(No Model.) 3 Sheets—Sheet 1.

L. C. WORRON.

MULTICYLINDER ENGINE.

No. 532,856. Patented Jan. 22, 1895.

Fig. 1.

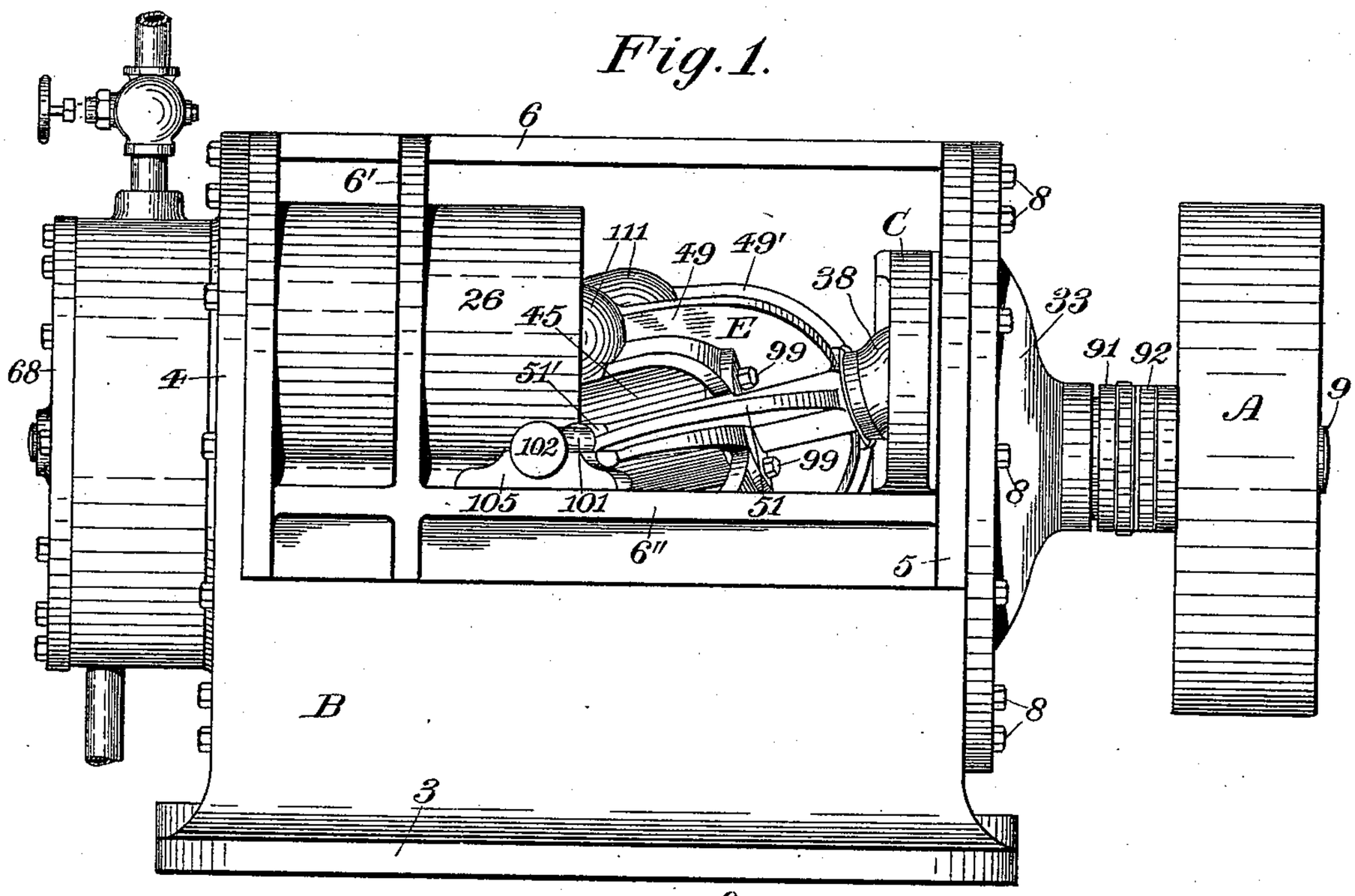


Fig. 15.

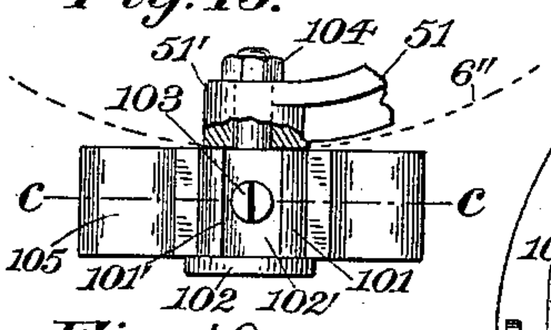


Fig. 16.

