(No Model.) 3 Sheets—Sheet 1.

E. C. JOHNSON.

STEAM ENGINE.

No. 453,641. Patented June 9, 1891.

FIG. 1.

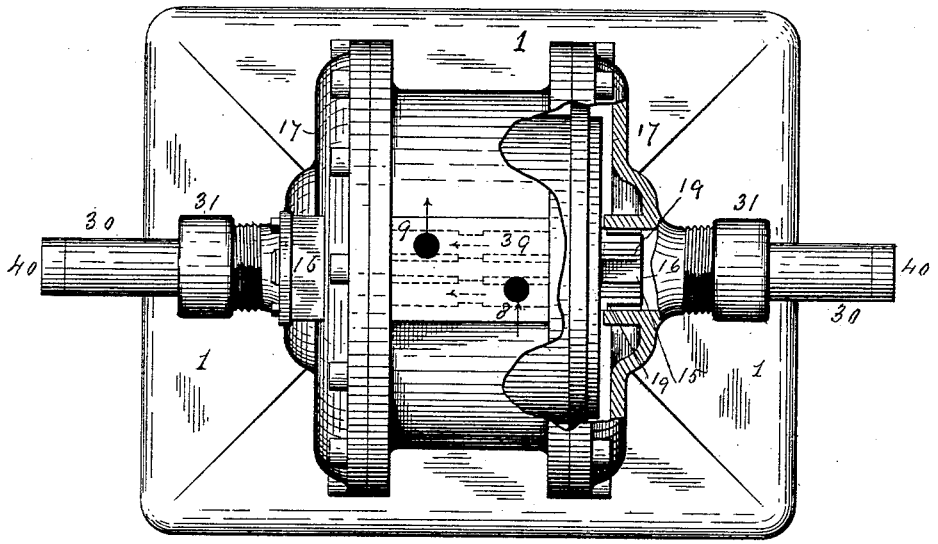

FIG. 2.

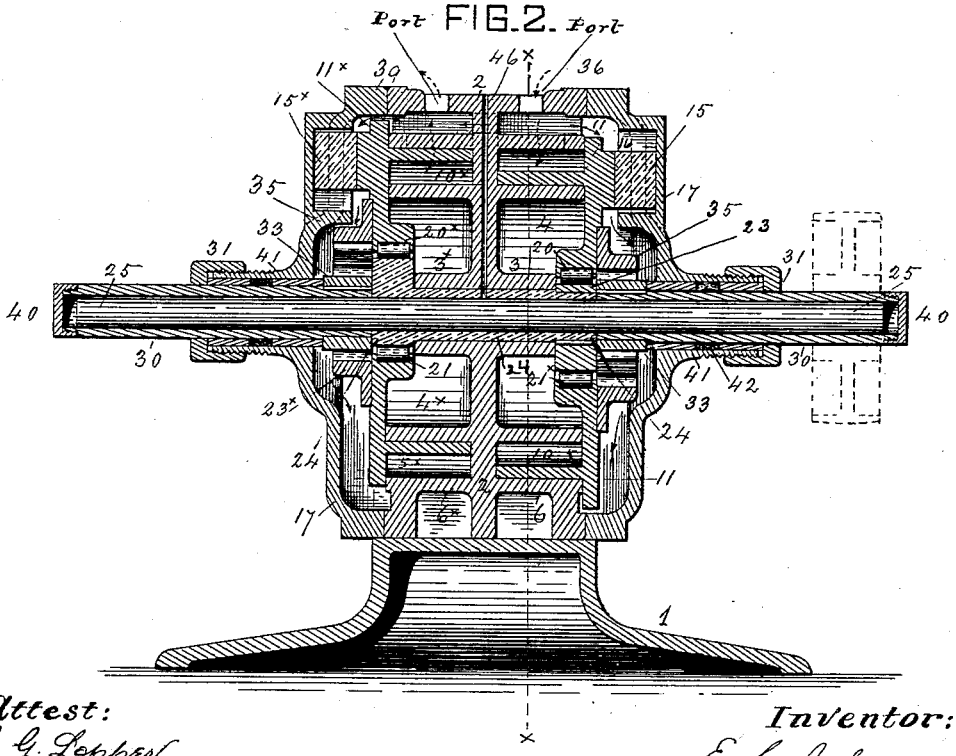

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FIG. 3.

