(No Model.) 3 Sheets—Sheet 1.

P. ROEDIGER.

HOT AIR ENGINE.

No. 579,654. Patented Mar. 30, 1897.

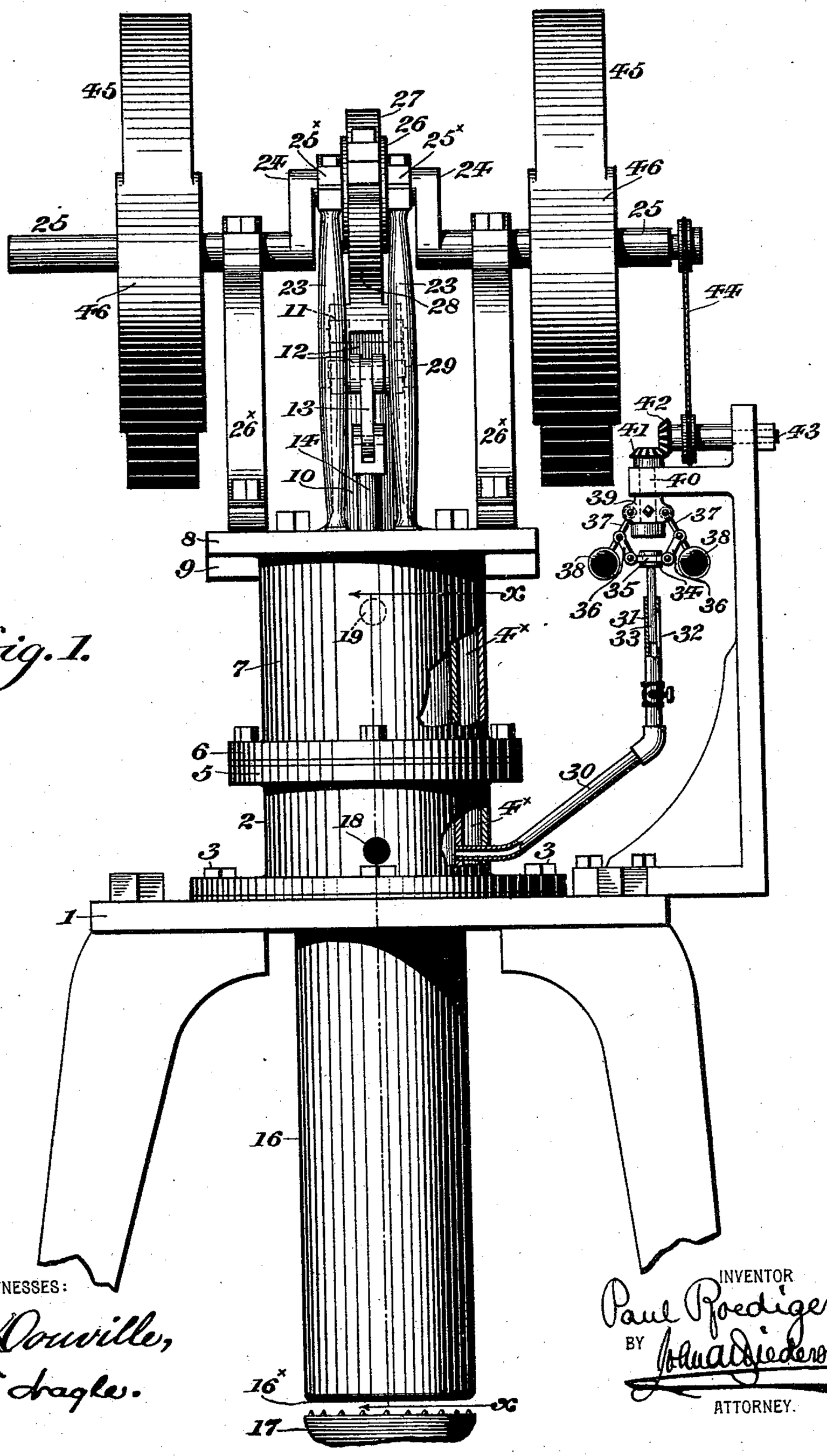

fig. 1.

