No. 615,810 Patented Dec. 13, 1898.

A. H. CROCKFORD.

FLUID PRESSURE ENGINE

(Application filed Dec. 31, 1897.)

(No Model.) 3 Sheets—Sheet 1.

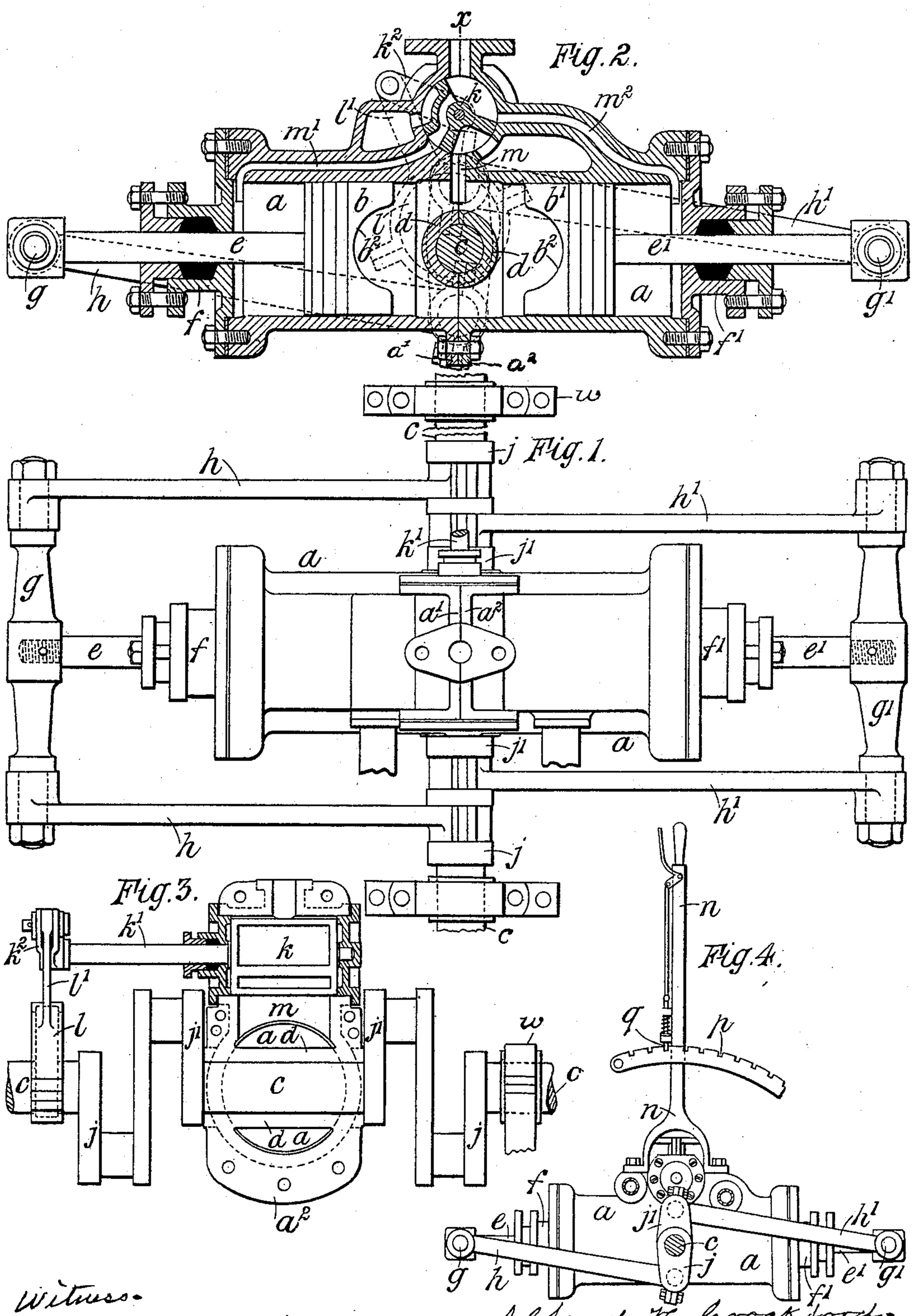

Fig. 2.

