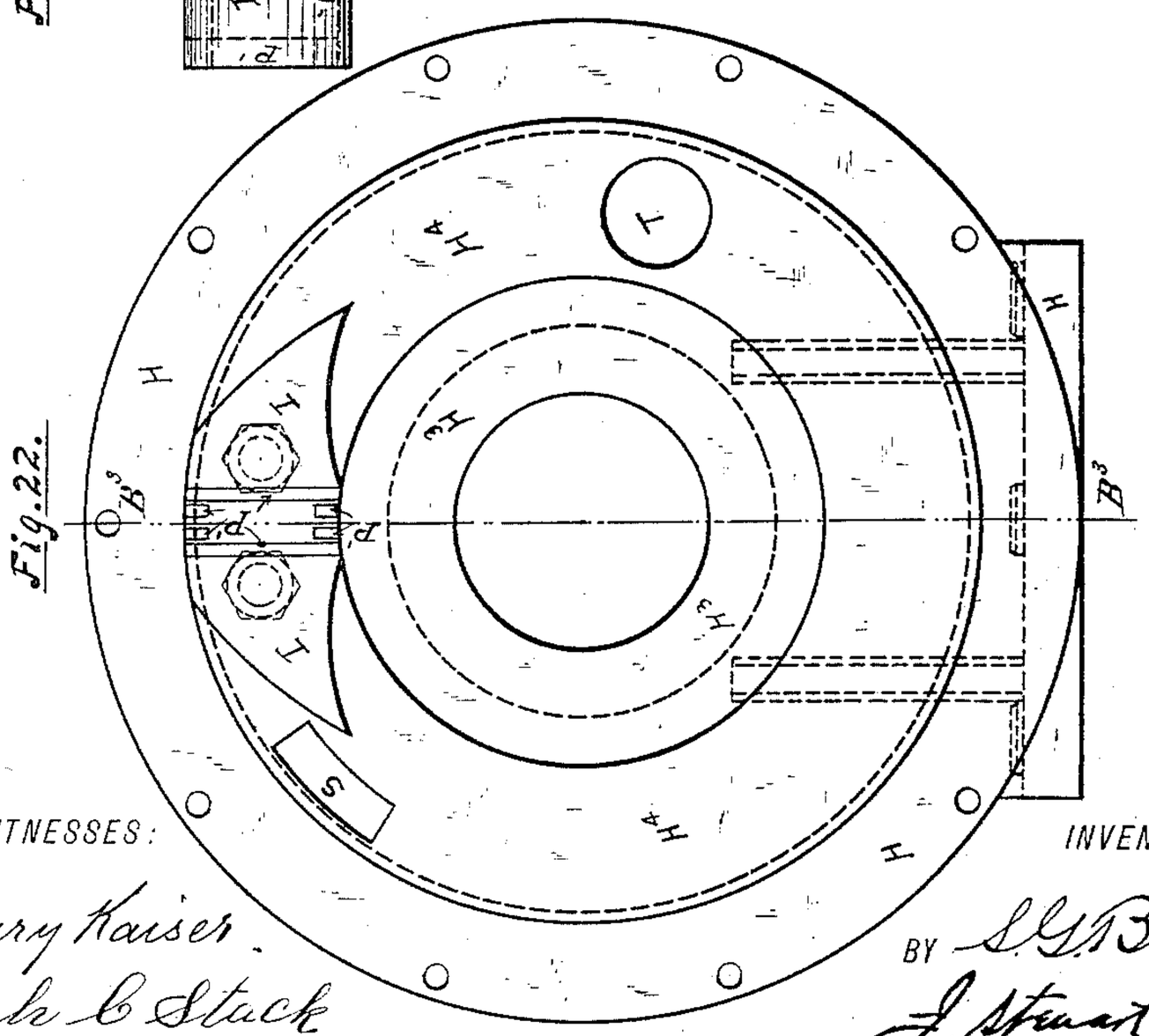

Fig. 22.