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(No Model.) 3 Sheets—Sheet 2.

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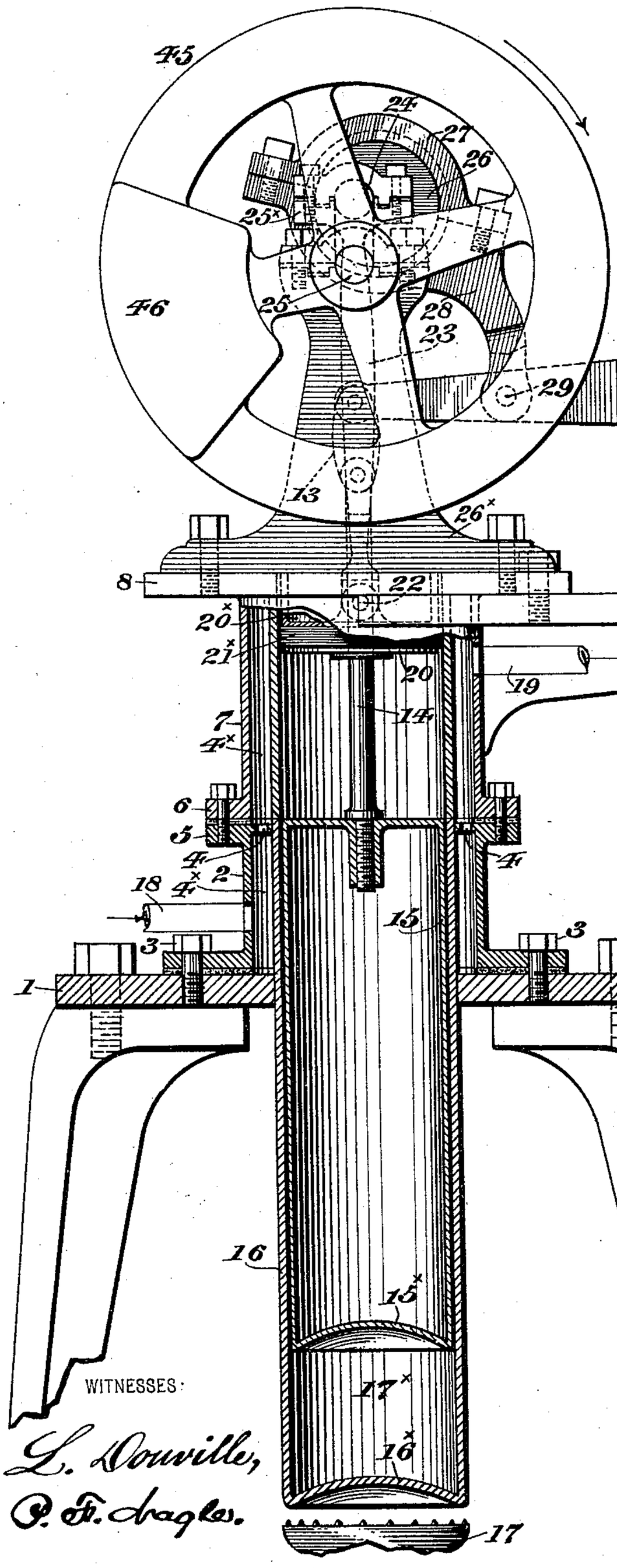

fig. 2.

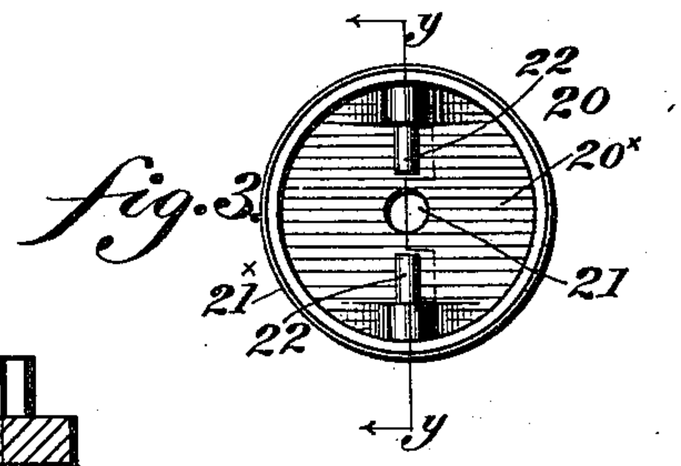

fig. 3.

