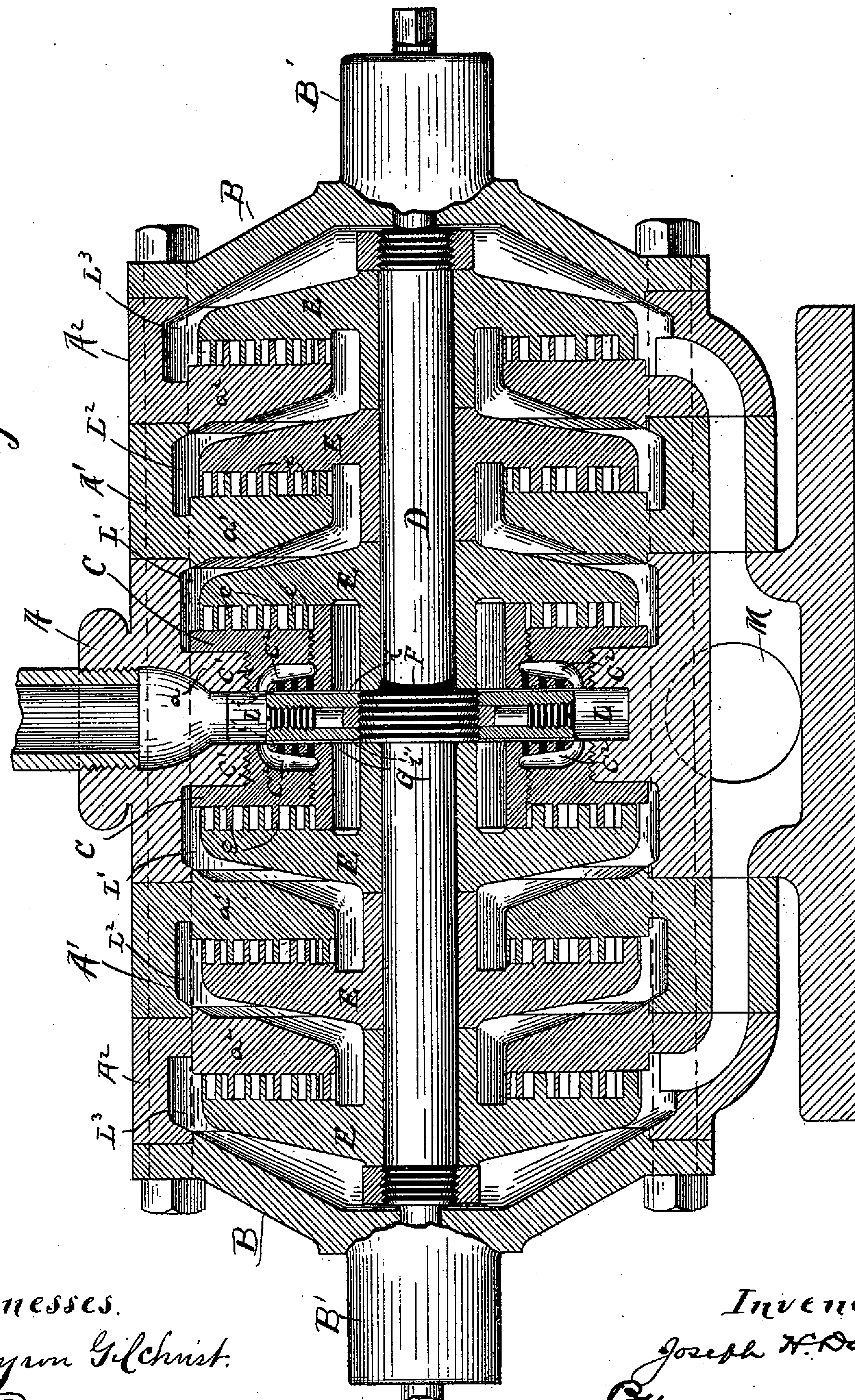
(No Model.) 3 Sheets—Sheet 1.

J. H. DOW.

ROTARY ENGINE.

No. 496,352. Patented Apr. 25, 1893.

Fig. 1.



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(No Model.)

