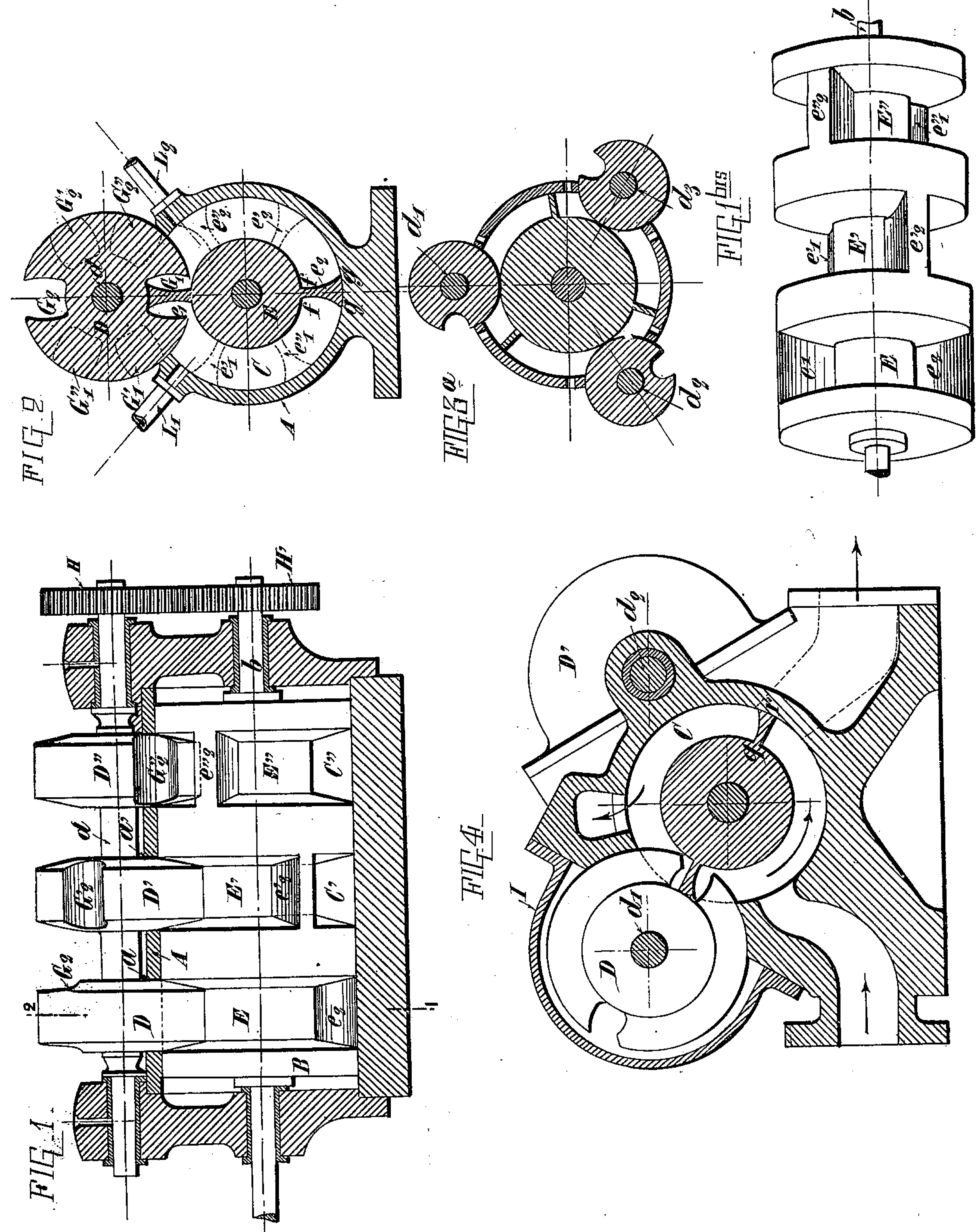
No. 646,151. Patented Mar. 27, 1900.

L. J. JEAN-BAPTISTE LE ROND.

ROTARY ENGINE.

(Application filed May 24, 1898.)