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# UNITED STATES PATENT OFFICE.

SAMUEL GLENVILLE BROSIUS, OF SAVANNAH, GEORGIA.

## ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 453,613, dated June 9, 1891.

Application filed March 28, 1891. Serial No. 386,872. (No model.)

*To all whom it may concern:*

Be it known that I, SAMUEL GLENVILLE BROSIUS, of Savannah, in the county of Chatham and State of Georgia, have invented a new and useful Improvement in Rotary Engines, of which the following, taken in connection with the accompanying drawings, is a specification.

The invention has the following objects: first, to produce a rotary engine of the least possible friction; second, to produce a rotary engine having a steam-tight packing; third, to construct an engine in such a manner that no part shall bind or cramp, and so that the pistons will be at rest with regard to the rotating cylinder when under pressure, and to admit steam, so as to avoid binding the cylinder or pistons in any position and to avoid all centrifugal and centripetal friction and any packing causing undue friction; fourth, to admit steam simultaneously to the cylinder or cylinders, so as to avoid all binding or cramping; fifth, to oscillate or rotate the pistons when the same are not under steam-pressure, thus avoiding friction which would be otherwise encountered; sixth, to construct the cam or cams which oscillate or rotate the pistons with the least possible throw, so as to avoid jar, and also to construct said cam or cams with periods of rest and periods of throw; (during the periods of throw the pistons are balanced and oscillate or rotate, traveling with the rotating cylinder, and during the periods of rest they propel and revolve the rotating cylinder;) seventh, to construct the engine in such a manner that the pistons after passing the abutments oscillate, thereby closing the cylinders and acting as piston-abutments, and being at rest with said cylinders during the period they are traveling and rotating with said cylinders around the axes of said cylinders to the point of the exhaust, where oscillations of said pistons again occur to pass said abutments, the said oscillations taking place during the time they are not under steam-pressure or after exhaust or when the steam is on both sides of the piston, so that the pistons will be balanced; (while it has been stated that the oscillations are not under pressure, yet they may be, if found advisable;) eighth, to journal the pistons so that the periods of oscillation and periods of rest may be controlled by a cam or some mechanical equivalent; ninth, to construct and connect the pistons so that they will be balanced against centrifugal force under oscillation; tenth, to construct the pistons with wings, which will balance each other against centrifugal force; eleventh, to propel the shaft by pressure on the piston, said power being communicated directly through the cylinder to the shaft, to which it is securely attached; twelfth, to obtain an abutment with curves so constructed to avoid the edges of the oscillating piston and reduce the waste-steam area to a minimum; thirteenth, to oscillate the pistons by levers operated by cams; fourteenth, to completely balance the end pressure on the pistons by placing two pistons on one shaft; fifteenth, to balance the levers which control the oscillations of the pistons against centrifugal force; sixteenth, to connect the cylinders so that steam admitted into one may readily pass through to the other; seventeenth, to connect the cylinders so that the steam admitted into one passes to the other by suitable passages, thus avoiding friction from end pressure; eighteenth, to obtain a simple and effective packing between the rotating cylinder and stationary disk; nineteenth, to obtain a perfectly-balanced engine in all its parts, which will not be jammed or cramped by steam-pressure, centrifugal or centripetal force, centrifugal packing, and do away with packing around the hub and all sliding friction, or any friction caused by any other than ordinary packing, and to obtain a practical and simple construction. These and other objects are accomplished by the engine hereinafter described.

My invention consists of certain broad and novel features of construction hereinafter described, and particularly pointed out in the claims.