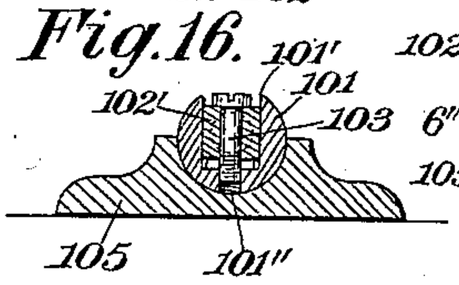
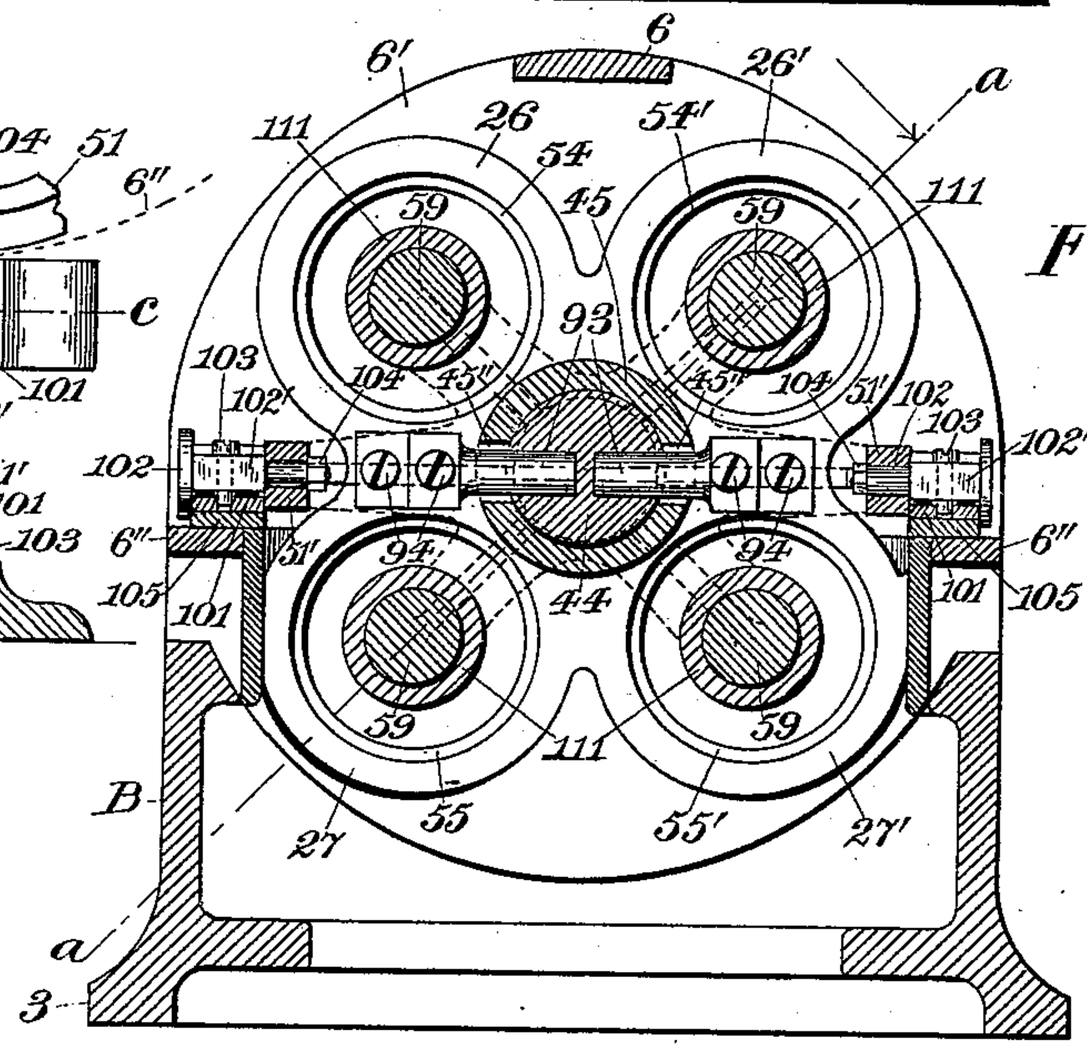


Fig. 2.



Witnesses

J. L. Edwards Jr.

Fred. J. Dole.

Inventor

Lewis C. Worron.

By his Attorney,

F. A. Richards.

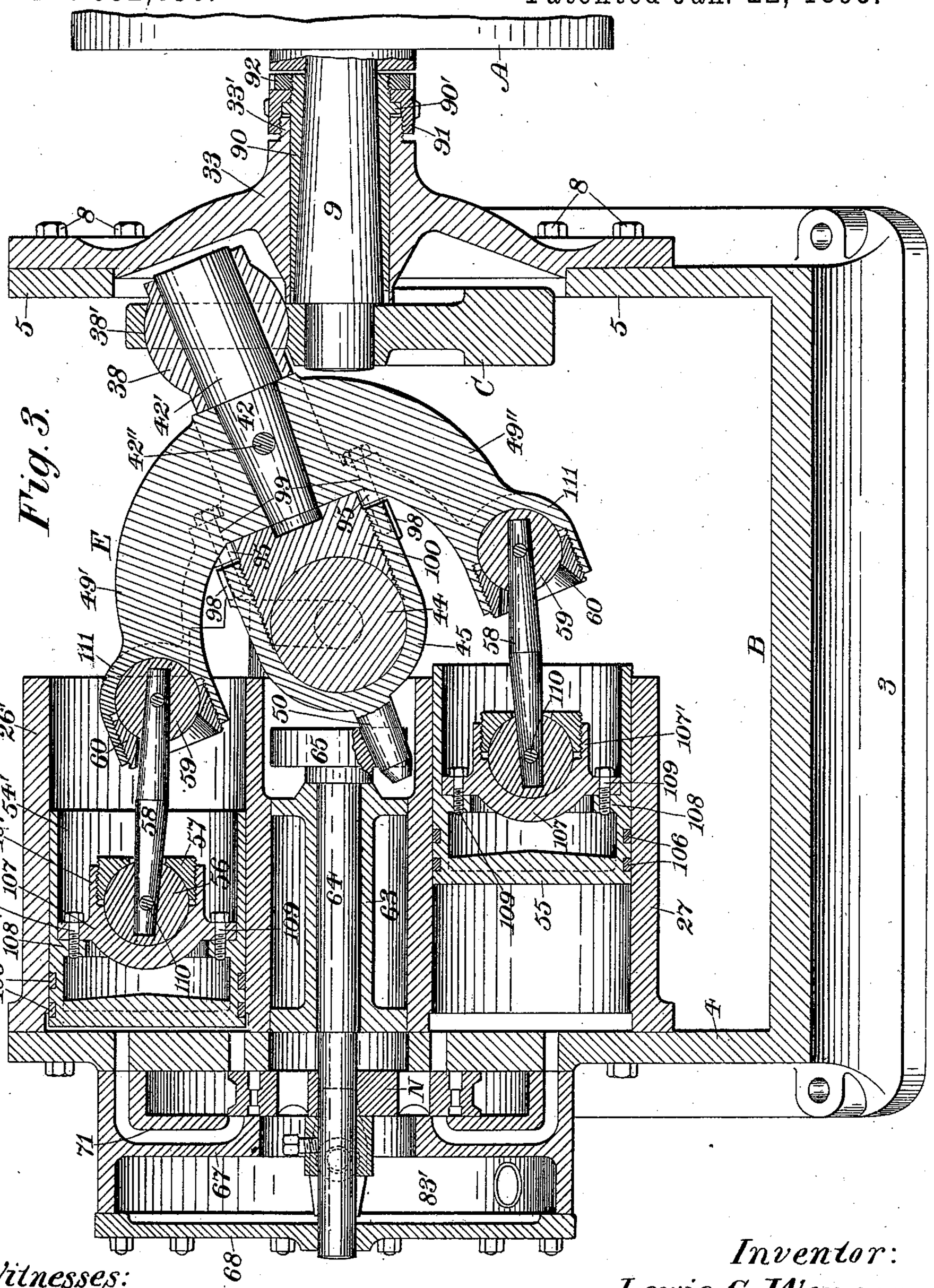
(No Model.) 3 Sheets—Sheet 2.