3 Sheets—Sheet 2.

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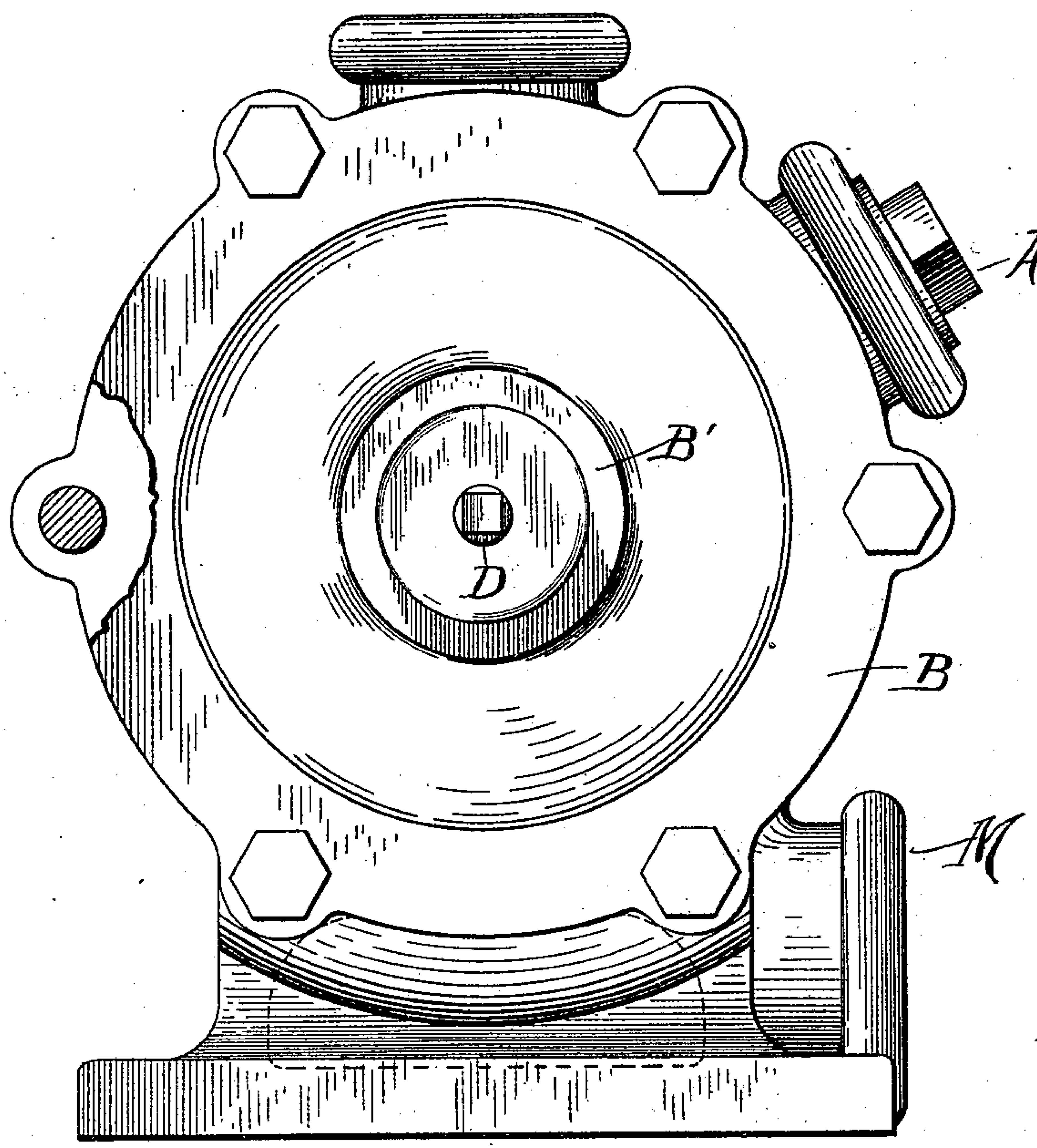
Fig. 2.



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(No Model.) 3 Sheets—Sheet 3.

