No. 734,226. PATENTED JULY 21, 1903.

M. FLEMING.

ROTARY ENGINE.

APPLICATION FILED JAN. 27, 1903.

NO MODEL. 5 SHEETS—SHEET 1.

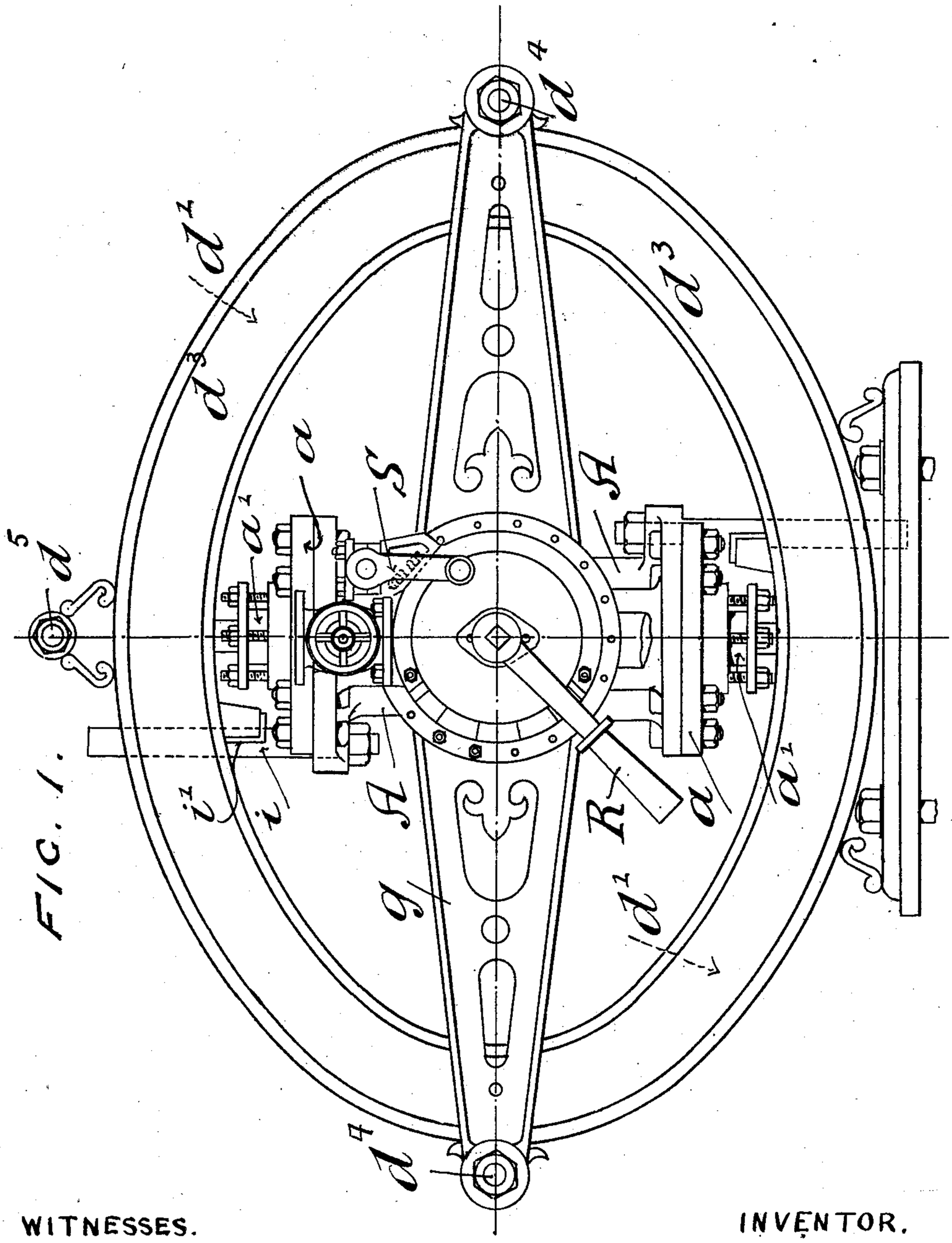

FIG. 1.

WITNESSES.

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NO MODEL. 5 SHEETS—SHEET 2.

FIG. 1a.