In the accompanying drawings, which illustrate my invention, Figure 1 is an end elevation of the engine, showing the location of steam and exhaust chests. The cylinders, pistons, and abutments are shown in broken lines. Fig. 2 is a cross-section of the engine on line $A^3$ $A^3$ of Fig. 1. Fig. 3 is a cross-section of the engine on line $A^4$ $A^4$ of Fig. 2. Fig. 4 is a cross-section of the engine on the line $A^5$ $A^5$ of Fig. 2. Fig. 5 is an elevation

of the pistons. Fig. 6 is an end view of the pistons. Fig. 7 is an end view of the pistons, a cross-section being taken on line $A^7$ $A^7$ of Fig. 5. Figs. 8 and 9 are respectively end and side elevations of the cam-blocks. Figs. 10 and 11 are respectively end and side elevations of the lever. Fig. 12 is a side elevation, part in cross-section, of the cam. Fig. 13 is a cross-section of the cam on the line $A^6$ $A^6$ of Fig. 12. Fig. 14 is an end view of the journal-box. Fig. 15 is a side elevation, part in cross-section, on the line $A^8$ $A^8$ of Fig. 14. Figs. 16, 17, and 18 are respectively the plan, side, and end elevations of the packing-strips in the piston-seats. Fig. 19 is an end elevation, part in cross-section on the line $B^5$ $B^5$ of Fig. 20. Fig. 20 is a cross-section on the line $B^4$ $B^4$ of Fig. 19. Fig. 21 is a cross-section on the line $B^3$ $B^3$ of Fig. 22, showing the abutment in position on the head. Fig. 22 is an end elevation of the head, showing the location of the abutment and the steam and exhaust ports.

Like letters of reference refer to like parts throughout the several views of the drawings.

Within an outer casing G, to which are attached the heads H H′, secured to a base-plate W, there are arranged rotating cylinders C, with their pistons A A′ B B′. Said pistons by their crank-shafts are controlled by the cam or cams. Said cams may be attached to the outer casing G.

The cylinders C are attached to the shaft N and drive it, and are constructed so as to have annular cavities $C^4$, which are formed by rings $C^7$ $C^8$ and disk $C^9$, and piston-seats $C^6$, with their flanges *h*, which complete the circles of the rings $C^7$ $C^8$, allowing complete ring-packing to be used between the packing-plate $H^4$ of the casing-heads H H′ and said rings $C^7$ $C^8$, as shown in Figs. 2, 3, 19, and 20. The shaft N is mounted in journal-boxes K, which may be attached to casing-heads H and H′. The said piston-seats $C^6$ contain packing-strips P, which have projections $p^5$ in their backs, forming the recess *p* to receive and hold in position the springs $p^4$. The packing-strips also have the oblong hole $p^3$ lengthwise, through which the pins $p^2$ pass. Said pins extend through the holes and engage the cylinder in such a manner as to hold said packing in place when the wings $A^2$ are not in contact with them, as shown in Figs. 3 and 16 to 20, inclusive. Said packing-strips are also beveled on the contact side, so as to allow the edges of the piston-wings $A^2$ to push said packing-strips back in place should they protrude too far. The cylinders are connected by the steamways Y′, having the channel Y, which is the passage between the cavities $C^4$ in the cylinders C, through which the steam freely passes from one cylinder to the other, which thus equalizes the pressure in both cavities simultaneously and admits of the use of one steam-port and one exhaust-port for each cylinder. The pressure on the outer ring $C^7$ is neutralized by the pressure on the inner ring $C^8$, and the end pressure on the two disks $C^9$ counteract each other in like manner, as also does the pressure on the disks L of the pistons A A′ on the opposite end of the piston-shaft *a*, thereby perfectly balancing the cylinder and all parts under pressure during its revolutions.

The cylinders C are provided with the piston-seat heads *c*, which are placed centrally with the piston-seat $C^6$ and contain the journal-boxes $c^2$, in which the journals of the piston-shaft *a* oscillate. These heads may be integral with said cylinder; but it will facilitate construction and repairs to make them separate and securely attached thereto.

The pistons A and A′ are constructed with wings $A^2$ and disk L. One piston is attached to each end of the crank-shaft *a*, which has the crank $a^2$. The wings $A^2$ balance each other against centrifugal force and are cut to the curves $L^2$ $L^3$, respectively, which correspond to the curves of the outer and inner periphery of the rings $C^7$ $C^8$, respectively, of cylinder C, as shown in Figs. 3, 5, 6, and 7.