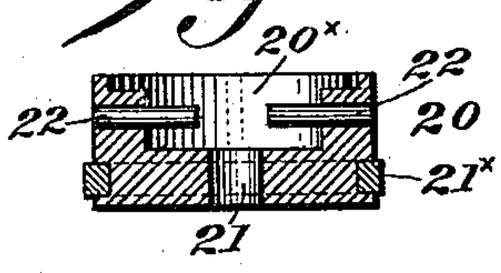

fig. 4.

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(No Model.) 3 Sheets—Sheet 3.

P. ROEDIGER.

HOT AIR ENGINE.

No. 579,654. Patented Mar. 30, 1897.

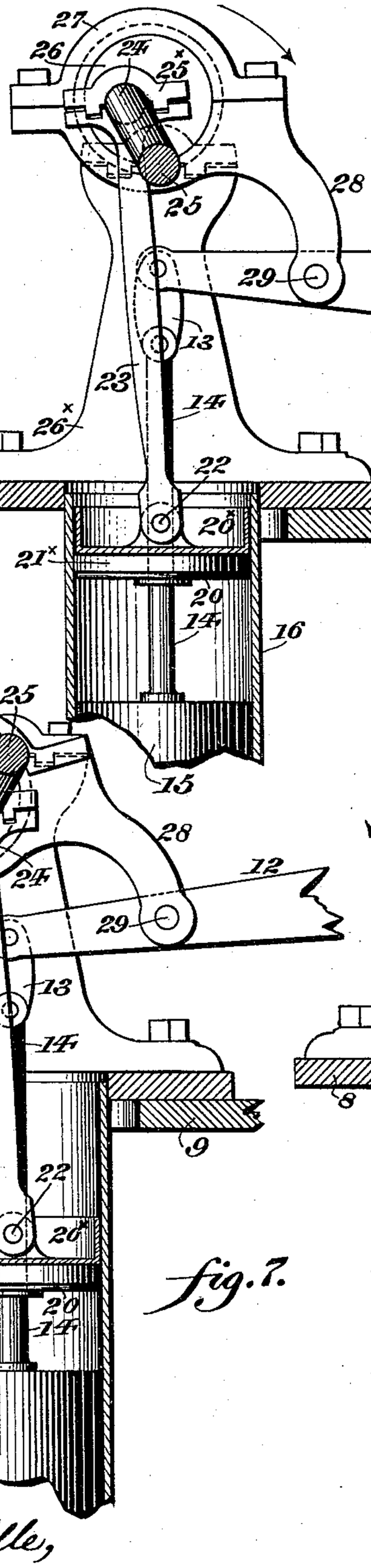

fig. 5.

fig. 7.

