No. 855,072. PATENTED MAY 28, 1907.

J. M. SPARKES.

ROTARY ENGINE.

APPLICATION FILED NOV. 17, 1905.

6 SHEETS—SHEET 1.

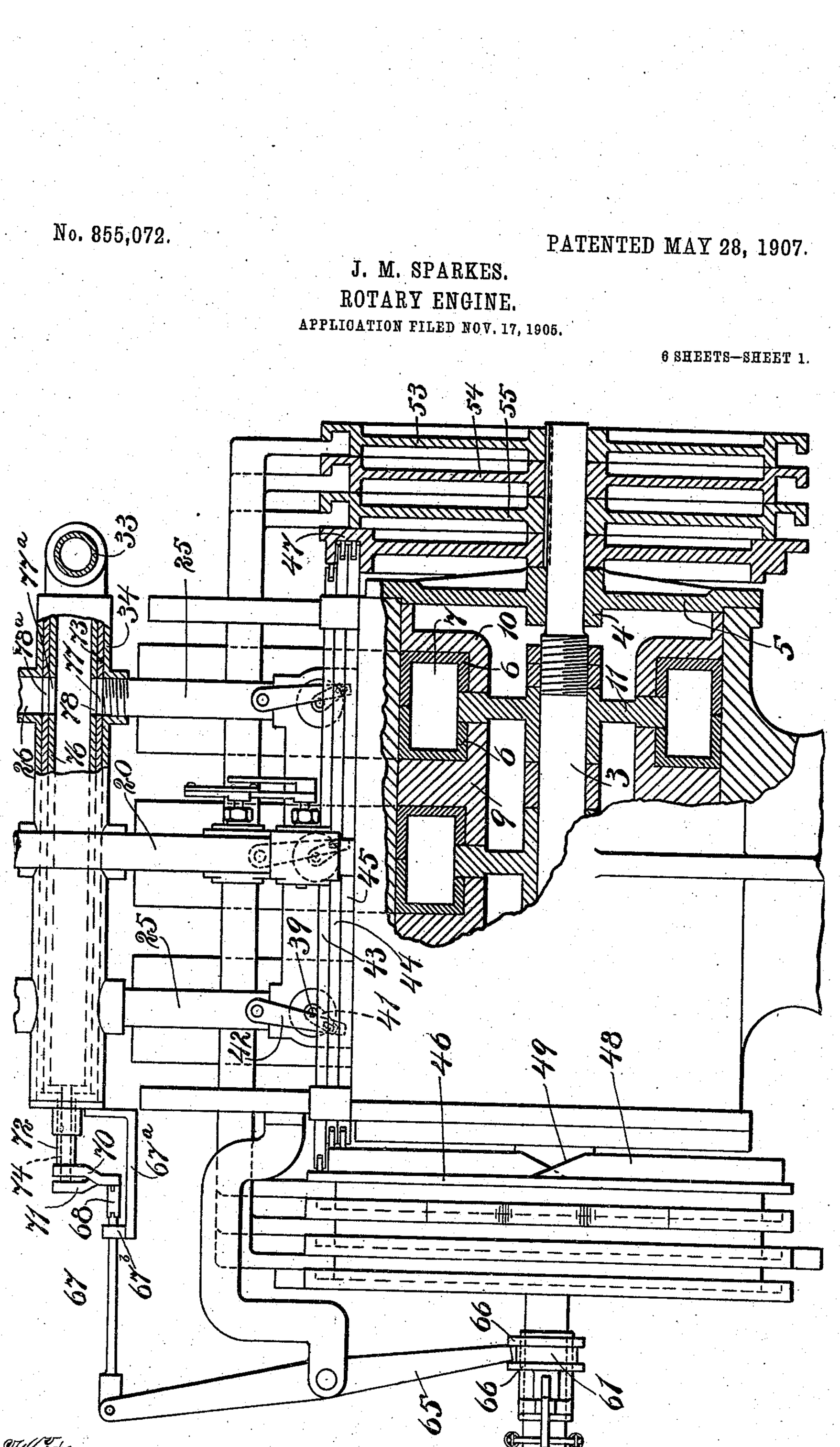

Fig. 1.

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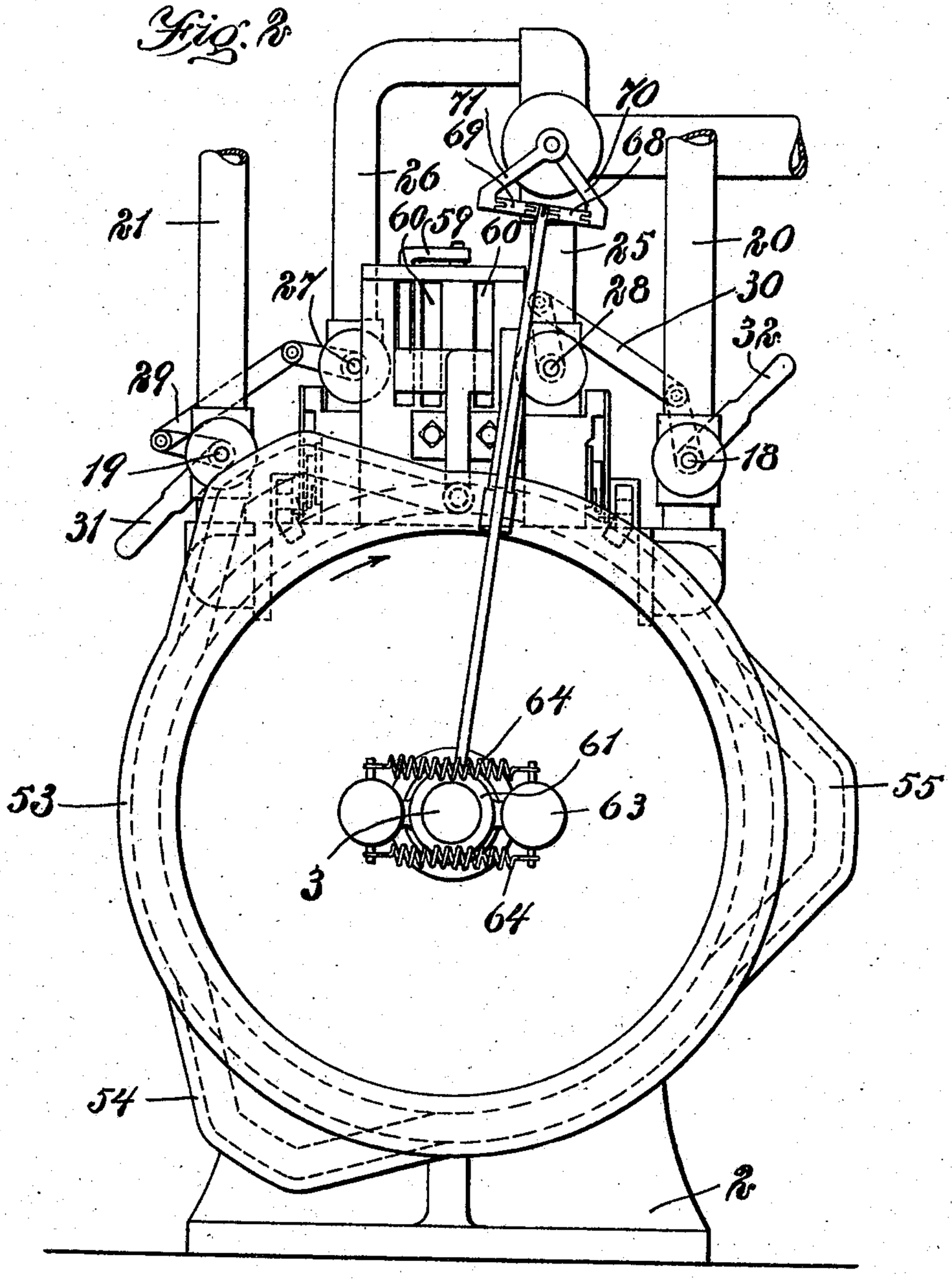
6 SHEETS—SHEET 2.