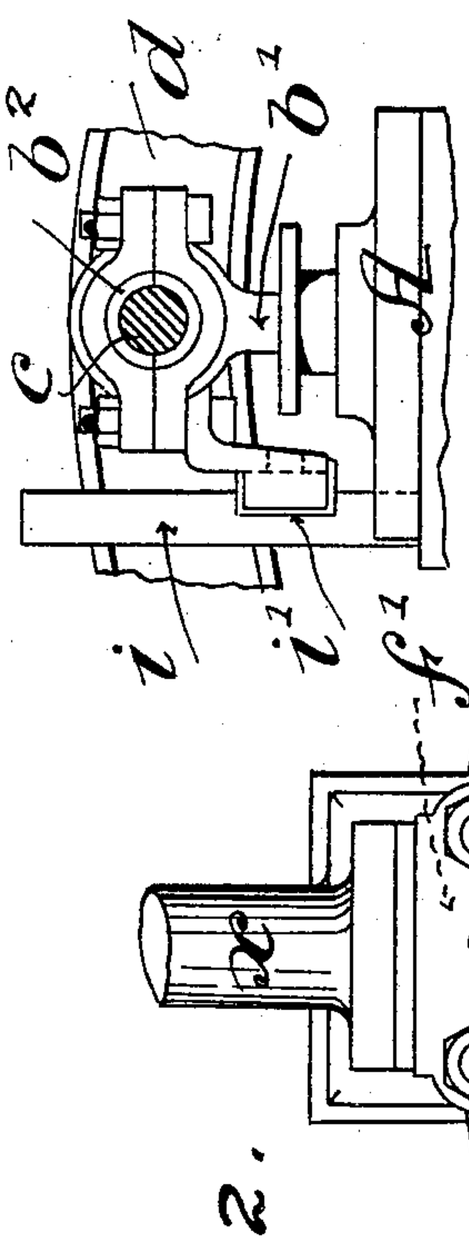

FIG. 2.

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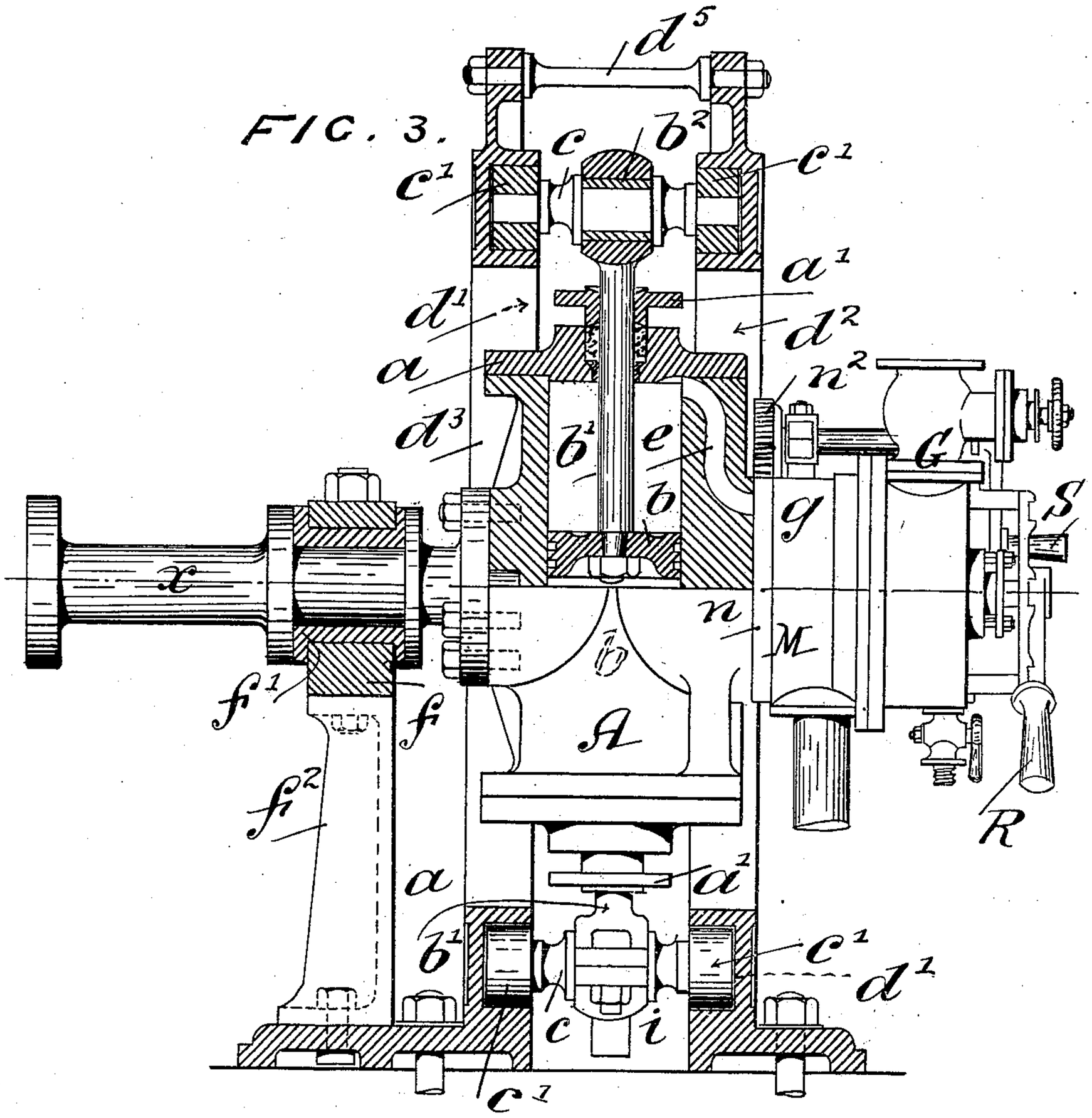
NO MODEL. 5 SHEETS—SHEET 3.