Fig. 1.

Fig. 3.

Fig. 4.

Witness.
Albert H. Norris
Chas. E. Fisher.

Alfred H. Crockford.
By James L. Norris.
his Attorneys

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Fig. 5.

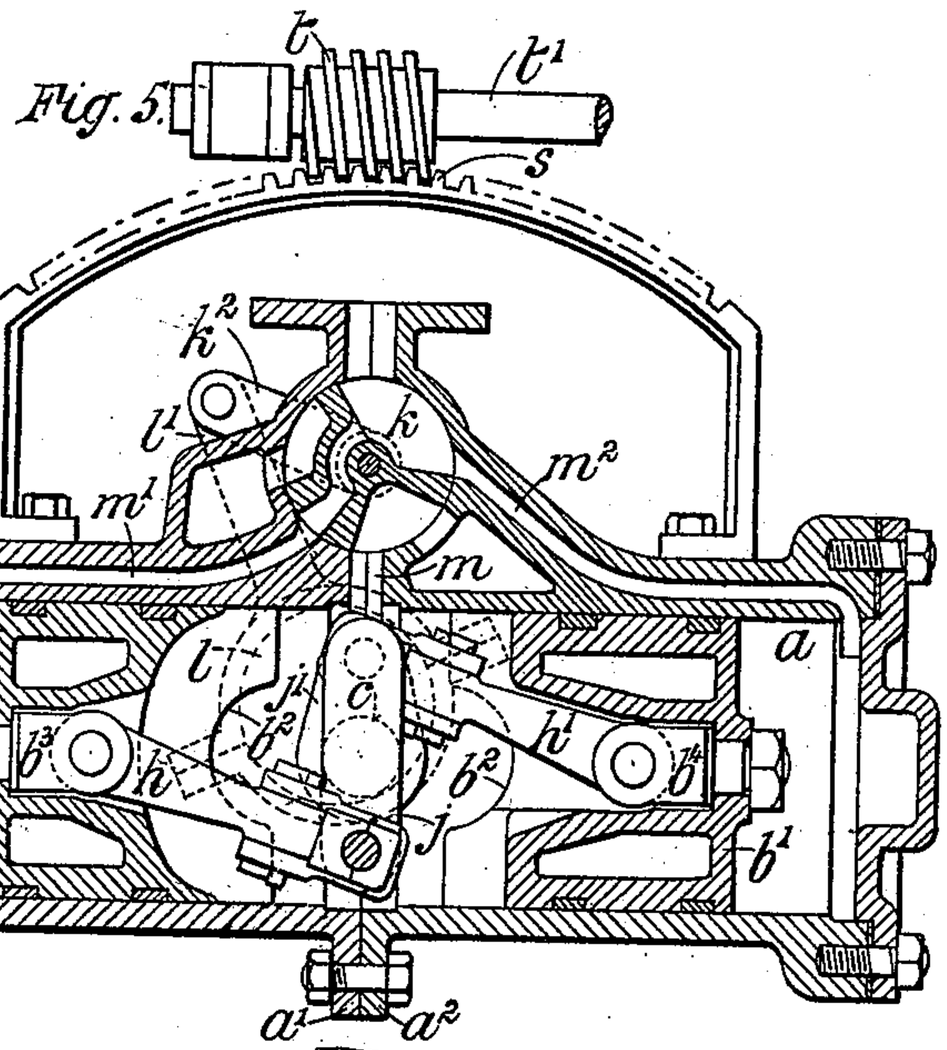
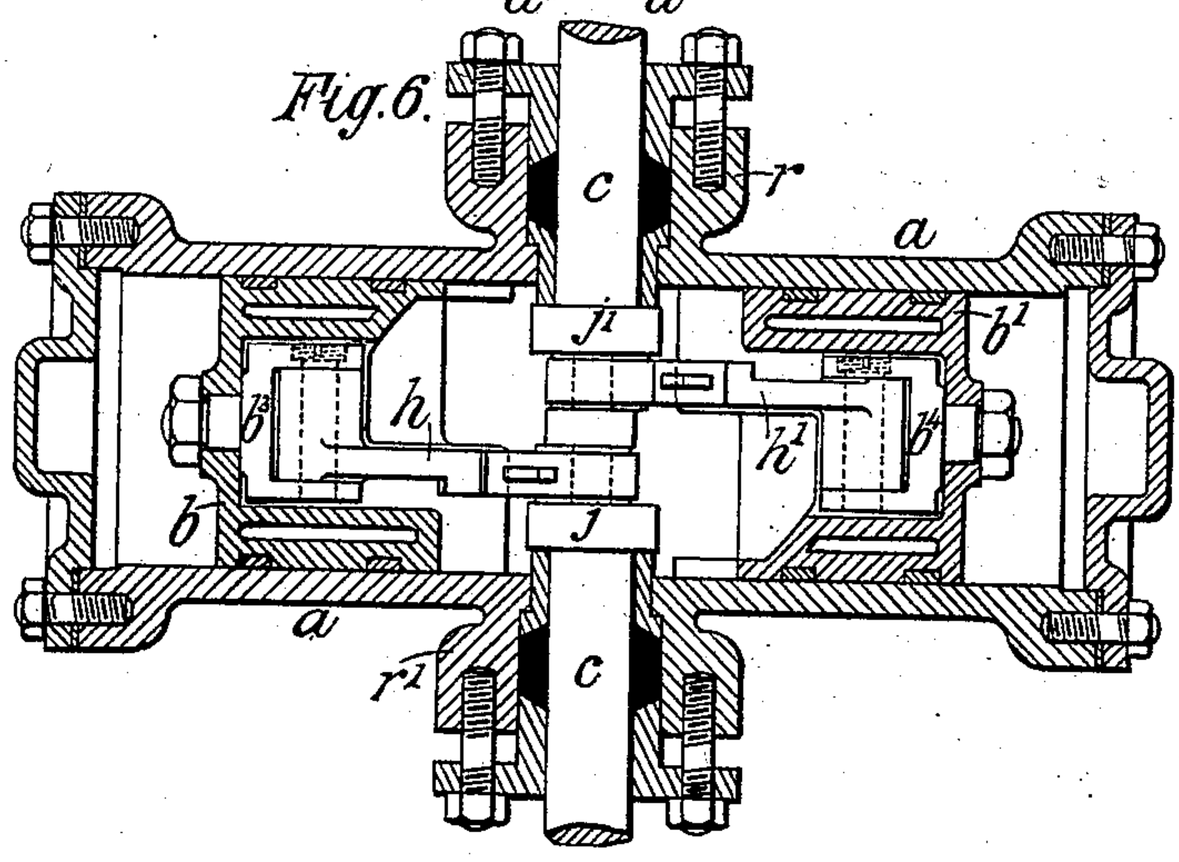