Fig. 2.



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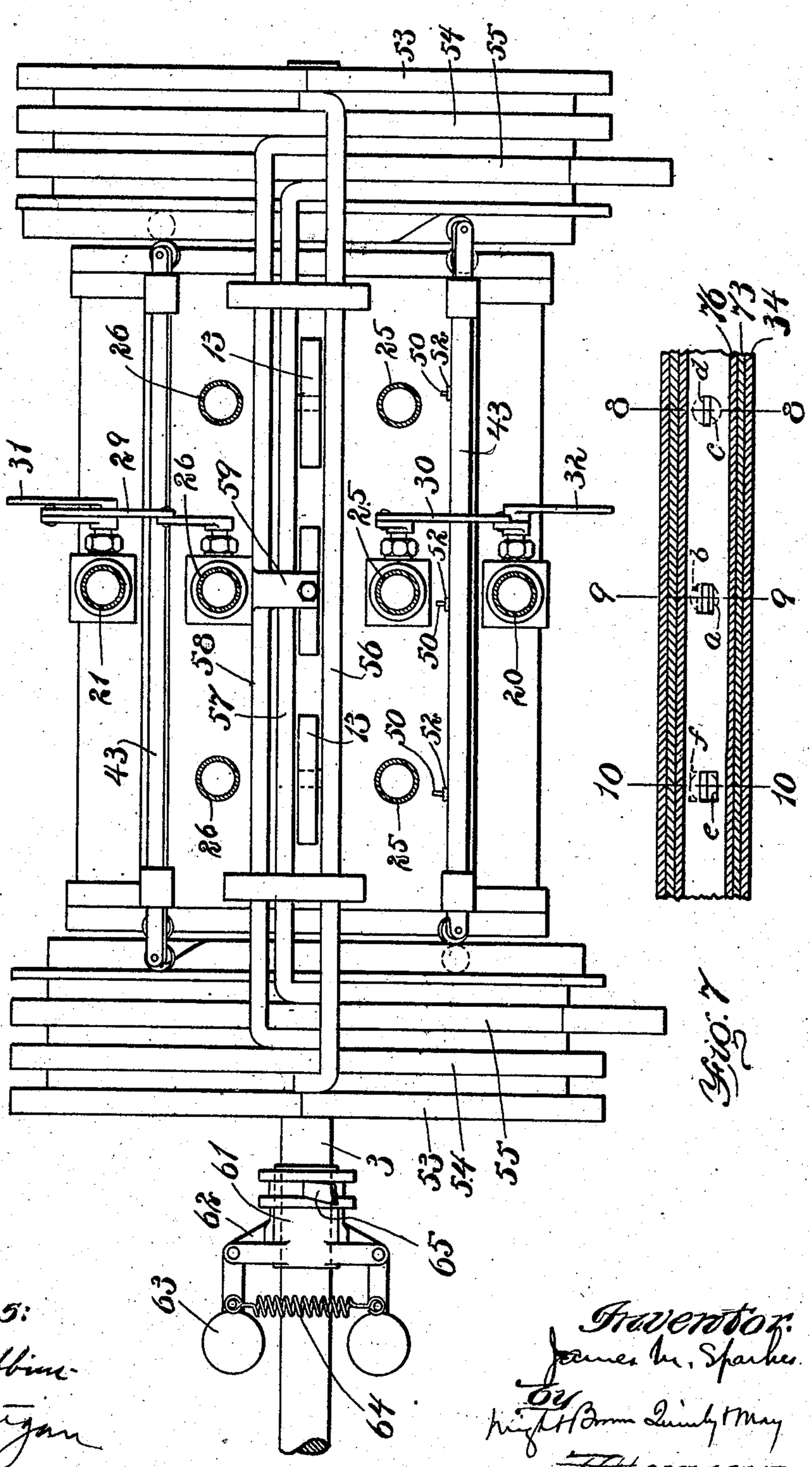


Fig. 3

Fig. 7

Fig. 10

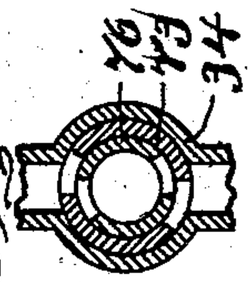


Fig. 9

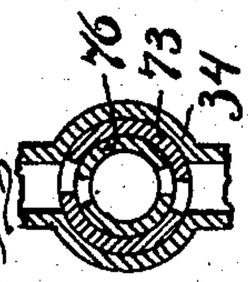
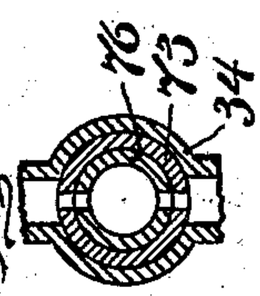


Fig. 8



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6 SHEETS—SHEET 4.