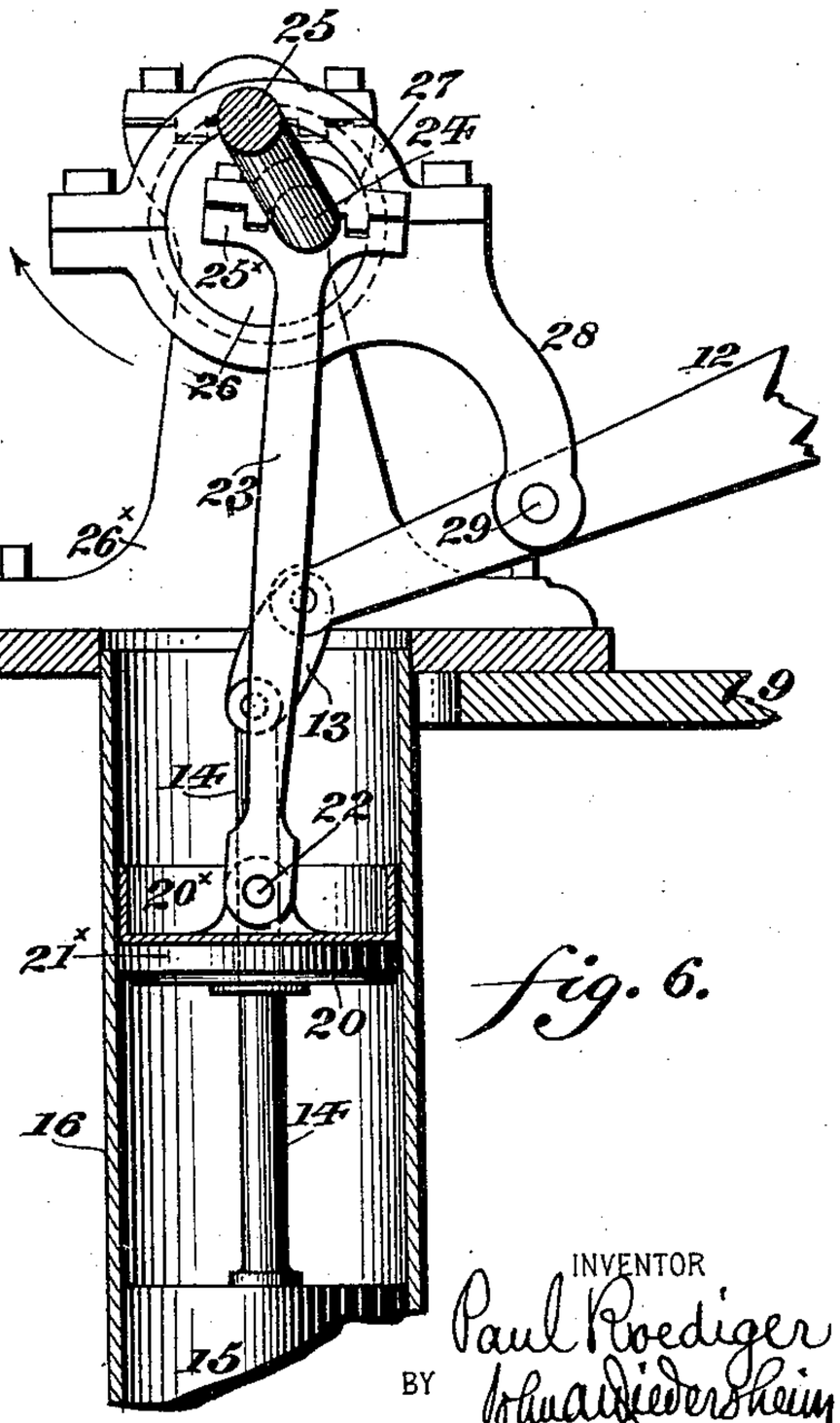

fig. 6.

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UNITED STATES PATENT OFFICE.

PAUL ROEDIGER, OF PHILADELPHIA, PENNSYLVANIA.

HOT-AIR ENGINE.

SPECIFICATION forming part of Letters Patent No. 579,654, dated March 30, 1897.

Application filed November 27, 1896. Serial No. 613,662. (No model.)

To all whom it may concern:

Be it known that I, PAUL ROEDIGER, a subject of the Emperor of Germany, (having resided one year last past in the United States and declared my intention of becoming a citizen thereof,) residing in the city and county of Philadelphia, State of Pennsylvania, have invented a new and useful Improvement in Hot-Air Engines, which improvement is fully set forth in the following specification and accompanying drawings.

My invention consists of an improved construction of hot-air or caloric engine in which the number of parts is reduced to a minimum and the effective operation of the engine greatly increased.

It also consists of novel means for imparting different ratios of speed to the plunger and piston employed.

It further consists of novel details of construction, all as will be hereinafter fully set forth, and specifically pointed out in the claims.