L. C. WORRON.

MULTICYLINDER ENGINE.

No. 532,856. Patented Jan. 22, 1895.

Fig. 3.



Witnesses:
F. L. Edwards Jr.
Fred. J. Dole.

Inventor:
Lewis C. Worron
By his Attorney,
F. A. Richards

(No Model.) 3 Sheets—Sheet 3.

L. C. WORRON.

MULTICYLINDER ENGINE.

No. 532,856. Patented Jan. 22, 1895.

Fig. 4.

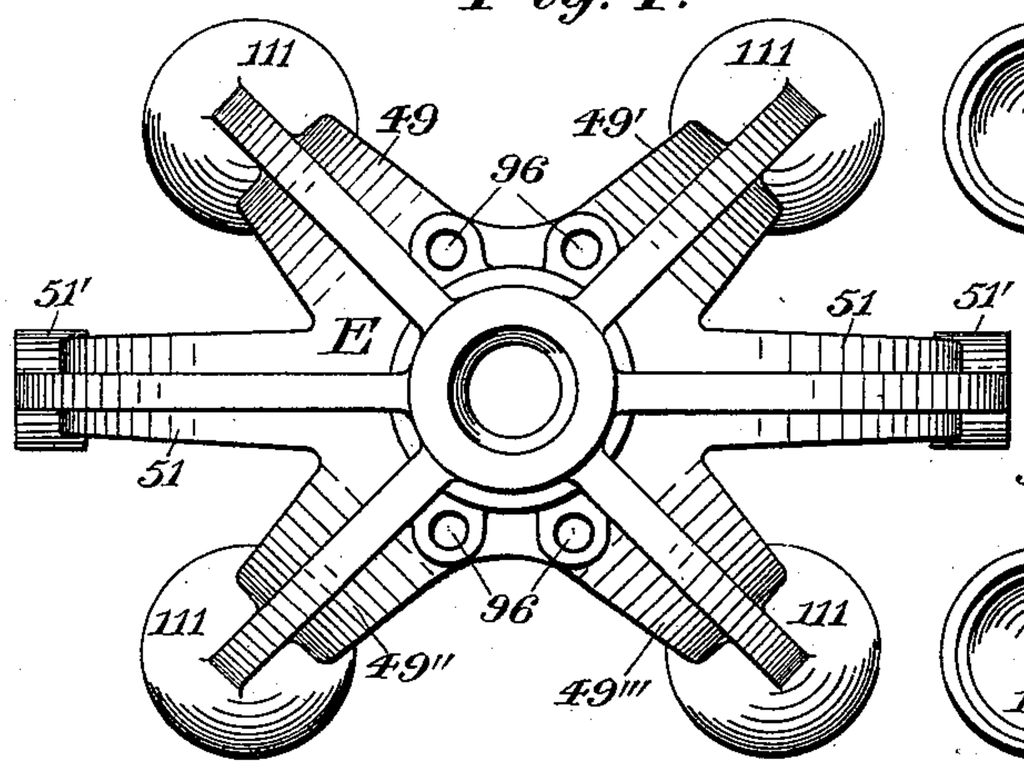


Fig. 5.

