(No Model.) 3 Sheets—Sheet 1.

A. RIGG.

ENGINE.

No. 368,424. Patented Aug. 16, 1887.

FIG 2

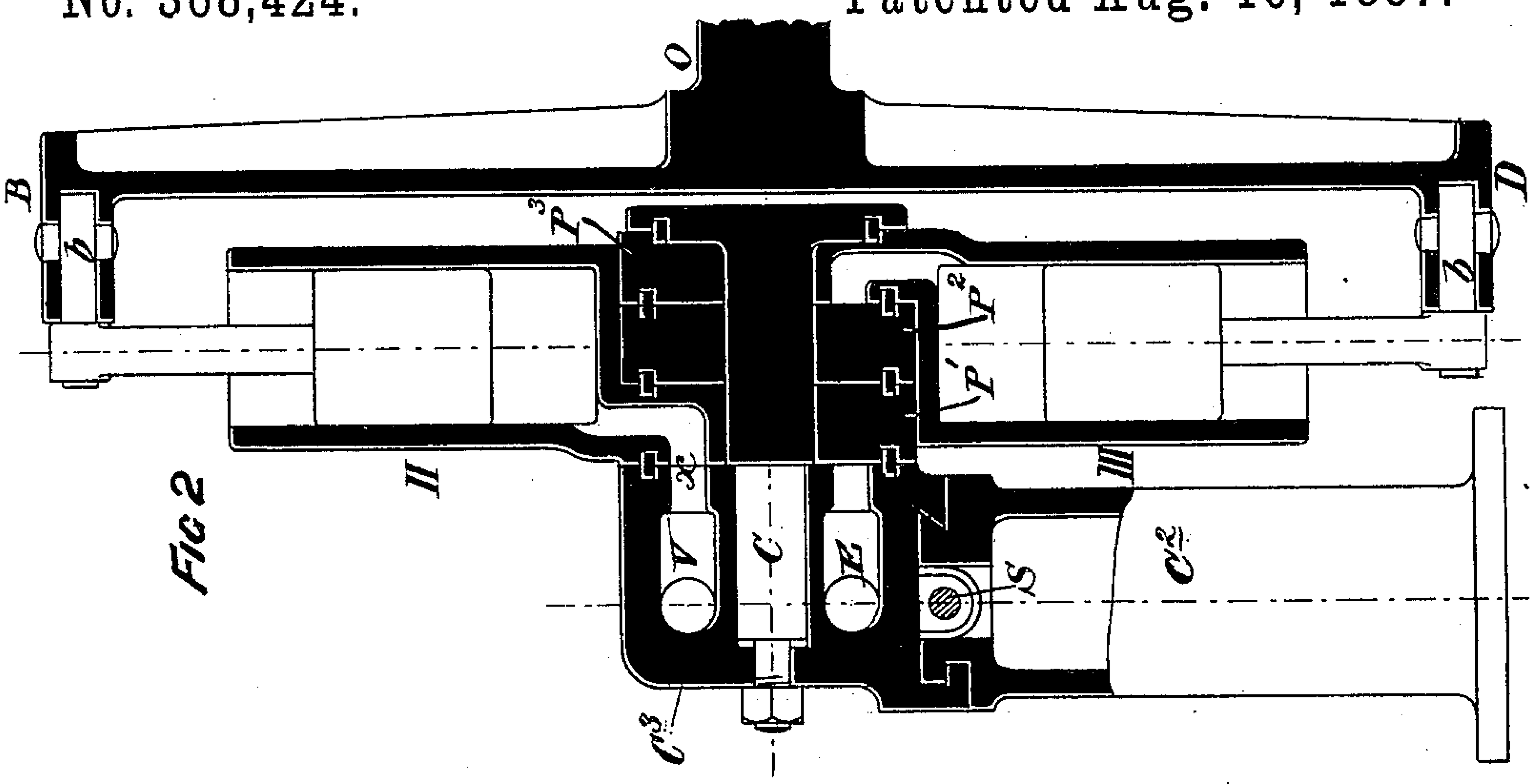
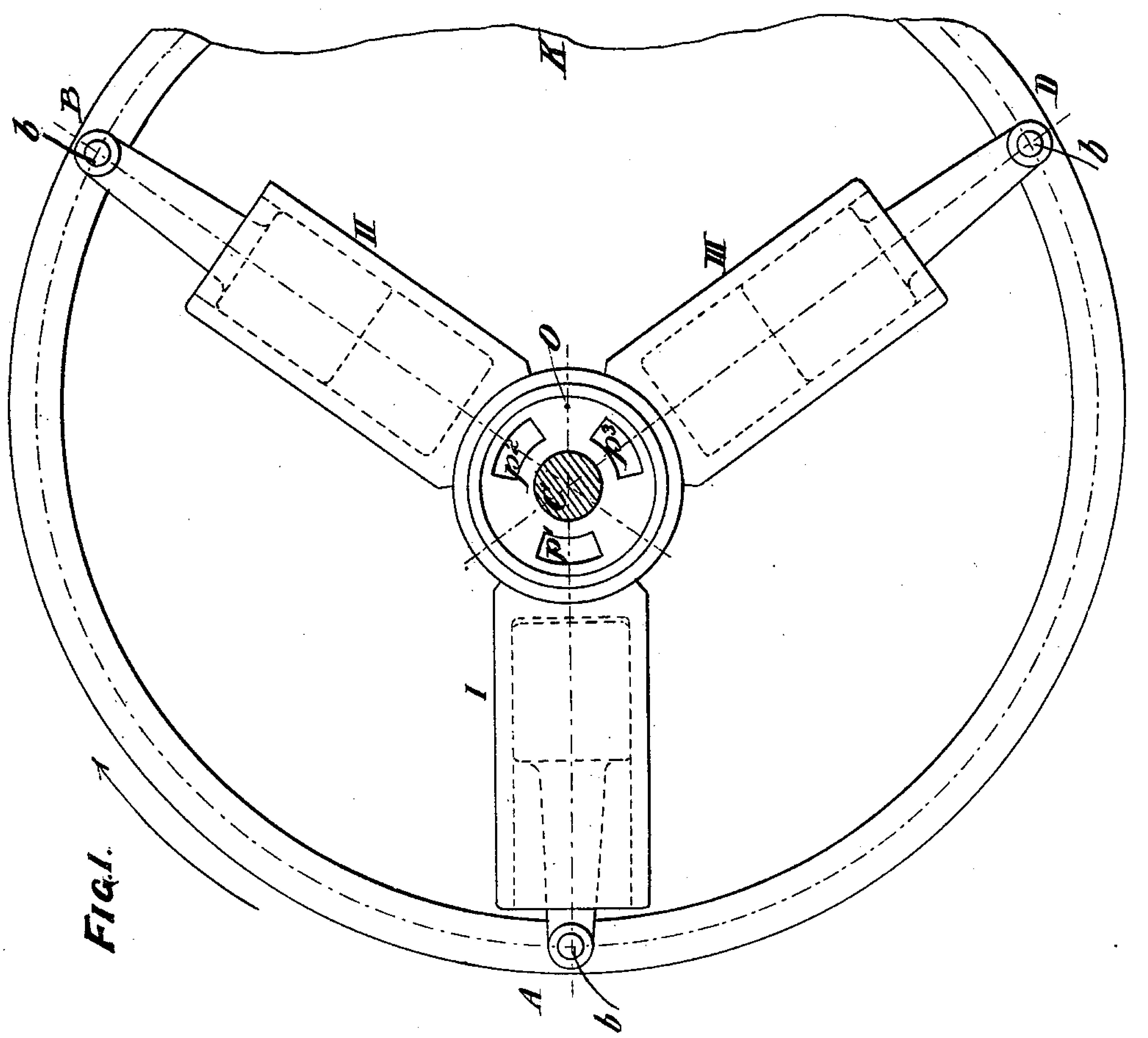