FIG. 3.



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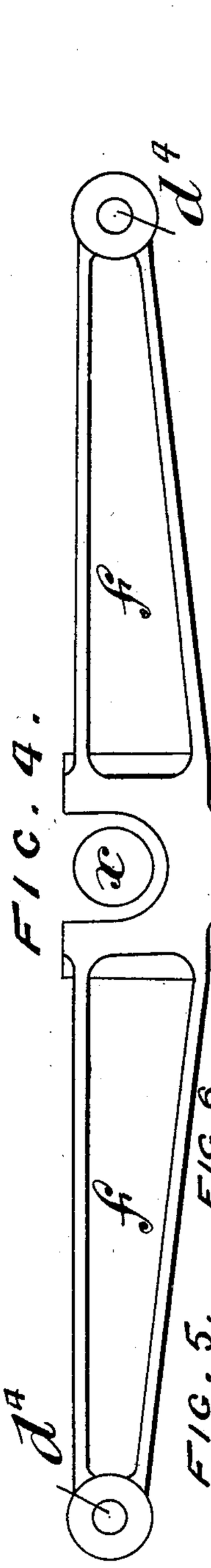
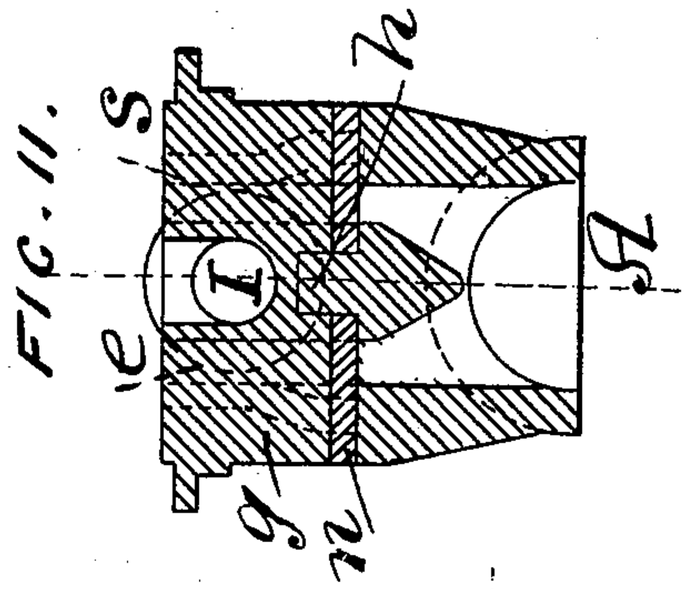