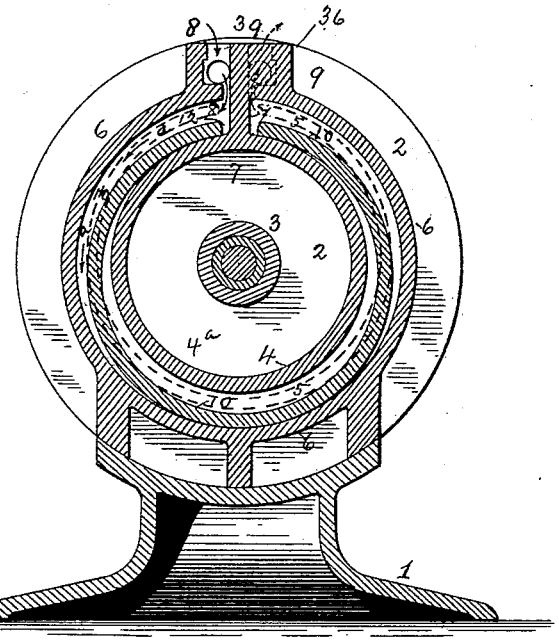

FIG. 5.

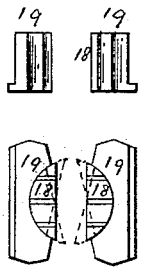

FIG. 6.

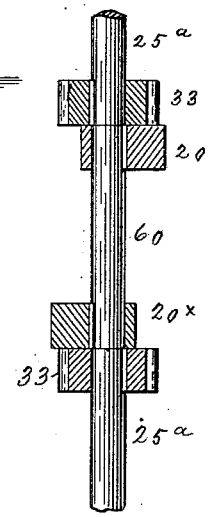

FIG. 4.

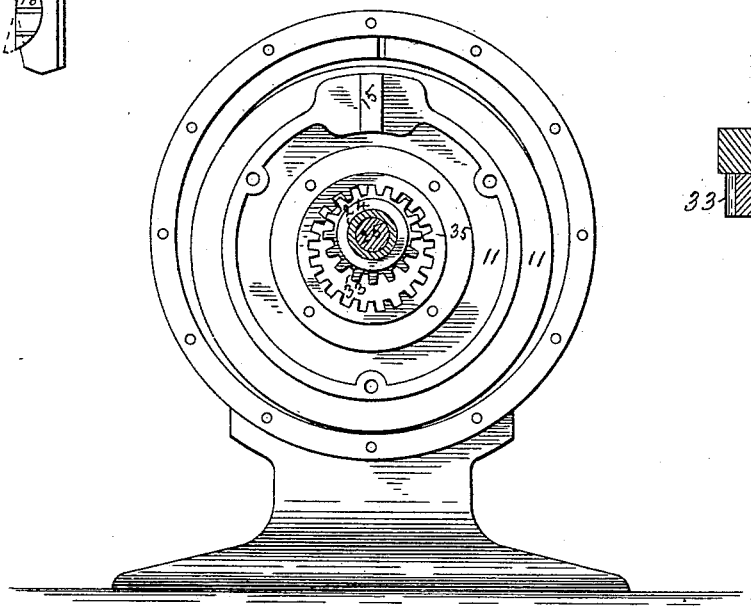

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FIG. 7.

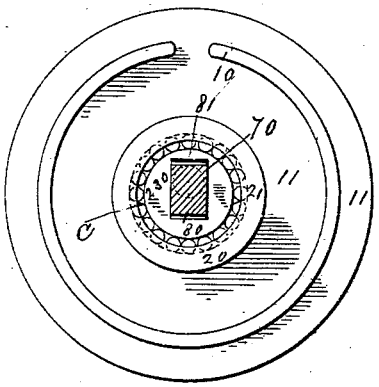


FIG. 8.

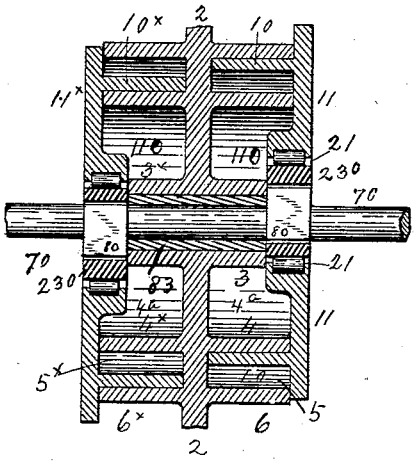


FIG. 9.