FIG.1.



Witnesses:
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John E. Parker,

Inventor:
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Howson & Sons

(No Model.)

3 Sheets—Sheet 2.

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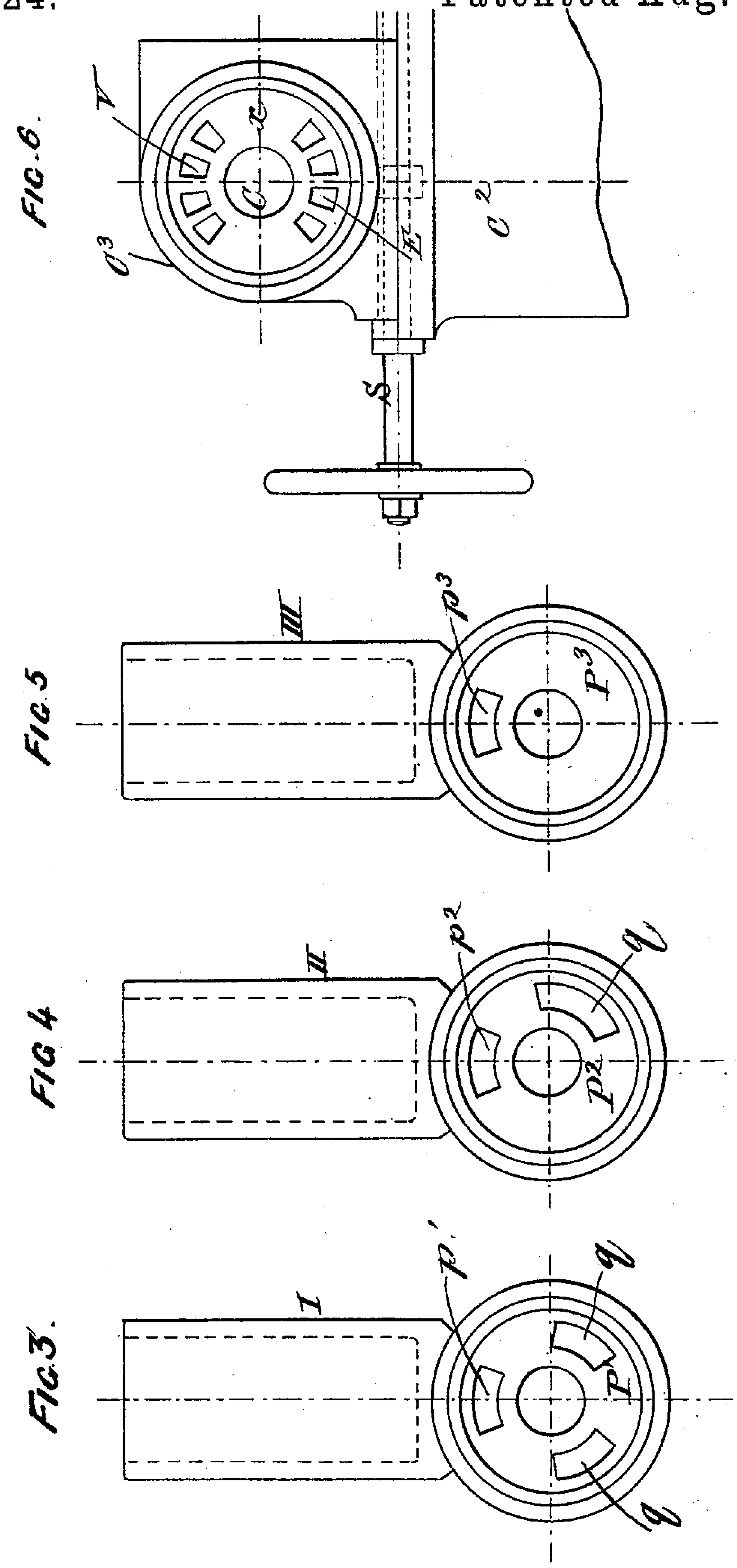

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FIG. 9.