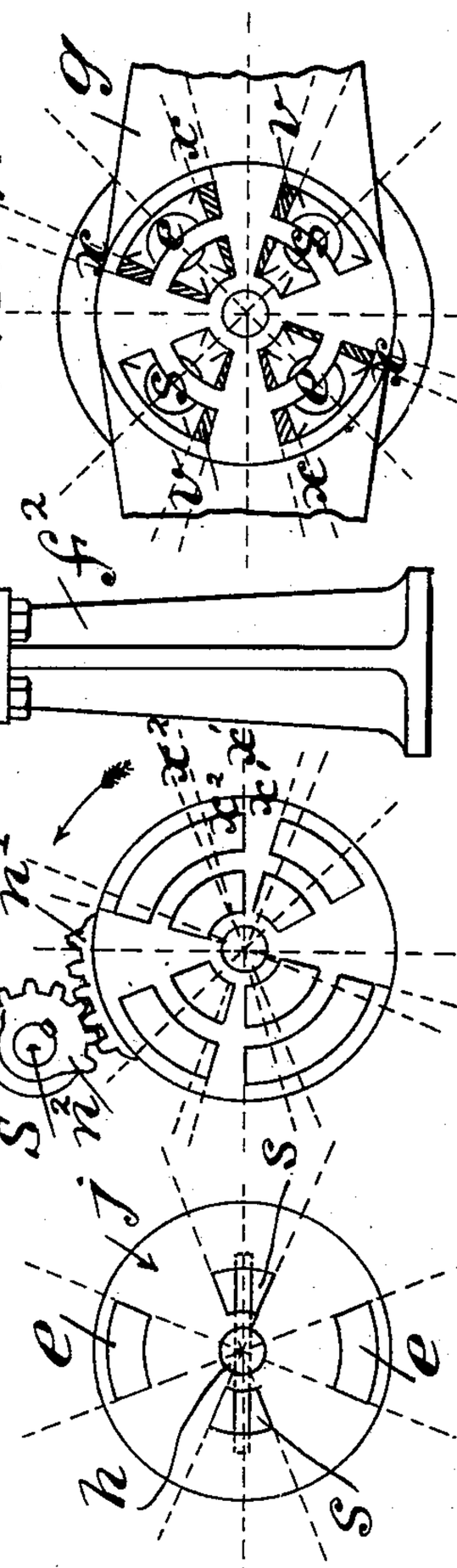
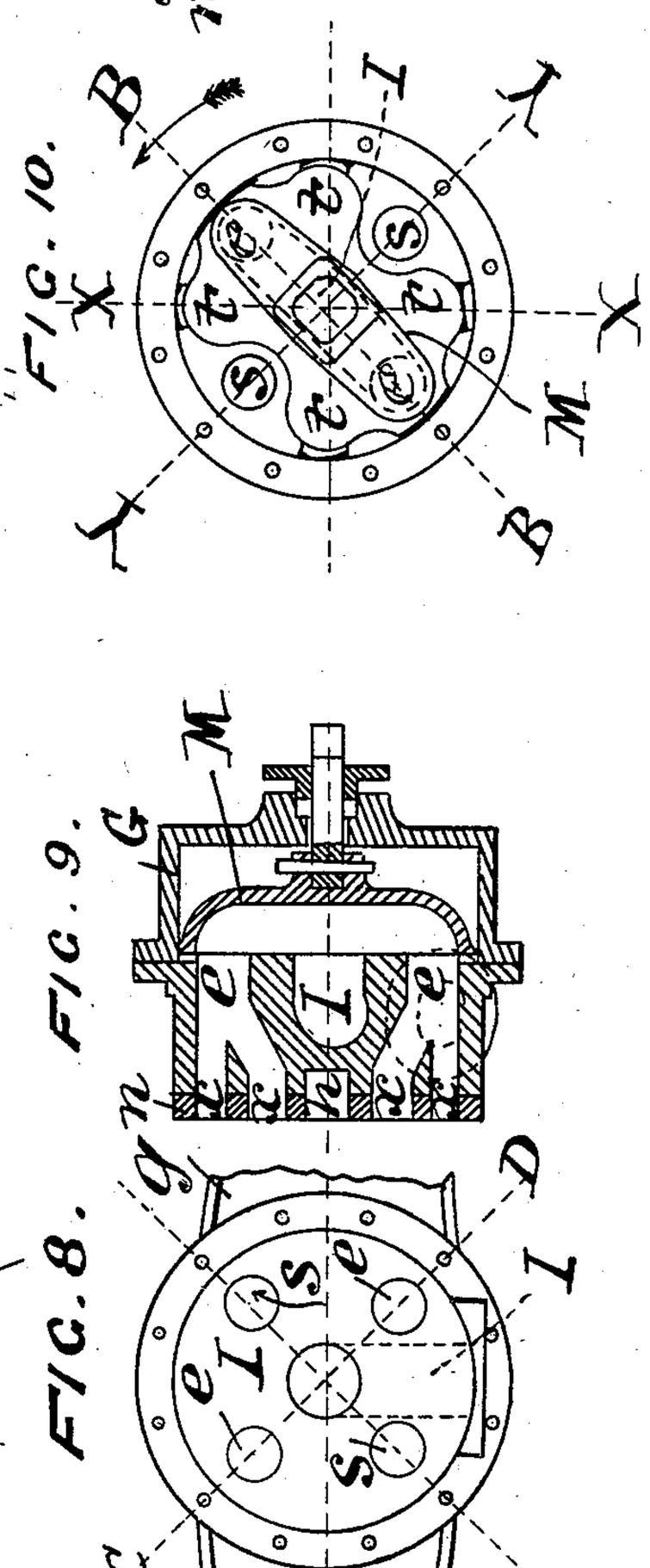
NO MODEL. 5 SHEETS—SHEET 4.









