No. 676,729. Patented June 18, 1901.

E. A. STEWART.

ROTARY ENGINE.

(Application filed Mar. 23, 1900.)

(No Model.) 3 Sheets—Sheet 1.

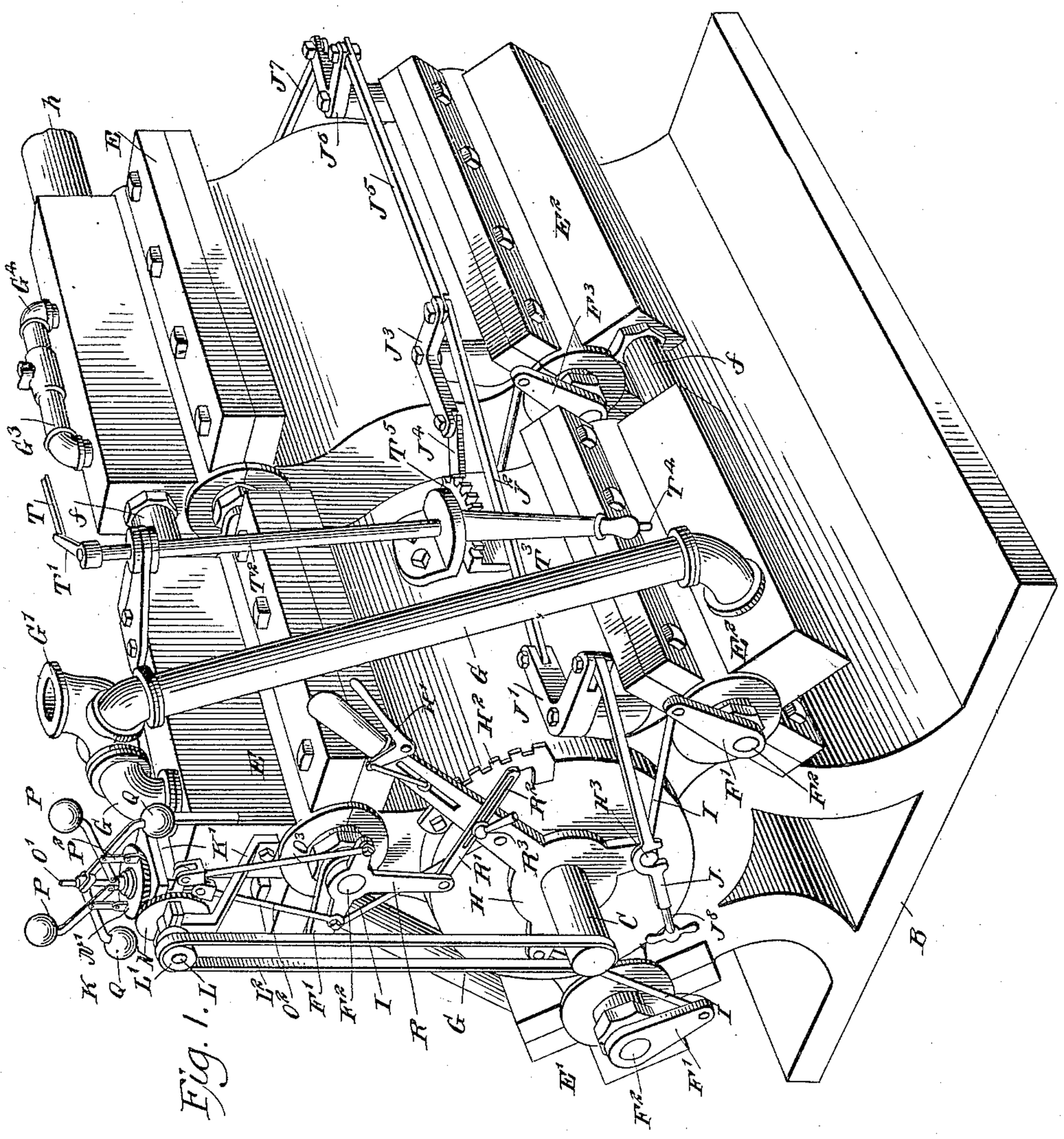

Fig. 1.

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Fig. 2.