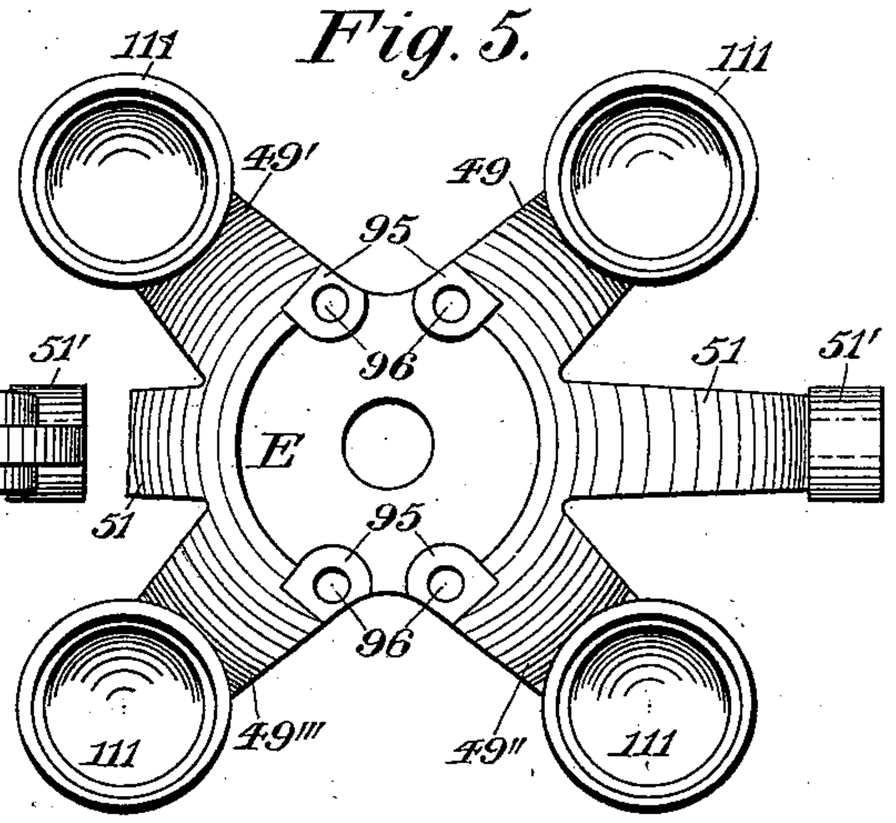


Fig. 9.

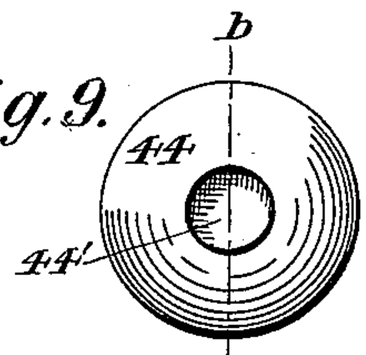


Fig. 10.

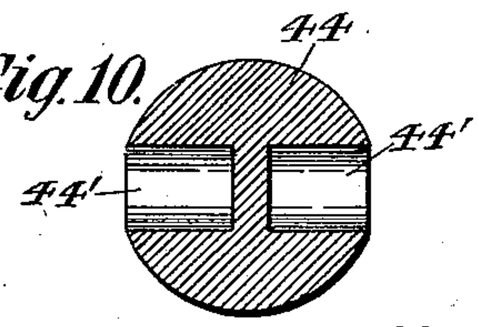


Fig. 6.

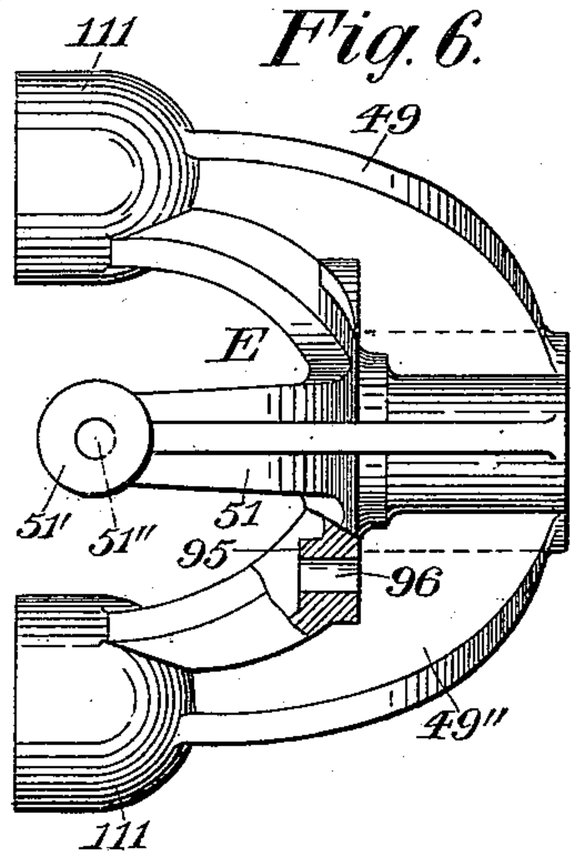


Fig. 8.

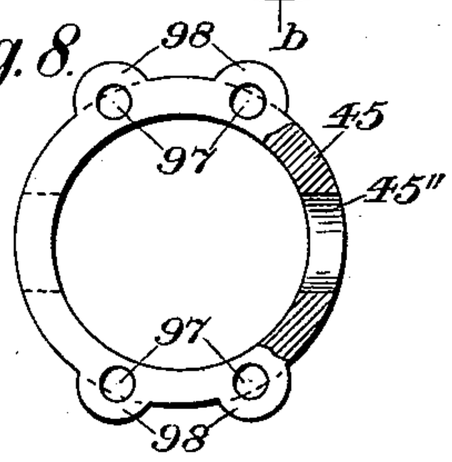


Fig. 7.

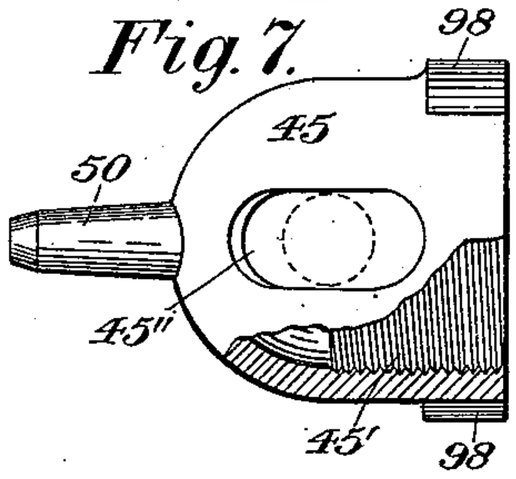


Fig. 11.