WITNESSES.

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APPLICATION FILED JAN. 27, 1903.

NO MODEL. 5 SHEETS—SHEET 5.

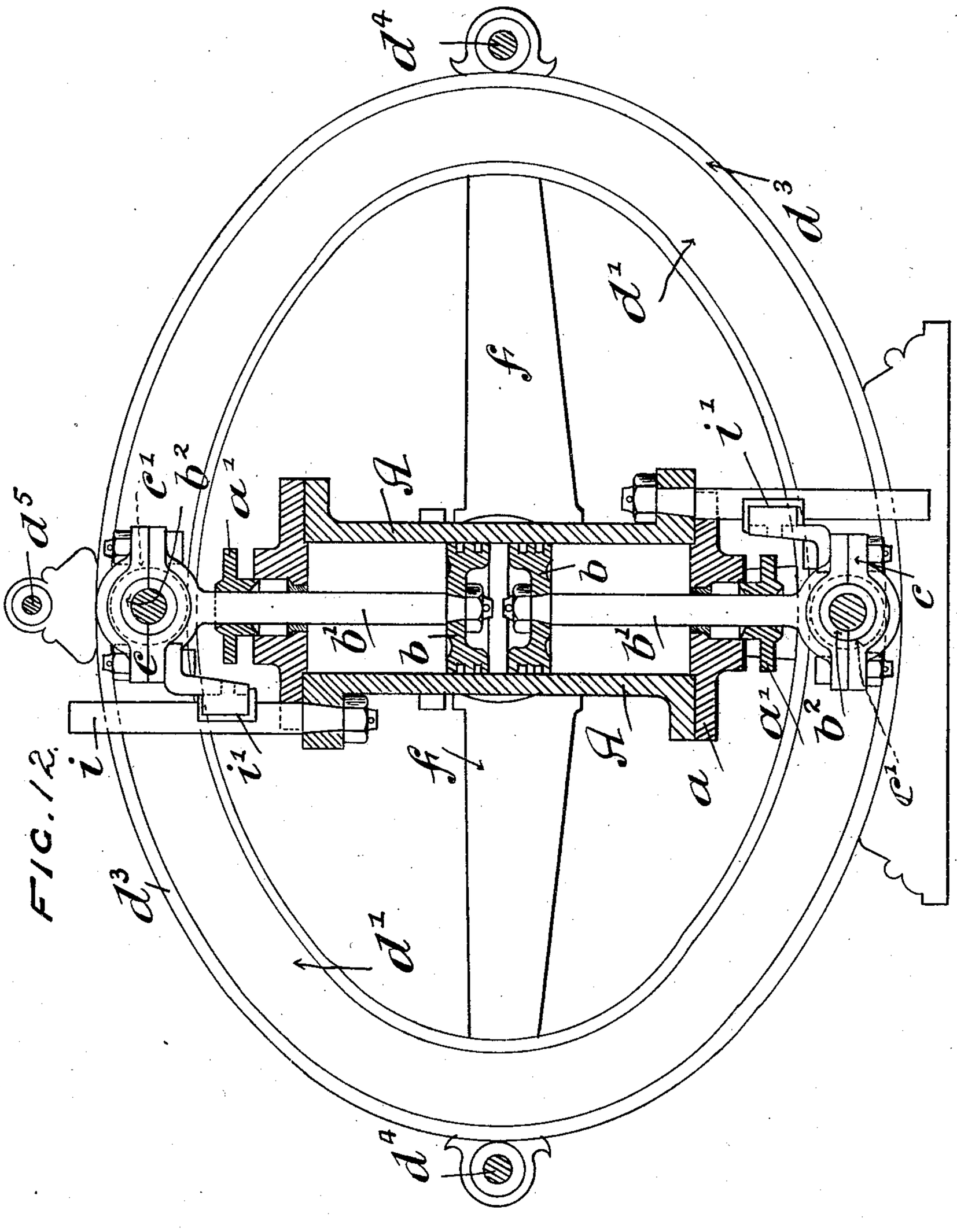

FIG. 12.