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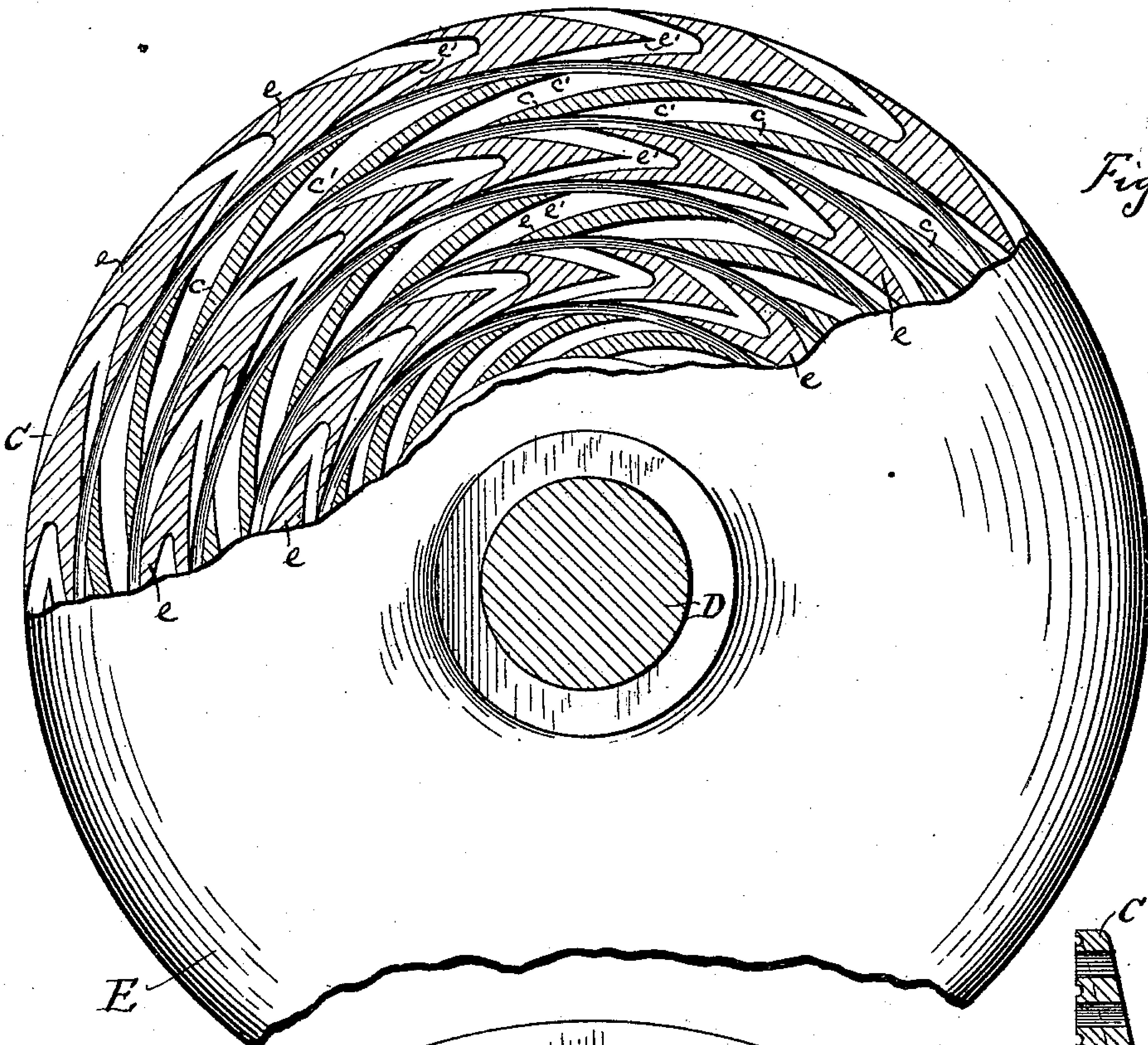
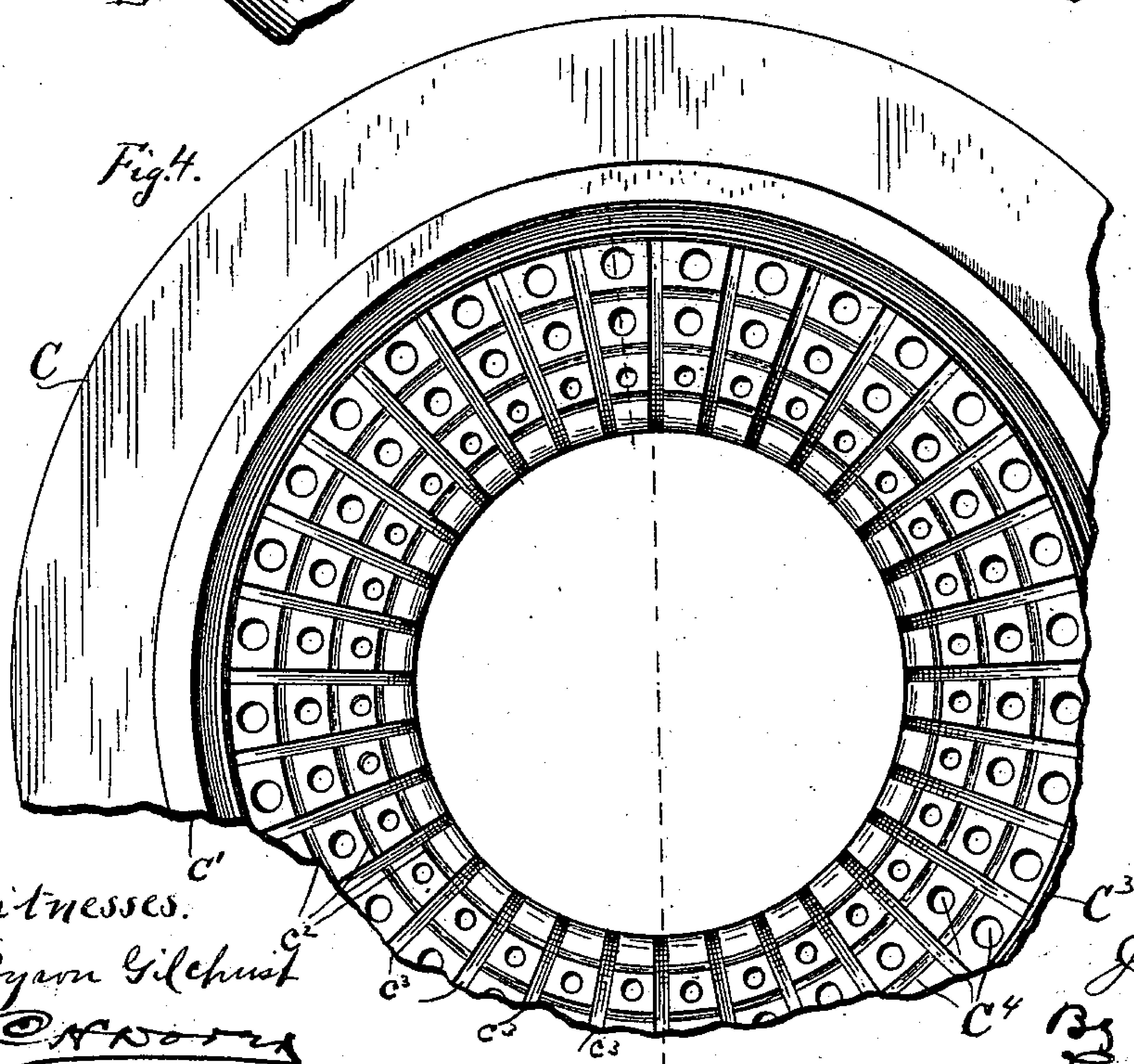