The pistons are provided with packing-rings $P^2$ in disks L and the packing-strips $P^4$ in the ends of the wings $A^2$. Said packing rings and strips respectively pack the disk L in the piston-seat $C^6$ and the ends of the wings $A^2$ against the packing-plate $H^4$ of the casing-heads H H′.

The pistons B B′ are identical in construction and operation to pistons A A′. Piston-shaft *b*, with its crank-shaft $b^2$, is also identical with piston-shaft *a* and its crank $a^2$.

The casing-heads H H′ are provided with abutments I, which protrude into the cavities $C^4$, and are packed against the rings $C^7$ $C^8$ and the disks $C^9$ of cylinders C and against the inner faces of wings $A^2$ of the pistons when passing said abutments I. Said wings complete the inner and outer periphery, respectively, of the rings $C^7$ $C^8$. The abutment I is so constructed as to reduce the waste-steam area to a minimum.

As shown in Figs. 2, 14, and 15, the journal-box K has its flange $K^3$ located so that the journal-box extends on each side of it to enable the engine to be shortened by such a distance as the journal-boxes extend within the casing-heads H H′. As a given length of journal is required for a given-sized shaft, it will be readily seen how this operates in making the engine more compact. The said heads H H′ are also provided with the packing-plates $H^4$. The faces of the said packing-plates may be made to the curve formed by the tractrix, known as the "Shield's anti-friction curve," or any other suitable curve, to avoid unequal wear between them and the packing-strips $P^4$ in the wings $A^2$ of the pistons. Said wear is caused by the difference in circumferential travel of the inner and outer ends of said packing-strips on packing-plate $H^4$. The same curve may be applied to the disks $C^9$ of cylinder C, where the packing-strips P′ in abutment I, Figs. 21 and 22,

are in contact with the said disks for the same reasons as above described. Said heads H H′ are provided with the steam and exhaust ports S and T.

Referring to Figs. 4, 12, and 13, the cam is shown as constructed with the outer flange F and the inner flange F′ forming between them the cavities $F^2$, in which the cam-block *f* travels. This cam-block has the journal-box $f^3$, which receives the journals $D^3$ of the lever D, which has the journal-box $d^2$, which receives the crank $a^2$ and the piston-shaft *a*.

It is evident that as the pistons rotate with the cylinders they must necessarily, by means of the crank-shaft *a* and lever D, as described, carry the cam-blocks *f*. As these blocks travel in said cavities $F^2$, it will be seen that the distance of the cam-blocks *f* from the center of said rotating cylinder C must be changed, said cams having periods of rest $x^3$ $x^3$ and $x^5$ $x^5$ and periods of throw $x^2$ $x^2$ and $x^4$ $x^4$, as shown in Fig. 12. The cam F F′ is constructed so as to have the least possible throw sufficient to oscillate the pistons. This is accomplished by placing the said cam outside of the circle described by the piston-shaft *a*, so as to obtain a throw comparatively small in proportion to the diameter of the cam, so as to avoid or modify jar. During the periods of throw $x^2$ $x^2$ and $x^4$ $x^4$ the pistons are balanced, as previously described, and oscillate or rotate so as to pass the abutment I and travel with the rotating cylinders. During the period of rest $x^3$ $x^3$ said pistons pass the abutments I, and during the period of rest $x^5$ $x^5$ they propel and rotate the rotating cylinders C. Said cylinders C are securely attached to shaft N. Shaft N is therefore driven by the pistons through the agency of the rotating cylinders. The oscillations or rotations of the pistons are controlled by said cams through the agency of the lever D and cam-blocks *f*. Said cam may be attached to the base-plate W or to the outer casing G, as shown in Figs. 2 and 4. The center lines Y Y and X X, respectively, of the abutments I and of the cam F F′ should not coincide. The angle of difference between said center lines is such as to allow for the distance of lead or follow of the crank $a^2$ past the center of the piston-shaft *a*, so as to have the center of rest $x^3$ $x^3$ in said cam coincident with the center of the abutments I.