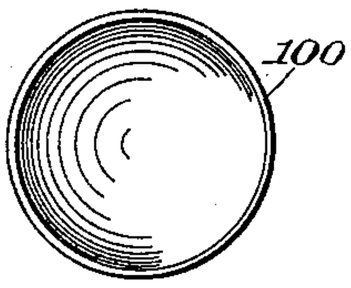


Fig. 12.

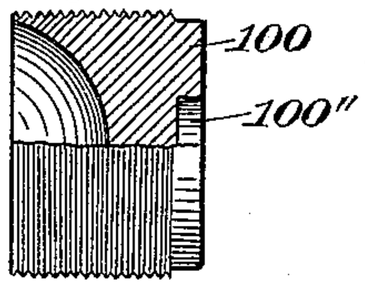


Fig. 13.

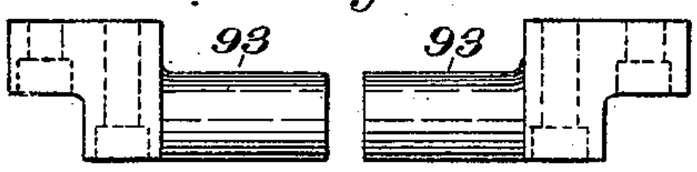
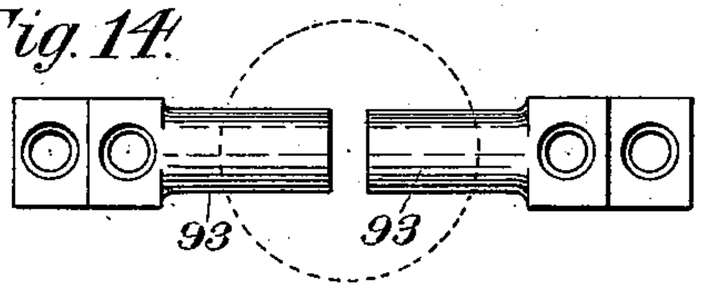


Fig. 14.



Witnesses
J. L. Edwards Jr.
Fred. J. Dole.

Inventor
Lewis C. Worron.
By his Attorney,
F. A. Richards.

UNITED STATES PATENT OFFICE.

LEWIS C. WORRON, OF HARTFORD, CONNECTICUT, ASSIGNOR TO ABRAHAM VANDERBEEK, OF SAME PLACE.

MULTICYLINDER-ENGINE.

SPECIFICATION forming part of Letters Patent No. 532,856, dated January 22, 1895.

Application filed October 4, 1894. Serial No. 524,913. (No model.)

To all whom it may concern:

Be it known that I, LEWIS C. WORRON, a citizen of the United States, residing at Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Multicylinder-Engines, of which the following is a specification.

This invention relates to that class of multicylinder engines having a series of single-acting cylinders connected with a single crank-shaft through a rocking-beam or cross-head common to all of the cylinders.

The present invention is especially intended as an improvement upon that shown and described in my prior patent, No. 501,983, granted July 25, 1893.

The object of my present improvements is to furnish an engine of the class specified of improved construction and organization, and in which a more perfect and positive control of the rocking-beam is obtained with less friction upon the operative parts of the engine, whereby the efficiency of the same is increased, as will be more particularly hereinafter described.

In the drawings accompanying and forming part of this specification, Figure 1 is a side elevation of a multi-cylinder steam-engine constructed in accordance with my present improvements. Fig. 2 is a transverse section through the main bearing of the engine. Fig. 3 is an enlarged, longitudinal section taken in a line corresponding to line *a—a*, Fig. 2 and looking in the direction of the arrow. Fig. 4 is a front elevation of a portion of the rocking-beam or cross-head of the engine. Fig. 5 is a rear elevation of the same. Fig. 6 is a side elevation of the same. Fig. 7 is a sectional, side elevation of one member of the socket of the main bearing and the valve-operating stem secured to said socket. Fig. 8 is a front elevation of the same, partially in section. Fig. 9 is a side elevation of the main bearing of the rocking-beam. Fig. 10 is a section in line *b—b*, Fig. 9. Fig. 11 is a rear elevation of the second or forward member of the socket for the main bearing. Fig. 12 is a sectional side elevation of the same. Fig. 13 is a plan of the studs for supporting the main bearing. Fig. 14 is a front elevation of the same. Fig. 15 is a plan of one of the trunnions and shoes for supporting the lateral guides of the cross-head of the engine. Fig. 16 is a section in line *c—c*, Fig. 15.

Similar characters designate like parts in all of the figures.

According to my present improvements the connection of the rocking-beam or cross-head to the main casting of the engine is by means of a ball-and-socket joint, or pivotal-bearing, the pivotal axis of which is in line with the axis of the main shaft of the engine, and in which joint the spherical bearing is mounted for rotation in a vertical longitudinal plane and is fixed against movement in a horizontal plane while the socket surrounding said spherical bearing is mounted for movement thereon in a horizontal plane, whereby a universal movement is obtained about a journal surface wholly upon the rocking-beam or cross-head, and each thrust of the pistons is received upon a substantially hemispherical portion of the journal or its bearing, and, in connection with said cross-head, lateral guides, acting in conjunction with corresponding ways upon the bed or frame of the engine, are provided for supporting the cross-head in vertical direction and thereby preventing strains and unnecessary friction upon the working parts of the engine.

The framework of my improved multi-cylinder engine may be of any construction adapted for carrying and supporting the several fixed and operative details. In the drawings I have shown a preferred form of framework, which is designated in a general way by B and consists of a base-plate, 3, the rearward end wall, 4, the forward end-wall 5, a longitudinal connecting bar or brace, 6, vertical braces, such as 6′, and horizontal ways, 6″. It will be understood that said several parts, while usually formed in one piece or casting, may be made separately and secured in their proper relative positions, if desired, by any suitable means, as by connecting bolts and securing nuts.