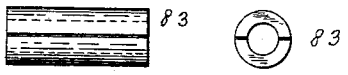
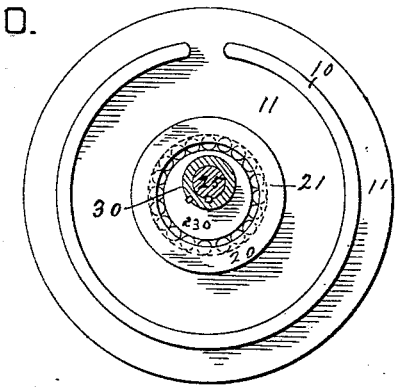


FIG. 10.



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UNITED STATES PATENT OFFICE.

EDWARD C. JOHNSON, OF KEOKUK, IOWA.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 453,641, dated June 9, 1891.

Application filed September 11, 1890. Serial No. 364,663. (No model.)

To all whom it may concern:

Be it known that I, EDWARD C. JOHNSON, of Keokuk, Iowa, have invented certain new and useful Improvements in Steam-Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to steam-engines of the variety known as "cycloidal" or "gyratory" engines. While specially intended for use with steam the engine may be propelled by other gases or fluids. The present description relates to a duplex or double-piston engine.

The object of the invention is to produce an engine of the character described having connection from the piston to the driving-gear by which the gyratory motion of the piston may be made to produce a rotary motion of the shaft, either by direct or indirect connection; also, to improve the construction of the various parts of the machine and the combination of the parts in an operative engine.

Figure 1 is a plan of the engine, one end of casing being broken away. Fig. 2 is a central vertical section, the central shaft being in elevation. Fig. 3 is a section on line *x x*, Fig. 2. Fig. 4 is an end elevation with end casing removed. Fig. 5 is a detail of the guide. Fig. 6 is a detail of shaft and eccentrics, the latter in section. Fig. 7 is an elevation of piston with modification of driving connections. Fig. 8 is a cross-section of same. Fig. 9 shows details of sleeve. Fig. 10 shows the piston of Figs. 3 and 4 with gears omitted and direct connections to shaft.

The numeral 1 indicates the base of the engine. 2 denotes the central partition held on this base and serving as a support or resistance piece for the pistons. The partition 2 is substantially a flat disk or plate. Hubs 3 $3^{\times}$ project from the center of the plate in opposite directions. Rings 4 and $4^{\times}$ project from the plate 2 at a little distance from the hubs, and these are again surrounded by rings 6 and $6^{\times}$. The partition or plate 2, hubs, and rings referred to may all be cast in one piece or may be built up separately. The annular chambers 5 and $5^{\times}$ between rings 4 and $4^{\times}$ and 6 and $6^{\times}$ are each divided by a vertical partition 7. The chamber 5 is therefore a curved chamber, less than a complete ring by the thickness of partition 7. One end of each of the chambers 5 or $5^{\times}$ has an inlet-steam port 8, and the other end has an exhaust-port 9—that is, the inlet-port 8 communicates with both said chambers, and both chambers open to the exhaust-port 9. The two sides of the partition are duplicates of each other. Chamber 5 contains a piston 10, which piston is a broken annular projection from disk 11. The broken ring is of the same width of the rings 4 and 6, so that piston 10 rests on the plate 2 at the bottom of chamber 5, while the disk 11 rests on the top of rings 4 and 6. The ring 10 is of such diameter and thickness that the inner concave face 10 lies against ring 4 at one side when the opposite convex face of ring 10 lies against the inner face of ring 6—that is, the ring 10 is of the diameter of ring 6 minus the stroke of piston, and the ring-piston 10 when placed in chamber 5, with the partition 7 lying in the break in ring 10, will be eccentric to chamber 5, one side of the ring piston touching the inside of ring 6 and the other the outside of ring 4. The break 12 in ring 10 is wider than the thickness of plate or partition 7 to permit the passage of steam between the partition and ring, and the broken ends of the ring piston are preferably rounded, as shown. The disk 11, Fig. 2, has a projection or fulcrum 15, extending from its face opposite the break in ring 10. This projection 15 enters a recess 16 in the cylinder-head cover or casing 17 and slides between guides 18 18 in said recess. These guides 18 are segments of cylinders, their convex sides having concave bearings in the guide-rests 19. The piston-ring $10^{\times}$, its disk $11^{\times}$, and guide-fulcrum $15^{\times}$ are duplicates of the piston, disk, &c., already described. The disks 11 and $11^{\times}$ have each a round hole 20 in the center, the same being concentric with the broken piston-rings. (Anti-friction rolls 21 may be used and have their face-bearings in these holes.) The openings inside the anti-friction wheels 21 are filled by circular pieces 22 and $22^{\times}$, which are bored eccentrically. These eccentrics 23 $23^{\times}$ are each secured to sleeve 24 on the main shaft. These eccentrics exactly fill the space between the anti-friction rolls, or fill the open-