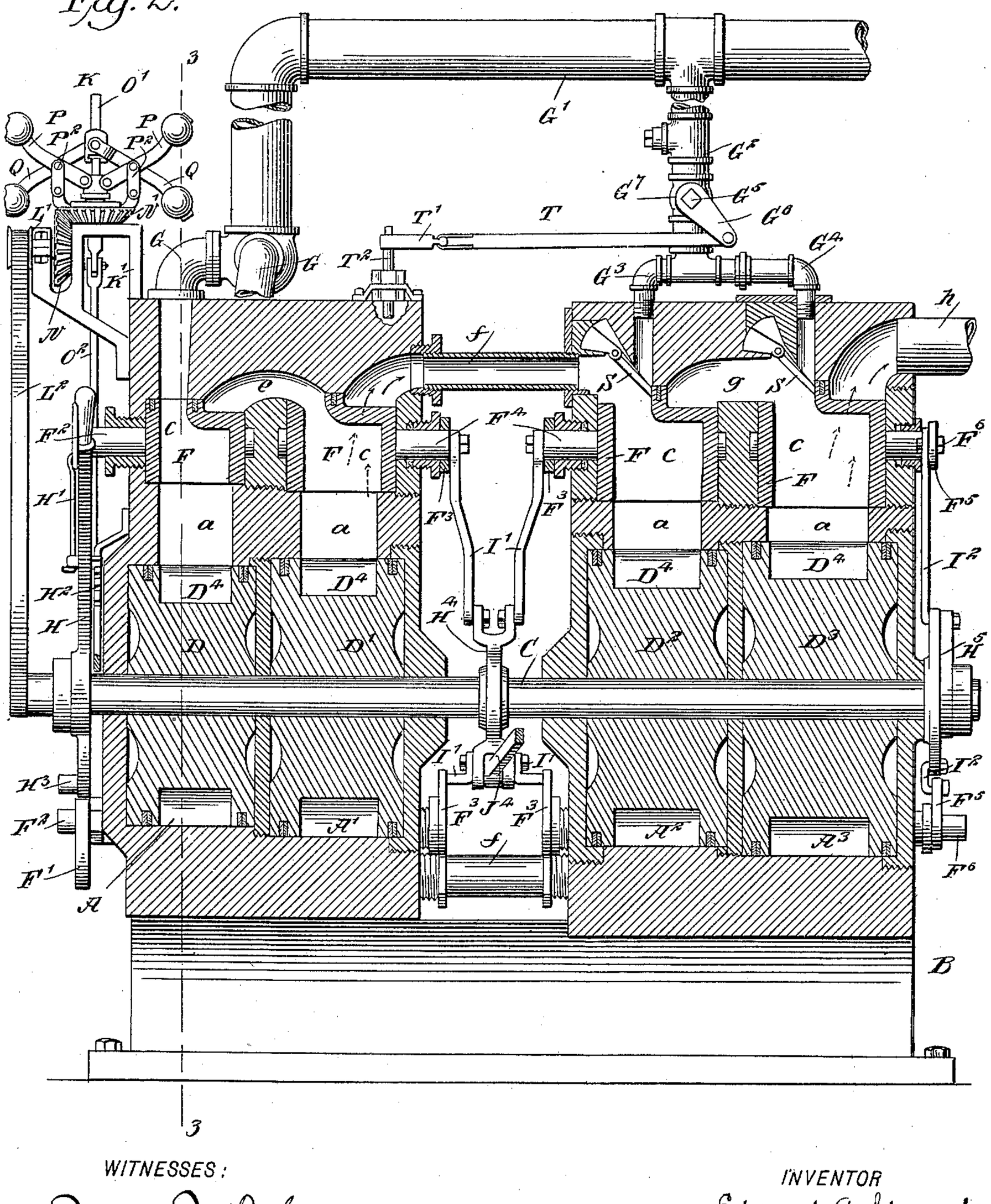

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Fig. 4.