Fig. 3.

Fig. 4.



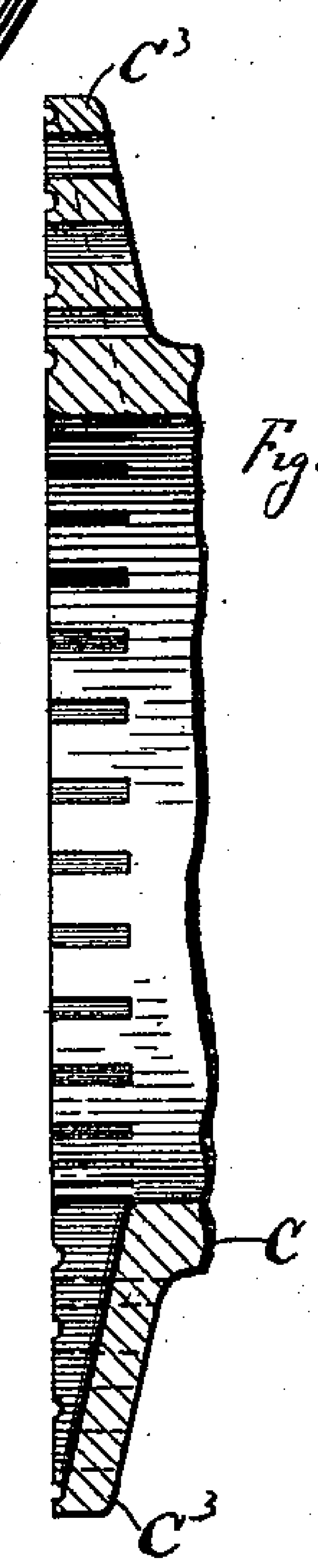


Fig. 5

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UNITED STATES PATENT OFFICE.