Fig. 4

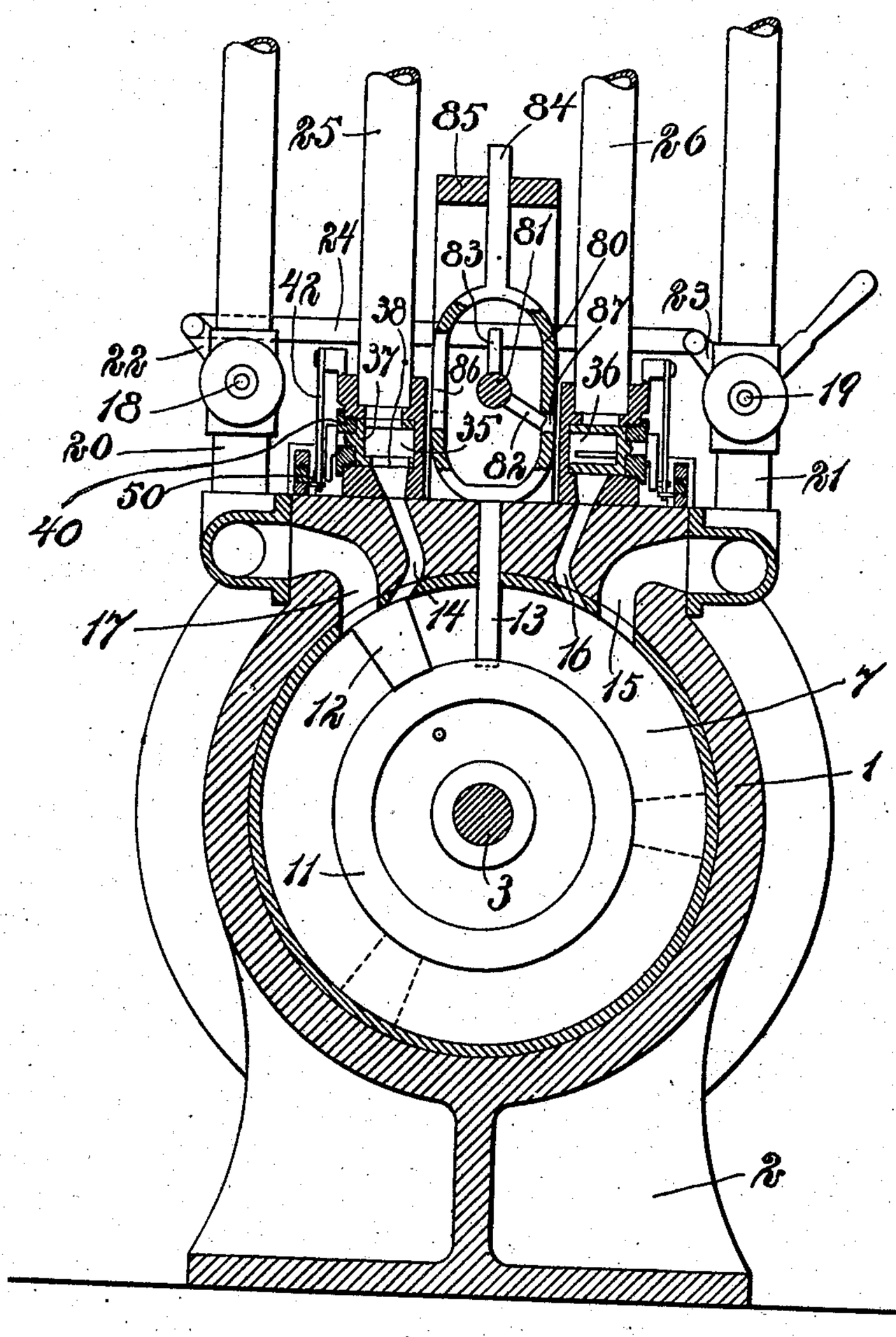
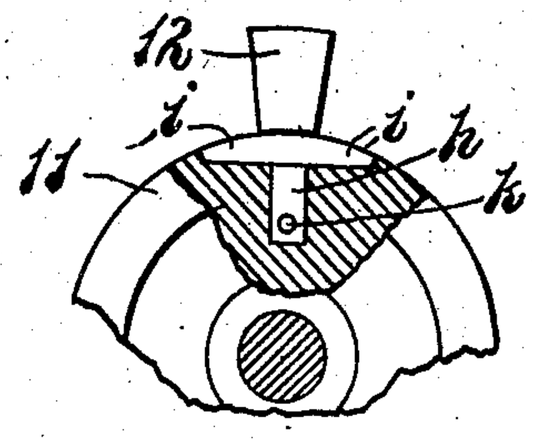


Fig. 13



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6 SHEETS—SHEET 5.