(No Model.) 2 Sheets—Sheet 1.



WITNESSES:

P. Cameron

[signature]

INVENTOR

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ATTORNEYS.

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FIG. 6.

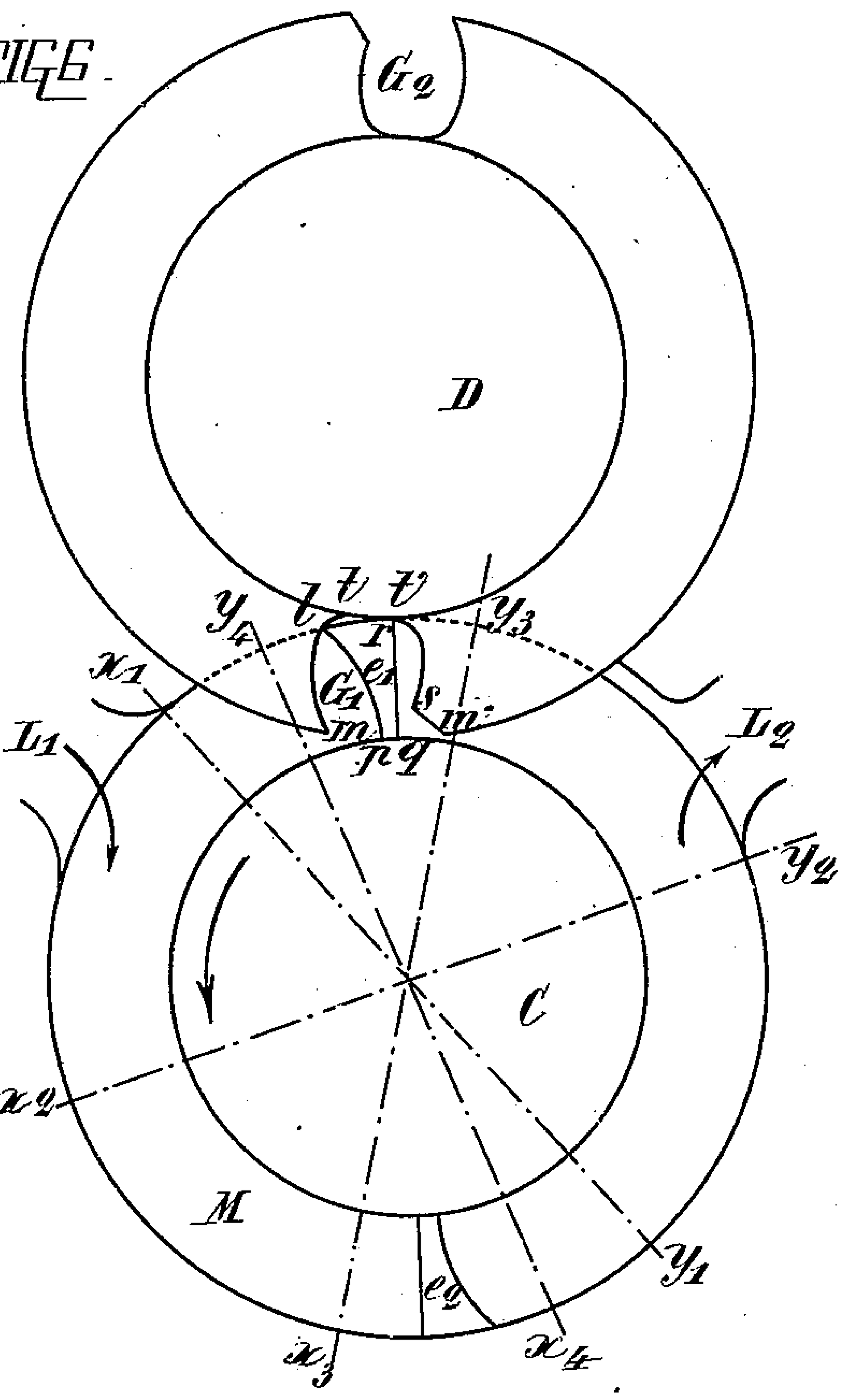


FIG. 3.