WITNESSES.

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By his Attorneys.

No. 734,226. Patented July 21, 1903.

UNITED STATES PATENT OFFICE.

MATTHEW FLEMING, OF GREENOCK, SCOTLAND.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 734,226, dated July 21, 1903.

Application filed January 27, 1903. Serial No. 140,714. (No model.)

To all whom it may concern:

Be it known that I, MATTHEW FLEMING, marine engineer, a subject of the King of Great Britain and Ireland, and a resident of Greenock, but at present residing at Bay View, William street, Dunoon, Scotland, have invented certain new and useful Improvements in Rotary Engines and in Valves for Such Engines, (for which applications have been made in France on the 4th of July, 1902, in Germany on the 7th of July, 1902, and in Great Britain, No. 211, dated January 5, 1903,) of which the following is a specification.

My said invention has reference to an improved rotary engine in which the steam or other actuating fluid drives the shaft in such a manner that no lateral or bending strain is put upon it, while a torsional strain with a leverage several times the length of the crank leverage in general use is obtained to effect rotation of the shaft.

The force of the steam expended at the end of the cylinder in ordinary reciprocating engines (which force may be termed the "negative" force) is in the case of my invention utilized as a positive force to act on an additional opposing piston. The moving pistons in turn effect the rotation of the cylinder and parts, and so revolve the shaft. Thus an equilibrium of bending strain of the steam on the shaft results, so that great increase of power for the amount of steam used is obtained, as well as great economy in the weight of and space occupied by the engine.

My invention will be clearly understood from the following description, in which reference is made to the annexed four sheets of drawings.

In the said drawings, on Sheet 1, Figure 1 is a front elevation of one form of my improved rotary engine. On Sheet 2, Fig. 2 is a plan view thereof. Fig. 1^a is a detail view of the cross-head and shows the guiding-slides more clearly. On Sheet 3, Fig. 3 shows an end elevation of Fig. 1, the view being partly in section. On Sheet 4, Fig. 4 shows the back girder and the main bearing-support. Figs. 5 to 11 are views of the cylinder and valve faces and parts and will be hereinafter particularly dealt with. Fig. 12 is a sectional view through the cylinders in a plane parallel to Fig. 1.

In constructing an engine in accordance with my invention I employ a cylinder A, which is bored straight through and provided with suitable covers *a a* and packed glands *a' a'*. Within the said cylinder two pistons *b b* are arranged, each piston having its own piston-rod *b'*. The ends of the piston-rods *b'* are bored and are preferably fitted with brass or similar metal bushes b^2 to receive the bar of cross-heads *c*. These cross-heads *c c* are provided with suitable bowls or pulleys *c'*, which are firmly keyed or shrunk thereon, the said bowls or pulleys being arranged to run in elliptical grooves *d' d'*, formed in elliptical frames or side standards d^2 d^3 of the engine.

The main shaft *x* is securely fastened, by means of a flange, studs, and nuts or in any other suitable manner, to the body of the cylinder A in a position at right angles to the longitudinal axis of the cylinder and centered at a point exactly midway between the ends of the cylinder. The shaft and cylinder are supported in main bearings *f'*, which form part of the back girder *f*, the said back girder resting on a stool or support f^2, which is bolted to the bed-plate of the back elliptical frame d^3. As before stated, there are two elliptical frames d^2 d^3, the elliptical grooves *d' d'* being formed on the inner faces and of such a width as to accommodate the cross-head bowls or pulleys *c'*. The difference between the half-diameters of the major and minor axis equals the stroke of each piston. The front girder *g* acts as a stay to the elliptical frames and also as a support to the cylinder by reason of the cylindrical projection *g'*, formed on the cylinder-face. On the outer face of the girder are the ports for the reversing-valve, which is inclosed in the steam-chest. At the center of the inner face of the girder *g* a suitable passage or recess is bored out to receive the gudgeon *h*. This gudgeon serves as a steadying device between the cylinder and the front girder and at the same time acts as an axle on which the cut-off valve works.