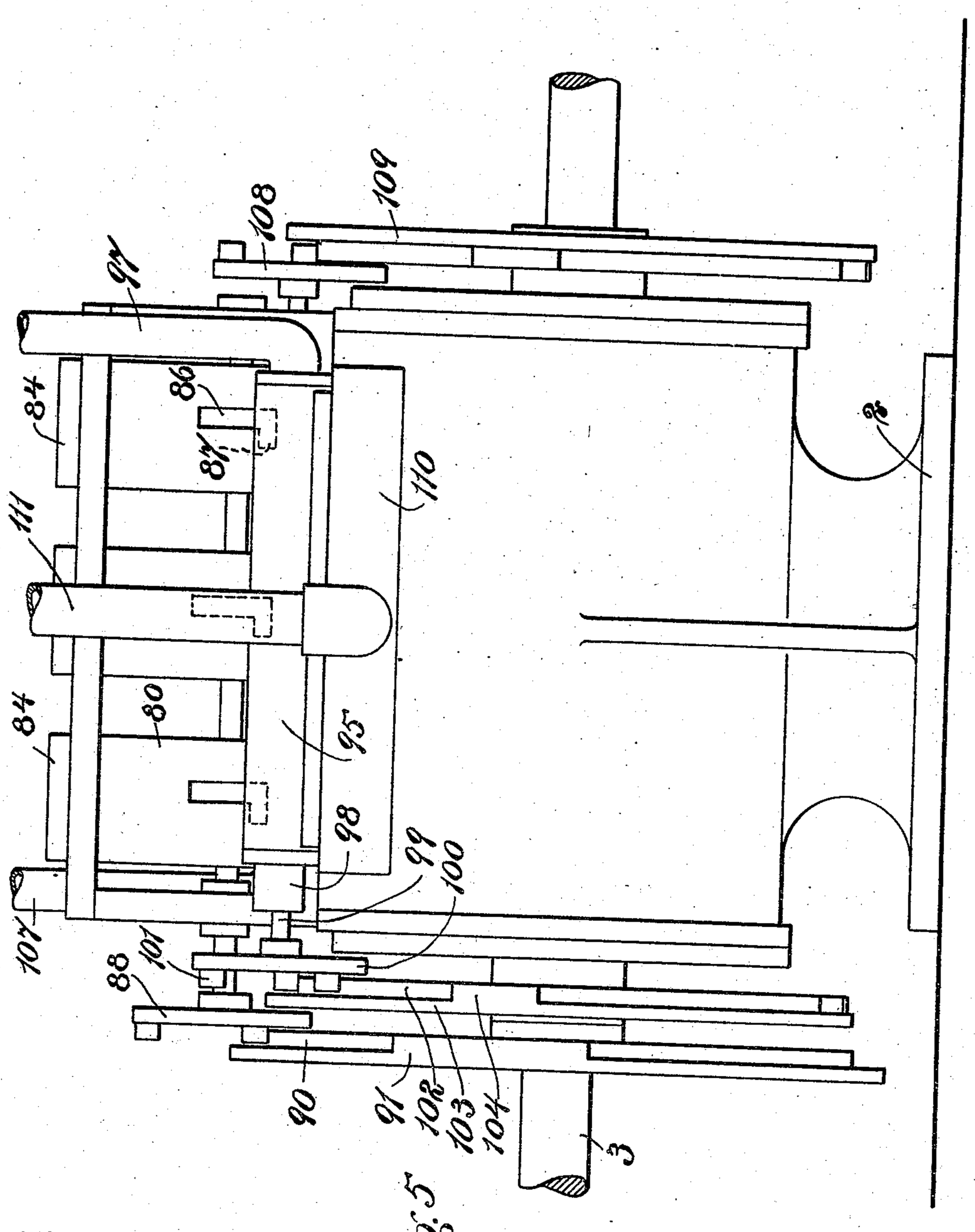

Fig. 7.

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6 SHEETS—SHEET 6.

Fig: 11

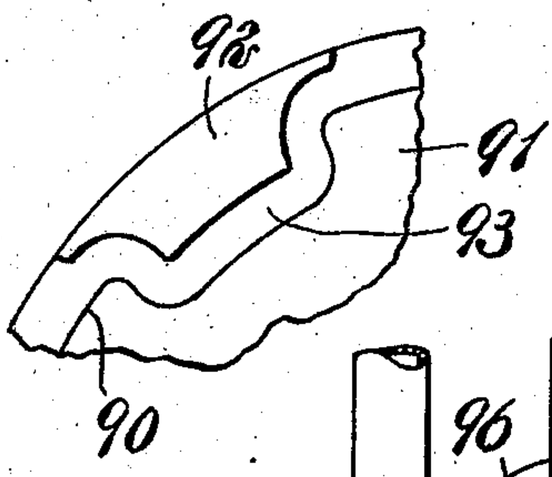

Fig: 12

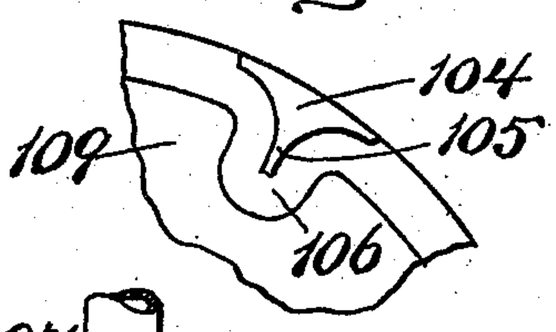

Fig: 6

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UNITED STATES PATENT OFFICE.

JAMES M. SPARKES, OF LYNN, MASSACHUSETTS, ASSIGNOR OF NINE-TWENTIETHS TO FRED H. SEAVEY, OF BOSTON, MASSACHUSETTS, AND ONE-TWENTIETH TO CHARLES W. BLACKETT, OF LYNN, MASSACHUSETTS.

ROTARY ENGINE.

No. 855,072. Specification of Letters Patent. Patented May 28, 1907.

Application filed November 17, 1905. Serial No. 287,776.

To all whom it may concern:

Be it known that I, JAMES M. SPARKES, of Lynn, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

The object of this invention is to produce a rotary engine in which the shaft may be acted on by steam of the full boiler pressure throughout a whole revolution, while the steam at the same time is being used expansively; to provide a novel mechanism operated by variations in load and speed of the engine for governing the steam admitted thereto; to make the form and arrangement of the steam chamber or cylinder and the piston such that packing may be dispensed with; and in general to provide an engine which is simple and inexpensive in construction and is also efficient and economical in operation.

The preferred embodiment of my invention and various modifications in which the details may be worked out are illustrated in the accompanying drawings, wherein,—

Figure 1 represents in side elevation, partly broken away, the preferred form of my invention. Fig. 2 represents an end elevation as seen from the left of Fig. 1. Fig. 3 represents a plan view of the same. Fig. 4 represents a vertical cross-section of the same looking from right to left, showing also a modification hereinafter described, of the means for operating the abutment. Figs. 5 and 6 represent respectively, side and end elevations of a modified form of engine. Fig. 7 represents a longitudinal horizontal section of the valve chamber and governing valves therefor. Figs. 8, 9 and 10 represent cross-sections of the same taken on lines 8—8, 9—9 and 10—10 respectively, of Fig. 7. Figs. 11 and 12 represent fragmentary detail elevations of the cams used in the form of engine illustrated in Figs 5 and 6. Fig. 13 represents a detail view, showing the manner of attaching the piston to its supporting disk.