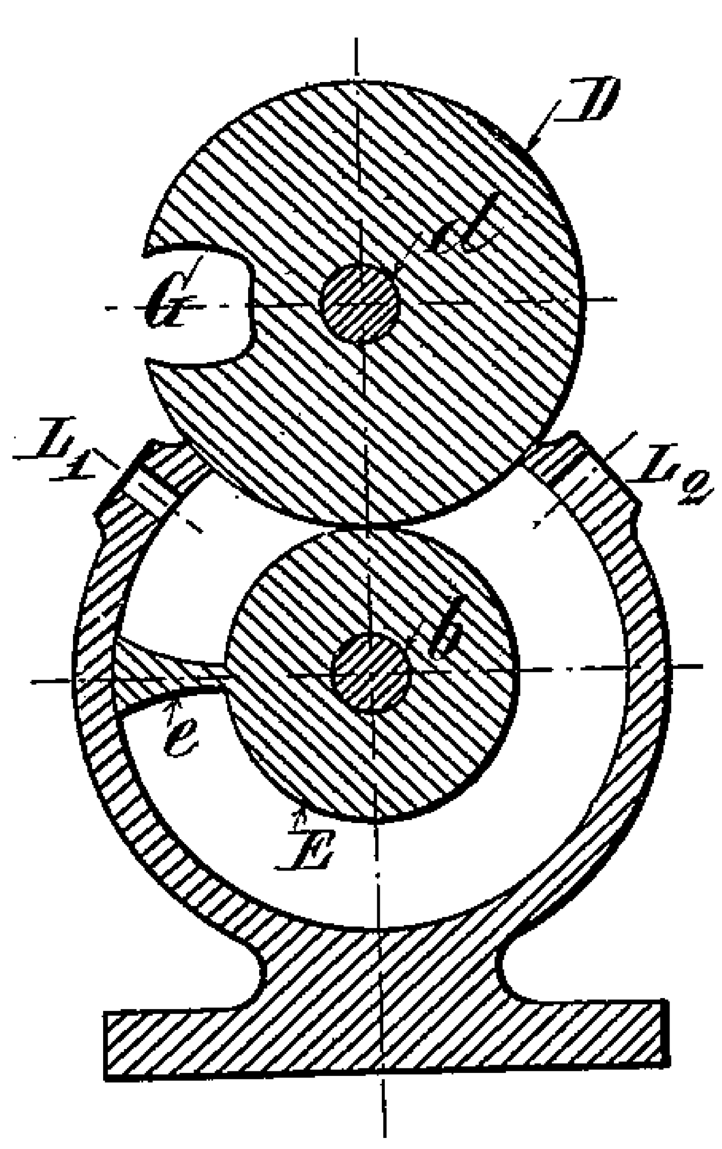
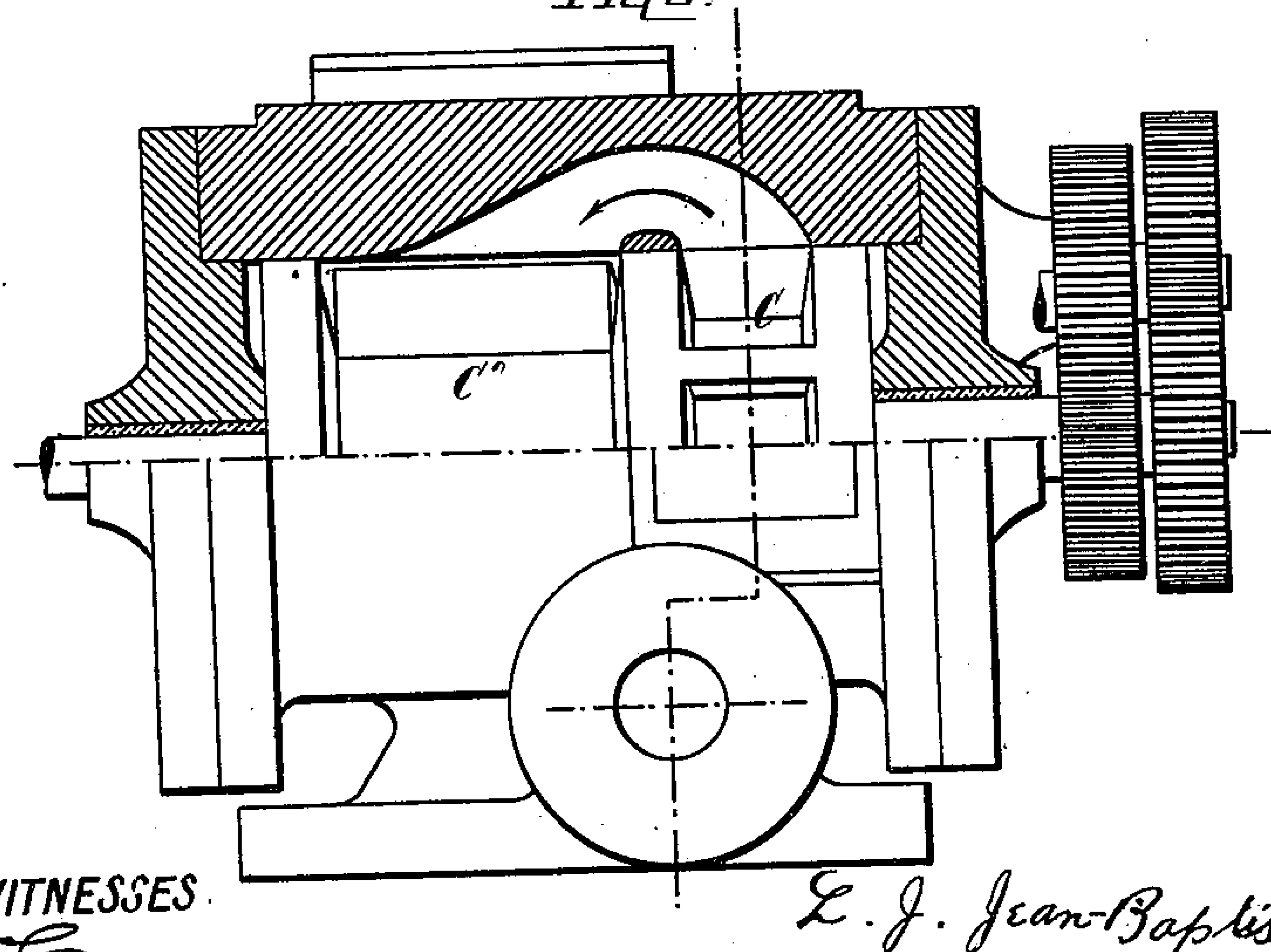