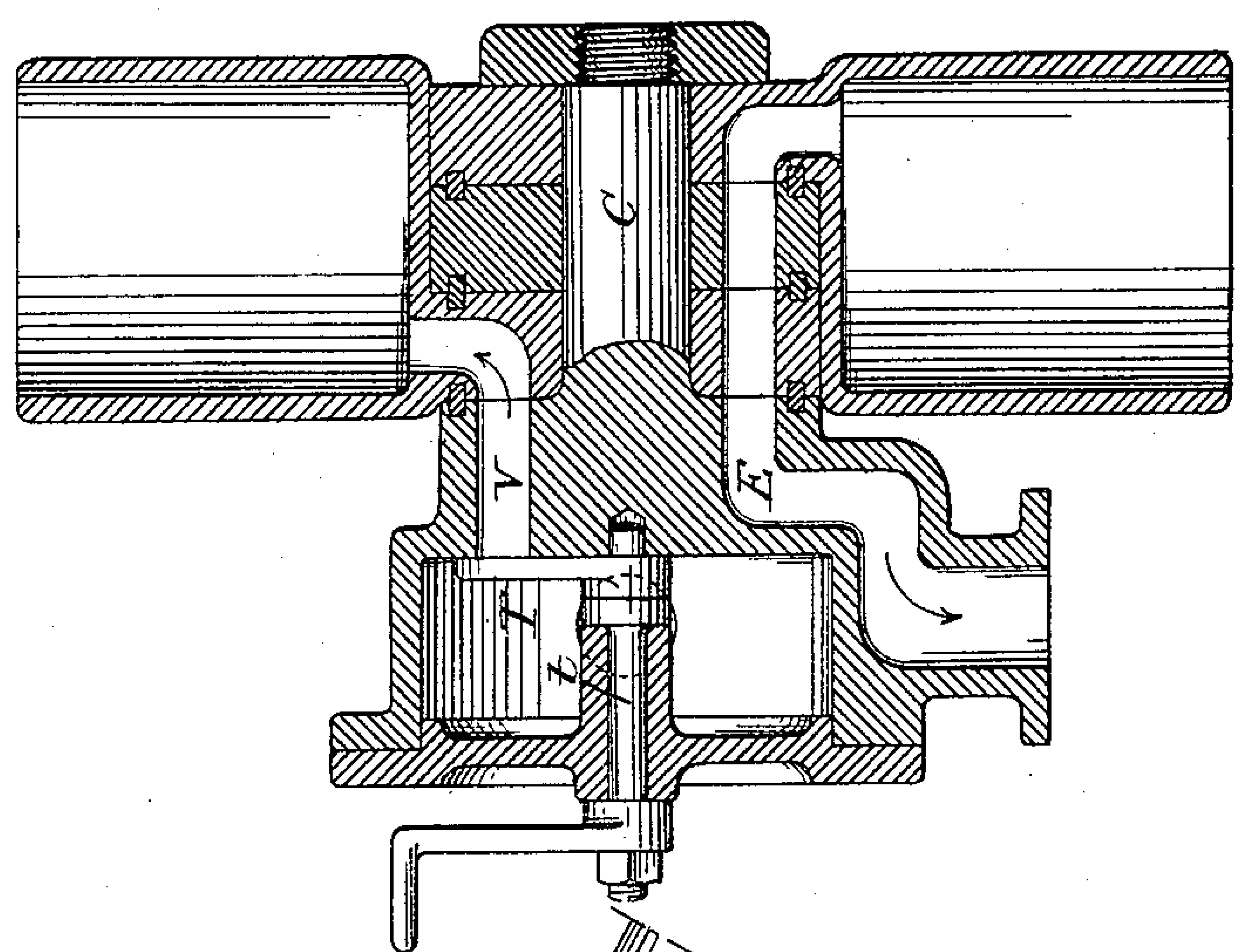


FIG. 8.

