No. 722,710. PATENTED MAR. 17, 1903.

# H. IGEL.

## ROTARY ENGINE.

APPLICATION FILED MAR. 15, 1902.

NO MODEL. 5 SHEETS—SHEET 1.

Fig. 2.

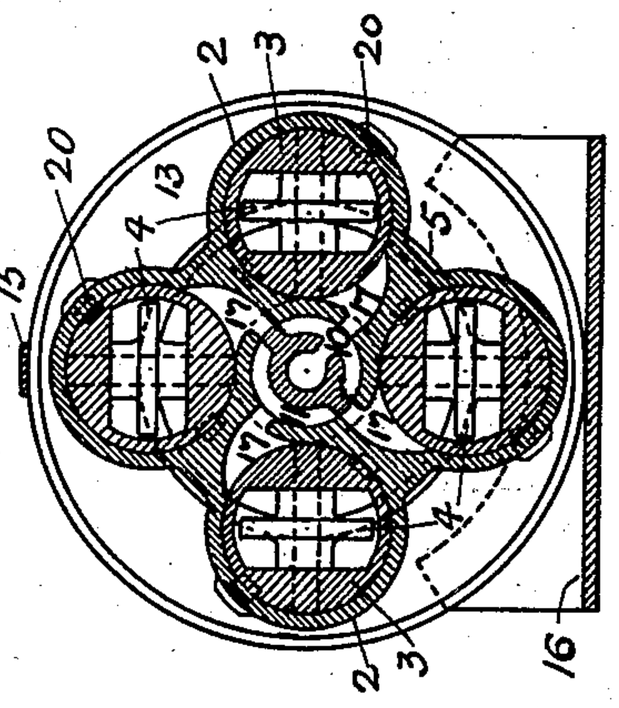



Fig. 3.

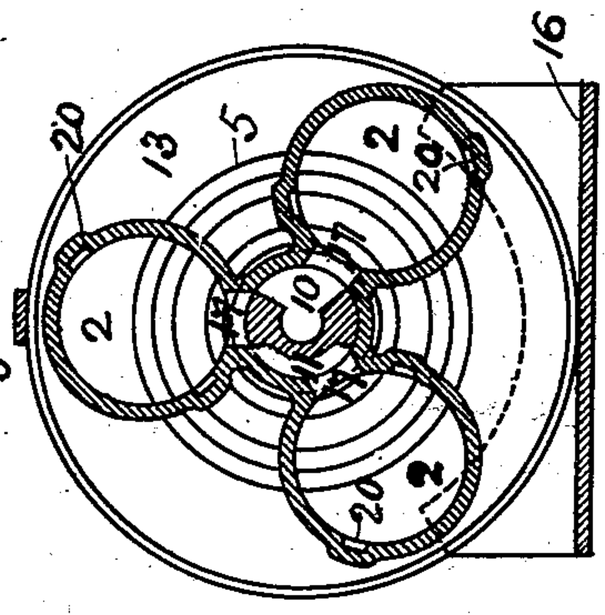



Fig. 1.