ings in the disks if the anti-friction devices be omitted. The two eccentrics 23 and 23× are at opposite sides of the sleeve 24. One eccentric, as 23×, may be integral with said sleeve and the other is keyed or otherwise fastened to the sleeve. The amount of eccentricity of the eccentrics is equal to the stroke of the piston from side to side in chamber 5 or 5×. By means of the eccentrics and sleeve 24 the piston disks and rings are held on opposite sides of the sleeve 24. The pistons will then begin their stroke alternately, one being exactly balanced by the other in all positions. The steam is pressing on the outside of one piston-ring and the inside of the other piston-ring at the same time, so that all parts are balanced. The sleeve 24 is bored through for the passage of shaft 25, which shaft is concentric with the rings 4 and 6 of the casing, the eccentrics 23 and 23× compensating for the eccentric relation of the pistons to these rings. Sleeves 30 30 surround the shaft 25 and extend outside the casing 17, through stuffing-boxes 31, attached to said casing or cover 17. A toothed gear 33 is keyed to each shaft 30 inside the casing 17. The gears 33 receive their movement from the internal toothed gears 35, one of said gears being attached to each of the disks 11 or 11×. The internal gears 35 have an internal diameter equal to the diameter of gears 25 plus the stroke of the piston, and the number of teeth on the gear 35 exceeds that on gear 33. One impulse of the piston presses the teeth of gear 35 against the teeth of gear 33, (see Fig. 4,) and moves the gear 33 a short distance, the teeth of the other gear 35× being in engagement with its gear 35× on its opposite side. The movement conveyed by the engagement of gear 35 with gear 33 will be inversely as the difference in the number of teeth in the gears. Now if piston 10 be in the position shown in Fig. 3, and steam be admitted by port 8 in steam-chest 39, the steam will follow the course of the arrows *a a* between the outside of the piston-ring and ring 6 and force the piston upward and toward the right. This permits the steam to pass inside the piston-ring 10 between the same and the ring 4, and the steam follows around the inside of the ring, the movement of the ring itself serving to cut off steam. The steam passing round the piston escapes from port 9. The piston swings from a movable fulcrum 15 with an oscillating or gyratory stroke acting to propel the gear 35 and gear 33 which is in engagement therewith. The steam is allowed to enter between the casing 17 and the outside of disk 11, so that disk 11 is properly balanced. The relation of the parts is such that any slight excess of pressure outside the disk 11 or 11× falls on the hubs 3. The ends of sleeves 30 are closed by caps 40, which prevent the escape of steam which may pass through the joint around shaft 25. Shaft 25 serves merely to center and align the parts relatively to each other. Either sleeve 30 outside the casing may bear the pulley by which the power is transmitted from the engine. As the pistons are loose in the cylinders, it is necessary to have some means to hold them in place until steam is admitted. This may be done by rings 41, which rings surround the sleeves 30 inside of the glands. A soft or elastic packing 42 lies next the rings 41, and rings or collars 18 fill the stuffing-box. By setting up the caps of box 31 pressure is brought onto the pinions 33 and eccentrics 23 23×, and the pistons are held until steam is admitted. The blocks or rests 19 are removable from the recess 16 in the cover for convenience in fitting and may be replaced when worn. An oil-aperture 46 leads through the central partition to the shaft 25. The steam acts as a lubricant to the moving parts. The connection between the disk 11 and its attached gear 35 and the driven pinion 33 is an excellent means of converting the gyratory motion of the piston into rotary motion of the pinion, and as the rotations of the shaft may be much less in number than the strokes of the piston I prefer this general connection. I may, however, use different connections.

In Fig. 6 I show the gears 3 3 attached the shafts 25ª instead of to sleeves on said shafts. The eccentrics 20 and 20× are attached to an intermediate shaft 60, the central sleeve being omitted.