JOSEPH H. DOW, OF CLEVELAND, OHIO, ASSIGNOR OF ONE-HALF TO WILLIAM CHISHOLM, SR., OF SAME PLACE.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 496,352, dated April 25, 1893.

Application filed January 23, 1891. Serial No. 378,785. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH H. DOW, of Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Rotary Engines of the Turbine Variety; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same.

My invention relates to improvements in rotary engines of the turbine variety; and it consists in certain features of construction and in combination of parts hereinafter described and pointed out in the claims.

In United States Letters Patent No. 430,568, granted to me June 17, 1890, and in Letters Patent of the United States, No. 403,335, of date May 14, 1889, is shown and described an engine having one pair of bucket-wheels mounted upon a shaft, these wheels co-operating with opposing pairs of stationary disks, these wheels having, respectively, series of buckets arranged in concentric order, these buckets traveling in annular paths between or radially outside of corresponding series of guide-plates or chutes projecting from the faces of the stationary disks toward the opposing wheels, the steam or elastic agent being introduced to these wheels at the inner edges of the disks and passing from thence radially outward across the face of the wheels and discharging at the periphery into the exhaust-chambers. Such construction was not adapted to develop the highest efficiency from the very high pressure of steam or elastic agent occasionally used because the number of compoundings upon a single disk and wheel of moderate diameter, will necessarily be few and a disk and wheel of large size would have the disadvantage of excessive leakage across the face of the bucket and too great a difference of circumferential speed as between the inner and outer series of buckets, and would increase the weight of the engine beyond the proportionate increase of effectiveness. To overcome these defects I now use two or more pairs of wheels and opposing disks, the different wheels being mounted on a shaft in common and the different disks being rigidly held by their connection with the casing. The elastic agent is first introduced into an initial pressure-chamber located midway between the central disks, and from such chamber the agent flows right and left to the inner pair of wheels, the agent entering the wheels at the inner edges of the disks and from thence passing radially outward between a disk and wheel and discharging at the periphery into exhaust-chambers, the latter serving also as pressure-chambers for the next wheels, and so on throughout the series of wheels. Enough of these wheels arranged in pairs are provided to substantially utilize the expansive energy of the elastic agent, steam, compressed air, gas, or whatever such agent may be, more or less of these wheels being provided according to the pressure to be employed. In combination with this multi-wheel turbine engine I use the automatic equalizer of end pressure shown and described in Patent No. 430,568 aforesaid, and this equalizer is found to be even more sensitive with my present motor than with my former motor because a slight endwise disturbance of the shaft will operate differentially on all of these wheels, whereas my former motor had but two of these wheels to be affected; consequently the play of the faces of the buckets toward and from their seats is practically so slight as to be imperceptible; yet the bucket-faces are always cushioned from rubbing contact with their seats. While I have shown a new layout of vents compounded upon wheels which at present I prefer, yet I do not wish to limit myself to any precise form of vents, buckets and guide-plates, or to the number of compoundings on a wheel. In my new layout the stationary guide-plates or chutes are curved to conform as nearly as convenient to the ordinary form used in the water turbine. The buckets also approximate the buckets of the water turbine except that they are V-shaped rather than U-shaped, the former being stronger than the latter and hence better adapted to withstand the great centrifugal force which the extreme speed of the motor generates. The relative areas of vent-passages through guide-plates and buckets are so proportioned that the highest velocity of flow will be through the inner legs of the buckets or V's, to the end that the full kinetic energy of the elastic agent may expend itself in a forward impelling flow against the apexes of the buckets.

In the accompanying drawings, Figure 1 is a side elevation, mostly in central section. Fig. 2 is an end elevation, partly in section. Fig. 3 is an elevation, partly in section, showing my improved layout of guide-plates and buckets. Fig. 4 is an elevation showing the inner face of one of the inner guide-plate-disks, and Fig. 5 is an elevation in transverse section of the same, showing more especially flange C^3.