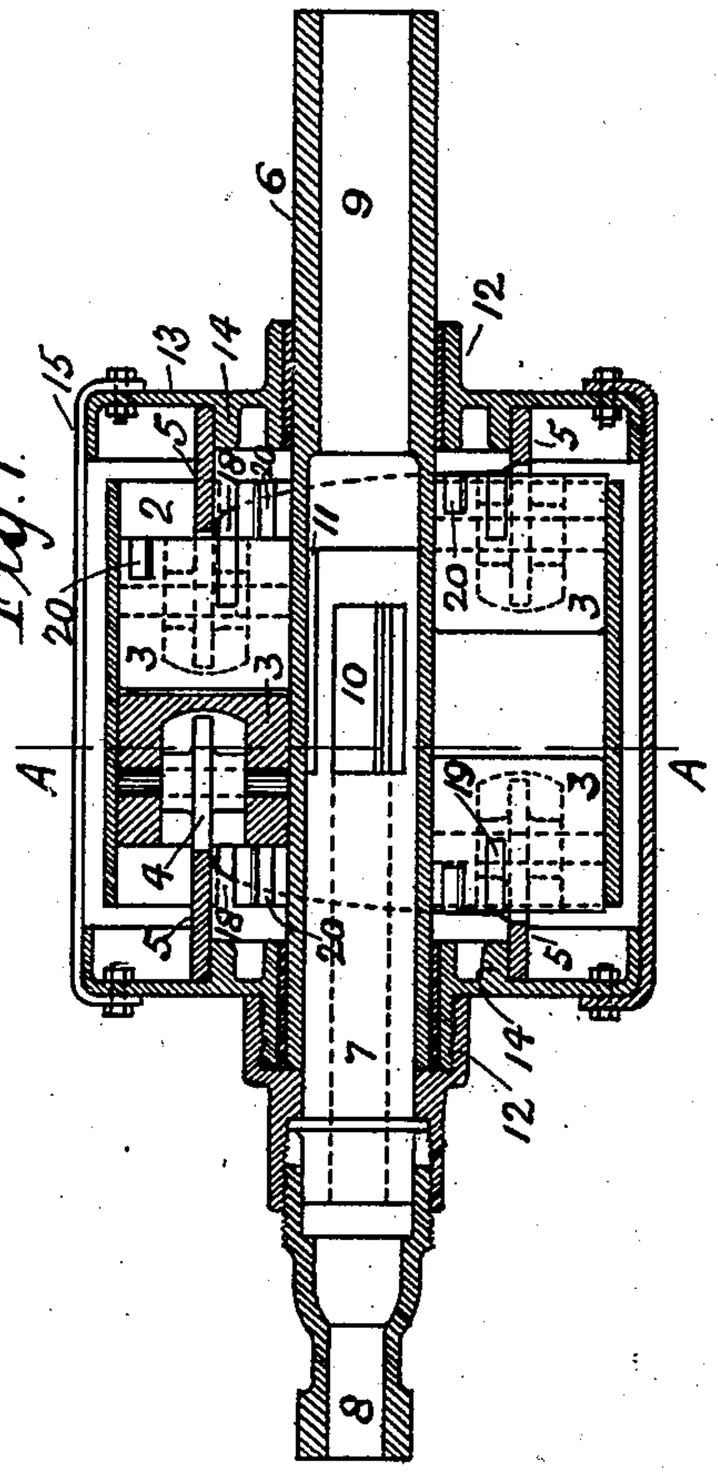
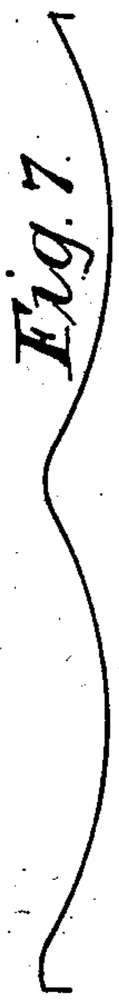



Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.



Witnesses

A. E. Melhuish

E. M. Moore

Inventor

Henry Igel

by A. Huddart

His Attorney.

No. 722,710. PATENTED MAR. 17, 1903.

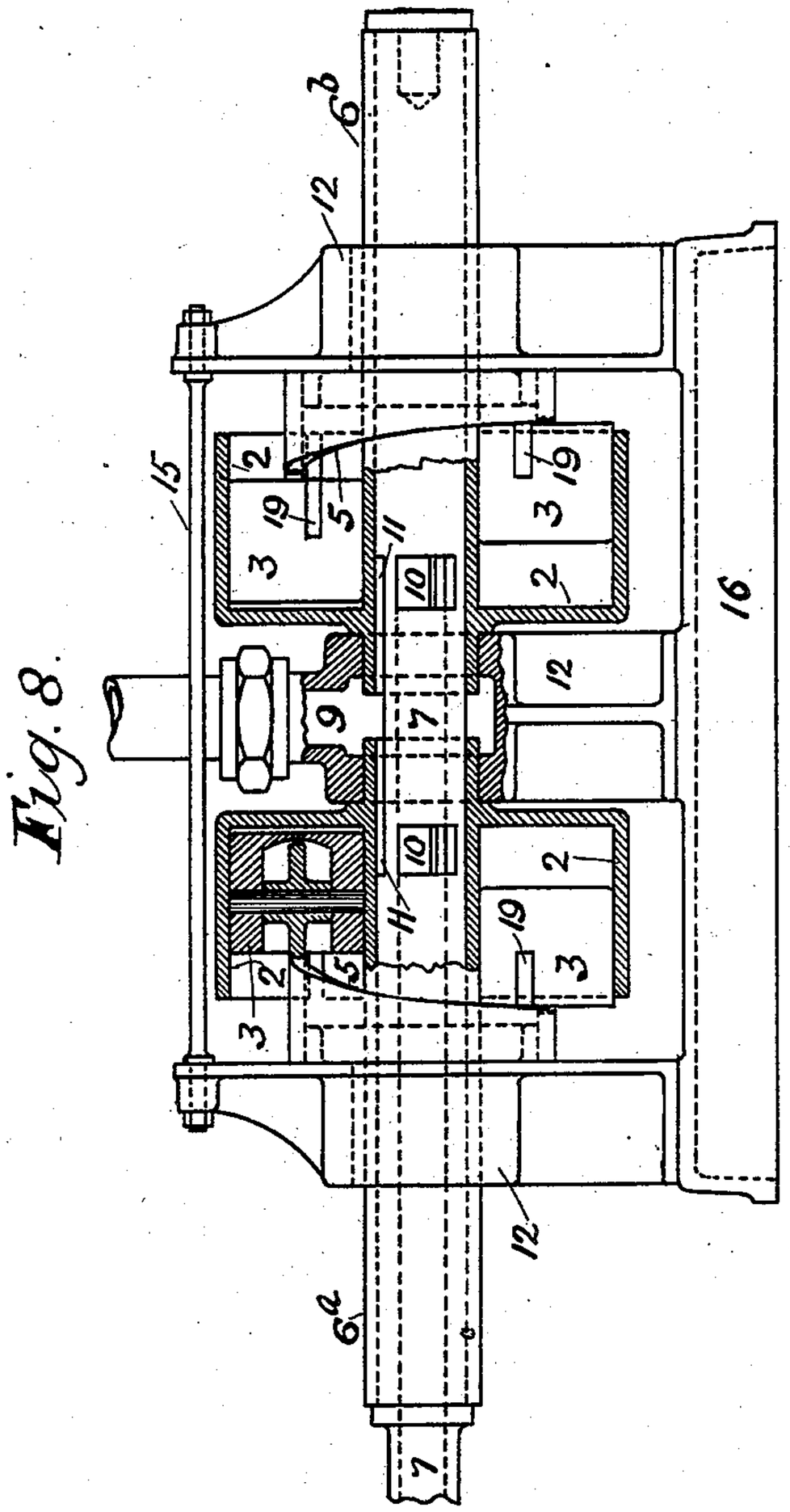
# H. IGEL.