The back and front girders *f g* and the two elliptical frames d^2 d^3 are firmly held in position by two turned stay-bolts d^4 d^4, one at each side of the frames, and also by a small stay-bolt d^5 at the top of the frames.

In Figs. 1, 2, and 3 a guide-bar is shown on each end of the cylinder on the go-ahead side and marked *i*. These bars are securely fixed to the side of the cylinder. The cross-heads are fitted with brass slides *i'*, working on these guides. The slides *i* take the driving thrust of the piston-rods and keep the cross-head bars in a position at right angles to their path. The cut-off and the reversing valves are controlled by levers, (shown in Fig. 1 and marked S and R, respectively.)

Referring now to the Figs. 5 to 10, I will now describe such valves as might be employed when my improved rotary engine is utilized for marine purposes.

Fig. 5 represents a view of the cylinder-face *j* and shows the steam-ports *e e* and *s s* and the gudgeon *h*. The ports *e e* lead, respectively, to each end of the cylinder, while the ports *s s* converge into one common narrow port, which admits the steam between the pistons. The gudgeon *h* is exactly in line with the main shaft *x*.

Fig. 6 shows the cut-off valve *n*, which is fitted steam-tight between the valve-faces. (Shown in Figs. 5 and 7.) Through the center of this valve *n* a hole is bored to fit easily onto the gudgeon *h*. On the outer edge is a toothed rack *n'*, gearing with a pinion n^2, which is operated so as to control the cut-off by means of the lever S. By turning the valve in the direction shown by the arrow the edge of the valve marked *x'* would butt on the side of the projection-line marked x^2. The distance *x'* to x^2 is the amount of lap given to the cut-off edge of valve.

Fig. 7 shows the cut-off-valve face on the girder *g*. There are eight ports corresponding to those on the cut-off valve *n*, (shown in Fig. 6,) each couple converging into one common port on the opposite face, such ports being marked *e e s s*. The projecting stop-pieces *x x v v* are neatly fitted into the ports on Fig. 6 and their ends faced flush with the face of the cut-off valve next to the cylinder. The stop-pieces on the lead edge of each steam-port are to allow the cut-off valve to move around the required amount for expansion without altering the position of the lead edge on steam-port. The double pieces on the exhaust-port insure the full width of the exhaust-port when cutting off. It will be obvious that were the ports on the cut-off valve *n* to correspond with the ports on the reverse side of girder-face (see Fig. 7) and the valve advanced to cut-off the lead edge of the port would be advanced a corresponding amount, and so would give the engine excessive lead, a thing condemned by engineers. For this purpose the stop-pieces *x x v v* are secured in the girder-face, Fig. 7, and fit or project into the ports of the cut-off valve, and so allow the valve to be advanced for cutting off without altering the lead edge. As before stated, the two stop-pieces on each of the exhaust-ports are to secure the full width of the exhaust-port, no matter whether working expansively or otherwise. Said two stop-pieces also insure the lead edge remaining the same when the exhaust-ports become steam-ports — viz., when the engine is reversed.

Fig. 8 illustrates the reversing-valve face on the girder *g*. If the engine were going ahead, *s s* would be the steam-ports and *e e* the exhaust-ports. The main exhaust-port is marked I.

Fig. 9 is a section of Fig. 8 on the line C D and shows the reversing-valve M covering the two exhaust-ports *e e* and putting them in communication with the main exhaust-port I. This section also shows the cut-off valve in position working on gudgeon *h*. The steam-chest G is bolted onto the front girder.

Fig. 10 is a face view of the reversing-valve, consisting of a suitable hollow box, the face of which is extended into four flat covers, (marked *t t t t*.) The two ports *e e*, also the main exhaust I, are covered by the hollow recess, while the ports *s s* are open to steam. By turning the valve M by means of the lever R, Fig. 2, in the direction indicated by the arrow, bringing the line B to position X X, all four parts would be covered by the faces *t t t t*, so that the engine would be stopped. Then by simply turning line B to position Y Y the ports *s s* would become exhaust-ports, and so reverse the engine.

Fig. 11 is a central horizontal section of the steam-ports, cut-off valve, cylinder, &c.