A represents the central section of the shell or body of the engine, the same having a supporting base or flange as shown and having an internal flange *a* for attaching disks C C, the internal edges of this flange being screw-threaded and the hubs of these disks being externally screw-threaded for engaging the screw-threads of the flange. The inner faces of the hubs of these disks are separated to form an annular pressure-chamber L, the latter being in open relation with the induction-steam-pipe, as shown. Disks C C on their outer faces are provided each with two or more concentric series of curved guide-plates or chutes *c* curved substantially like the corresponding members of a water turbine, the opposing ends of next adjacent chutes overlapping but being separated slightly to form vents c'.

A′ A′ are the next outer sections of the shell, each section A′ having an internal flange a', such flanges being provided, on the outer faces thereof, with chutes or guide-plates *c*, vents c' and annular paths between the different series of guide-plates, the same as on the inner disks C C aforesaid. A^2 A^2 are similar shell sections, each having internal flanges a^2 a^2 provided with guide-plates as just described. The guide-plates of the different disks and internal flanges all present outward. The different sections of the shell are nicely fitted the one to the other and these together with the heads B B are usually fastened by bolting through and through as shown. The hubs B′ of heads B are constructed to form suitable journal bearings for shaft D. On this shaft is mounted a series of wheels E arranged in opposing pairs and facing inward or toward the adjacent disks bearing the guide-plates. Each wheel E on the inner face thereof is provided with two or more concentric series of buckets *e*, each series of buckets being made to run in an annular path between the guide-plates or radially outside the guide-plates. These buckets are preferably of the V-shaped variety shown more clearly in Fig. 3. These buckets overlap each other, more or less, the V or point of one bucket extending more or less between the legs of the next adjacent bucket, but are located a little nearer the inner leg of the next bucket so that the inner portion of a port e' will be a little smaller than the outer portion of the same port. The steam or other agent from the initial pressure-chamber L flows right and left past the inner edges of disks C C, and from thence passes radially across the faces of the inner pair of wheels E, of course, passing through the vents and ports of guide-plates and buckets and exhausting at the peripheries of these wheels into chambers L′ L′, these chambers serving as pressure-chambers for the next outer pair of wheels E, and so on throughout the series. The outer chambers L^3 connect with the exhaust-pipe M. By means of the compounding on each wheel aggregated by the different wheels, the kinetic energy of the steam or other elastic agent is supposed to be substantially utilized, so that the agent when it reaches the final exhaust, is substantially at atmospheric pressure, and of course there will be more or less wheels E and their corresponding stationary disks, according to the pressure employed, and inversely, according to the compoundings on each wheel.

My improved pressure balance for holding the shaft and wheels endwise may be substantially as shown and described in Patent No. 430,568 aforesaid, and may be briefly described as follows: F is a ring rigidly mounted on the shaft, for instance, between the hubs of the inner pair of wheels E, this ring being screw-threaded externally for engaging the internal screw-threads of ring G, whereby the latter may be adjusted lengthwise of the shaft, ring G extending into and dividing the initial pressure-chamber L between the opposing hubs C′ C′ of disks C C. Hubs C′ are provided with annular undercut grooves, C^2, whereby are constructed annular rims, C^3, on the inner faces of these hubs. Rims C^3 have lateral holes C^4 arranged preferably in three circumferential series, each series being concentric with the shaft and the next adjacent holes of the different series registering with each other radially, as shown more clearly in Fig. 4. The face of each rim C^3 is provided with annular grooves c^2 between and radially outside of the different series of holes C^4, and radial grooves c^3 are provided extending between the holes, these radial grooves connecting the outer grooves c^2 and extending from thence to the inner edge of the rim, this system of grooving leaving intact a flat surface around each hole C^4, but the elastic agent having passed these margins, has from thence free passage through the grooves to the inner edge of the disk. These holes are alike in size and number on the two rims and their aggregate capacity is several times greater than that of the annular spaces *i* i' between rims C^3 and ring G at the periphery; hence, a small clearance may be had between these members combined with ample eduction capacity from the primary pressure-chamber. The elastic agent passing through the inner pair of wheels, is exhausted into chambers L′ L′ had between the back or outer sides of these wheels and the back or inner sides of the next adjacent disks, and these chambers serve as pressure-chambers for the next outer pair of wheels, the fluid passing through these chambers to the inner edges of the next outer disks and so on throughout the series of wheels and disks, the outer chambers, in the present instance L^3, being connected by ducts cored in the different members A, A′, A^2, &c., and connecting with the general exhaust-pipe M.

