(No Model.)

2 Sheets—Sheet 1.

G. H. REYNOLDS.

RADIAL CYLINDER ENGINE.

No. 436,568. Patented Sept. 16, 1890.

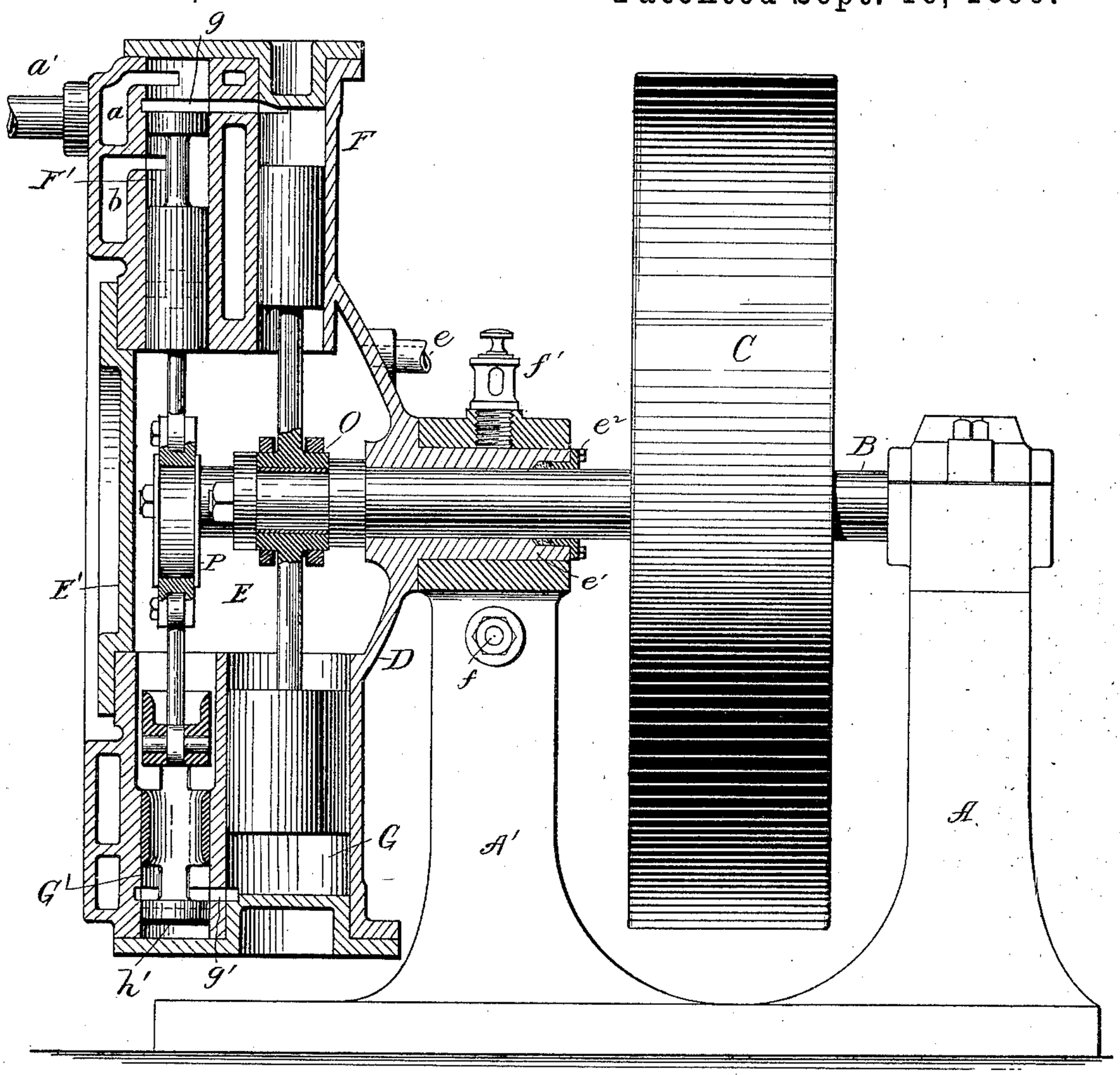

Fig. 1.