FIG. 5.



WITNESSES

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UNITED STATES PATENT OFFICE.

LOUIS JULES JEAN-BAPTISTE LE ROND, OF PARIS, FRANCE.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 646,151, dated March 27, 1900.

Application filed May 24, 1898. Serial No. 681,637. (No model.)

To all whom it may concern:

Be it known that I, LOUIS JULES JEAN-BAPTISTE LE ROND, a resident of Paris, in the Republic of France, have invented a new and useful Rotary Engine, which is fully set forth in the following specification.

My invention relates to a new rotary engine which can work either with or without distributing-valves—that is to say, this engine is so disposed that fluid can be let in either as a continuous stream or at intermittent periods.

Referring to the accompanying drawings for an easier explanation of my invention, Figure 1 is a longitudinal section of a three-tore engine without distributing-valves. Fig. 1^{bis} is a perspective view of the motive cylinder of said three-tore engine. Fig. 2 is a transverse section of the same engine through motive tore C. Figs. 3 and 3^a are transverse sections of engines of my plan which work in connection with distributing-valves, said valves not being shown in the drawings. Fig. 4 is a transverse section through the high-pressure tore of a double-expansion engine of my plan with high and low pressure tores. Fig. 5 shows half of a side view and half of a longitudinal section of the same engine. Fig. 6 is a schematic diagram which is intended to illustrate the various phases of a full revolution of the engine and as an example some profiles which may be given to some of its principal parts.