In Figs. 7 and 8 the toothed gearing is not used. A shaft 70 passes through the cylinder and pistons. The eccentrics 230 are placed so as to project at opposite sides of the shaft, and are adjustable on a squared portion 80 on said shaft by means of shims. Anti-friction rolls 21 are inserted between the eccentrics 230 and the bearing-rings 110 of disks 11 11×. Eccentrics 230 have oblong recesses *c*, which pass over the squared portion of the shaft, and in which shims 81 may be inserted. By changing the shims the eccentricity of the parts 230 with relation to the shaft may be changed, and by this means the eccentricity of parts 230 may be made to conform to that of the ring pistons. A shaft-sleeve 83 in the hubs 3 3× makes a central bearing for shaft 70. It will be seen that the two sides of the engine are duplicates in construction, but arranged to balance each other. The steam connection to inlet and exhaust ports communicates to both parts of the engine, as indicated in dotted lines, Fig. 1. The central chamber 4ª of the cylinder may be open to the steam or not; but as this chamber will usually receive steam by leakage no special port to the chamber is generally needed. The pressure in said chamber is one of the forces to balance the pistons. As has been shown, the driving-shaft may be either hollow or solid, and suitable connections can be made to either.

It will be apparent that minor modifications may be made without departing from the spirit of my invention.

In the claims I desire to be understood as covering mechanical equivalents of the parts specified.

In my application, Serial No. 364,664, of even date herewith I show an eccentric on which the piston acts; but the same is differently connected to the shaft, and the combinations are differently claimed; also, in application, Serial No. 364,665, of even date herewith, I show some of the parts herein described; but the claims in each case are independent.

What I claim is—

1. A cycloidal engine, substantially as described, having a central partition and a divided annular chamber at each side thereof, a broken-ring piston in each chamber and connected to a disk or plate, a movable fulcrum connected to each plate and having a guiding-support in the casing, and geared connections from said pistons to the driving-shafts, in combination, substantially as described.

2. In an engine of the character described, the combination of a central partition having a divided annular chamber at each side thereof, a broken-ring piston in each chamber connected to a disk or cover over the chamber, an eccentric in each disk mounted on a central support, and gears connecting the piston-disk and the driving-shaft, substantially as described.

3. The combination, in a steam-engine, of two annular divided steam-chambers, a broken annular piston in each chamber, each of said pistons extending into the chamber from a disk or cover, and eccentrics connecting the disks to a driving sleeve or shaft, substantially as described.

4. The combination, with the divided annular chamber, of the broken-ring piston in said chamber, the disk or plate connected to said piston, the shaft or sleeve having a pinion thereon, and the annular driving-gear connected to the disk of greater internal diameter than the diameter of pinion and engaging said pinion, substantially as described.

5. The divided annular chamber or cylinder, the broken-ring piston therein, the disk or cover connected to said piston, the central shaft having an eccentric thereon and engaging a circular recess in the disk or cover, and a geared connection between the disk or cover and the shaft, all in combination, substantially as described.

6. The combination of the divided steam-cylinder, the broken-ring piston therein, the disk or cover connected to said piston, an eccentric working in a recess in the disk or cover and connected to the central sleeve, a fulcrum on said cover, and a cylinder-head in which said fulcrum is guided, substantially as described.

7. The combination of the divided annular cylinder or chamber, the broken-ring piston therein and connected to a cap or cover, a circular recess in said cover containing an eccentric and interposed anti-friction rolls, the eccentric being connected to a shaft or sleeve, as described, the cylinder-head, and a fulcrum on the piston working in a guide in said head, all substantially as described.

8. The combination of the central partition, the divided annular chamber at opposits sides thereof, the broken-ring pistons having disk-covers, and a central shaft having eccentrics at opposite sides, said eccentrics working in recesses in the disk-covers of the pistons, substantially as described.

9. The duplex engine having central partition with divided annular chambers, the broken-ring pistons in said chambers having disk-covers with fulcrums connected thereto, the cylinder-heads having bearings for said fulcrums, and the gear connecting the piston-disks to the driving-shaft at opposite sides thereof, all substantially as described.

10. The combination of the divided annular chamber, the broken-ring piston therein having a disk-cover, the shaft and gear connecting the piston-disk to said shaft, a stuffing-box through which the shaft passes, and clamping mechanism within the stuffing-box by which the piston may be supported until steam is admitted, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

EDWARD C. JOHNSON.

Witnesses:

W. A. BARTLETT,

PHILIP MAURO.