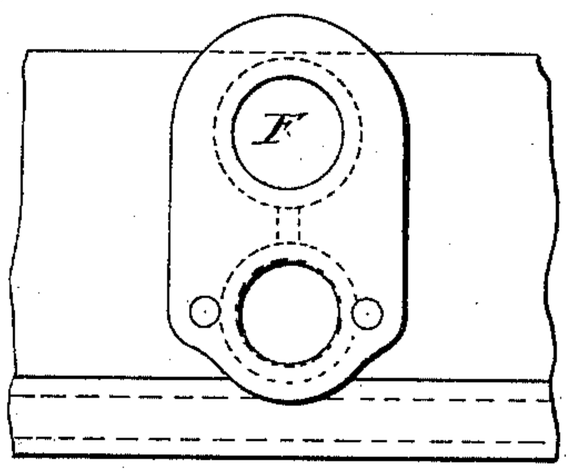

Fig. 3.

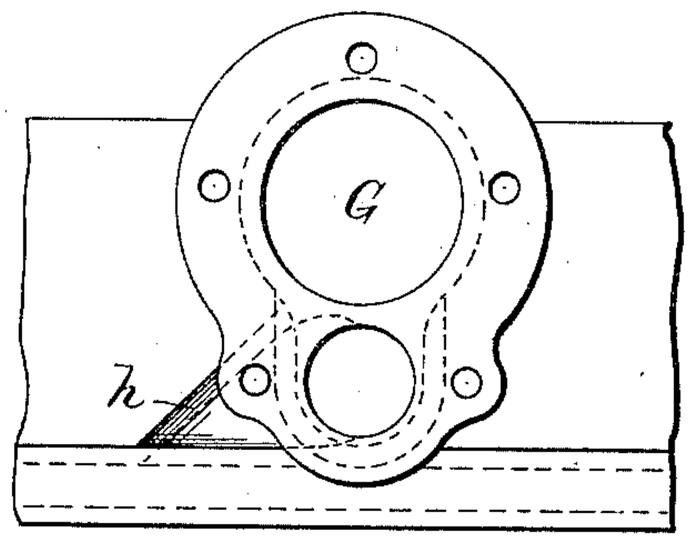

Fig. 4.