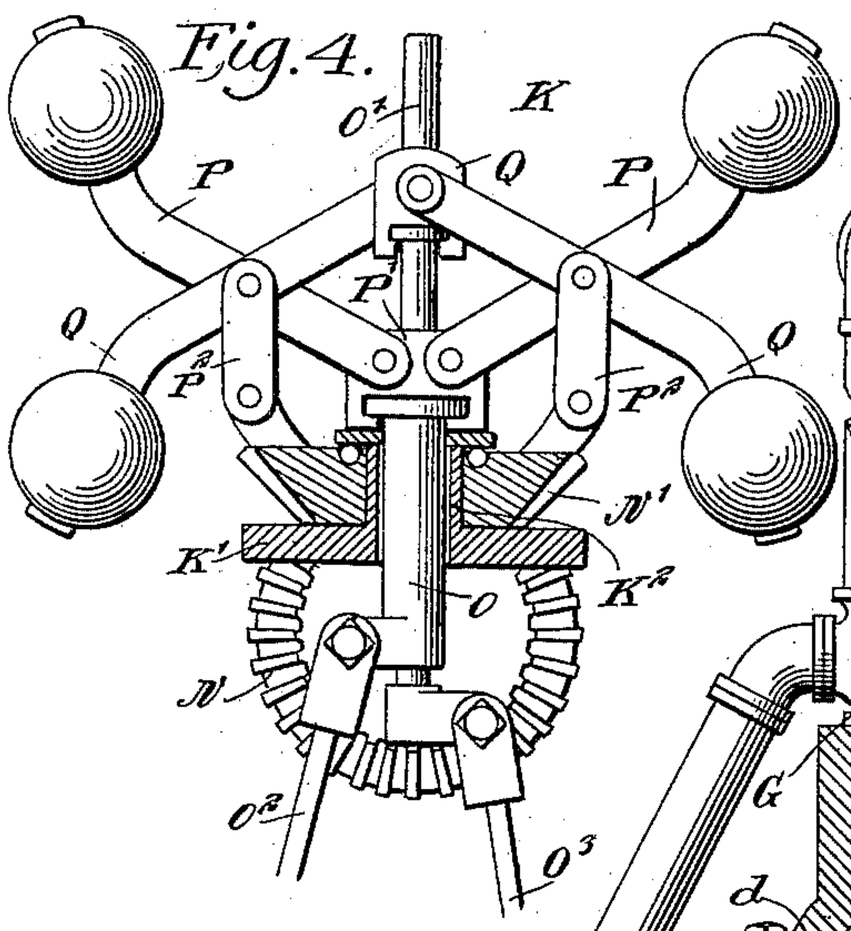

Fig. 5.

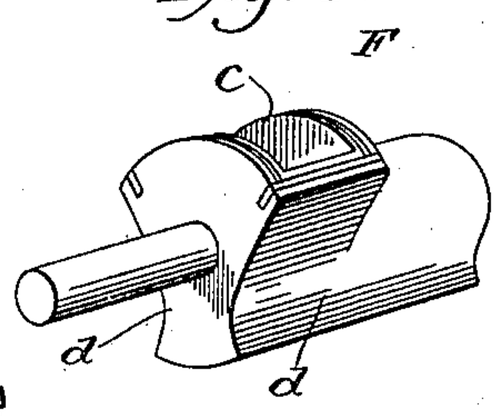

Fig. 6.

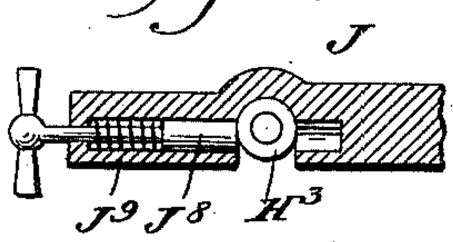

Fig. 3.

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UNITED STATES PATENT OFFICE.

EDWARD ARCHIE STEWART, OF TROY, OHIO, ASSIGNOR OF ONE-FOURTH TO FRANK E. SCOBEY, OF SAME PLACE, SHERMAN T. McPHERSON, OF CINCINNATI, AND ELVA A. JACKSON, OF TIPPECANOE, OHIO.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 676,729, dated June 18, 1901.

Application filed March 23, 1900. Serial No. 9,923. (No model.)

To all whom it may concern:

Be it known that I, EDWARD ARCHIE STEWART, a citizen of the United States, and a resident of Troy, in the county of Miami and State of Ohio, have invented a new and Improved Rotary Engine, of which the following is a full, clear, and exact description.

The invention relates to rotary engines in which the motive agent acts by impact force on buckets in the peripheral surface of the piston.

The object of the invention is to provide a new and improved rotary engine which is simple and durable in construction, very effective in operation, and arranged to utilize the motive agent expansively and to the fullest advantage in high or low pressure cylinders, to allow of conveniently starting the engine with either a light or a heavy load, and to permit of reversing the engine whenever desired.

The invention consists of novel features and parts and combinations of the same, as will be fully described hereinafter and then pointed out in the claims.

A practical embodiment of my invention is represented in the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the views.

Figure 1 is a perspective view of the improvement. Fig. 2 is a longitudinal sectional elevation of the same on the line 2 2 in Fig. 3. Fig. 3 is a transverse section of the same on the line 3 3 in Fig. 2. Fig. 4 is an enlarged end elevation of the governor with parts in section. Fig. 5 is a perspective view of one of the admission and exhaust valves, and Fig. 6 is an enlarged sectional side elevation of a valve-link.