In the three-tore engine, which is shown by way of example in Figs. 1, 1^{bis}, and 2, essential parts are the following:

A is a fixed cylindrical casing, through which are cut openings a a' a'', the use of which shall be further explained.

B is the rotary or motive cylinder, fixed upon the main shaft b, the whole being concentrically mounted inside of the case A. The cylinder B may be fixed in any way to its shaft b or may be turned solid with it on the lathe. The internal diameter of the cylindrical casing A exceeds but by a very small quantity the external diameter of cylinder B in such a way that, according to concentricity, the cylinder B can rotate inside of its casing A without any friction, however small the play may be between both. Cylinder B bears in the example three annular grooves C C′ C″ or hollow or female tores, which are the motive tores, corresponding to cuttings a, a', and a'' in casing A, above mentioned. It is obvious from the very construction of the engine that the cylinder B may bear instead of three any number of grooves of any different or equal dimensions.

D D′ D″ are rotary abutments or male tores, which may be mounted either on one single shaft d, as in Figs. 1 and 2, or on independent shafts d^1 d^2, as in Figs. 4 and 5, said shafts being parallel to each other and to the main shaft b. These male tores D D′ D″ have within a minimum play the same transverse profile as the female tores C C′ C″, so as to fit closely into their grooves. Shaft d or shafts d^1 d^2 may be supported by any style of bolsters, but for this condition that the bulb of the male tores must remain constantly engaged into the grooves or female tores and closely fit into them. Under the stated conditions above—viz., penetration and fitting—the profile of the tores may be any curved or broken lines. Tores D D^3 D″ are fastened to their shaft d or to their respective shafts d^1 d^2 d^3 by any proper means.

Hollowings a, a', and a'' cut through casing A are intended to allow the male tores D D′ D″ to project inside of the casing and to fit into female tores C C′ C″, as aforesaid. These hollowings have therefore, but for a minimum play, the geometrical form necessary to allow said penetration.

Each female tore has two parts L^1 L^2 for the inlet (or suction) and exhaust (or forcing) of fluids, and each groove of cylinder B is divided by diaphragms or pistons e' e^2 e' e'_2, and to these diaphragms or pistons correspond in the male tores D D′ D″ recesses or notches G^1 G^2 G' G'_2, which are designed to allow the pistons to pass through the male tores as the cylinder B and the male tores rotate in unison by the effect of a proper gearing connecting their respective shafts.

It must be noticed that by using at least two diaphragms to a groove and geometrically-reciprocal profiles for the diaphragms e' e^2 e'_1 e'_2 and notches G^1 G^2 G' G'_2 no direct flow of the fluid from inlet to exhaust can take place during rotation, and the engine can therefore work without any distributing valve or slide. Being so constituted, the engine is composed with grooves or female tores that act as the cylinders of ordinary steam engines or pumps and the tightness of which can be simply obtained by means of the quick rotation of parts moving as closely as convenient side by side without any friction.

Before I describe the working of the engine I will remark that the parts above described are subject to vary in form and constitution without altering the engine.

The cylinder B (and casing A accordingly) may be turned solid or be built from annular parts of any respective dimensions or from any separate parts. The only condition is that each built member must act as a solid member. Diaphragms may have symmetrical or unsymmetrical profiles. Even in the valveless engine special valves or slides may be used in order to reverse motion. Tores D may be, as shown in Fig. 4, inclosed in a casing in order to avoid deperdition of heat and to limited leakage, and the engine can be worked either without valves (the fluid being allowed to flow in continuously) or with any style of distributing valves or slide, Figs. 3 and 3ᵃ. When such valves are used, a single piston-diaphragm suffices in each female tore.