The main shaft, 9, is shown herein as tapered and fitted within a correspondingly-tapered, tubular bushing, 90, secured within the bearing, 33, which is shown as fixed to the forward end-wall 5 of the engine by means of suitable bolts, such as 8. Said bearing 33 is

formed at its forward end with a reduced screw-threaded portion 33′, over which is fitted an internally-screw-threaded adjusting-collar 91, whose inner stop-wall engages with and forms an abutment for the flange 90′ of the bushing. Said bushing is also shown herein as screw-threaded at its forward end and as carrying a check-nut, 92, for retaining the adjusting collar in operative position with respect to the bearing, the bushing and the shaft. It will be evident that, by means of this construction and organization of adjusting devices, a perfect adjustment of the shaft within the bushing may be obtained to compensate for wear between the journal surfaces. The outer end of the main shaft 9 is shown as of cylindrical form and carrying upon its journal surface the hub of the main driving pulley A, which may be secured to said shaft in any suitable manner.

The inner end of the main shaft 9 is shown as carrying a crank-disk, C, fixedly secured thereto. This disk is also shown as having on one side thereof a journal or socket, shown at 38′, and which is adapted to receive the forward, spherical journal, such as 38, carried by the rocking-beam.

For the purpose of communicating power from the pistons of the engine to the crank-shaft C, I have shown herein a rocking-beam or cross-head, designated in a general way by E, and adapted to have the universal, rocking movement common to engines of this type. Said beam or cross-head is shown as carried upon the driving spindle or shaft, 42, the forward end 42′, of which engages and revolves in a longitudinal bore in the aforesaid spherical journal, as shown in Fig. 3. The driving spindle or shaft 42 is supported to have, together with the rocking-beam to which it is attached, a universal rocking motion by means of the said spherical journal 38 at its forward end, and by means of a universal joint, or ball-and-socket connection, of the rocking-beam or cross-head with the main frame or casting of the engine. In the form thereof herein shown and described this connection comprises a main spherical bearing, 44, having transverse, aligned, radial sockets or journals, 44′, adapted to receive the inner ends of suitable trunnions or studs, such as 93, which are herein shown as secured by means of bolts, 94, to the frame or casting of the engine. As will be seen this main bearing is located substantially in the plane of the ends of the four radial beam-arms, 49, 49′, 49″ and 49‴, of the main beam or cross-head E and centrally of said arms and in line with the main shaft. The driving-spindle or shaft 42 is shown herein as tapered at its rear end and firmly wedged within a correspondingly-tapered bore in the rocking beam or cross-head, and as maintained in a fixed position relatively to said beam by suitable securing means, such as the bolt 42″. At the rear side thereof said beam is shown as provided with lugs, 95, having bolt-holes, 96, drilled therethrough and adapted to register with corresponding bolt-holes, 97, in peripheral lugs 98, carried by a cap, 45, adapted to form one member of an adjustable socket for the reception of the main bearing 44. This cap or socket is shown herein as aligned with the driving-spindle or shaft 42, and as secured in position upon the beam or cross-head by suitable fastening devices, such as the bolts, 99, passed through the corresponding bolt-holes or taps, 96 and 97 of the beam and cap, respectively, the cap, when in position, thus forming a part of the cross-head. The interior of said cap is so shaped, as shown in Figs. 2, 3 and 7, as to form a hemispherical journal for the main bearing 44, the other half of said journal being formed by means of an externally-screw-threaded cap or closer, 100, adapted to be engaged by the corresponding, interior screw-threads, 45′, of the cap 45. By means of this construction the two halves of the journal may be readily and positively adjusted for any wear that may occur upon the journal surfaces.

As shown herein it will be seen that the cap 45 is provided with lateral openings, 45″, through which the trunnions or studs 93 supporting the main bearing pass, and upon which studs said cap is adapted to have free oscillatory movement transversely of the longitudinal axis of the cap and the cross-head.

The cap 100, which forms the forward half of the journal for the main bearing, is shown as having a central recess or countersink, 100″, into which the rear, tapered end of the driving-shaft 42 is adapted to be received, to obtain greater solidity of the connected parts.

At its extreme rear end the cap 45 is shown as provided with a centrally-disposed stem, 50, which is in line with the shaft 42 and preferably integral with the cap 45. This stem is adapted for driving the valve-mechanism of the engine, in a manner substantially similar to that described in my patent hereinbefore referred to, and to which reference may be had for a more detailed description thereof. Said stem is shown herein as engaging an inclined bore in the head, 65, of the valve-shaft, or spindle, 64, upon which spindle is mounted a suitable valve, such as N, fitting between the rear side of the end-wall 4, which forms the cylinder-head of the engine, and between the cover, 71, of the valve-chest and the steam-chest cover 67. An outer cover, 68, is shown as secured to the steam-chest cover and as closing the rear end of the exhaust-chamber 83′. The valve-spindle 64 is shown herein as having its principal journal in the bearing 63, which is disposed centrally with respect to the engine cylinders and is in line with the main shaft 9 of the engine.