## ROTARY ENGINE.

APPLICATION FILED MAR. 15, 1902.

NO MODEL. 5 SHEETS—SHEET 2.

Fig. 8.




Witnesses
A. E. Melchuish
E. M. Moore.

Inventor
Henry Igel
by R. H. Addams
His Attorney

No. 722,710. PATENTED MAR. 17, 1903.

# H. IGEL.

## ROTARY ENGINE.

APPLICATION FILED MAR. 15, 1902.

NO MODEL. 5 SHEETS—SHEET 3.

Fig. 10

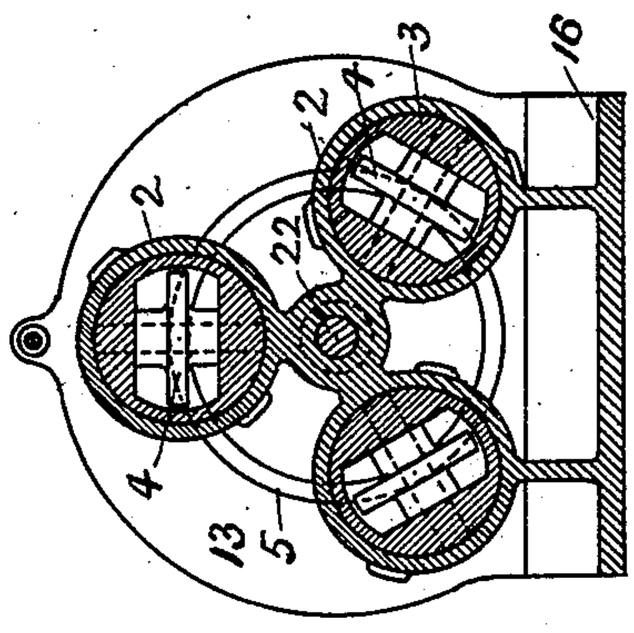



Fig. 12.

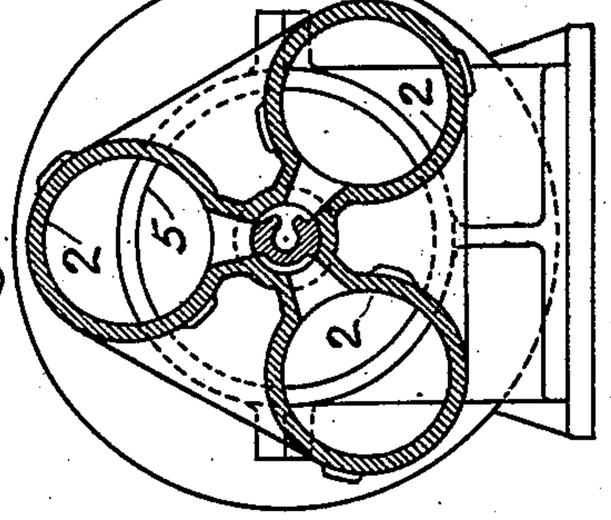



Fig. 9.