Figure 1 represents a front elevation of a hot-air engine embodying my invention, a portion thereof being shown in section. Fig. 2 represents a vertical sectional view of Fig. 1, the section being taken on line *x x* of said figure, certain of the parts being shown in elevation. Fig. 3 represents a plan view of the piston employed, the same being shown in detached position. Fig. 4 represents a section on line *y y*, Fig. 3. Fig. 5 represents a partly sectional view and partly side elevation of the valve-gear employed, showing the relative position of the parts at starting. Fig. 6 represents a view similar to Fig. 5, showing the position the parts assume when the crank-shaft has revolved about one hundred and eighty degrees from the position seen in Fig. 5. Fig. 7 represents a view similar to Fig. 5, showing the position the parts assume when the crank-shaft has revolved about sixty degrees from the position seen in Fig. 6.

Similar numerals of reference indicate corresponding parts in the several figures.

Referring to the drawings, 1 designates the bed of the engine, upon which the casing or section 2 is supported, said section being held in position by means of the bolts or other fastening devices 3.

5 designates a flange on the section 2, on which the flange 6 of the upper section 7 is adapted to rest, said flanges being suitably held in juxtaposition and the space or jacket $4^{\times}$ inclosed by said sections having communicating ports 4. (Best seen in Fig. 2.)

8 designates a plate attached to the upper portion of the section 7, said plate having the shelf 9 projecting laterally therefrom, said shelf having a post 10 mounted thereupon.

12 designates a lever which is fulcrumed at the point 11 to said post, the other end of said lever being pivoted to an end of the link 13, the other end of the latter being pivotally attached to the rod 14, which latter is secured at its lower portion to the plunger 15, having the closed end $15^{\times}$.

16 designates a cylinder having a base $16^{\times}$, within which said plunger reciprocates, said plunger fitting loosely in said cylinder, which latter is heated at its lower portion by the application of a suitable heating medium thereto from a source 17, thereby heating the air in the chamber $17^{\times}$, formed when the parts are in the position seen in Fig. 2.

18 designates a pipe by means of which water or other cooling medium is conducted to the aforesaid jacket $4^{\times}$, which is formed between the sections 2 and 7 and the cylinder 16, said cooling fluid being conducted from the latter through the pipe 19.

20 designates a piston which is located in the upper portion of the cylinder 16 and over the plunger 15, said piston being provided with a suitable packing $21^{\times}$, which forms a tight joint against the inner walls of the cylinder 16 and having an opening 21 therein, through which the rod 14 passes. $20^{\times}$ designates a cup-shaped chamber in said piston, into which extend the laterally-projecting pins 22, which pass through the lower ends of the connecting-rods 23, the upper ends of said rods terminating in the boxes $25^{\times}$, which engage the crank 24 of the crank-shaft 25, which latter is mounted in suitable bearings in the posts $26^{\times}$.

26 designates an eccentric which is mounted on the crank 24 intermediate the boxes $25^{\times}$, said eccentric being engaged by the eccentric-strap 27, which is in the present instance made in sections and has an arm 28 project-

ing therefrom, the lower extremity of said arm being pivotally attached to the lever 12 by means of the pin 29.

30 designates a pipe leading from the interior of the cylinder 16 to the upright branch 31, which has a slot 32 in the side thereof, said branch having a plunger 33 working therein, which has mounted thereon the head 34, which has a strap 35 engaging therewith, said strap having the end of the links 36 pivoted thereto, the other ends of said links being pivoted to the arms 37, which carry the weights 38, said arms being pivoted to the revolving block 39, which is mounted on the shaft 40, the latter having the bevel-gear 41 thereon, which meshes with the gear 42. 43 designates a shaft upon which said gear is mounted, said shaft being rotated from the crank-shaft 25 by means of the belt 44. 45 designates fly-wheels mounted on said shaft 25 and provided with counterbalances 46, so located that they tend in every instance to carry the crank and its adjuncts over the dead-center.