Fig. 6.



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Inventor
Alfred H. Crockford.
By James L. Norris.
his Attorney.

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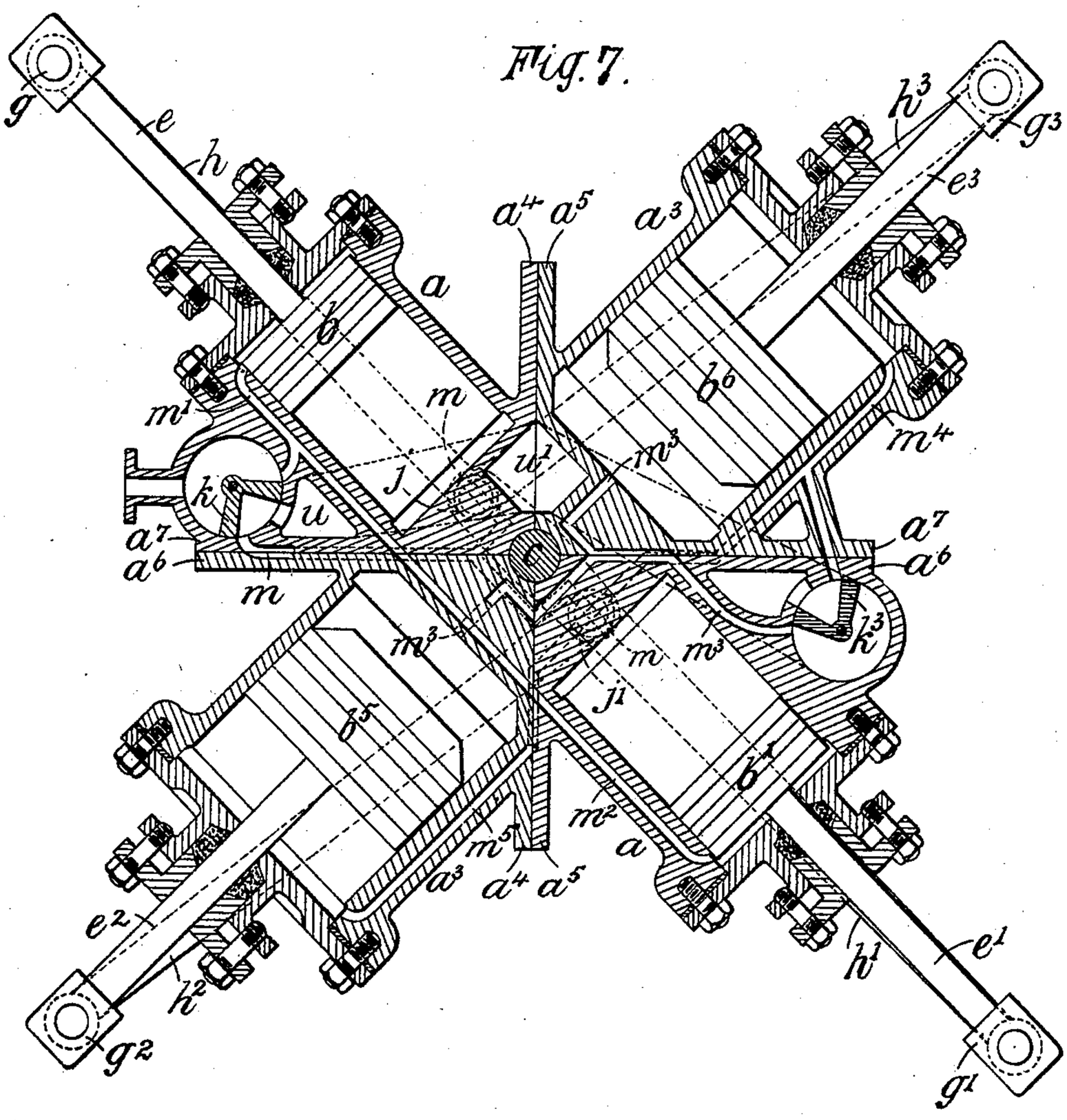
Fig. 7.



Witnesses:
Albert H. Norris
Chas. E. Fisher

Inventor
Alfred H. Crockford
By James L. Norris
his Attorney.

UNITED STATES PATENT OFFICE.

ALFRED HENRY CROCKFORD, OF DARTFORD, ENGLAND.

FLUID-PRESSURE ENGINE.

SPECIFICATION forming part of Letters Patent No. 615,810, dated December 13, 1898.