The improved engine is provided with a plurality of cylinders A A' A^2 A^3 of different diameters, and the cylinder A is a high-pressure cylinder, and the succeeding cylinders A' A^2 A^3 are low-pressure cylinders. The several cylinders are mounted on a suitable base B, and through the several cylinders extends centrally the main shaft C, on which are secured cylindrical pistons D D' D^2 D^3, mounted to rotate in the several cylinders A A' A^2 A^3, respectively, as is plainly indicated in Fig. 2. The cylinders and their pistons are the same in construction except as to size, as previously mentioned, and hence it suffices to describe but one piston and cylinder in detail.

Each of the pistons is provided in its peripheral surface with pairs of buckets D^4, said pairs of buckets being located a distance apart, as is plainly indicated in Fig. 3, a packing D^5 being in the peripheral surface of the piston between adjacent pairs of buckets. Each of the cylinders is provided with a plurality of steam-chests E E' E^2, containing valves F and connected by supply-pipes G with a main supply-pipe G', connected with a boiler or other suitable source of motive-agent supply. The steam-chests E E' E^2 and their valves F are grouped around a cylinder an equal distance apart, and from each steam-chest lead two ports *a b* to the peripheral surface of the corresponding piston to allow the motive agent to enter the buckets and rotate the piston in the desired direction and to allow the exhaust motive agent to pass from the buckets, as hereinafter more fully described.

Each of the valves F is provided with a diametrical port *c* for the passage of live motive agent from the supply-pipe to the port *a* or *b*—that is, whichever of the two ports is the admission-port at the time. In the sides of each valve F are cavities *d* for allowing the exhaust motive agent to pass from a pair of buckets through the corresponding port *b* or *a* by way of the steam-chest of the adjacent cylinder.

As shown in Fig. 3, the valves F are in such position that the ports *c* connect the supply-pipes G with the ports *a*, so that the latter are the admission-ports, while the ports *b* are the exhaust-ports and connect with one of the cavities *d*. The cavity *d* conducts the exhaust-steam from the first engine by way of a channel *e* to the port *c* of the valve F of the second cylinder A', as shown in Fig. 2, and the exhaust-steam from this cylinder passes by way of the cavity in the valve F through

a pipe *f* to the port *c* of the valve F in the third cylinder A^2, and the exhaust from this cylinder passes by way of the exhaust in the valve F through a channel *g* to the valve F of the fourth cylinder A^3, and the exhaust in said cylinder A^3 passes from the exhaust in the valve F to a pipe *h* for conducting the exhaust-steam to the outside.

As shown in Fig. 3, the several ports *a b* are arranged in such a manner relatively to the pairs of buckets D^4 that when one pair of buckets receives motive agent from, say, the steam-chest E then the ports *a b* of the steam-chest E′ are both cut off from the corresponding buckets, and likewise the ports *a b* of the steam-chest E^2 are also cut off; but when the piston D rotates and the pair of buckets at the port *a*, leading from the steam-chest E, is cut off then the pair of buckets at the port *a* from the steam-chest E^2 begin to take steam, and when these buckets are cut off from said port *a* then the ports *a* at the steam-chest E′ take steam, so that one pair of buckets always receives motive agent, whereby a continuous impulse is given to the piston D when the engine is running. By reference to Fig. 3 it will be seen that the distance between the inner ends of a pair of ports *a b* is approximately double the length of a pair of buckets D^4 to prevent any suction or pressure from the exhaust back upon the piston. When the valves F are in the position shown in Fig. 3, the piston D is rotated in the direction of the arrow *a′*, and when the position of the valves F is changed to connect the ports *c* of said valves with the ports *b* then the engine is reversed, as the piston D will then rotate in the inverse direction of the arrow *a′*.

It is evident that the exhaust motive agent from the first cylinder A is passed into the second cylinder A′ to act on the buckets of the piston D′ in the same manner as described in reference to the cylinder A, but with expansive force, and a like action takes place in the cylinders A^2 A^3 as they receive motive agent from the preceding cylinders. Thus by the arrangement described the motive agent is utilized to the fullest advantage and expansively.