Let us suppose that we consider a steam-engine, for instance, and that Fig. 6 shows the diagram of a tore of the "continuous-steam" or "valveless" type—viz., that works without any distributing-valve. 1 is the steam-port, and 12 the exhaust-port. e' and e^2 are the diaphragms or pistons, and G′ and G^2 the corresponding notches or recesses of the rotary abutment D. In the period of one-half revolution the four following phases take place: The first phase begins when the diameter joining the rear faces of the pistons e e^2 being set, as x' y', piston e' uncovers the steam-port L. From this moment steam fills the space inclosed between the casing and the rotary abutment back of piston e', and on account of the unequal pressures on the back of e' and on the front of e^2 drives the whole motive cylinder, as shown by the arrow. The second phase begins in x^2 y^2, when, diaphragm e^2 uncovering exhaust-port L^2, the steam included in e' M e^2 escapes. Motion continues on account of unequal pressure on the two faces of the piston e. The third phase begins in x^3 y^3, when, piston e^2 entering recess G^2, the faces of the pistons which are on the left side of the drawings bear both the steam-pressure, while both right faces of the same bear the exhaust-pressure. Tore C then ceases to be a mover; but the pressures on both faces of groove G^2 being unequal and that on the left face being greater tore D becomes a mover and motion continues. The fourth phase, which constitutes a dead angle that, as may be seen, is very small, begins in x^4 y^4, when tore D ceases to be a mover and takes end in x y, when e^2 uncovers steam-port L on account of the momentum of rotating parts, and then a new period including the same phases begins again.

When distributing-valves are used, the phases are the well-known "admission, "expansion," "exhaust," and "dead angle."

In Fig. 6 diaphragms are supposed to be profiled only for progressive motion. If the engine must afford also retrograde motion, the profile ought better to be symmetrical, as shown in Fig. 2.

If the engine is designed for multiplex expansion, with several motive tores set on one single shaft, diaphragms must be so set that exhaust in the high-pressure tore shall coincide with admission in the next low-pressure tore, and so on.

Explanations above apply to any fluid-pressure supplied by steam, gas, air, &c., and even by liquids; but a discrimination ought to be made. If the fluid on account either of its low pressure or of its incompressibility cannot be expanded, each of the various tores C C′ C″ ought to be directly fed from the source, as is shown in Fig. 1. On the contrary, if the fluid can expand like steam does the fluid, flowing continuously with full pressure into a high-pressure tore or chamber, will flow henceforth into a second tore or chamber of greater size, where it shall expand, then, again, if useful, in a third still larger chamber, and so on. In short, the method of expansion used in my valveless engine is the multiplex one on Woolf's plan, and a typical attribute of this engine is that fluid flows in as a continuous and uniform stream and flows out equally as a uniform and continuous stream, the latter condition supposing that the fluid, if compressible, escapes into a medium the pressure of which is not lower than its own.

It is obvious that in this valveless type of engine the high-pressure tore constitutes a true distributer which lets in for each half-revolution its half-volume of steam at full pressure into the following series of lower-pressure tores, where this steam successively expands, and so allows to dispense with the use of a separate distributing-valve.

In engines of my plan where distributing-valves are used any style of expansion may be used.

Explanations above apply, respectively, to any fluid that can exert a pressure on a moving piston or expand in a closed space of varying volume, and my engine so allows by merely repeating its constituting parts (an improvement which causes but a lengthening and eventually widening of cylinder B and casing A) a full utilization of the motive pressure exerted by any fluid, gas, vapor, or liquid.

Figs. 4 and 5 show a valveless double-expansion motor with two tores connected on the Woolf plan. Tores D of the first groove and D′ of the second groove have each an individual shaft d^1 d^2, an advantageous disposal which avoids disturbance from unequal dilatation and allows a maximum shortening of the intermediate port connecting the high and low pressure tores.

Figs. 4 and 6 are an illustration of peculiar reciprocal profiles for the groove and diaphragm, which insure in my engine a geometrically steam-tight joint. In this example the diaphragms are confined on the rear face by a diametrical plane *gr* and on the front face by the cylindrical edge *m* of the recess. Reciprocally the recess is confined by—viz., first, a circular cylindrical surface in *t t'*; second, cylindrical surfaces *m t* and *t' s*, cut into tore D by edges *l* and *r* of the diaphragm; third, a cylindrical surface *m' s*, which slides and rolls on plane *gr* during the rotation.