I will here call attention to the fact, first, that if ring G were divided into two narrow rings, each narrow ring bearing the same relation to the opposing rim C^3 that ring G bore, the result would of course be the same whether the one broad ring or the two narrow rings were employed, and this being the case it will readily be understood, second, that if these two rings instead of being located in the central or primary pressure-chamber, were, under like conditions, located, for instance, in chambers L′ L′, or in chambers L^2, L^2, or in any two corresponding chambers throughout the series, the result would be precisely the same as with the construction shown.

It is more convenient and less expensive in manufacturing the engine to locate the equalizing mechanism in the central chamber, because, for instance, but one set of rings F and G is required, in which case there is but one ring to be adjusted. A^4 is merely a screw-threaded plug, by removing which access is had for internal adjustment. The number of compoundings necessary will, of course, be in proportion to the pressure employed, and suppose the number of compoundings required were twelve, in which case, if three compoundings were had on each wheel it would require four pairs of wheels, whereas if four compoundings were had on each wheel, but three sets of wheels would be required. These compoundings may be varied indefinitely according to circumstances. As aforesaid the pressure in the outer chambers is supposed to be reduced approximately to atmospheric pressure, and hence, no stuffing-boxes are required for the engine-shaft, and at the high speed of these engines it seems about impossible with any present known material to construct practical stuffing-boxes for this purpose, but were it not for such difficulty with the stuffing-boxes, the initial pressure might be introduced to the outer chamber and exhaust from the central chamber, and there might be conditions under which such arrangement would be advisable or even preferable, for instance, if the engine were operated inside a reservoir containing compressed air or elastic agent for operating the engine, or suppose it were desired to operate the engine inside a tube through which compressed air was conveyed to a mine or tunnel, such compressed air from the tube being used to drive the engine. In such cases if the compressed air were admitted first to the outer chambers of the engine no stuffing-boxes would be required for the reason that the pressure outside the engine would be greater than the pressure inside the engine. If, for any reason such arrangement as last referred to of the engine were desirable, any skilled mechanic would have no trouble in so doing, to wit,—the bucket wheels would be reversed on the shaft so as to present outward and the guide-plate disks would have to be reversed so as to present inward, and all this would necessitate a change before referred to, to wit, dividing the pressure regulator and placing it in halves at the eduction of two corresponding chambers on opposite sides of the central chamber.

What I claim is—

1. In a turbine engine of the variety indicated, the combination, with two equal and opposing series of bucket-wheels and co-operating guide-plate-disks and chambers, of pressure-equalizers of the class specified and located so as to control the induction of two corresponding bucket-wheels of the opposing series of bucket-wheels, substantially as set forth.

2. In a turbine engine, in combination, a casing constructed in transverse sections, each section having an internal flange, the flange of the central section having guide-plate-disks attached thereto, the other internal flanges serving as guide-plate-disks, the disks of the respective series of disks having outwardly-presenting faces and corresponding number of bucket-wheels arranged in opposing series and mounted on a shaft in common, the two series of wheels facing inward, guide-plates and buckets arranged respectively on the faces of the disks and wheels, the buckets being adapted to travel in annular paths between the series of guide-plates or radially outside the latter, substantially as set forth.

3. In a turbine engine, in combination, with casing having a series of internal flanges, and mounting within the casing a shaft upon which are fixed four or more turbine bucket-wheels arranged in two equal and opposing series, each wheel carrying upon the one side thereof and concentric therewith two or more series of buckets, the buckets of the one series of wheels facing toward the buckets of the other series of wheels, of guide-plate-disks corresponding in number and position with the bucket-wheels and fixed in the shell to partition the shell into separate chambers, each guide-plate-disk carrying upon one side and concentric with such disk two or more series of guide-plates, the guide-plates being on the outwardly-presenting faces of each disk, the guide-plate-disks and bucket-wheels being in such working relation with each other that the impelling elastic agent shall flow alternately through guide-plate-vents

and bucket-ports in radial direction from within outward toward the circumference, substantially as set forth.

4. The combination, with motor-case, shaft, four or more turbine bucket-wheels in two equal and opposing series, the buckets of the one series of wheels facing toward the buckets of the other series of wheels, guide-plate-disks corresponding in number and position with the bucket-wheels and having outwardly-presenting guide-plate-disks which co-operate with the respective buckets, of one or more disks or rings within the central pressure-chamber and adjusted upon the shaft to run with narrow clearance between two annular face-plates fixed respectively to each end of the central chamber and in axial coincidence with the shaft, substantially as set forth.