Referring to Figs. 4 and 8 to 11, inclusive, it will be seen that the lever D is constructed with the journals $D^3$, which have a bearing in the journal-boxes $f^3$ of the cam-blocks *f* and the journal-boxes $d^2$, which receive the crank $a^2$ of the piston-shaft *a*. The guides $D^4$ work over the shaft N and hold the lever in proper position with respect to the crank $a^2$ of the piston-shaft *a* and the cam-blocks *f*. The counter-balances $D^5$ on the lever D are placed so as to counterbalance the centrifugal force of the end which is provided with the journals $D^3$ and journal-box $d^2$. Said lever is provided with gib-blocks *d* and $d^4$ to facilitate placing in position, as shown in Figs. 2, 4, 10, and 11. The lever D′ is identical in construction and operation with the lever D.

The operation is as follows: Referring to Fig. 3, it will be seen that piston A, having oscillated from its position around the abutment I into the position as shown at $A^{10}$, the piston B will have taken the position of $B^{10}$. The steam enters at port S and propels piston A in the direction indicated by the arrow. The steam which has just propelled piston B escapes at exhaust-port T. Piston B then oscillates and takes the position formerly occupied by piston A in passing the abutment I. The piston A in turn takes the position formerly occupied by piston B. Continuing the revolution, piston B, after passing the abutment I, again oscillates, taking the position as shown at $A^{10}$, and is acted on by steam from port S. It is evident that the piston A has taken the position as shown at $B^{10}$, and the steam which has just propelled it is ready to exhaust at port T. Piston A then oscillates to take its original position. Piston B also takes its original position, as shown. This constitutes a full stroke. The steam passes freely from one cylinder into the other through the passages Y, thus admitting steam simultaneously on the pistons A A′ and on B and B′, respectively. The pistons A′ and B′ necessarily operate in the same manner. The steam and exhaust ports $S^3$ $T^3$, respectively, may be provided in the casing-heads H H′, as shown in Fig. 3, so as to make the engine reversible, the steam and exhaust ports S and T being closed. A suitable cut-off of the usual kind may be used at the steam or exhaust ports, or both. The steam-chests S′ and the exhausts T′ may be located on heads H H′, as shown in Fig. 1. The cut-offs in the steam-chests S and S′ may be operated through the levers U′ $U^2$, attached to rocker-shaft U, which is mounted in journal-boxes V. Said levers U′ $U^2$ may be operated by the eccentric and eccentric-rod R and R′, respectively. Where a non-reversible engine is desired, one steam-chest and one exhaust-port are sufficient, the steam passing from one cylinder to the other through passages Y in Y′.

While four pistons and two abutments have been shown, I do not limit myself to this number, as any number may be used, with all their corresponding parts; and, further, I do not confine myself to the exact construction shown, as the same may be varied without departing from the spirit of my invention.

Having thus ascertained and set forth the construction of my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A rotary engine having oscillating pistons connected in pairs by a shaft, and cylinders connected by passages for the simultaneous introduction of pressure into the cylinders, whereby the end pressure resulting in friction is avoided, substantially as set forth.

2. A rotary engine having oscillating pis-

tons connected in pairs by a shaft, and rotating cylinders connected by passages for the simultaneous introduction of pressure into the cylinders, whereby the end pressure resulting in friction is avoided, substantially as set forth.

3. A rotary engine having oscillating pistons connected in pairs by a shaft, and rotating cylinders connected on their adjacent sides by passages for the simultaneous admission of steam to balance against the end pressure, said cylinders being closed on the outer sides by stationary heads, substantially as set forth.