For controlling the movements of the rocking-beam or cross-head E, and for supporting the same so that the weight thereof will not be carried at any time by the piston-rods, or connections to the pistons of the engine cylinders, said cross-head is shown herein as pro-

vided with oppositely-disposed guide-arms, 51, having transverse apertures or bores, 51″ at their outer ends and passing through the shoulders or lugs 51′. A journal member, such as 101, is shown herein as connected with said shoulder in the following manner: Said journal-piece 101 is shown as having a transverse rectangular guide-way, 101′, in which is mounted the substantially square shank 102′, of a connecting bolt, 102, an adjusting-screw, 103, being shown as passing transversely through said squared portion of the connecting bolt and as engaging at its screw-threaded point the correspondingly threaded hole or tap 101″, in the journal member. This screw is shown herein as threaded for but a short distance from its point, and as provided with a smooth shank throughout the greater portion of its length, so that when screwed into or out of the threaded hole 101″, there will be a correspondingly greater or less distance between the lower side of the connecting bolt 102, and the bottom wall of the guide-way 101′, whereby the guide-arms 51 may be properly adjusted in position relatively to the ways or guides 6″, with which they are in operative connection. The journal member 101 is shown herein as held in position laterally of the engine by means of the nut 104 which engages the reduced, threaded end of the cylindrical portion 102″ of the connecting-bolt, thereby holding the bolt itself in position, at the same time, with respect to the guide-arms, through the bores 51″ of which the connecting bolts are passed. In adjusting the journal member and connecting bolt relatively to one another the space between the under side of said bolt and the bottom wall of the guide-way in said journal piece is usually filled with flat pieces of metal piled one upon another, in a well known manner, to prevent "pounding" between said connected parts. Each of said journal members 101 is mounted upon and within a corresponding journal of the shoe, 105, which is loosely mounted for reciprocatory movement upon the corresponding way 6″, said way being curved upon its inner side to provide for the oscillatory movement of the cross-head in lateral direction.

It will be seen from the foregoing that each of the journal members 101 constitutes a vertically-adjustable trunnion adapted for loosely engaging the shoe upon which it is journaled, and for having an oscillatory movement in said journal while said shoe reciprocates in a slightly curved path upon the horizontal ways 6″ of the engine.

The cylinders of the engine may, if preferred, be constructed separately from the framework and from each other, but I have herein shown all of the cylinders 26, 26′, 27 and 27′, as formed integral with the framework, said cylinders being preferably arranged with their axes substantially parallel with, and at equal distances from, the axis (continued) of the main shaft. Said cylinders are shown provided with pistons, designated in a general way by 54, 54′, 55 and 55′, respectively. All of said pistons are of substantially the same construction in the preferred form thereof herein shown, and are substantially similar to the pistons shown and described in my patent before referred to, with the exception that the strains transmitted through the piston rods, or connecting devices, are taken up more directly by the said pistons. The piston 54′, for instance, is shown as formed with the usual head or body-portion having suitable piston- or packing-rings, 106, and constructed for connection with the cross-head or rocking-beam. For this purpose said piston-head is provided with a transverse disk, 107, secured to the internal flange, 108, of the piston by suitable securing means, as the screws or bolts, 109, and said disk is formed with a central, journal seat substantially hemispherical in form opening into a substantially-cylindrical, cup-shaped portion, 107′, screw-threaded internally as shown. Within the socket formed in said disk a spherical bearing 56, is mounted and is held in place by means of a cap 57, externally screw-threaded to engage with respect to the socket and the spherical bearing. Said spherical bearing is bored diametrically, as shown, to receive the rearward, tapered end of the piston-rod or connecting-rod, 58, which is held in place within said bearing, as by a cross-pin or bolt, 110. The cap 57 is suitably slotted at its forward side to permit free play of the connecting rod therein. It will, of course, be understood that the connection between each of the outer pistons and its rod is substantially the same as that just described. At its opposite end the connecting-rod is pivoted to the corresponding arm of the cross-head or rocking-beam in a substantially similar manner. The arm 49′ is shown as formed with a hemispherical socket, 111, adapted to receive the spherical bearing 59, which is secured to the forward, tapered end of the connecting-rod 58, as before described with reference to the bearing 56. A cap, 60, is also adapted to maintain said bearing 59 in position and to adjust it, as before described with reference to the cap 57.

It will be understood from the foregoing that, by means of the construction and organization of my present improvements, the rocking-beam is mounted so that the main bearing of the engine is substantially independent of the frame thereof, and does not have to support the entire weight of the beam, but that said beam is provided with guides working upon supporting ways whereby said beam is mounted for operation as a substantially-independent cross-head.

It will also be observed that, by means of the spherical journal or socket entirely surrounding the main bearing, a journal surface which faces toward the cylinder end of the engine and is substantially a hemisphere in extent is opposed to each thrust of an arm of

the rocking-beam, and to each strain thereon, from whatever direction said strain may be exerted. The sockets and bearings for the piston-rods or connecting-rods are also so organized that the thrusts of said rods are received almost entirely by the corresponding piston or arm of the cross-head, and not by the cap for adjusting and maintaining the bearings, carried by said parts, in position.

By the described construction and organization of the main shaft, its journal and bearing, I also obtain a very perfect means for taking up the wear incident to the rotation of said shaft and its fly-wheel, when operated at a high rate of speed.

Having thus described my invention, I claim—

1. In a multi-cylinder-engine, the combination with the main shaft, of a rocking beam or cross-head in operative connection with said shaft, means for connecting said cross-head with the pistons of the engine, a main pivotal bearing for the cross-head and having its axis in line with the axis of said shaft and adapted to partially support said cross-head, and cross-head-supporting means independent of said bearing and adapted to form the main support for the cross-head whereby the friction at said pivotal bearing is reduced to the minimum, substantially as described.

2. In a multi-cylinder-engine, the combination with the main shaft, of a rocking beam or cross-head in operative connection with said shaft, means for connecting said cross-head with the pistons of the engine, a main pivotal bearing for said cross-head and having its axis in line with the axis of said shaft and adapted to partially support said cross-head, oppositely-disposed lateral guides carried by the cross-head, and fixed guides or ways mounted upon the engine and adapted to cooperate with said guides upon the cross-head to form the main support for said cross-head whereby the friction at said pivotal-bearing is reduced to the minimum, substantially as described.