The same reference characters indicate the same parts in all the figures.

1 represents the cylindrical outer shell or casing of the engine supported upon a base 2. Centrally located within the shell is a shaft 3 supported in bearings 4 in the heads 5 of the casing. Within the casing are fitted a number of division rings 6 which are annular and are carefully set so as to be exactly concentric with the shaft 3. In the meeting sides of the division rings there are formed annular recesses 7 which together form between each pair of rings an annular chamber which surrounds the shaft concentrically and is adapted to act as the pressure chamber or steam cylinder of the engine. Although the shaft is surrounded by the chamber, the inner wall of the latter is separated from the shaft and therefore the shaft is entirely outside of the chamber. The sides of the endmost rings are also separated from the heads 5 of the casing and thus there is a space between the division rings and the shaft and casing heads which may be filled with air or with steam, whereby the temperature of all parts of the engine may be made uniform, and whereby also the temperature may be regulated so as to regulate the expansion of the rings 9 10 and disks 11. There may be one or more of these annular chambers, and the engine here illustrated has three, showing a system which will be found convenient in practice. The interior division rings 9 are recessed on opposite sides and are identical so that any number of them may be placed side by side to provide the number of chambers which may be required in any engine. It will be noted that the parts designated by the numeral 6 appear as lining rings set within grooves in the rings 9 and 10, but it is evident that they need not be separate pieces and in practice I prefer that the recesses be formed directly in the division rings 9 and end rings 10 without the interposition of lining pieces.

Disks 11 are secured to the shaft and project through slots in the inner walls of the chambers, one into each, and reside with their peripheries flush with said inner walls. Upon each disk there is securely mounted a piston 12 which is of a shape to fit and entirely fill the cross-sectional area of the chamber 7, and is adapted to be revolved therein about the shaft by pressure of steam in the chamber. The chamber is of the same cross-sectional area and dimensions at all points so that there is no necessity of the piston changing its position relatively to the shaft either

by moving radially toward and away from it axially thereof, or in any other direction, with consequent increasing liability to leakage of steam, but on the contrary each piston may be held rigidly upon its respective disk and carried about at an invariable distance from the shaft.

In order to provide an abutment for the reaction of steam acting upon the piston, I mount a rectangular plate 13 radially of the engine, projecting through a slot in the top of the casing and extending into and across the chamber 7. There is one of these abutment plates for each chamber and all are preferably arranged in line and in substantially the same plane. The side walls and inner cylindrical wall of each chamber are grooved or recessed to a suitable depth to receive the sides and end of the abutment plate and so prevent leakage of steam past the abutment. On one side of the abutment the chamber is provided with an admission port and on the opposite side with an exhaust port. As this engine, however, is intended to be reversible, there are admission and exhaust ports on both sides of the abutment. Referring to Fig. 4, 14 represents the admission port and 15 the exhaust when the engine is running in the direction of the arrow, while 16 and 17 represent the admission and exhaust ports used for reverse rotation. Suitable valves 18 19 are provided in the exhaust pipes 20 21 respectively, to close the latter, and these are preferably so connected by arms 22 23 and link 24 so that one is closed simultaneously with the opening of the other. Thereby it will be impossible for the exhaust 17 to be opened when steam is admitted through 14 and in the same way 15 cannot be opened when steam flows through the admission 16. 25 26 represent the live-steam pipes which conduct steam to the inlet ports 14 and 16 respectively. These pipes also may be provided with throttle valves as shown at 27 and 28. In Fig. 2, instead of the exhaust valves 18 and 19 being connected to each other, they are connected to the throttle valves, 19 being connected through a link 29 with the valve 27, and 18 by a similar link 30 with throttle valve 28. Handles 31 32 are provided for operating the valves. Thus when 31 is turned to open the exhaust valve 18, the throttle valve 27 is simultaneously closed, and when moved in the opposite direction the reverse action takes place. If desired, all the valves may be connected together so that when one set of admission and exhaust valves are opened, the other set will simultaneously be closed, but for general purposes I prefer the arrangement described with respect to Fig. 2.

Steam is carried from the boiler through a pipe 33 into a valve chamber 34 which is in the form of a cylindrical shell. To this valve chamber the pipes 25 and 26 are connected and from the same they conduct steam to the valve chests 35 36 respectively. In each of said valve chests there is a valve 37 cylindrical in form and having openings 38 adapted to register with the steam pipes and the steam ports in the cylindrical casing to permit flow of steam and being also rotatable out of line with the pipe and ports to cut off the steam. The valves in all the chests are substantially identical and each has a stem 39 projecting through a stuffing-box 40 outside of which an arm 41 is connected to the stem, said arm being engaged through the medium of a lever 42 with one of the rods or bars 43 44 or 45. There are two sets of these bars, one set on each side of the engine, and each bar is adapted to operate one of the valves. The bars carry anti-friction rolls on their ends which engage cam disks 46 47 keyed upon the main shaft 3 adjacent the opposite ends of the engine casing. There are annular flanges 48 formed upon the disk having inclined cam surfaces 49, which are adapted to engage the ends of the bars and reciprocate them in a direction parallel to the axis of the engine. The cams on the opposite ends of the shaft are complemental so that a positive reciprocating movement is given to each of the bars. There is the same number of the latter on each side of the engine as there are steam chambers.

The levers or arms 42 are connected to the valve arms 41 by means of pins on the latter entering slots in the levers 42, while the free ends of the latter are engaged by pins 50 carried by the reciprocating bars. The intermediate levers 42 acting against the arms 41 when the latter are in their extreme position in a more nearly perpendicular direction than would the reciprocating bars if arms 41 were directly engaged therewith, serve to diminish the power necessary to operate the valves. Those reciprocating bars which are above the lowest bar 45 are provided with hanger straps 52 which project downward and carry the pins 50 at their ends so that all of the levers 42 are engaged at the same distance from their fulcrums.