Application filed December 31, 1897. Serial No. 664,917. (No model.)

To all whom it may concern:

Be it known that I, ALFRED HENRY CROCKFORD, engineer, a citizen of the United States of America, residing at Dartford, England, have invented an Improved Fluid-Pressure Engine, (for which I have obtained Letters Patent of Great Britain, No. 19,120, dated August 29, 1896,) of which the following is a specification, reference being had to the accompanying drawings, in which—

Figure 1 is a plan, some of the parts being removed, and Fig. 2 a vertical longitudinal central section, showing one form of my improved double-acting balanced reciprocating engine. Fig. 3 is a transverse section on the line *x x*, Fig. 2, some of the parts being removed. Fig. 4 is a side elevation of the said engine, drawn to a reduced scale, showing means for turning or adjusting the cylinder about the axis of the crank-shaft. Fig. 5 is a vertical longitudinal central section, and Fig. 6 a plan, partly in horizontal section, showing another form or modification of my improved double-acting balanced engine, and Fig. 7 is a vertical longitudinal central section showing a compound engine constructed according to my present improvements.

The object of my invention is to provide an improved fluid-pressure balanced reciprocating engine or motor which will occupy a comparatively small space in proportion to its power, which can be run at a very high speed, and which will be otherwise advantageous for use in horseless vehicles and for the driving of dynamo-electric machines, and also for the propulsion of torpedo-boats, launches, and the like, and for various other purposes; and my said invention consists in the several combinations and forms of construction hereinafter particularly described, and pointed out in the claims.

Referring to Figs. 1 to 6, *a a* are the cylinders, which are joined end to end about the rotary crank-shaft. *b b'* are the reciprocating pistons, which work therein in opposite directions. *c* is the rotary crank-shaft. This shaft *c* is made with pairs of cranks *j j'*, set at an angle of one hundred and eighty degrees, so as to insure the working of the two pistons in opposite directions at all times, and thus obtain a properly-balanced engine. The said shaft is mounted in journal-bearings *w*, located on opposite sides of said cylinders and cranks, and the cylinders *a* are supported solely by said shaft, the said journal-bearings being attached to the frame of a motor-car or to any other suitable support for the said shaft.

In the form of construction shown in Figs. 1 to 4 the cylinder-casting is divided transversely into two halves or parts to permit the introduction of the rotary crank-shaft *c*, which extends transversely through the said casting, a bearing *d* for the said shaft being formed on the said halves or parts and the latter being firmly united by bolts passed through flanges $a' a^2$. The pistons *b b'* are provided with rods *e e'*, respectively, which extend through stuffing-boxes *f f'* in opposite ends of the cylinder *a*. On these rods are fixed cross-heads *g g'*, which are coupled by connecting-rods *h h'*, respectively, to cranks *j j'*, of which there are a pair at each side of the cylinder. I also construct the connecting-rods *h h'* as shown, so that I am enabled to make the cross-heads *g g'* of the same length, and thus equalize the weight of the parts which move in opposite directions.

k is a rotary valve for distributing the steam or other fluid under pressure. This valve is arranged in a casing on the outside of the cylinder-casing and is worked by means of an eccentric *l* on the crank-shaft *c*, the eccentric-rod *l'* being coupled to a lever k^2 on the valve-spindle *k'*. The said valve distributes the fluid under pressure alternately to the space between the pistons through the port *m* and to the spaces at the ends of the cylinder simultaneously through the ports $m' m^2$. The pistons *b b'* are made with semicylindrical recesses b^2 in their inner ends, so that they will fit over the crank-shaft bearing *d*, and thus reduce to appropriate dimensions the clearance-space between the pistons when at the inner end of their stroke.