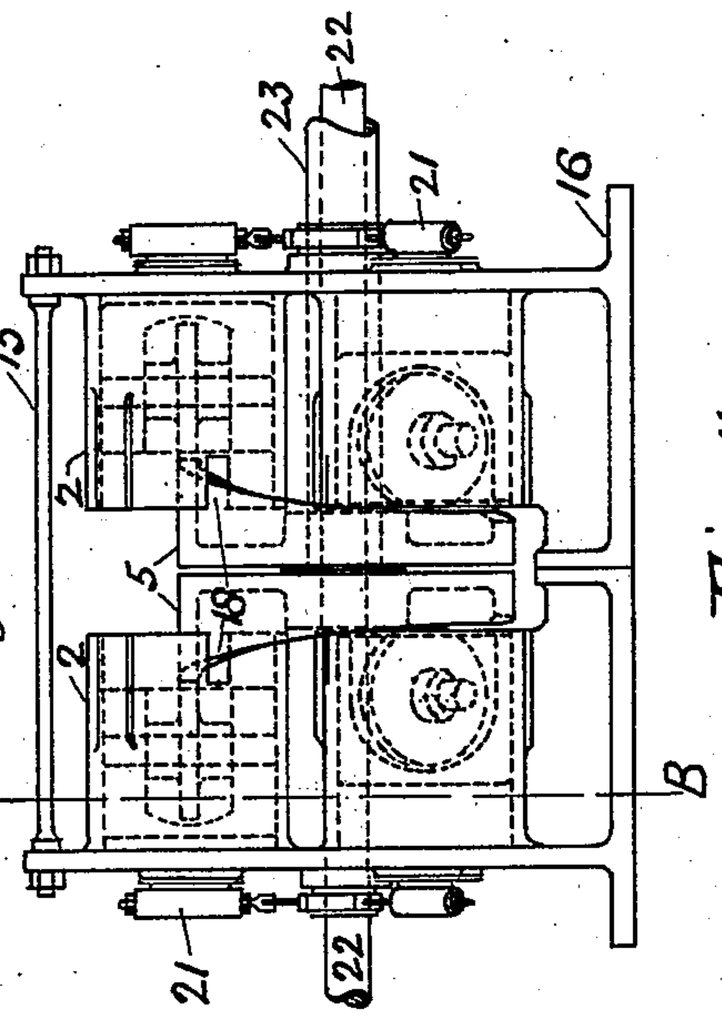
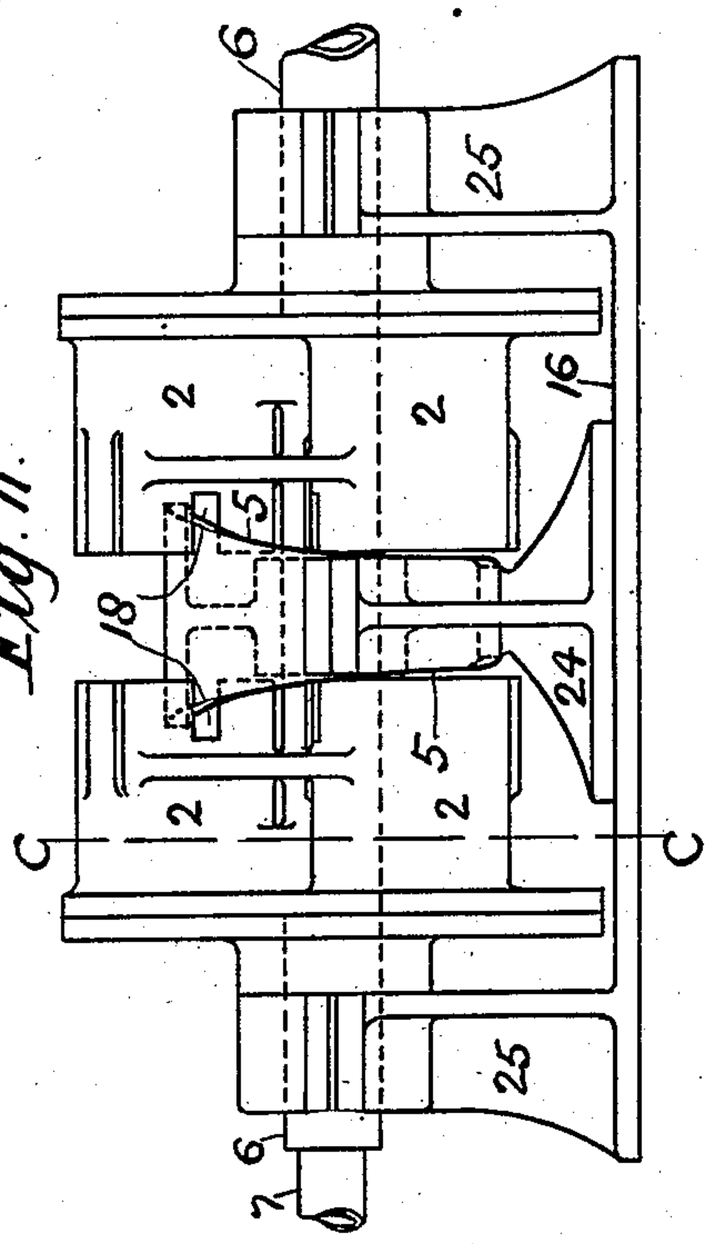



Fig. 11.