In order that the pistons may travel entirely around through the cylinders, it is necessary that the abutments should be periodically withdrawn out of their way and in order to accomplish this the mechanism shown in Figs. 1 to 3 is provided. On the drive shaft 3 at opposite ends of the engine are provided cams 53 54 55 with which are engaged cross-heads or yokes 56 57 and 58 respectively, extending longitudinally of the engine. Each one of these yokes is connected with one of the abutment plates 13, the yoke 58 being connected by a strap 59 which extends over the intermediate yoke 57 at a height sufficient to permit reciprocation of the latter without interference. The yokes travel in guideways 60 which constrain them

to move in straight lines and prevent cramping of the abutments in their passage-ways. Each cam is arranged with reference to one of the pistons and is formed with a groove which is concentric with the shaft throughout its greater extent, but has a single offset portion. The offset comes into position to engage and lift the respective yoke and abutment just as the piston approaches closely to the abutment, the latter being removed entirely from the chamber as the piston moves by and being projected again across the piston just before the latter uncovers the steam port and steam rushes in. The cams are designed so as to operate the abutments smoothly and with no undue friction, and also to retain the abutments withdrawn the exact length of time necessary to permit the pistons to pass without danger of interference.

Preferably the pistons are not all in the same plane but are spaced about the shaft angularly with equal intervals between them. Thus in the construction here illustrated where three pistons are employed, they are set at angles of 120° apart around the shaft. Consequently the cams are set with their offset portions correspondingly spaced apart. The spacing above referred to of the pistons also requires that the admission valves 37 should be operated at different times and accordingly the cams 49 are placed relatively to the pistons so that as each piston passes an admission port, the admission valve is opened and steam is allowed to enter the chamber. These cams are also arranged to shut off the steam after the piston has traveled a fractional part of its revolution. With this form of engine, the cut-off occurs in each chamber after a third of the revolution and thus there is a period of one-third a revolution in which steam acts at the full boiler pressure, and two-thirds of a revolution wherein it acts expansively. As the admission ports are all in the same plane, while the pistons are separated by angles of 120°, it follows that the admission takes place successively in one chamber after another at the same time that cut-off has occurred in the chamber immediately preceding. Thereby the shaft is acted upon at every instant during the revolution in one of the chambers by steam at full boiler pressure, while at the same time in the other chambers the steam is expanding and acting with diminishing pressure. Of course the number of pistons is immaterial. There may be two, in which case steam would be admitted during one-half a revolution if the result above described is desired, or there may be four, or a greater number, with which the admission would be one-fourth, one-fifth, etc., of the revolution. In any case it will be seen that to get the result referred to, the fractional part of the revolution during which steam is admitted into each chamber is the reciprocal of the number of pistons and chambers. By increasing the number of chambers, the amount of expansion of the steam may be increased to any desired extent.

There is a centrifugal governor for varying the steam supply with increase of speed, and successively cutting off one after the other of the chambers. The governor consists of a sleeve 61 mounted to slide axially upon the shaft and engaged with the short arm 62 of weighted bell-crank lever 63. The weighted arms of the levers are drawn together by springs 64 and caused to fly outward by centrifugal force when the shaft 3 with which they revolve attains a predetermined speed. Divergence of the weights causes the sleeve to be moved toward the left in Figs. 1 and 3, carrying in the same direction the lower end of a lever 65 which is held between collars 66 of the sleeve. The upper end of said lever is moved to the right and thereby similarly moves a rod 67 connected by links 68 69 with arms 70 71 respectively. The first of these arms is fixed to a tubular stem 72 fastened to a cylindrical valve 73 fitting within the valve chamber 34 while the other arm 71 is attached to a stem 74 passing through stem 72 and connected to a second cylindrical valve 76. The latter valve is open at its end and is able to receive steam into its interior from the main 33. Valves 73 and 76 have openings 77 78 respectively, which are adapted to register with each other and with the pipe 25 leading to one of the steam chambers. When the governor balls fly outwardly and move the rod 67 to the right as described, the latter acts through the inclined links 68 69 and through them moves the valves 73 76 in opposite directions. Thereby the opposite edges of the openings 77 78 are caused to approach each other and gradually diminish and close the passage which they furnish from the interior of the valve to the pipe. A bracket 67[a] is secured to the end of the valve casing and has a guide portion 67[b] embracing the rod 67 for constraining the latter to move in a fixed path and preventing lateral displacement thereof. This insures that the movements of both valve members 73 and 76 shall be equal and opposite with respect to the stationary valve casing and prevents both together being displaced in one direction.

Preferably the openings in the valves which lead to the middle chamber are half again as wide as the openings leading to the right-hand chamber, and their operative edges *a* and *b* respectively, are located distances equal to half the width of the openings 77 78 to the right and left of longitudinal lines through the edges *c d* respectively, of said openings. The openings leading to the left-hand chamber are greater than those of the middle chamber by amounts also equal

to half the width of openings 77 78 and are correspondingly arranged. Where a greater number of chambers is employed, the additional passages are increased in width by similar increments. The operative edges of the openings leading to the left-hand chamber are designated by *e f*, respectively. It will be evident that as the valve members 73 76 are moved in opposite directions, the edges *c a* and *d* simultaneously approach edges *d b* and *f*, respectively. By the time each cylinder has rotated a distance equal to half the width of openings 77 78, the edges *c d* have come into coincidence and said openings are closed, shutting off the steam to the right-hand chamber. By this time, however, the edges *a b* of the second set of openings have approached until they are a distance apart equal to the width of the first opening, and as the movement continues *a* and *b* draw together until they overlap and shut off steam to the middle chamber. Then the edges *e f* are still separated enough to allow steam to enter the third chamber without throttling It will thus be seen that as the load diminishes, or the pressure increases, and the engine speeds up, the chambers are cut off one after another until the amount of power developed is reduced enough to reduce the speed, and slowing of the engine produces the reverse effect. Accordingly by this mechanism the speed can be governed with accuracy. The action is to throttle down gradually and finally cut off the chambers one at a time so that the ill effect due to loss of pressure from throttling is reduced to a minimum or wholly eliminated. The valve members have in their opposite sides corresponding openings 77^a and 78^a which are adapted to register with and cut off in the same manner the passages through pipes 26 which lead to the reversing admission ports of the engine.