Heretofore it has been customary to rigidly secure the engine-cylinder to a bed-plate, entablature, or like support, so that its position cannot be varied; but in my improved engine the cylinders *a* are supported solely by the rotary crank-shafts *c*, as shown in Figs. 1 to 4 or in Figs. 5 and 6, so that it is free to be

turned or adjusted about the axis of the said shaft to permit of its being used at different angles between the horizontal and vertical, or to permit of shifting the cranks from or to their dead-center as desired, and I provide suitable means for turning or adjusting the said cylinder about the crank-shaft and for securing it in any desired position. For instance, I firmly attach to the cylinder a a lever n, Fig. 4, combined with a relatively-fixed quadrant p and provided with a locking-bolt q, the said quadrant being firmly secured to any suitable support. Since the forces tending to rotate the crank-shaft are always equal and opposite, the cylinder can be easily held in any desired position by means of the lever n and bolt q. The steam-pipe and exhaust-pipe are made with flexible connections or in any other convenient manner to permit such turning or adjustment of the cylinder. Instead of the lever and quadrant above described I sometimes provide a screw working in a pivoted nut or a worm geared with a worm-segment attached to the cylinder a for the purpose of turning the said cylinder about the axis of the crank-shaft. It will be seen that the distributing-valves, being carried by the cylinders, are capable of turning therewith about the axis of the rotary crank-shaft.

In the modification of my invention shown in Figs. 5 and 6 the cranks $j\,j'$ and connecting-rods $h\,h'$ are arranged within the cylinder a, the said connecting-rods being coupled to bolts $b^3\,b^4$, fixed in the pistons $b\,b'$, respectively, and the crank-shaft c, extending through stuffing-boxes $r\,r'$ on opposite sides of the cylinder a. The pistons $b\,b'$ are suitably recessed, as shown, so as to allow them to closely approach each other when at the inner end of their stroke, and thus reduce the clearance-space to appropriate dimensions. The ports for the distribution of the fluid under pressure are arranged substantially as above described with reference to Figs. 1, 2, and 3. In this arrangement I have shown a worm-segment s, attached to the cylinder a, and a worm t, geared with the said segment and fixed upon a spindle t', which is to be mounted in a suitable support and provided with any convenient means for rotating it about its axis. Other suitable means may, however, be employed for turning or adjusting the cylinder about the axis of the crank-shaft.

In Fig. 7 I have shown an arrangement in which there are two high-pressure cylinders a, arranged opposite each other, and two low-pressure cylinders a^3, arranged opposite each other and extending in a direction at right angles to the high-pressure cylinders. The distribution of the fluid under pressure to the high-pressure cylinders is effected by an oscillating valve k through the ports $m\,m'\,m^2$. The exhaust u of the high-pressure cylinders is connected through a passage u' with the inlet of the casing of the valve k^3, whereby the exhaust-steam from the high-pressure cylinders is distributed to the low-pressure cylinders through the ports $m^3\,m^4\,m^5$. The pistons $b^5\,b^6$ of the low-pressure cylinders are connected, by means of the piston-rods $e^2\,e^3$, cross-heads $g^2\,g^3$, and connecting-rods $h^2\,h^3$, with the same cranks $j\,j'$ as the high-pressure pistons $b\,b'$, respectively. The low-pressure valve-casing is provided with means for admitting steam directly thereto for the purpose of starting the engine. The cylinders $a\,a^3$ are made with flanges $a^4\,a^5\,a^6\,a^7$, whereby they are firmly united, the crank-shaft c extending through the central space between the said cylinders. The cylinders and distributing-valves in this arrangement are likewise supported solely by the rotary crank-shaft and are capable of angular adjustment about the same. The engine, being perfectly balanced, can be efficiently supported by simply fitting the rotary crank-shaft in suitable journal-bearings with the cylinders arranged horizontally or vertically or in any inclined position.