In a general way a geometrically steam-tight joint may be obtained by the use for the diaphragm-pistons and the corresponding recesses in the rotary abutment of such corresponding profiles that each profile is the curve along which rolls or slides during rotation either the other profile or a determined point of this other profile.

This construction may be adapted for use as a motor or as a pump. As a motor, it can be driven by steam, compressed air, hot air, gas, petroleum, water under pressure, and in a general way by any fluid that can exert a pressure upon a moving piston or expand in a closed space with a varying volume. As a pump, this engine can be used as a sucking or forcing pump for fluids and as an exhausting or compressing pump for gases and vapors.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination with a cylindrical casing, of a rotatable motive cylinder fitting closely within the casing, said cylinder having about its peripheral surface a recess or groove of increasing width from its bottom outward, a diaphragm or partition across said recess or groove adapted to act as a piston, a circular abutment decreasing in thickness at its peripheral edge so that its lateral contour exactly corresponds to that of the groove or recess in the cylinder, said edge having a lateral notch therein in which the diaphragm or partition in the groove or recess is adapted to closely engage in passing said abutment as the cylinder and abutment are rotated together, the abutment being rotatable in bearings exterior to the cylindrical casing on an axis parallel to the axis of the cylinder, but projecting through and tightly fitting the edge of an opening in the casing and bearing in and making a tight joint with the wall of the recess or groove in the cylinder.

2. The combination with a cylindrical casing, of a rotatable motive cylinder fitting closely within the casing, said cylinder having about its peripheral surface a flaring recess or groove, a diaphragm or partition across said recess or groove adapted to act as a piston, a circular abutment tapering at its peripheral edge so that its lateral contour exactly corresponds to that of the groove or recess in the cylinder, said edge having a lateral notch therein in which the diaphragm or partition in the groove or recess is adapted to closely engage in passing said abutment as the cylinder and abutment are rotated together, the abutment being rotatable in bearings exterior to the cylindrical casing on an axis parallel to the axis of the cylinder, but projecting through and tightly fitting the edge of an opening in the casing and bearing in and making a tight joint with the wall of the recess or groove in the cylinder.

3. In a rotary multiple-expansion engine, the combination with a casing, of a motive cylinder fitting closely and rotatable within said casing, said cylinder having recesses or grooves extending about its periphery in different positions along the same, two diaphragms or partitions across each groove adapted to act as pistons, two circular abutments each rotatable on an axis parallel to the axis of the cylinder, said abutments closely engaging through openings in the casing and projecting into and tightly fitting the grooves in the cylinder respectively, inlet and exhaust ports for the grooves respectively, said ports being nearer together than the diaphragms in the grooves, so that no direct escape of fluid can take place from the inlet to the exhaust ports, and a passage connecting the exhaust-port of one groove with the inlet-port of the other.

4. In a rotary multiple-expansion engine, the combination with a casing, of a motive cylinder fitting closely and rotatable within said casing, said cylinder having recesses or grooves extending about its periphery in different positions along the same, two diaphragms or partitions across each groove adapted to act as pistons, two circular abutments each rotatable on an axis exterior to the casing and parallel to the axis of rotation of the cylinder, said abutments being arranged at a suitable angle about the casing and projecting through openings in the casing and fitting in the grooves or recesses in the cylinders respectively and having lateral notches in their peripheries in which the diaphragms or partitions in the grooves are adapted to make tight joints as the cylinders and abutments are rotated together, inlet and exhaust ports for the high-pressure groove or recess whose angle is greater than the angle of the diaphragms or partitions, so that no direct escape of motive fluid can take place from the inlet to the exhaust ports, suitable inlet and exhaust ports for the low-pressure groove or recess, and a pipe or passage leading from the exhaust-port of the high-pressure recess to the inlet-port of low-pressure recess.

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

LOUIS JULES JEAN-BAPTISTE LE ROND.

Witnesses:
EDWARD P. MACLEAN.
ANTOINE ROUSSANNOR.