In Figs. 4, 5 and 6 is shown a second operative method for working the abutments. In this construction each abutment has connected to it outside of the casing a frame 80 within which is a shaft 81 having pins 82 83. The frame is guided to reciprocate accurately by a projecting rod 84 extending through a guide 85. In the opposite sides of the frame 80 and opposite to each other are slots 86, each of which at the bottom has an offset 87. The pins 82 83 are offset by a corresponding amount axially of the shaft 81. Upon the shaft 81 is a disk 88 which has studs 89 equal in number to the abutments. These studs project out and engage a shoulder 90 on a cam 91. At intervals the shoulder 90 is recessed and an abutment 92 formed adjacent the periphery of the cam and extending into the recess, leaving a groove 93, which, when it comes opposite one of the studs 89, engages the latter and turns the disk 88 through one-third of a revolution. If the pin 82 happens to be adjacent the slot 87 and the shaft 81 is turning in left-hand rotation, the pin elevates the abutment and holds the same elevated while the concentric portion of groove 93 is passing by the stud 89. The movement of the stud is then continued so that 82 passes out of engagement with the frame 80, allowing the abutment to drop, and subsequently pin 83 enters slot 86 on the opposite side and bearing against the bottom of said slot forces an abutment inward and seats it firmly. There are a pair of pins similar to the pins 82 83 arranged to engage each of the abutments and each is rendered operative at every third actuation of the disk 88 and shaft 81.

A modification is illustrated in Figs. 5 and 6 for operating the admission valves. Here there is a single chest 95 for admitting steam to all the chambers for rotation in one direction, while a corresponding valve chest 96 furnishes steam for the reverse. A pipe 97 admits live steam to the chest 95 within which there is a cylindrical valve 98 similar to valve 37, having ports arranged at angular intervals to uncover the passages leading into the several chambers successively. To the stem 99 of the valve is fixed a disk 100 having studs 101 which project so as to engage a shoulder 102 on a cam 103. This latter cam has at intervals abutments 104 on its periphery having inward extensions 105 which project into recesses 106 and provide an inwardly deflected cam groove. Periodically one of the studs 101 is engaged by this inwardly-deflected groove and the disk 100 is rotated, thereby turning the valve through an angle necessary to close the port leading to one steam chamber and open that leading to the next one. Thus a successive admission to the chambers one at a time, is provided. For reversing the engine, steam is admitted through pipe 107 to the other chest 96 and a similar mechanism consisting of disk 108 and cam 109 is provided for operating the valve. 110 represents an exhaust chamber into which steam is discharged from all of the steam cylinders and from which it passes through a pipe 111 to the atmosphere or a condenser.

Fig. 13 illustrates a construction for making a firm union between the pistons 12 and disks 11. The piston is formed from one piece with a shank *h* and forwardly and rearwardly extending braces *i*. The latter are set into the periphery of the disk 11 and the shank is forced into a hole therein, and after being seated is secured by a cross-pin *k* passing through from one side of the disk to the other and through the shank *h*.

I claim:—

1. A rotary engine comprising a single external cylindrical casing, a shaft extending longitudinally through said casing, a plurality of annular rings set side by side within the casing and having grooves in their meeting faces forming an annular pressure cham-

ber, and a piston fitting in said grooves and connected to the shaft.

2. A rotary engine comprising a single external cylindrical casing, a shaft extending longitudinally through said casing, a plurality of annular rings having external cylindrical surfaces set side by side and fitted closely within the casing, said rings having in their adjacent faces annular grooves forming together a pressure chamber, and a piston fitting in said chamber and connected to the shaft.

3. A rotary engine comprising a single external cylindrical casing, a shaft extending longitudinally through said casing, a plurality of annular rings having external cylindrical surfaces set side by side and fitted closely within the casing surrounding and out of contact with the shaft, said rings having in their adjacent faces annular grooves forming together a pressure chamber, and a piston fitting in said chamber and connected to the shaft.

4. A rotary engine comprising a single external cylindrical casing, a shaft extending longitudinally through said casing, a plurality of annular rings having external cylindrical surfaces arranged side by side and fitting closely within the casing, being held thereby in perfect alinement and contact, and surrounding the shaft out of contact therewith, disks mounted on the shaft with their peripheries projecting slightly between adjacent rings and being out of contact with the inner cylindrical surfaces of the rings, said rings having in their sides annular grooves of which each two adjacent grooves form a single pressure chamber, and pistons secured to the disks and fitting in said chambers.

5. A rotary engine comprising a single external cylindrical casing, a shaft extending longitudinally through said casing, a plurality of annular rings having external cylindrical surfaces arranged side by side and fitting closely within the casing, being held thereby in perfect alinement and contact, and surrounding the shaft out of contact therewith, disks mounted on the shaft with their peripheries projecting slightly between adjacent rings and being out of contact with the inner cylindrical surfaces of the rings, said rings having in their sides annular grooves of which each two adjacent grooves form a single pressure chamber rectangular in cross section, and pistons secured to the disks and fitting in said chambers.

6. A rotary engine consisting of rings placed closely together and having annular grooves formed in their adjacent sides, these grooves in adjacent rings forming separated pressure chambers, the rings being equal in diameter and forming externally an extended cylindrical surface, a cylindrical shell closely surrounding all the rings, heads secured to the ends of said shell, a shaft journaled in said heads, and pistons connected to the shaft and movably mounted in the chambers, the rings being separated by open spaces from the shaft and heads of the casing.

7. A rotary engine comprising a shaft, a plurality of pistons secured thereto extending at different angles therefrom, a plurality of annular rings recessed on their adjacent sides to form chambers into each of which one of the pistons extends and fits movably, a casing surrounding and binding together said rings, admission ports in the chambers in line axially of the engine, and valves operated successively by the shaft for admitting steam to each chamber as the piston therein passes the port.

8. A rotary engine comprising a shaft, a plurality of pistons secured thereto extending at different angles therefrom, a plurality of annular chambers into each of which one of the pistons extends and fits movably, admission ports in the chambers in line axially of the engine, a valve for admitting and cutting off the steam to each chamber, a plurality of reciprocable bars lying side by side parallel to the shaft and each connected to one of the valves, and cams arranged to operate the bars and thereby the valves successively for admitting steam to each chamber as the piston therein passes the port, and cutting off the steam after a fractional revolution of the piston.