4. A rotary engine having oscillating pistons connected in pairs by a shaft, and rotating cylinders formed by inner and outer rings and adjacent disks, said cylinders being connected by steam-passages through said disks and the open ends abutting against and being packed on stationary heads, substantially as set forth.

5. A rotary engine having oscillating pistons connected in pairs by a shaft, and rotating cylinders formed by inner and outer rings and adjacent disks, said cylinders being connected by steam-passages through said disks and the open ends abutting against and being packed on stationary heads, said cylinders being firmly attached to a driving-shaft, substantially as set forth.

6. A rotary engine having oscillating pistons connected in pairs by a shaft, and rotating cylinders formed by inner and outer rings and adjacent disks, said cylinders being connected by steam-passages through said disks and the open ends abutting against and being packed on stationary heads, said cylinders being firmly attached to a driving-shaft and mounted in journal-boxes attached to said stationary heads, substantially as set forth.

7. A rotary engine having rotating cylinders provided with annular cavities, said cylinders having seats for oscillating pistons connected in pairs by a shaft, which revolve with the cylinders, said seats being formed by the enlargement of said cylinders, substantially as set forth.

8. A rotary engine having rotating cylinders provided with annular cavities, said cylinders having seats for oscillating pistons connected in pairs by a shaft, which revolve with the cylinders, said seats being formed by the enlargement of said cylinders and having heads provided with journals to receive the shafts of the oscillating pistons, substantially as set forth.

9. A rotary engine having rotating cylinders provided with annular cavities, said cylinders having seats for oscillating pistons, which revolve with the cylinders, said seats being formed by the enlargement of said cylinders and having removable heads provided with journals to receive the shafts of the oscillating pistons, substantially as set forth.

10. A rotary engine having cylinders formed by outer and inner rings, and adjacent disks forming between them annular cavities, said cylinders having seats for oscillating pistons, which revolve with the cylinders, said seats being formed by the enlargement of said cylinders and having heads provided with journals to receive the shafts of the pistons, said heads being in the adjacent disks, substantially as set forth.

11. A rotary engine having stationary heads and packing-plates and rotating cylinders provided with cavities, and piston-seats formed by enlargements thereof, said piston-seats having flanges on the open side to complete the circles formed by the inner and outer peripheries of said cavity, so as to allow the ring-packing to be used in packing said cylinder against said head, substantially as set forth.

12. In a rotary engine having oscillating pistons connected in pairs by a shaft and stationary cylinder-heads, and rotating cylinders forming annular cavities open at outer sides, said cylinders being packed against said heads on the said open side, substantially as set forth.

13. In a rotary engine having stationary heads and rotating cylinders forming annular cavities open at outer sides, said heads having protruding annular packing-plates which are packed within said cylinders on the open side, substantially as set forth.

14. In a rotary engine having rotating cylinders into which stationary abutments extend, said cylinders having piston-seats to receive oscillating pistons connected in pairs by a shaft, and said pistons having wings which are curved so as to pass by and be packed in passing said abutments, substantially as set forth.

15. In a rotary engine having rotating cylinders into which stationary abutments extend, said cylinders having piston-seats to receive oscillating pistons connected in pairs by a shaft, and said pistons having wings which are curved so as to pass by said abutments, substantially as set forth.

16. A rotary engine having rotating cylinders provided with seats for oscillating pistons, said pistons constructed of a disk and curved wings connected by a crank-shaft which oscillates them, substantially as set forth.

17. A rotary engine having rotating and oscillating pistons and crank-shafts, respectively, and mounted in seats and journals provided for them in said cylinders, said pistons being connected by a crank-shaft and balancing each other against end pressure by means of the said crank-shaft between them by simultaneously admitting pressure to each, substantially as set forth.

18. A rotary engine having rotating cylinders and oscillating pistons, said pistons connected in pairs by a shaft, being constructed

with diametrically-opposed wings balancing each other against centrifugal force during oscillation, substantially as set forth.