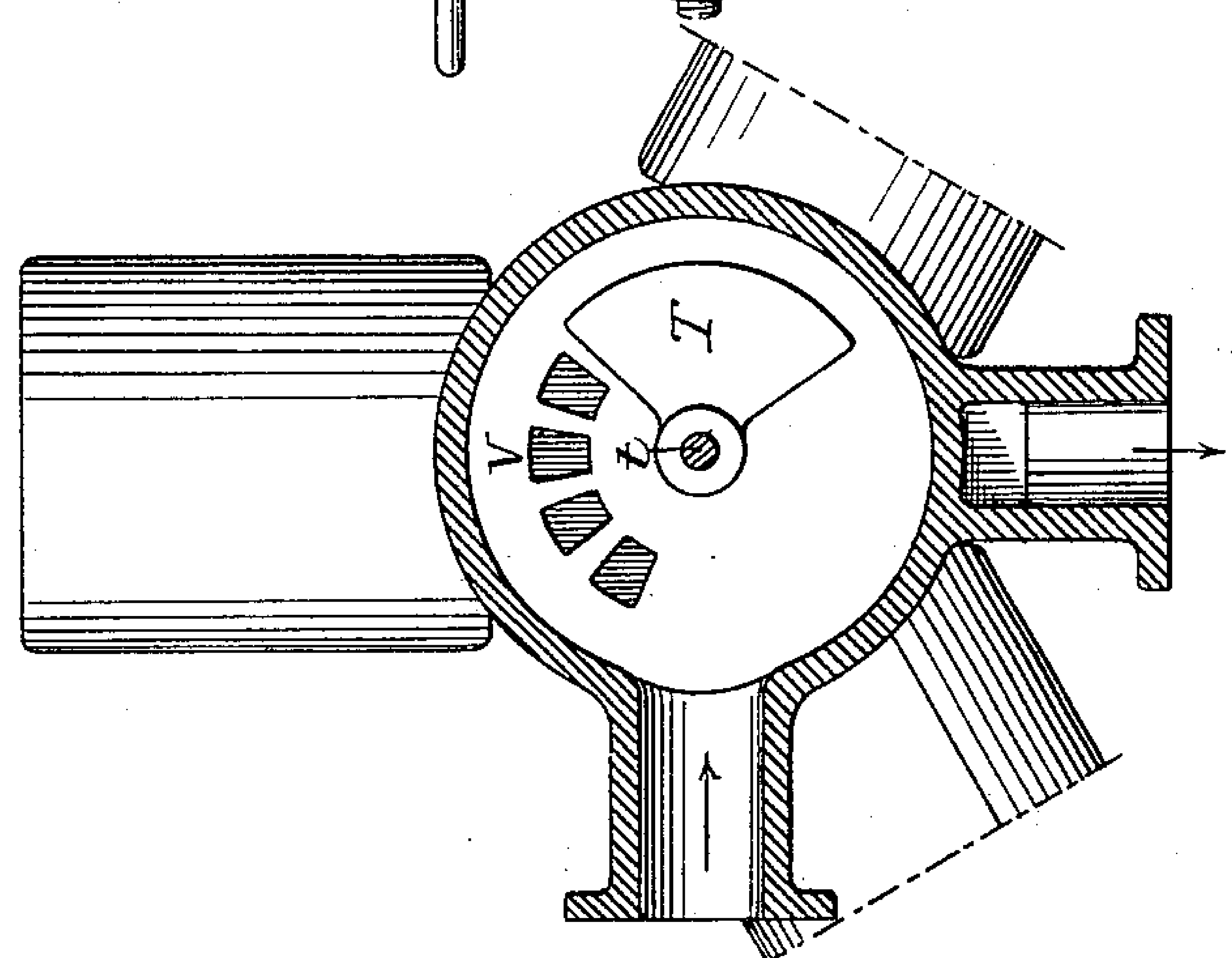
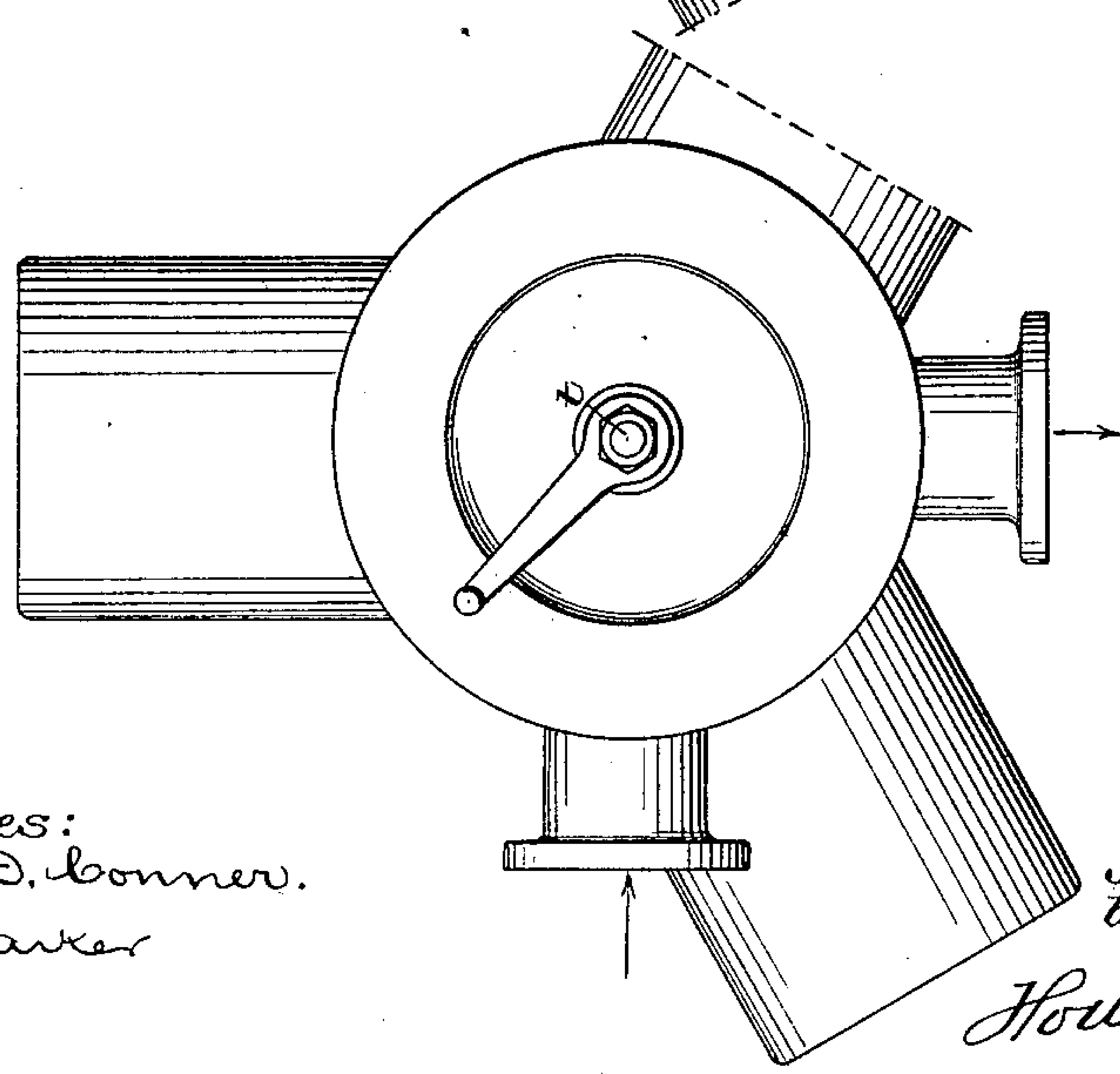