9. A rotary engine comprising a shaft, a plurality of pistons secured thereto extending at different angles therefrom, a plurality of annular chambers into each of which one of the pistons extends and fits movably, admission ports in the chambers in line axially of the engine, an abutment extending across each chamber, said abutments being all approximately in the same plane, and in alinement, cams equal in number to the abutments connected to each end of the shaft, and yokes extending longitudinally of the engine engaged at their ends with the cams and each connected to one of the abutments for retracting and again projecting each of the abutments as the piston in the respective chamber approaches and passes the same.

10. A rotary engine comprising a shaft, a plurality of pistons secured thereto extending at different angles therefrom, a plurality of annular chambers into each of which one of the pistons extends and fits movably, admission ports in the chambers in line axially of the engine, a plurality of abutments substantially in the same plane and in alinement extending into and across the chambers, one in each, an admission and cut-off valve for each chamber, and cams rotated by the shaft having eccentric grooves and cylindrical flanges varying in width and connected respectively to the abutments and valves for operating them successively to retract and

project the abutments and subsequently open the valves as the pistons in the respective chambers approach and pass the corresponding abutments and admission ports.

11. In a rotary engine, a rotary admission and cut-off valve, a cam connected to the ennine shaft, a reciprocating member actuated by said cam, an arm connected to the valve stem, and an intermediate connection engaged with said arm and member for communicating motion to the former from the latter, and arranged to travel at its point of engagement in a path divergent from those of the reciprocating member and intermediate the two.

12. In a rotary engine, a rotary admission and cut-off valve, a cam connected to the engine shaft, a reciprocating member actuated by said cam, an arm connected to the valve stem, and a pivoted intermediate longer arm engaged adjacent its movable end with said member and intermediate its ends with the first arm through which rotation is given to the valve.

13. In a rotary engine, a shaft, a piston, a steam chamber, a rotary valve interposed in the steam passage to the chamber, cams on the shaft on opposite sides of the chamber, a bar extending parallel to the shaft and connected to each cam to be reciprocated endwise thereby, a pivoted arm engaged with the bar, and a second arm secured to the valve stem and engaged with the first arm intermediate the ends of the latter, whereby the valve is rotated to admit and cut off the steam.

14. In a rotary engine, a casing having annular chambers, abutments arranged to slide radially through the casing and into and across the chambers, a shaft, pistons carried by the shaft and movable within the chambers, cams mounted on the shaft at opposite sides of the chamber, and cross-heads or yokes arranged parallel side by side engaged at their opposite ends with said cams and connected intermediate their ends each to one of the abutments for reciprocating the latter.

15. In a rotary engine, a casing having annular chambers, abutments mounted substantially in line arranged to slide radially through the casing and into and across the chambers, pistons carried by the engine shaft movable within the chambers, cams on the shaft at opposite ends of the casing, a yoke parallel with the shaft lying beside the abutments and connected to one of them, a second yoke lying on the other side of the abutments and connected to another of them, and a third yoke beside the second having an arm extending over said second yoke and connected to a third abutment, said yokes being engaged at their ends, each with one of the cams.

16. In a rotary engine having a plurality of pressure chambers, speed-governed means including coaxial valve members for diminishing and stopping the supply of working fluid to the chambers successively.

17. In a rotary engine having a pressure chamber and a steam admission passage leading thereto, speed-controlled means for diminishing and stopping the flow of steam through the passage comprising oppositely-movable valve members having registering openings, and mechanism operated by variations in speed for moving said means to cover the openings therein.

18. In a rotary engine, a pressure chamber, a steam passage leading thereto, and means governing the supply of steam thereto, comprising concentric cylindrical valve members having openings, and mechanism operated by variations in speed for moving said valve members in opposite directions to bring their openings into and out of line with each other and the steam passage.

19. In a rotary engine, a pressure chamber, a valve casing, a steam passage leading from the valve casing to the pressure chamber, concentric cylindrical valves rotatably mounted in the casing and each having an opening, and a centrifugal governor connected to the valve members for rotating them oppositely with variations of speed to bring their openings into and out of registry with each other and with the passage.

20. In a rotary engine, a pressure chamber, a valve casing, a steam passage leading from the valve casing to the pressure chamber, concentric cylindrical valves rotatably mounted in the casing and each having an opening, a collar slidable on the engine shaft, a centrifugally-operated weight engaged to move the collar, and connections between the collar and valve members for rotating the latter simultaneously and oppositely.

21. In a rotary engine, a pressure chamber, a valve casing, a steam passage leading from the valve casing to the pressure chamber, concentric cylindrical valves rotatably mounted in the casing and each having an opening, stems connected to the valve members and co-axial therewith, a centrifugal governor, a rod connected for reciprocation thereby, arms connected to said stems, and links joining the arms and rod.

22. In a rotary engine, a plurality of pressure chambers and pistons, and a governing device comprising a valve casing having outlets leading to each pressure chamber, superposed valves having openings of varying widths, and centrifugal means for moving said valves oppositely to bring the openings into and out of line with each other and with the respective passages, said valves and openings being arranged so that continued motion thereof will close the passages successively.

23. In a rotary engine, a plurality of pres-

sure chambers and pistons, and a governing device comprising a valve casing having outlets leading to each pressure chamber, superposed valves, and centrifugal means for moving said valves oppositely with variations of speed, each valve having openings adapted to register with those of the other valve and with the passages leading to the respective chambers, successive openings being extended in width in the direction opposite to that of the valve-closing movement, whereby such movement causes the chambers to be cut off one by one.

24. In a rotary engine having a pressure chamber, a disk secured to the engine shaft, and a piston shaped to fit in the chamber, formed with acting faces radial of the disk a shank set into a socket in the periphery of the disk, and front and rear steadying extensions continuing beyond said faces and bearing on the rim of the disk.

In testimony whereof I have affixed my signature, in presence of two witnesses.

JAMES M. SPARKES.

Witnesses:
ARTHUR H. BROWN,
A. C. RATIGAN.