What I claim is—

1. A double-acting fluid-pressure engine comprising a rotary crank-shaft having cranks set at an angle of one hundred and eighty degrees to each other, journal-bearings supporting said shaft on opposite sides of said cranks, cylinders secured end to end about said crank-shaft between said journal-bearings and capable of being rocked through a small angle about said crank-shaft, pistons in said cylinders and connecting-rods coupling said pistons to said cranks, an oscillating distributing-valve arranged in a casing on the outside of said cylinders and adapted to distribute the fluid to both ends of said cylinders, and an eccentric fixed on said shaft and having a rod coupled to an arm or lever on the spindle of said valve, substantially as, and for the purposes, above specified.

2. A double-acting balanced fluid-pressure engine comprising journal-bearings for the crank-shaft, a rotary crank-shaft mounted in said bearings and having cranks set at an angle of one hundred and eighty degrees to each other, cylinders arranged radially to said crank-shaft between said journal-bearings and supported by said crank-shaft, said cylinders being capable of angular movement about said crank-shaft, means for distributing the fluid to both ends of each cylinder, reciprocating pistons in said cylinders and connecting-rods coupling said pistons to said cranks, and means for turning said cylinders about said crank-shaft, substantially as, and for the purposes, above specified.

3. The combination, with a rotary crank-shaft and journal-bearings supporting the same, of a pair of cylinders located in line with each other on opposite sides of said rotary crank-shaft between said journal-bearings, said cylinders being supported by and capable of being rocked about said crank-shaft, reciprocating pistons in said cylinders,

connecting-rods coupling said pistons to said cranks respectively, an oscillating distributing-valve arranged in a casing on the outside of said cylinders and adapted to distribute the fluid to both ends of both of said cylinders, an eccentric on said shaft and a rod connecting said eccentric to an arm on the spindle of said valve, substantially as, and for the purposes, above specified.

4. A double-acting balanced fluid-pressure engine comprising radially-arranged cylinders provided with a journal-bearing between their adjacent ends, a rotary crank-shaft having cranks set at an angle of one hundred and eighty degrees to each other, extending transversely through said journal-bearing and mounted in journal-bearings on both sides of said cylinders and serving as the sole support for said cylinders, said cylinders being capable of being turned about said crank-shaft, reciprocating pistons in said cylinders and connecting-rods coupling said pistons to said cranks, substantially as, and for the purposes, above specified.

5. A double-acting balanced fluid-pressure engine comprising a rotary crank-shaft having cranks set at an angle of one hundred and eighty degrees to each other, journal-bearings for said shaft on opposite sides of said cranks, cylinders arranged radially to said crank-shaft between said journal-bearings and supported solely by said shaft, reciprocating pistons in said cylinders and connecting-rods coupling said cranks respectively with the pistons of two of said cylinders located at a right angle to each other, distributing-valves each adapted to distribute the fluid to both ends of two cylinders located on opposite sides of said crank-shaft, and means for operating said valves from said crank-shaft, substantially as, and for the purposes, above specified.

6. A double-acting balanced fluid-pressure engine comprising journal-bearings, a rotary crank-shaft mounted in said bearings and having cranks set at an angle of one hundred and eighty degrees to each other, cylinders arranged radially to said crank-shaft between said journal-bearings and supported solely by said crank-shaft, said cylinders being capable of angular movement about said crank-shaft, means for distributing the fluid to both ends of each cylinder, reciprocating pistons in said cylinders and connecting-rods coupling said pistons to said cranks, substantially as, and for the purposes, above specified.

7. A double-acting fluid-pressure engine comprising a rotary crank-shaft having cranks set at an angle of one hundred and eighty degrees to each other, journal-bearings supporting said shaft on opposite sides of said cranks, cylinders secured end to end about said crank-shaft between said journal-bearings and capable of being rocked through a small angle about said crank-shaft, pistons in said cylinders and connecting-rods coupling said pistons to said cranks, substantially as, and for the purposes, above specified.

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

ALFRED HENRY CROCKFORD.

Witnesses:

JOHN T. KNOWLES,

ALEXANDER W. ALLEN.