FIG. 7.



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UNITED STATES PATENT OFFICE.

ARTHUR RIGG, OF LONDON, ENGLAND.

ENGINE.

SPECIFICATION forming part of Letters Patent No. 368,424, dated August 16, 1887.

Application filed February 2, 1886. Serial No. 190,599. (No model.) Patented in England May 16, 1885, No. 6,047.

To all whom it may concern:

Be it known that I, ARTHUR RIGG, a subject of the Queen of Great Britain and Ireland, residing in London, England, have invented certain Improvements in Engines, (for which I have obtained British Patent No. 6,047, dated May 16, 1885,) of which the following is a specification.

My invention consists of certain improvements in the construction of that class of rotary engines in which a number of motive-power cylinders are caused to revolve around one center, while the pistons with their rods revolve around another center; and my invention further consists in means for obtaining a scientific method of regulation, either by altering the stroke (where a non-elastic medium is the power) or by varying the rate of expansion, (where an elastic fluid is the source of power.)

In the accompanying drawings, Figure 1 is a front elevation, and Fig. 2 a transverse vertical section on the lines B D, Fig. 1, of an engine embodying the special features of my invention. It is represented as having three cylinders, numbered I, II, and III, respectively; but the exact number of cylinders employed may be varied, as desired. Figs. 3, 4, and 5 represent front views of the three cylinders taken apart, so as to indicate the construction of their ports more plainly than can be seen in Fig. 1, where these cylinders are superposed on each other. Fig. 6 represents a front view of the distributing-valve, showing its inlet and outlet ports. Figs. 7, 8, and 9 are views of a device whereby variations in the rate of expansion of the elastic motive fluid may be obtained.

The circle A B D, Fig. 1, may be regarded as the rim of a wheel. This wheel is overhung upon its bearings and is free to turn upon and around a center marked O, Fig. 2. Projecting from its circumference there are studs b, as many in number as there may be single or double acting cylinders constituting one engine. These are equidistant and at angles of one hundred and twenty degrees apart when three cylinders are used. On another center, which may be at a fixed or changeable distance or eccentricity from O, around which the above-mentioned wheel revolves, there is a stud, C, mounted on any suitable standard or support, as at C^2. This stud C serves as a center around which each and every cylinder revolves.

The piston of the cylinder I is represented at the bottom of its stroke and ready to receive pressure. The piston of the cylinder II is represented as having moved partly out, and when each cylinder reaches the point K its piston will have reached the extreme limit or end of a stroke, and exhaust should have begun. Thus during half of a revolution (from A to K) the pistons move out, while in half a revolution (from K to A) the pistons move in.

It will be understood that the piston of each cylinder in revolution passes through corresponding phases, all the said pistons successively traveling radially outward or inward distances each equal to twice the distance apart or eccentricity of the centers O and C, and these movements or reciprocations are not absolute in relation to the earth, but only relative in regard to cylinders and pistons, respectively.

To each cylinder there is a port, (marked p' p^2 p^3 for the cylinders I, II, and III, respectively.) In the drawings these ports are shown as being made through the central bosses, P' P^2 P^3, with which the cylinders are furnished, and by means of which they are mounted to turn upon the pin C. P' is the boss of the cylinder I, P^2 is the boss of the cylinder II, and P^3 is the boss of the cylinder III. The inlet and exhaust passages are shown at V and E, illustrated as being made through an adjustable piece, C^3, on the standard or support C^2 for the center C. The passages from the cylinders made through the aforesaid bosses and communicating with these passages V and E bend to a right angle, as shown in Fig. 2, and form channels from inside the cylinders to the passages V and E, which open on a faced side, x, of the piece C^3, against which the boss P' bears. The openings of the said passages at the face x have a radius corresponding to that of the slots in the cylinder-bosses, as seen in Figs. 3, 4, 5, and 6, which respectively show the passages or ports through the bosses of each cylinder and the face x, the said passages or ports being marked p' p^2 p^3. The passages marked q are those made through the bosses of the cylinders I and II, to allow inlet to and exhaust from the cylinder or cylinders behind them to pass through the said bosses.