WITNESSES

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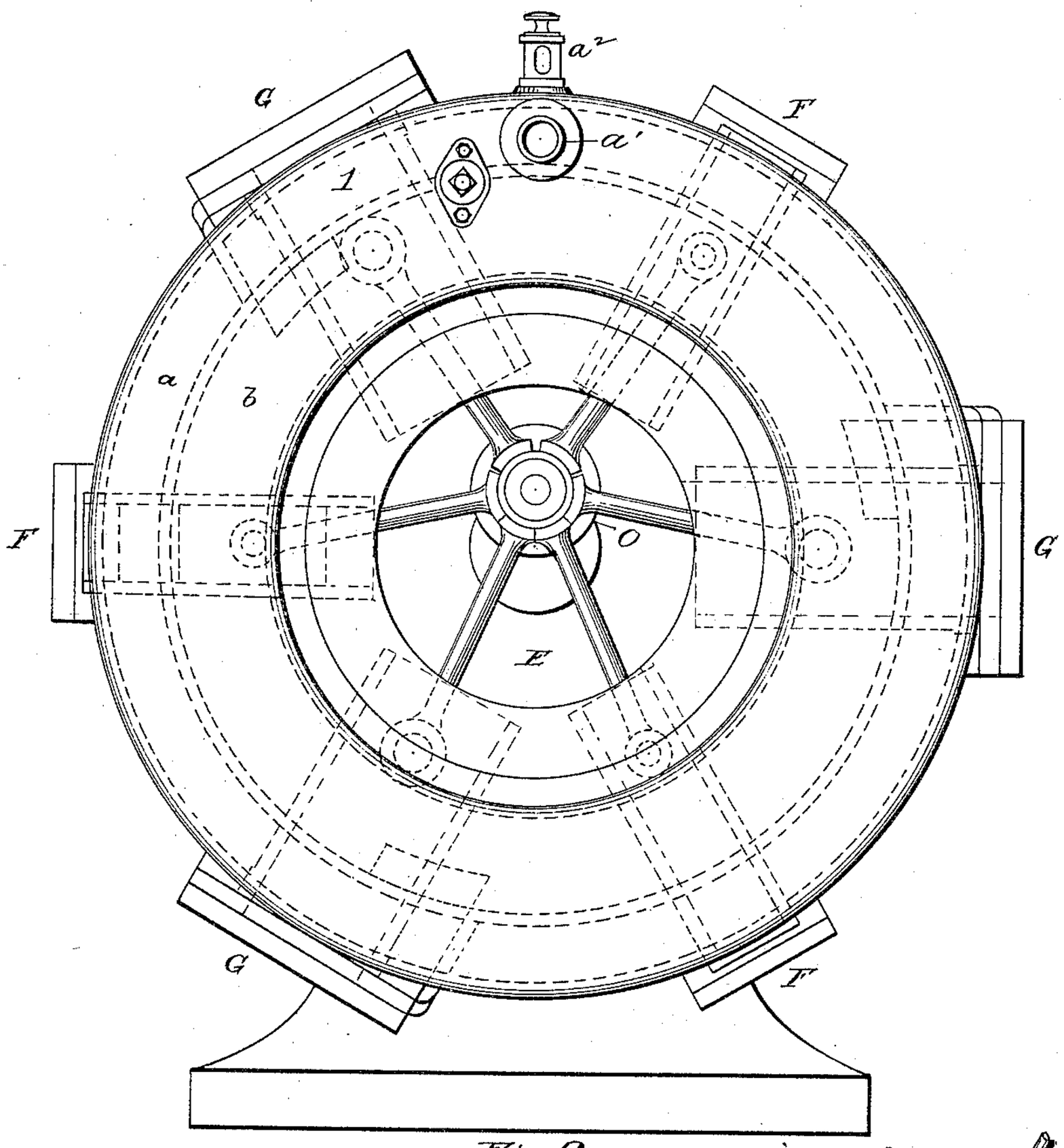

Fig. 2.

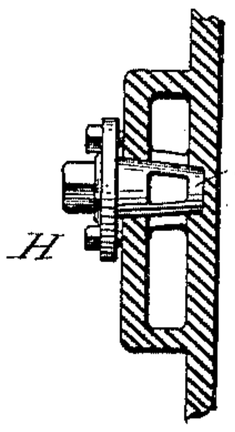

Fig. 5.