19. A rotary engine having oscillating pistons connected in pairs by a shaft and rotating cylinders into which extend stationary abutments, said pistons when under pressure being at rest with respect to and rotating said cylinders, the pistons oscillating and passing said abutment when not under pressure, thereby avoiding all friction due to oscillation of said pistons under pressure, substantially as described.

20. A rotary engine having oscillating pistons connected in pairs by a shaft and rotating cylinders, into which cylinders extend stationary abutments having curved projections protruding in opposite directions to reduce the waste-steam area, said pistons in passing the abutments being packed and in oscillating clear the curved projections, substantially as set forth.

21. A rotary engine having rotating cylinders provided with oscillating pistons which are connected by a shaft, and stationary abutments protruding therein and packed in said cylinders, said abutments attached to stationary heads which are also the heads of the cylinders, substantially as set forth.

22. A rotary engine having rotating cylinders with seats to receive oscillating pistons, said seats having packing-strips held in place by pins in oblong holes and adapted to pack said pistons, substantially as set forth.

23. A rotary engine having rotating cylinders and oscillating pistons and packing-strips held in place by pins in oblong holes and projections for holding springs in place, substantially as set forth.

24. A rotary engine having rotating cylinders and oscillating pistons connected in pairs by a shaft and packing-strips held in place by pins in oblong holes, substantially as set forth.

25. A rotary engine having rotating cylinders and oscillating pistons and packing-strips beveled on the contact sides, substantially as and for the purpose set forth.

26. A rotary engine having rotating cylinders, oscillating pistons connected in pairs by a shaft, abutments mounted on stationary heads, and a stationary cam which oscillates said pistons in passing said abutments, substantially as set forth.

27. A rotary engine having rotating cylinders, oscillating pistons, abutments mounted on stationary heads, and a stationary cam which oscillates said pistons to pass said abutments, said cam having grooves running alternately concentric and eccentric to control said pistons, whereby the pistons are held stationary with regard to said cylinders and are oscillated to pass said abutments, respectively, the pistons in oscillating and passing said abutments rotating with the cylinder and being at rest with respect to said cylinder in propelling and rotating it, substantially as set forth.

28. A rotary engine having rotating cylinders, oscillating pistons, abutments mounted on stationary heads, and a stationary cam located between said rotating cylinders, said cam controlling the movements of the oscillating pistons, substantially as set forth.

29. A rotary engine having rotating cylinders, oscillating pistons with their shafts and abutments mounted on stationary heads, and a stationary cam located between said rotating cylinders, said cam being located beyond the circle described by said piston-shafts, thereby producing a cam of large diameter and small throw, substantially for the purpose set forth.

30. A rotary engine having rotating cylinders, oscillating pistons with their crank-shafts and abutments mounted on stationary heads, a stationary cam, and levers with their ends moving in said cam and oscillating and controlling said pistons through their crank-shafts by means of said cam, by which they are operated, substantially as set forth.

31. A rotary engine having rotating cylinders, oscillating pistons with their crank-shafts, abutments mounted on stationary heads, a stationary cam, and levers with their ends moving in said cam and oscillating and controlling said pistons by their crank-shafts by means of said cams, by which they are operated, said levers being provided with guides which pass around the main driving-shaft, on which they slide, thereby holding said levers in position with regard to the cam travel and piston crank-shafts, substantially as set forth.

32. A rotary engine having rotating cylinders, oscillating pistons with their crank-shafts, abutments mounted on stationary heads, a stationary cam, and levers with their ends moving in said cam and oscillating and controlling said pistons by their crank-shafts by means of said cams, by which they are operated, said levers being provided with guides, substantially as set forth.

33. A rotary engine having rotating cylinders, oscillating pistons with their crank-shafts, abutments mounted on stationary heads, a stationary cam, and levers with their ends moving in said cam and oscillating and controlling said pistons by their crank-shafts by means of said cams, by which they are operated, said levers being provided with counter-balances to overcome centrifugal force, substantially as set forth.