Witnesses

A. D. Melhuish

E. M. Moore

Inventor.

Henry Igel

by R. H. Addams

His Attorney

No. 722,710. PATENTED MAR. 17, 1903.

H. IGEL.

ROTARY ENGINE.

APPLICATION FILED MAR. 15, 1902.

NO MODEL. 5 SHEETS—SHEET 4.

Fig. 14.

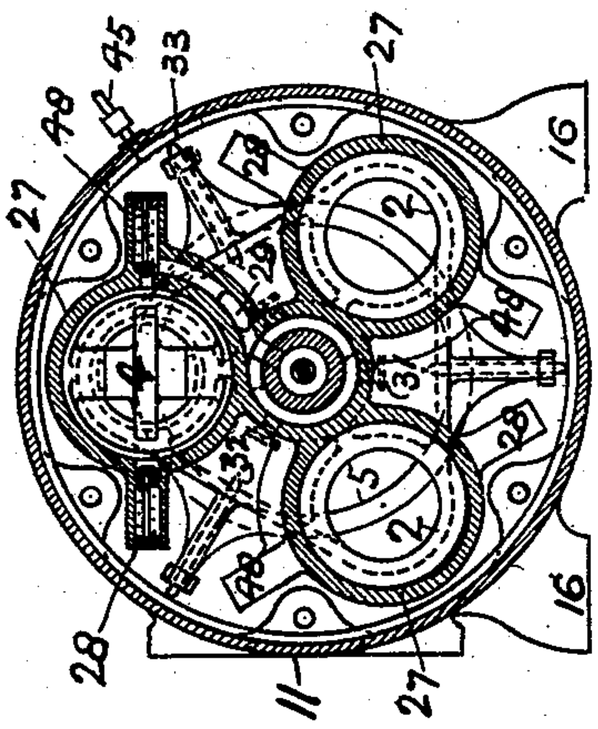



Fig. 13.

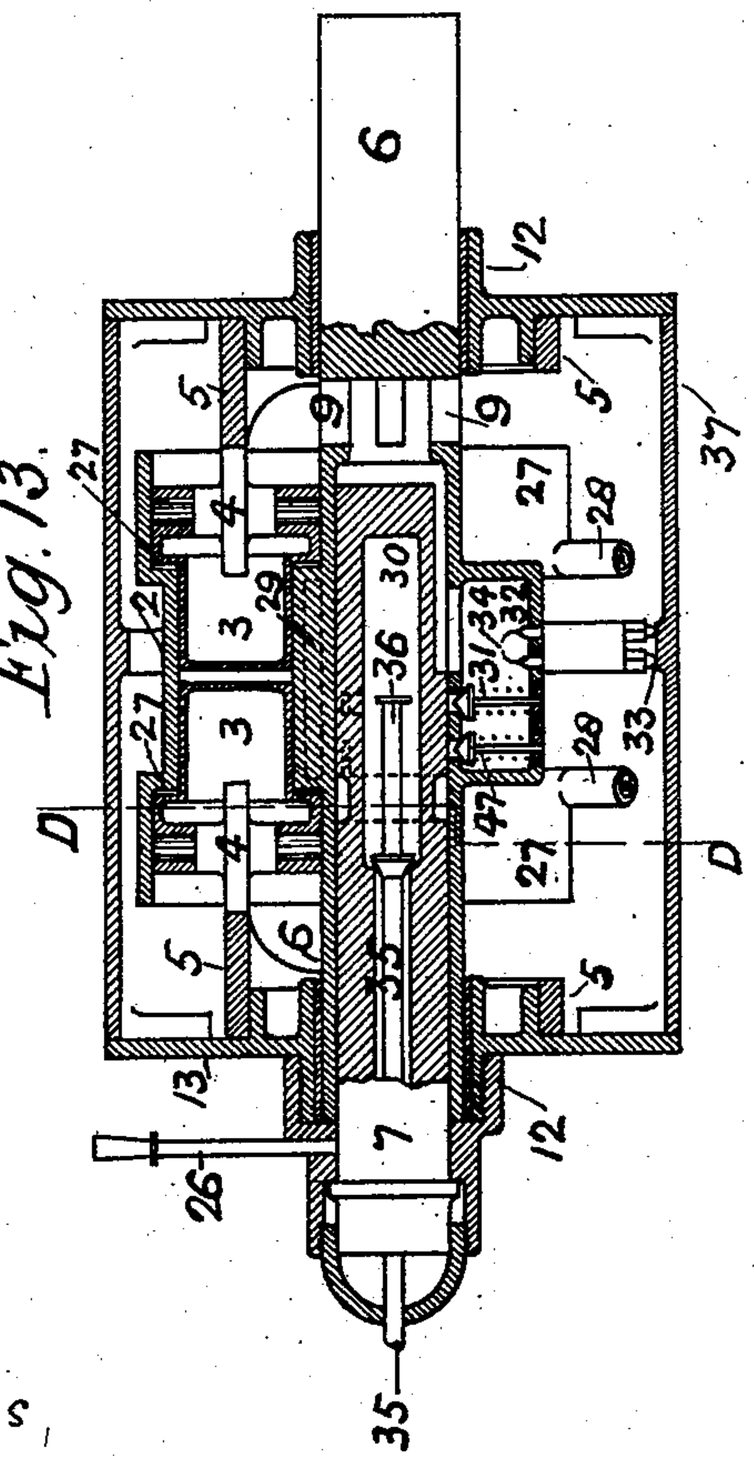
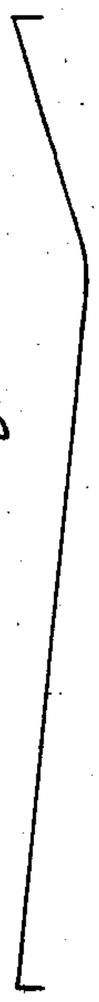