The valve-slot V serves as inlet to, and the other, E, for exhaust from, each cylinder as the port in its boss revolves and comes opposite to one or other of the valve-ports V and E. The slots or passages q q through the boss of the cylinder I are superposed over the ports p^2 and p^3 of the cylinders II and III when these are in their proper working position, and the slot or passage q in the boss of the cylinder II similarly is superposed over the port p^3 of the cylinder III, so that an open passage is always provided for the supply and exhaust of cylinder II through the boss of the cylinder I, and also for cylinder III through the bosses of the cylinders I and II. It is obvious that however many cylinders may be employed in one engine similar provision can be applied.

An engine constructed according to my invention can be driven either by an elastic or by a non-elastic fluid pressure, or by explosions of mixed gases requiring only appropriate distribution of ingress and egress for the particular motive agent employed.

When an engine thus constructed, as already described, and illustrated by Figs. 1, 2, 3, 4, 5, and 6, is intended to be driven either by an elastic-fluid pressure—such as steam—or by a non-elastic-fluid pressure—such as water—it can be governed (that is, regulated as to speed or power) by a throttle-valve or its equivalent, diminishing the pressure as required, and such valve may be controlled by a governor. This method, however, is not conducive to an economical use of either an elastic or a non-elastic fluid, and it is desirable to adopt a construction which shall enable variations to be made in the point where expansions begin when an elastic fluid is used, and to vary the volume of a non-elastic fluid without altering the number of revolutions an engine thus driven shall make in any given time. The details of these systems differ somewhat from each other, and I will now proceed to describe my method for varying the rate of expansion in the case of an engine constructed according to my invention and intended to be driven by an elastic fluid.

Whatever permanent relationships subsist as to the commencement or termination of exhaust can be determined by a fixed angular length of its port in conjunction with that of the cylinder-port in question. Similarly, any desired "lead" for the inlet can be permanently fixed by proper location of the leading end of the port from which a supply is obtained.

The point of cut-off—that is, where expansion begins—is determined by the angular location of the hinder end of that port from which a supply is obtained, and so long as the termination of such port remains fixed so long will the rate of expansion remain constant, just as in an ordinary engine unprovided with a variable cut-off valve, and any change in the angular length of an inlet-valve port or of the cylinder-ports, by adding to or taking from the hinder end thereof, will cause a corresponding change in the cut-off and in the rate of expansion. I take advantage of this expedient for the purpose of regulating how much elastic fluid shall be used in such engines as are made with revolving cylinders having means for inlet and exhaust arranged substantially as herein described, and intended to be governed by placing their rates of expansion under the control of any suitable or convenient regulating influence, whether operated by hand or by governor.

A method by which changes can be made in the angular length of an inlet-port is shown by Fig. 6. It consists in dividing the inlet-port as to its angular length into spaces, and these can be successively closed by a slide or shutter, T, turning on a center, t, Figs. 7, 8, and 9, passing over and closing one or more spaces successively, as desired. This shutter therefore constitutes an expansion-valve, and by connecting it or any other valve arranged to effect a corresponding result to any suitable governor an automatic regulation of expansion can be secured and a regular speed maintained, as already well understood in relation to ordinary engines. Whether steam or other elastic fluid be expanded in each cylinder, as in simple engines, or whether it be expanded in more than one cylinder, as in compound or triple expansion engines, arrangements can be carried out by which such engines shall be regulated by varying their rates of expansion and by placing such changes under the control of a proper governor.

For marine and other purposes it may be desirable to provide an engine that can be reversed, or that can be reversed and also regulated, by having its rates of expansion variable at will in either one or both directions of motion. So far as mere reversal is concerned a simple removal of the centers of motion of cylinders and wheel, respectively, will accomplish that object, (as described for inelastic-fluid engines;) but for elastic-fluid engines I prefer to use a valve that changes inlet into outlet, or vice versa.

When it is desired to construct a compound engine according to my invention, two distinct sets of wheels and cylinders, as described, may be arranged to drive opposite ends of the same shaft, one set exhausting into the other, or such engines can drive independent shafts; or, if preferred, compound engines can be constructed, according to my invention, as one system of cylinders revolving on the same stud, permitting steam or other elastic fluid to expand in two or more cylinders consecutively.