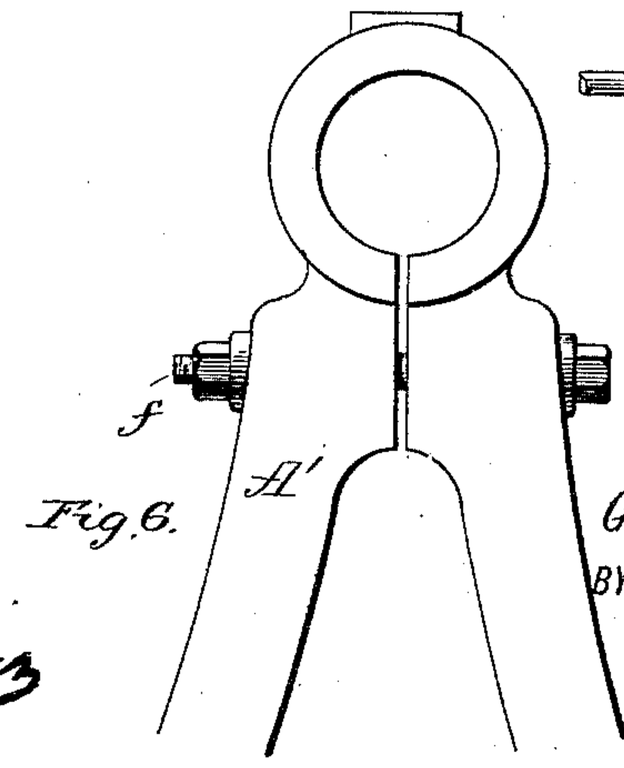

Fig. 6.

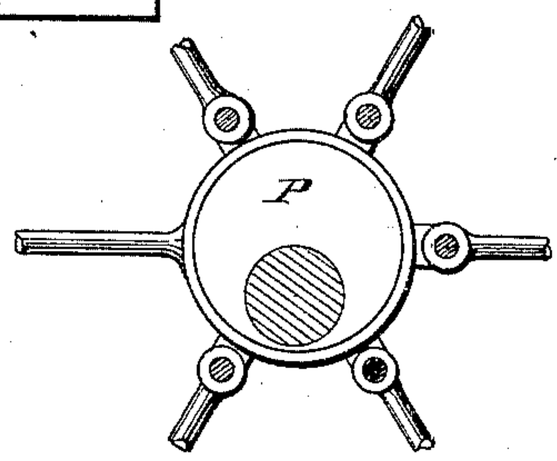

Fig. 7.

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UNITED STATES PATENT OFFICE.

GEORGE H. REYNOLDS, OF NEW YORK, N. Y., ASSIGNOR TO HENRY B. RICHARDSON AND EDWARD B. MARSH, OF AMHERST, MASSACHUSETTS.

RADIAL-CYLINDER ENGINE.

SPECIFICATION forming part of Letters Patent No. 436,568, dated September 16, 1890.

Application filed March 7, 1888. Renewed March 11, 1890. Serial No. 343,550. (No model.)

To all whom it may concern:

Be it known that I, GEORGE H. REYNOLDS, a citizen of the United States, residing in the city, county, and State of New York, have invented certain new and useful Improvements in Radial-Cylinder Engines; and I do hereby declare that the following is a full, clear, and exact description of my invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to radial-cylinder engines, the primary object being to provide a compound engine of this type.

In the construction of radial-cylinder engines heretofore it has universally been the case that the exhaust has taken place directly into the atmosphere, the power of the exhaust-steam being thus entirely wasted. I have by my present invention adapted a radial-cylinder engine to work as a compound engine, the exhaust from my high-pressure cylinders being utilized in low-pressure cylinders to increase the working power of the engine.

In experimenting with machines of this kind I have found that the best, if not the only practical, number of cylinders to be used in a compound radial-cylinder engine is six. With this number of cylinders I am enabled to arrange the high and low pressure pistons oppositely and alternately. This produces a symmetrical structure, which can easily be controlled by simple valve-operating mechanism. If any other number of cylinders besides six be chosen—as four, eight, ten, &c.—it will be found that an arrangement of the cylinders in which the high shall always be opposite to and alternate with the low is impossible, at least until such a number of cylinders is reached as would be impractical.

In carrying out my invention I combine with my radial cylinders two annular steam chests or belts, through one of which the steam from the boiler passes to the high-pressure cylinders and into the other of which the exhaust from the high pressure is received and passed into the low-pressure cylinders.

My invention is concerned with various other details of construction—such as the valve-operating mechanism, the manner of mounting the engine upon its supporting-frame, and means for starting the engine under a heavy load—all of which will be described hereinafter, and more particularly pointed out in the claims.