Fig. 15.



Witnesses,
A. E. Melhuish
E. McMoon

Inventor
Henry Igel
By R. H. Addams
his Attorney

No. 722,710. PATENTED MAR. 17, 1903.

H. IGEL.

ROTARY ENGINE.

APPLICATION FILED MAR. 15, 1902.

NO MODEL. 5 SHEETS—SHEET 5.

Fig. 17.

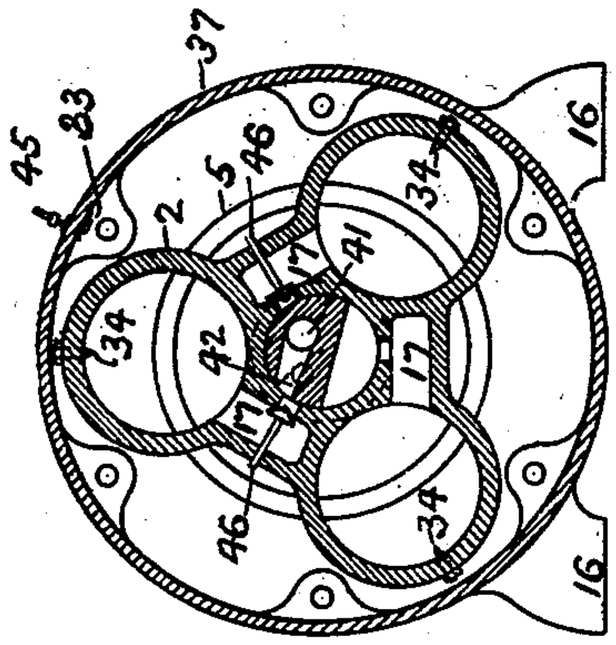
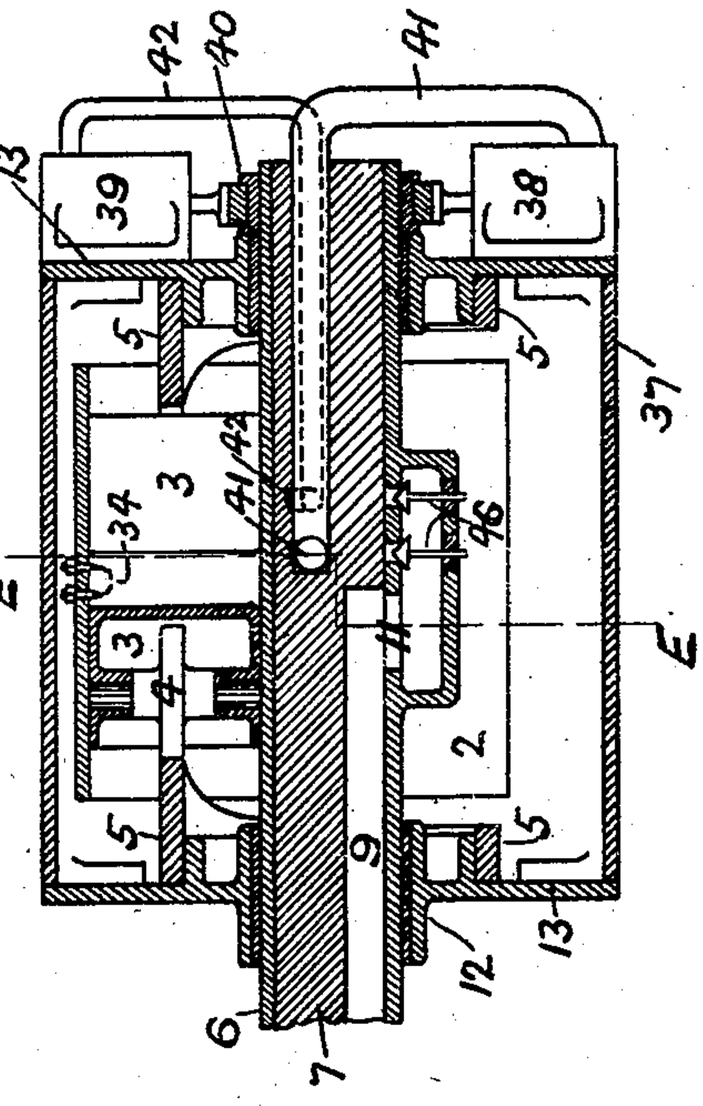