The principle upon which the engine works is as follows: In Fig. 2 the cylinder is shown in line with the minor axis. If steam be now admitted between the pistons through the ports *s s*, Fig. 5, the pistons are forced outward and press the bowls or pulleys *c' c'* against the outer rim of the elliptical groove. The bowls or pulleys will then revolve around toward the major axis. In this position the steam will be admitted through the ports *e e*, forcing the pistons together, and so pressing the pulleys against the inner rim of the elliptical groove, thus causing them to travel around to the minor axis. By this means a rotary motion is communicated to the engine. The momentum of the revolving parts acts as a fly-wheel.

It will be seen from the above that each piston makes four strokes for one revolution of the shaft.

I may mention in conclusion that in the case of twin propellers these engines can be used as compound and for three shafts as triple-expansion engines. In any case they may be worked as condensing-engines, by having separate condenser, pumps, and auxiliary engines in the usual way. Engines such as I have indicated are also exceedingly well adapted for use as stationary engines for driving dynamos, &c., as they run smoothly, regularly, and practically without vibration.

My improved engine may be equally well

worked as a non-reversible engine. In this case the construction is very simple and light, there being no reversing or cut-off valves, as the steam is admitted direct to the cylinder through the ports in the girder *g*. The ports on the valve-face, Fig. 7, are simply fitted with sufficient lap on the cut-off edge to insure the required amount of expansion.

The arrangement of the elliptical frames can be made suitable either for head-space or for side space, as is most convenient, since the engine will work equally well no matter whether the major axis be in a vertical or in a horizontal position.

I do not confine myself in respect of the valve-gear employed to regulate and control the supply of fluid-pressure to my improved rotary engine, as it will be obvious that this may be varied under certain circumstances and to suit the particular object of the engine.

I declare that what I claim is—

1. A rotary steam-engine having a cylinder, oppositely-arranged double-acting pistons in said cylinder, piston-rods connected to said piston, said piston-rods passing through cylinder-covers and being provided with cross-heads carrying bowls which engage on either side with elliptical grooves formed in side standards, said elliptical grooves corresponding on either side of said cylinder, a main driving-shaft connected up to rear of said cylinder, said pistons being worked by the steam-pressure acting on either side of said pistons, and steam-controlling valves on front side of said engine, substantially as described and shown.

2. In combination in a rotary steam-engine, elliptical frames d^2, d^3, formed on their inner faces with grooves, bowls c' engaging said grooves and carried by cross-heads connected to piston-rods of double-acting pistons said double-acting pistons being inclosed in a cylinder disposed between said elliptical frames, front and back girders *f*, *g*, girder *f* forming a bearing for the driving-shaft *x*, and front girder *g* having cut-off valve intermediate between itself and rotating cylinder all the parts being arranged as and for the purposes herein described and shown.

3. In a rotary engine, having two double-acting pistons inclosed in a steam-cylinder and piston-rods carrying bowls engaging two elliptical guides, a cut-off valve, arranged between said steam-cylinder and a fixed girder, said cut-off valve consisting of a metal plate or disk cut with suitable ports and mounted on a center, and actuating means for said cut-off valve, said cut-off valve being fitted with stop-pieces *x x*, *v v*, projecting from the girder-face, in the manner for the purposes and substantially as described and shown.

4. A rotary engine, having two double-acting pistons inclosed in a steam-cylinder mounted between two frames having elliptical grooves, said pistons having piston-rods carrying cross-heads, said cross-heads supporting bowls engaging said elliptical grooves, a cut-off valve *n* intermediate between the face of said cylinder and a girder *g*, and a reversing-valve, consisting of an open-faced box or chamber, said chamber connecting any two ports with the exhaust-port I, or serving to shut off the whole of the ports *e*, *e*, *s*, *s*, from steam, in the manner and substantially as described and shown.

5. A rotary steam-engine comprising a single cylinder A, double-acting pistons within said cylinder, and cylinder-covers for said cylinder, oppositely-arranged piston-rods *b*, *b'*, cross-heads *c*, bowls *c'* engaging elliptical grooves formed in frames d^2, d^3, front and back girders *f*, *g*, cut-off valve intermediate between cylinder A and girder *g*, ports in said girder, and a reversing-valve M within steam-chest, all combined and acting, in the manner, for the purposes, and substantially as described and shown.

In witness whereof I have hereunto set my hand in presence of two witnesses.

MATTHEW FLEMING.

Witnesses:

ADAM LEISK CRAWFORD,

ROBERT HANNAH.