I have illustrated my invention in the accompanying drawings, in which—

Figure 1 represents a side elevation, partly in section, of the engine and bed frame. Fig. 2 represents an end elevation of the engine with the center plate of the frame removed, showing the arrangement of cylinders and piston-connections with the crank, all valve mechanism being omitted. Figs. 3 and 4 are top views of a high and a low pressure cylinder with their valve-chambers, the cylinder-heads in each case being removed, and the latter-named view also showing the duct or passage by way of which the steam in the low-pressure belt passes into the low-pressure valve-chamber to be admitted to the corresponding cylinder. Fig. 5 is a detail sectional view of a cock or valve connecting the high and low steam-belts to be used for starting the engine against a heavy load. Fig. 6 is an end view of one of the bolsters or standards on which the engine is mounted, showing means for rapidly and conveniently attaching and detaching the engine and its frame from the bed-frame. Fig. 7 is a detail of the eccentric.

Referring to the drawings by letter, A A′ represent two standards on a suitable bed-plate, between which is hung on the shaft B the fly-wheel or belt-wheel of the engine.

D is the frame, which supports the radial cylinders. The frame is formed at its middle portion into a cup-shaped box or chamber E, from the sides of which radiate six cylinders. Alongside the cylinders are the piston-valves, whose chambers connect with two annular steam belts or passages *a* and *b*. The front opening of the chamber E is covered by circular plate E′, as shown in Fig. 1. The chamber is provided with an outlet *e*, for a purpose hereinafter described. The annular steam-belt *a* takes steam from the boiler through pipe *a*′. The wall of the chamber opposite the plate E′ is perforated, and has formed upon it a laterally-extending sleeve *e*′, which forms the bearing for the main shaft B of the engine.

Returning now to the main supporting-frame of the machine, it will be seen that the upper end of the standard A′ is of peculiar construction. The head is split underneath the bearing and a heavy bolt *f* passes laterally through it, which when screwed up by means of a nut forces the parts together.

In mounting the engine-frame upon the main supporting-frame the sleeve *e′* of the engine-frame is passed over the shaft and into the opening in the head of the standard A′. The nut or bolt *f* is then set up until the sleeve is firmly gripped by the head of the standard. This construction affords a speedy and convenient means for removing the engine proper from the other parts of the apparatus or for rotating the engine-frame into any desired position most convenient for coupling the steam-supply pipe with the inlet *a′*.

On the head of the standard A′ an oil-cup *f′* is carried and the oil from it passes down through a perforation or perforations in the sleeve *e′* and onto the shaft B. The outer end of the sleeve *e′* is formed with a stuffing-box e^2, which prevents the escaping of the oil in that direction and forces it to flow inward to lubricate the journal and the parts within the chamber E.

In Fig. 2 I have shown another oil-cup a^2, which admits oil into the steam-belt *a*, whence it traverses the several valve-chambers and cylinders, and which, together with the cup *f′*, lubricates all the parts of the engine.

The main shaft extends into the chamber E and connects with the crank O, with which the several piston-rods of the engine are connected. The eccentric P for operating the valves is hung on the extreme inner end of the shaft, and consists of the usual grooved circular block mounted eccentrically; but the strap and its connection with the several valve-rods have a novel construction, which is shown in Fig. 7. One of the valve-rods is rigidly attached to or forged with the strap, while the others are connected with it by hinged joints. This construction prevents the strap from slipping round and holds it in one position with respect to the valve-rods.

I have shown three high-pressure and three low-pressure cylinders F and G arranged alternately with each other, the high and low pressure being located diametrically opposite each other. The pistons of each cylinder connect with the crank O of the engine and act consecutively thereon. The pistons G of course are made larger, in order that the resulting pressure may equal that of the pistons F.

The valve-chambers F′ and G′ of the several cylinders are located next to the two steam-belts, and steam passes from the high-pressure belt *a* into the valve-chamber above the head of the valve, and thence through passage *g* into the cylinders F. The exhaust from these cylinders passes out through *g* below the valve-head and into the low-pressure steam-belt *b*.