34. A rotary engine having rotating cylinders, oscillating pistons with their crank-shafts, abutments mounted on stationary heads, a stationary cam, and levers with their ends moving in said cam and oscillating and controlling said pistons by their crank-shafts by means of said cams, by which they are operated, said levers having cam-blocks moving in said cams.

35. A rotary engine having rotating cylinders, oscillating pistons with their crank-shafts, abutments mounted on stationary

heads, a stationary cam, and levers with their ends moving in said cam and oscillating and controlling said pistons by their crank-shafts by means of said cams, by which they are operated, the center line of said cams and abutments diverging by the angle which is made by the distance of the lead or follow of the said piston crank-shaft past the center of said oscillating pistons, substantially as and for the purpose set forth.

36. A rotary engine having rotating cylinders, oscillating pistons connected in pairs by a shaft, abutments mounted on stationary heads provided with steam and exhaust ports, said cylinders being connected by passages which equalize simultaneously the pressure in each, for the purpose set forth.

37. A rotary engine having rotating cylinders securely attached to a driving-shaft, oscillating pistons connected in pairs by a shaft, abutments mounted on stationary heads, said heads provided with journal-boxes which receive the said driving-shaft, said boxes extending inward to enable the engine to be shortened, substantially as and for the purpose set forth.

38. A rotary engine having rotating cylinders, oscillating pistons with the crank-shafts, abutments mounted on stationary heads, a stationary cam, and levers moving in said cam, by which they are operated, said levers being provided with the gib-blocks *d* to facilitate placing in position, substantially as set forth.

39. A rotary engine having rotating cylinders, oscillating pistons with the crank-shafts, abutments mounted on stationary heads, a stationary cam, and levers moving in said cam, by which they are operated, said levers being provided with the gib-blocks $d^4$ to facilitate placing in position, substantially as set forth.

40. In a rotary engine having stationary heads, oscillating pistons, and rotating cylinders forming annular cavities open at outer sides, said heads having annular packing-plates which pack against said cylinders, the faces of said plates and end of pistons in contact therewith being made to an anti-friction curve to avoid unequal wear between the said ends and said faces, substantially as set forth.

41. A rotary engine having oscillating pistons, rotating cylinders provided with annular cavities, and stationary abutments protruding and being packed in said cavities, the ends of said abutments and the faces of the annular disk of said rotatory cylinder being in contact therewith and forming an anti-friction curve to avoid unequal wear between said ends and faces, substantially as set forth.

42. A rotary engine having rotating cylinders revolving within an outer casing, abutments, oscillating pistons connected in pairs by a shaft, and a stationary cam placed within and attached to the outer casing, said cam oscillating said pistons in passing the said abutments, substantially as set forth.

43. A rotary engine having rotating cylinders, oscillating pistons, abutments, and a stationary cam placed within and attached to the outer casing, said cam oscillating said pistons to pass said abutments and having grooves running alternately concentric and eccentric to control said pistons, whereby the pistons are held stationary with regard to said cylinders and are oscillated, respectively, to pass said abutments, the pistons in oscillating passing said abutments rotating with the cylinder and being at rest with respect to said cylinder in propelling and rotating it, substantially as set forth.

44. A rotary engine having rotating cylinders revolving within an outer casing, abutments, oscillating pistons, and a stationary cam placed within and attached to the outer casing, said cam oscillating said pistons in passing the said abutments, substantially as set forth.

45. A rotary engine having rotating cylinders revolving within an outer casing, abutments, oscillating pistons, and a stationary cam placed between the said cylinders and within and attached to the outer casing, said cam oscillating said pistons in passing the said abutments, substantially as set forth.

In testimony whereof I, SAMUEL GLENVILLE BROSIUS, have signed my name to this specification, in the presence of two subscribing witnesses, on this 21st day of March, A. D. 1891.

SAMUEL GLENVILLE BROSIUS.

Witnesses:

THOS. J. STALEY,

J. HENRY KAISER.