The operation is as follows: The parts just prior to starting are shown in the position they assume in Fig. 5, the crank 24 being turned one-twelfth of a circle to the left of the longitudinal axis of the shaft 25, the plunger 15 being now raised higher than it appears in Fig. 2 from the bottom of the cylinder 16. The heating device 17, being in operation, has heated the air contained in the chamber $17^{\times}$ to a high degree, and if the lever 12 is caused to move downwardly the descent of the plunger 15 will force the hot air upwardly around the plunger 15, it being remembered that the latter fits loosely in the cylinder 16 into the space between the top of the plunger and the bottom of the piston 20. The expansion of the heated air will impart an upward impulse to the piston, while the relative position of the plunger and piston and their adjuncts to each other when the crank has advanced one hundred and eighty degrees from the position seen in Fig. 5 will be understood from Fig. 6. A further rotation of said crank will cause the parts to assume the position seen in Fig. 7, it being noticed that the ascent of the plunger 15 is comparatively rapid as compared with the movement of the piston 20, as is evident from Figs. 6 and 7. A further rotation of the crank-shaft brings the parts into the positions seen in Fig. 5 and then Fig. 2, respectively, and the operation is repeated. The jacket $4^{\times}$ has normally a cooling fluid circulating therethrough, whereby the chamber between the plunger and piston is kept cool.

Especial attention is called to the function attained by imparting the different speeds to the piston and plunger, respectively, it being noticed that when the lever 12 begins to descend from the position seen in Fig. 5 the piston 20 has first a movement upward, while the plunger 15 is rapidly descending, the space between the piston and plunger increasing while the latter is descending and the hot air in chamber $17^{\times}$ is passing to the top of the plunger 15. When the parts are in the position seen in Fig. 2, the piston is in its highest position and the plunger is still descending, the latter being substantially in a state of rest in about its lowest position, when the parts assume the position seen in Fig. 6. At this period the lever 12 is rapidly raised, and with it the plunger 15, while the piston 20 also rises, but at a much slower speed than said plunger, the plunger still rising rapidly, and the piston moves slowly when the lever 12 begins to move downwardly again, carrying with it the plunger, the latter moving slowly at first and then more rapidly. Just prior to the time the parts assume the position seen in Fig. 5 the plunger is stationary, while the upward movement of the piston continues, the latter being in its highest position when the crank is as seen in Fig. 2.

Any variation in the rotation of the shaft 25 will cause the weights 38 to move out or in, thereby raising or lowering the plunger 33 to the proper extent relative to the port 32, thus controlling the admission of cool or exterior air to the upper portion of the cylinder 16, thereby increasing or decreasing the speed of the engine according to requirements. When the engine is not doing work, the plunger moves nearer but slowly toward the piston, so that the air does not pass suddenly but gradually toward the bottom of cylinder 16.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a hot-air engine, a crank-shaft suitably supported, an eccentric mounted on the crank thereof, a lever, a fulcrum therefor, an eccentric-strap engaging said eccentric, connections intermediate said strap and lever, a cylinder, a plunger fitting loosely therein, connections intermediate said plunger and lever, a piston movable in said cylinder, and connections from said piston to said crank.

2. In a hot-air engine, a crank-shaft, an eccentric mounted on the crank thereof, a lever suitably fulcrumed, an eccentric-strap mounted on said eccentric, an arm extending from said eccentric-strap, and pivotally attached to said lever, a cylinder having one end open and the other end closed and adapted to be heated, a plunger loosely mounted in said cylinder, a rod attached to said plunger, a link common to the latter and to said lever, a piston mounted in said cylinder above said plunger and connecting-rods having their lower ends attached to said piston and their upper ends engaging said crank adjacent said eccentric, said plunger in its initial movement being impelled downwardly, thus imparting a pull on the lever, and thereby throwing the eccentric over its center.

3. In a hot-air engine, a cylinder suitably supported, means for heating the lower portion thereof, a cooling device surrounding the upper portion thereof, a plunger fitting loosely in said cylinder, a piston fitting tightly

therein, a crank-shaft suitably supported and having an eccentric mounted on the crank thereof, an eccentric-strap, an arm projecting from the latter, a lever suitably fulcrumed, a pivotal connection common to said arm and lever, a link having one end attached to said lever and its other end to a rod, said rod passing through said piston and being secured to said plunger, and connecting-rods pivotally attached to said piston at one end and having their other ends mounted on said crank.

PAUL ROEDIGER.

Witnesses:
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E. HAYWARD FAIRBANKS.