5. The combination, with motor-case, shaft, four or more turbine bucket-wheels, a like number of guide-plate-disks, each bucket-wheel and each guide-plate-disk carrying upon its working face and concentric therewith two or more series respectively of buckets and guide-plates in such working relation with each other that the impelling agent shall flow alternately through guide-plates, vents and bucket-ports in radial direction from within toward the circumference, of one or more disks or rings located within the central pressure-chamber and adjusted upon the shaft to run with narrow clearance between annular face-plates fixed respectively to each end wall of such central chamber, substantially as set forth.

6. The combination, with shaft, two series of bucket-wheels having the buckets of the one series facing the buckets of the other series and guide-plates co-operating with the buckets, a case having in axial line with each other a central pressure-chamber, two exhaust-chambers and one or more pairs of intermediate chambers symmetrically located right and left of the central chamber, of two disks or rings adjusted true upon the shaft and running, respectively, in any two symmetrically related intermediate pressure-chambers, each disk or ring running with narrow clearance from the face of an annular fixed face-plate attached to the eduction-end of the chamber and in axial coincidence with the shaft, substantially as set forth.

7. The combination, with a shaft, two series of bucket-wheels, each wheel having two or more series of buckets concentric therewith, all the buckets of the one series of wheels facing toward the buckets of the other series of wheels, guide-plates in working relation with the buckets, a case in which are arranged in axial line with each other a central pressure-chamber, two exhaust-chambers and one or more pairs of intermediate chambers symmetrically located right and left of the central chamber, of disks or rings adjusted upon the shaft and running respectively in any two symmetrically related intermediate chambers, each disk running with narrow clearance from the face of an annular fixed face-plate attached to the eduction end wall of the chamber, substantially as set forth.

8. In combination, a shaft, four or more bucket-wheels mounted thereon in opposing pairs, a corresponding number of guide-plate-disks so arranged that the guide-plates thereof co-operate with the opposing buckets, an automatic pressure-regulator substantially as indicated, and a case composed of short sections, the central section containing the initial compression-chamber and each added section of the shell on either side of the central chamber bearing a disk or internal flange whereby is added another chamber of the casing, the outer chambers being connected with an exhaust in common, heads secured to the end of the case, the hubs of these heads carrying journal-boxes for the shaft, substantially as set forth.

9. In combination, a case constructed in transverse sections inclosing a corresponding number of chambers, a bed-plate integral or rigid with the central section, the end chambers being connected by passage-ways with an exhaust located in the bed-plate, of shaft mounting four or more bucket wheels in two equal and opposing series and corresponding stationary guide-plates, a pressure equalizer substantially as indicated and located so as to regulate the induction to two corresponding bucket-wheels of the opposing series of wheels, substantially as set forth.

10. In a turbine engine of the variety indicated, in combination, a bucket-wheel and an opposing stationary guide-plate-disk, such disk bearing one or more series of curved guide-plates arranged in concentric order with the engine-shaft, the ends of the next adjacent guide-plates of a series overlapping each other and separated by suitable vents, the buckets being of the V-shaped variety shown, the V or apex of a bucket extending more or less between the legs of the next adjacent bucket, but being separated by angular ports between next adjacent buckets of a series of buckets, the inner branch of such ports being less in cross section than the outer branch of the same port, the aggregate discharging capacity of the ports of a series being less than the aggregate discharging capacity of the vents of a series of guide-plates, substantially as set forth.

11. In a turbine engine of the variety indicated, the combination, with engine case and shaft, of bucket-wheels mounted on the shaft in opposing series so as to balance the end-thrust of the shaft, of stationary guide-plate-disks arranged in series corresponding with the bucket-wheels, substantially as set forth.

12. In an elastic fluid compound turbine engine of the variety indicated, the combination, with motor-case and mounted within it a shaft upon which are fixed four or more turbine bucket-wheels arranged in two equal and

opposing series, the one series having buckets upon the right hand face of each wheel, and the other series having buckets upon the left hand face of each wheel; of guide-plate-disks corresponding in number and position with the bucket-wheels, and fixed in the motor-case to partition it into separate chambers, the guide-plates upon each guide-plate-disk being in working relation with the buckets of the adjacent bucket-wheel, substantially as set forth.

In testimony whereof I sign this specification, in the presence of two witnesses, this 26th day of November, 1890.

JOSEPH H. DOW.

Witnesses:

C. H. DORER,

WARD HOOVER.