In order that the steam from the low-pressure belt *b* may gain access to the upper side of the head of the valves controlling the low-pressure cylinders, an offset of metal *h* is cast on the inner side of the frame adjacent to the outer end of each of the low-pressure cylinders. This casting has a passage through it, which leads from the low-pressure belt around the high-pressure belt to the outer end of the valve-chambers belonging to the low-pressure cylinders. One of the openings into this valve-chamber is shown in Fig. 1 and marked *h′*. When the steam has reached this point, the movement of the valve allows it to pass through the port *g′* into the low-pressure cylinders. Thence it exhausts through the same port and through the valve itself into the chamber E, and then out through the final exhaust *e*. When the exhaust-steam reaches the chamber E, its pressure is very considerably reduced—say to about a pound. It acts as a vehicle to convey the oil which flows into the chamber from the bearing of the main shaft to the crank and other working parts of the engine, and also serves to maintain the parts at a uniform temperature.

It will be seen that the construction of the valves belonging to the cylinders F is different from the construction of the valves belonging to the cylinders G. In the former case the exhaust passes around the neck of the valve or between the head and the body into the low-pressure belt *b;* but in the latter case a part of the body of the valve is a hollow cylinder, through which the exhaust-steam passes, and the remainder or that part of the body of the valve wherein the valve-rod is pivoted is on its outer surface grooved longitudinally to allow steam to pass between it and the wall of the valve-chamber into the chamber E.

The eccentric is arranged so that steam will be admitted to the cylinders consecutively. Referring to Fig. 2 and beginning with the cylinder marked 1, whose piston is shown at its extreme outward position ready to receive steam, its valve will now operate and admit steam behind the piston and cause it to move inward, forcing the crank around. Live steam continues to enter the cylinder until the piston reaches the end of its stroke, when it begins to exhaust into the low-pressure belt *b*. Before this cylinder begins to exhaust, however, steam has entered cylinders 2 and 3. Cylinder 2 takes its steam from the low-pressure belt and cylinder 3 takes its steam from the high-pressure belt. The piston of cylinder 3 reaches the inner end of its stroke and begins to exhaust at just the time when the piston in cylinder 4 reaches the outer end of its stroke and begins to take steam. Therefore cylinder 4 utilizes the steam exhausted from cylinder 1, and so on all around, the low-pressure cylinders operating by the force of the steam exhausted from the high-pressure cylinders diametrically opposite them. With this arrangement of the valves three of the

cylinders are constantly at work on the crank, while the other three are exhausting, thus making it impossible at any time for a dead-center to be established. It will be seen, however, that all three of the working-cylinders cannot be exerting their full pressure at the same time—that is to say, their force is exerted at different angles, and therefore is not fully exerted simultaneously. For this reason it may be found impossible, or at least difficult, to start the engine when there is a heavy load on, and I have devised a valve or cock *c* (shown in detail in Fig. 5 and also shown in Fig. 2) for use under such circumstances. This valve connects directly the high and low pressure belts, so that on starting with a heavy load high-pressure steam may be admitted to both belts and to those cylinders whose valves are open, whether high or low pressure, thus making a combined force of the three cylinders at work greater than it would be if one or two of them were working on low pressure. This will enable the engine to easily overcome the load and make a start, after which the valve may be closed and the engine allowed to operate regularly.

Having now described my invention, what I claim is—

1. A radial-cylinder engine having a frame provided with a sleeve through which the main shaft passes and has its bearing, the sleeve extending into a standard on the bed-frame of the engine.

2. The combination, with the main shaft, of a series of radial cylinders, a frame for supporting them provided with the sleeve e' and the stuffing-box e^2, as described.

3. In a compound radial-cylinder engine, the combination of two annular steam belts or chests, one for high-pressure steam and the other for low-pressure steam, with a valve or cock whereby direct connection may be established between the two steam-belts, as described.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

GEO. H. REYNOLDS.

Witnesses:
AUGUSTUS MERRITT,
WM. A. ROSENBAUM.