Fig. 16.




Witnesses

A. D. Melhuish

E. M. Moore

Inventor

Henry Igel

by Wm. Middleton

His Attorney

# UNITED STATES PATENT OFFICE.

HENRY IGEL, OF NEWCASTLE-UPON-TYNE, ENGLAND.

## ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 722,710, dated March 17, 1903.

Application filed March 15, 1902. Serial No. 98,406. (No model.)

*To all whom it may concern:*

Be it known that I, HENRY IGEL, a subject of the King of England, residing and having my post-office address at 59 Side, Newcastle-upon-Tyne, county of Northumberland, England, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

My invention relates to reciprocating rotary engines of that class in which the conversion of the reciprocating strokes into rotary motion takes place without the aid of crank and connecting-rod.

The object of the present invention is to make an engine which keeps in balance during the complete cycle of rotation and avoid all strain and vibration upon the trunnion and other parts; also, to do away with dead-centers.

In the annexed drawings, Figure 1 is a longitudinal section, with parts in elevation, of a four-cylinder engine of this invention with two pistons to each cylinder, the cylinders being made to revolve around the axis of the motor. Fig. 2 is a cross-section thereof on line A A, Fig. 1. Fig. 3 is a cross-section of a three-cylinder engine of the same type. Figs. 4 to 7 show developments of cams or roller-paths hereinafter referred to. Fig. 8 is a side elevation, partly in section, of an engine of the same type in which each piston has a separate cylinder. Fig. 9 is a side elevation, and Fig. 10 a cross-section on line B B, Fig. 9, showing a six-cylinder engine in which the cylinder-heads of each pair are turned away from one another, the cylinders being stationary. Fig. 11 is a side elevation, and Fig. 12 a cross-section on line C C, Fig. 11, showing an engine similar to that of Fig. 9, but in which the cylinders are mounted on rotary instead of stationary frames. Fig. 13 is a longitudinal section, and Fig. 14 a cross-section on line D D, of an explosive-engine of this type. Fig. 15 illustrates the development of a cam used therein. Fig. 16 is a longitudinal section, and Fig. 17 a cross-section on line E E, Fig. 16, of another type of explosive-engine.

In the form of the invention shown in Figs. 1 to 3 a central shaft 6 (preferably hollow) is supported in suitable bearings 12. Two or more cylinders 2, with their axes parallel to the axis of the shaft, equidistant from each other and from the axis of the shaft, are preferably cast in one piece with the shaft. The drawings show four such cylinders. There are two pistons 3 in each cylinder, with their outer ends provided with rollers 4, which run on two roller-paths 5, fixed to or in one piece, with flanges 14 on corresponding end disks 13 at right angles to the axis of the shaft 6. Straps or casing 15 firmly connect the end disks 13 to each other, and one or more cylindrical or other valves 7 serve for the admission and release of the motive fluid. If one cylindrical valve is used, it is inserted in one end of the shaft a suitable distance, but does not revolve with it. The valve may also be provided with means for varying the size of the pressure port or ports, so as to vary the speed of the engine. The motive fluid may be admitted at one end of the shaft—namely, the end 8 in which the valve is inserted—and is preferably discharged at the other end at 9. The motive fluid is admitted to each cylinder at about the middle through a port 17 in the shaft, which is in communication with the pressure-port 10 or exhaust-port 11 of the valve as the engine revolves. The pressure on the pistons 3 tends to force them apart and out of the cylinder 2 and causes the rollers 4 on the outer ends of the pistons to bear against the roller-paths 5 on the end disks 13. Guides 20 are provided for guiding the pistons 3 and keeping the rollers 4 in proper position with respect to the roller-paths 5.

16 is a base-plate for carrying disks 13.

18 represents slots cut in the cylinders to clear the roller-path 5. 19 represents slots in the pistons for the same purpose.

The roller-paths consist of a cam-like series of inclined planes suitable in each case for the particular requirement.