3. In a multi-cylinder-engine, the combination with the main shaft, of a rocking-beam or cross-head in operative connection with said shaft, a substantially-continuous spherical socket carried by said cross-head and axially aligned with the main shaft, a main spherical bearing working in said socket and trunnioned upon the frame of the engine and also having its pivotal axis aligned with the axis of said shaft, means for connecting said cross-head with the pistons of the engine, oppositely-disposed lateral guides carried by said cross-head, and fixed guides or ways mounted upon the engine and adapted to cooperate with said guides upon the cross-head whereby said cross-head is supported independently of its main bearing, substantially as described.

4. In a multi-cylinder-engine, the combination with the main shaft, of a rocking-beam or cross-head in operative connection with said shaft, means for connecting said cross-head with the pistons of the engine, and a main bearing for the cross-head disposed centrally of the engine cylinders and in line with said shaft and adapted to receive each thrust of the piston upon a continuous and substantially hemispherical bearing-surface facing toward the cylinder end of the engine and irrespective of the direction of such thrust, substantially as described.

5. In a multi-cylinder-engine, the combination with the main shaft, of a rocking-beam or cross-head in operative connection with said shaft, means for connecting said cross-head with the pistons of the engine, a main bearing for the cross-head disposed centrally of the engine-cylinders and in line with said shaft and adapted to receive each thrust of the pistons upon a continuous and substantially hemispherical bearing-surface facing toward the cylinder end of the engine and irrespective of the direction of such thrust, and a main journal carried by said cross-head and cooperating with said bearing and also adapted to receive such thrust upon a continuous and substantially hemispherical surface, substantially as described.

6. In a multi-cylinder-engine, the combination with the main shaft, and with the engine pistons, of a rocking beam or cross-head in operative connection with said shaft and the pistons, a universal bearing for said cross-head and cooperating with the universal journal of the cross-head, a universal journal carried by said cross-head and cooperating with said bearing to partially support the cross-head and adapted to receive each thrust of the pistons upon a continuous and substantially hemispherical surface, and cross-head-supporting means independent of said bearing and adapted to form the main support for the cross-head whereby the friction between said universal bearing and its journal is reduced to the minimum, substantially as described.

7. In a multi-cylinder engine, the combination with the main shaft and with the engine pistons, of a rocking-beam or cross-head having a plurality of radial arms, an adjustable two-part spherical socket disposed centrally of said cross-head and in line with the main shaft and substantially in the plane of the ends of said radial arms, a spherical bearing journaled in said socket, supporting trunnions adapted to carry said bearing and prevent lateral movement thereof and means for operatively connecting said cross-head with the main shaft and with the pistons of the engine, substantially as described.

8. In a multi-cylinder engine, the combination with the main shaft and with the engine pistons, of a rocking-beam or cross-head having a plurality of radial arms, an adjustable spherical socket disposed centrally of said cross-head and in line with the main shaft and substantially in the plane of the ends of said radial arms and comprising connected screw-threaded members adjustable toward and from each other, a spherical bearing jour-

naled in said socket and having lateral aligned disconnected sockets, supporting trunnions engaging said sockets and adapted to carry said bearing and prevent lateral movement thereof, means for connecting the lateral arms of the cross-head with the pistons of the engine, and means for operatively connecting said cross-head and the main shaft, substantially as described.

9. In a multi-cylinder engine, the combination with the main shaft, the engine-pistons, and means for connecting said shaft and pistons with the rocking-beam, of a rocking-beam or cross-head having an adjustable spherical socket disposed centrally thereof and in line with the main shaft and comprising connected screw-threaded members adjustable toward and from each other, a valve-operating stem carried by one of said members, a spherical bearing journaled in said socket, and means for supporting said bearing and for preventing lateral movement thereof, substantially as described.

10. In a multi-cylinder-engine, the combination with the main shaft, of a rocking-beam or cross-head having a plurality of radial arms, means for connecting said arms with the engine-pistons, means for operatively connecting said cross-head with the main shaft, a main universal bearing for said cross-head and cooperating with the universal journal of the cross-head, a universal journal carried by the cross-head and cooperating with said bearing and adapted to receive each thrust of the pistons upon a continuous and substantially hemispherical surface; a pair of oppositely-disposed lateral guides carried by said cross-head and each comprising a horizontally-disposed oscillatory trunnion and a reciprocatory shoe having a journal adapted to receive said trunnion; and ways or guides adapted to carry said reciprocatory shoe, substantially as described.

11. In a multi-cylinder-engine, the combination with the main shaft, of a rocking-beam or cross-head having a plurality of radial arms, means for connecting said arms with the engine-pistons, means for operatively connecting said cross-head with the main shaft, a main universal bearing for said cross-head and cooperating with the universal journal of said cross-head, and a universal journal carried by the cross-head and cooperating with said bearing and adapted to receive each thrust of the pistons upon a continuous and substantially hemispherical surface; and means for supporting said cross-head independently of said bearing, said means comprising a pair of oppositely-disposed lateral guides carried by the cross-head, vertically-adjustable horizontally-disposed oscillatory trunnions carried by said lateral guides, reciprocatory shoes having journals adapted to receive said trunnions, and ways or guides adapted to carry said reciprocatory shoes, substantially as described.

12. In a multi-cylinder engine, the combination with the engine pistons, of a rocking-beam or cross-head, means for connecting said cross-head with said pistons of the engine, a main bearing for said cross-head, means for supporting said cross-head independently of said bearing, a tapered main shaft, means for operatively connecting said cross-head with said main shaft, a cylindrical internally tapered bushing surrounding said shaft and externally screw-threaded at its end and having a stop-flange, a bearing carrying said bushing and having an externally screw-threaded end, an internally-threaded adjusting-collar adapted to engage said threads of the bearing and also engaging said stops of the bushing and adapted to carry with it said bushing, and means for locking said adjusting-collar in position, substantially as described.

LEWIS C. WORRON.

Witnesses:
FRED. J. DOLE,
FREDERICK A. BOLAND.