When it is desired to regulate or govern the power of an engine constructed according to my invention that is intended to be driven by a non-elastic fluid—such as water—I alter the piston-stroke, while always admitting a full supply of such fluid, and this alteration in stroke is brought about by changing the eccentricity or distance between those centers upon which the wheel and cylinders respectively revolve. As the centers O and C, Fig. 1, approach each other, so does the piston-stroke and therefore the engine-power diminish until they coincide, in which case there would be no piston-stroke as the engine turned round. Indeed, whatever may be the eccentricity or distance measured between the center of main shaft and that of the stud, around which all the cylinders revolve, it will be found exactly one-half of whatever stroke the pistons may have in relation to the cylinders, just as in an ordinary reciprocating engine the piston-stroke usually equals twice the radius of its crank.

In engines constructed according to my invention any change in eccentricity or distance between the centers and the main shaft and cylinders causes an alteration in the stroke of all the pistons in relation to all the cylinders of any one motor, and I take advantage of this circumstance for regulating such prime movers as are intended to be driven by inelastic fluids for determining the amount of fluid-pressure expended during each revolution. This control may be exercised by hand or by a governor, so as to secure a uniform or nearly uniform speed of rotation and proper relationships between speed, power, and expenditure of pressure.

Whenever, therefore, an engine constructed according to my invention, with separate revolving cylinders, is required to give a variable power, or has to be governed or regulated as to speed, power, or quantity of fluid expended, I take advantage of the ready means for changing the stroke of all the pistons by simply varying the distance between the centers C and O of cylinder and wheel, respectively. Thus the quantity of fluid is caused to vary as desired. If it be arranged that the center C shall travel beyond the center O toward the opposite side—namely, toward K, Fig. 1—then motion will recommence and power will increase until C approaches and at last reaches its final limit toward K; but the direction of such movement will be reversed. Thus from an engine so provided power can be had in either direction of motion.

In Figs. 2 and 6 the stud or center C, upon which all the cylinders revolve, is shown upon a slide which can be moved backward or forward and held in any position, so as to give any desired eccentricity, and thus any desired stroke to the pistons. Such movement of the center C can be produced by the direct action of a feed-screw, S, Figs. 2 and 6, by hand or otherwise; but where a relay action is desired, hydraulic rams may be employed to provide whatever power may be needed to produce the required changes of eccentricity. When governing a non-elastic-fluid engine so provided with hydraulic rams, valves may be arranged to determine their movements, and such valves may be placed under the direct control of a governor.

Engines with revolving cylinders can be constructed according to my invention to be driven by explosions of gases, and necessary supplies (say of coal-gas and atmospheric air) can be provided by pumps of any usual construction, or else some one or more of the revolving cylinders may serve as pumps, while others receive those impulses which set the entire system in motion. The valve arrangements already described will suffice to explain how inlet and outlet can be arranged and modified, however desired; only it may be generally advisable that inlet of gases shall occupy a separate portion of the valve or opposite faces of such as are concerned with determinations of explosions.

When an engine constructed according to my invention is driven by extraneous power in a direction opposite to that of its own proper motion, and its usual exhaust can draw a supply of fluid, then the motor becomes converted into a pump, and a pump of varying capacity, when used with a non-elastic fluid, whenever the eccentricity is capable of regulation, as described. These features are of importance when such an engine is used for such purposes as hoisting, as its power can be varied according to demand, and, moreover, it can be changed into a pump for lowering or the like, and it will thus serve as a brake, pumping back some of the fluid into the main supply at the same pressure as originally received.

I wish it to be understood that I do not confine myself to the use of any particular number of cylinders, nor do I restrict myself to the exact and only details of construction which have been described; but I hold myself free to make use of any known or convenient mechanical contrivance or combination that may be useful in conjunction with the main or essential features of my invention.

I claim as my invention—

1. A rotary engine having a number of cylinders separately mounted upon a common stud or center, on which they revolve, with a wheel which turns upon another center and to which the piston-rods are connected, substantially as described.

2. A number of cylinders having separate bosses provided with inlet and exhaust ports, and a central stud upon which said cylinders are separately mounted by their bosses, in combination with pistons and a wheel to which the piston-rods are connected, all substantially as specified.

3. A rotary engine having separate cylinders revolving around a common center and adapted to vary their angular positions relatively to each other during revolution, and having means, substantially as set forth, for varying the rate of expansion of the motive fluid or the strokes of the pistons, all substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ARTHUR RIGG.

Witnesses:
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CHAS. JAS. JONES,
Both of 47 Lincoln's Inn Fields, London, W. C.