Fig. 4 is a development of roller-path suitable when each set of pistons makes only one inner and outer stroke during one revolution around the shaft-axis and the engine is not reversible.

Fig. 5 shows a development of roller-path suitable when each set of pistons makes three inner and outer strokes during one revolution around the shaft-axis and the engine is not reversible.

Fig. 6 is similar to Fig. 4, but for a reversible engine.

Fig. 7 is similar to Fig. 5, but for a reversible engine and suitable for two strokes per revolution instead of three.

If the disks 13 are not permitted to revolve and the cylinders 2, and therefore the shaft 6, are free to do so, the latter will revolve, due to the pressure on the back of the pistons 3, causing the rollers 4 to move down the inclined planes of the roller-paths 5. When the rollers have reached the lowest possible positions on the paths, the pistons will be at full stroke and the pressure to the cylinders cut off, if not previously cut off. Owing to the formation of the roller-path the piston will begin to move back again into the cylinder, which is now open to the exhaust. As each cylinder in its turn is open to the pressure a uniform rotary motion of the shaft is obtained. It is not necessary that the speed of the outer and inner strokes of the pistons be the same.

The above description refers to the case when the cylinders and shaft rotate around the axis of the latter and the end disks and roller-paths remain stationary; but it is evident that the cylinders and shaft may be made stationary and the disks allowed to revolve, if provided with suitable bearings.

Fig. 8 is an elevation showing cylinders divided so that each piston has a cylinder. The shaft to which the cylinders are connected is also divided into two parts $6^a$ and $6^b$, so that each part can be run in opposite directions, if required, by suitable arrangement of valve-ports 10, the valve 7 being held centrally.

Fig. 9 shows another form in which the cylinders are reversed in position with respect to Fig. 8, they being also fixed and stationary and the roller-paths 5 revolving independent shafts 22 23.

Fig. 11 shows a construction somewhat similar to Fig. 9, but with cylinders fixed to and revolving with shaft 6, shown in one piece in this case in the bearings 25, the roller-paths 5 being stationary and carried by a foot-piece 24.

Fig. 13 is a vertical section of a three-cylinder explosive-engine suitable for use with oil-vapor or gas as the motive fluid. 26 is the valve hand-lever; 27, the compression-chamber, 28 being the inlet to chamber 27.

48, Fig. 14, is the air-outlet from chamber 27. 29 is an air-passage; 30, oil-vapor or gas reservoir; 31, the valve between reservoir 30 and the combustion-chamber 32; 47, a valve admitting air to the combustion-chamber 32; 33, the contact for electric ignition 34; 45, wires therefor; 35, a pipe from the oil-pump. 36 is the spray-carbureter; 37, the casing.

Fig. 16 is a vertical section of another arrangement suitable for oil-vapor or gas.

In Figs. 16 and 17, 38 is an air-pump; 39, a gas-pump; 40, eccentric cam or equivalent means for driving said pumps. 41 is a passage from pump 38 to cylinders 2; 42, a passage from pump 39 to said cylinders. 46 represents check-valves.

The remaining reference-numerals indicate the same parts as in the other figures previously described.

In all these forms it is preferred that the axes of the cylinders 2 and of the plane of the roller-paths 5 be parallel to the axis of the shaft 6; but this arrangement may be varied, for by making suitable alterations in the construction and arrangement of the several parts the engine will work if the axis of each cylinder be at a greater or less angle to the axis of the shaft either tangentially or obliquely, or the cylinder when divided into two, either by a partition or into two separate cylinders, may have the axes of the two parts not in alinement and need not necessarily be in the same plane, but whatever the angle of the cylinder-axis to the shaft-axis the pistons are always so placed to act in pairs symmetrically that the components parallel to the shaft-axis of the forces of the piston of each pair always balance and neutralize one another. There is thus no end thrust of the cylinders upon the shaft. When four or other even number of cylinders are used, they may be compounded into two or more pairs of high and low pressure cylinders.

What I claim is, in a rotary engine—

1. The combination of a plurality of cylinders equidistantly disposed around a central axis, pistons in said cylinders arranged in pairs to balance one another in respect of the components of their movements parallel to said axis, rollers journaled in said pistons and roller-paths, adapted to coöperate with said rollers to convert the reciprocatory movement of said pistons into a relative rotary motion between said roller-paths and cylinders substantially as set forth.

2. The combination of a plurality of cylinders equidistantly disposed at equal radial distances around and parallel to a central axis, pistons in said cylinders adapted to reciprocate therein in pairs in opposite directions, rollers journaled in said pistons and roller-paths in planes cylindrically concentric with said axis, adapted to coöperate with said rollers to convert the reciprocatory movement of said pistons into a relative rotary motion between said roller-paths and cylinders.

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

HENRY IGEL.

Witnesses:

JOSEPH GLADSTONE,

WILLIAM DAGGETT.