The several valves F are simultaneously set to the desired position by the operator for running the engine either in a forward or reverse direction, as desired, and, if desired, the valves can be set in an inactive position with the ports *c* between the ends of the ports *a b*—that is, out of register with either of them. When the engine is running, the actuating device for the valves can be connected with a governor, so as to cause the valves to cut off sooner or later, according to the speed of the engine. For this purpose the following arrangement is made: A three-armed lever H is loosely fulcrumed on the shaft C outside of the cylinder A, and on said lever is arranged a hand-lever H′, adapted to engage a notched segment H^2 for locking the said lever in position for running the engine forward or backward or for stopping the engine when the valves F are in an intermediate position, as above explained. The lever H is pivotally connected by links I with crank-arms F′ on the stems F^2 of the several valves F in the steam-chests E E′ E^2, so that when the lever H is shifted into either of the three positions mentioned then the said valves F assume corresponding positions in their steam-chests. On one of the wrist-pins H^3 of the lever H is adapted to be hooked a link J, connected with a bell-crank lever J′, fulcrumed on the engine-frame, and the said bell-crank lever J′ is connected by a link J^2 with a bell-crank lever J^3, likewise fulcrumed on the engine, and connected by a link J^4 with a three-armed lever H^4, mounted to turn loosely on the shaft C between the somewhat-separated cylinders A′ A^2, as shown in Fig. 2. The lever H^4 is connected by links I′ with crank-arms F^3 on the valve-stems F^4 of the valves controlling the motive agent in the cylinders A′ A^2. The bell-crank lever J^3 is also connected by a link J^5 with a bell-crank lever J^6, connected by a link J^7 with a three-armed lever H^5, connected by links I^2 with crank-arms F^5 on the valve-stems F^6 for the valves controlling the admission and exhaust of the motive agent for the cylinder A^3. It is evident that when the lever H is shifted the link J imparts motion to the connection above described, so that the several valves F of all the cylinders are simultaneously adjusted and set to the same position relatively to the ports leading from the steam-chests to the cylinders.

When the engine is running, the link J can be disconnected from the wrist-pin H^3, and then the hook-opening in said link is closed by a bolt J^8, pressed on by a spring J^9 to close the opening in the hook, so that said link J rides loosely over the wrist-pin, and consequently the position of the valves F in the low-pressure cylinders A′ A^2 A^3 is not affected, while the governor K changes the positions of the valves F in the high-pressure cylinder A. The governor K is mounted on a suitably-constructed frame K′, attached to the front end of the steam-chest E, as is plainly shown in the drawings, and in said frame is journaled a shaft L, carrying a pulley L′, connected by a belt L^2 with the shaft C or a pulley thereon, so that when the shaft C is rotated a rotary motion is given to the shaft L. On the latter is also secured a bevel gear-wheel N, in mesh with a bevel-gear wheel N′, mounted to rotate on a hub K^2, formed on the frame K, as is plainly shown in Fig. 4, and through said hub K^2 extends loosely a sleeve O, and through the sleeve extends loosely a stem O′. The top of the sleeve O is engaged by a collar P′ on weighted levers P, fulcrumed on links P^2, pivotally connected with the top of the gear-wheel N′, and on said links P^2 are also pivoted weighted levers Q, connected with a sleeve Q′, secured on the stem O′. The levers P and Q cross each other, as shown in Fig. 4,

so that said levers swing in opposite directions by centrifugal force, whereby the sleeve O and the rod O′ are simultaneously moved in opposite directions to each other. The lower ends of the sleeve O and the stem O′ are connected by links O^2 O^3 with the side arms of a three-armed lever R, mounted to turn loosely on the valve-stem F^2 of the upper valve F, the said lever having its depending arm connected by a link R′ with a locking-bolt R^3, carried by the lever H and extending through an elongated slot R^2 in said link. In starting the engine the bolt R^3 is loosened sufficiently to allow free swinging movement of the lever H without moving the link R; but after the lever is adjusted to the desired position and the engine is running then the link R′ is secured to the lever by the bolt R^3.

When the engine runs above a normal rate of speed, the weighted levers P and Q cause a swinging of the three-armed lever R, and the motion of the latter is transmitted by the link R′ to the lever H, so that the valves F for the high-pressure engine are shifted to reduce the admission of motive agent to the admission-ports *a* or *b* until the speed of the engine is reduced. When this takes place, the weighted levers P and Q cause the three-armed lever R to move the lever H back to its normal position. It is understood that the other valves F for the cylinders A' A^2 A^3 remain unobstructed during the shifting of the levers H and the valves F for the high-pressure cylinder A, as the link J rides loosely over the wrist-pin H^3 during the time the engine is running.

In case of a very heavy load it is desirable to start the pistons D^2 D^3 in the cylinders A^2 A^3 with live motive agent, and for this purpose the following arrangement is made: From the main supply-pipe G′ leads a branch pipe G^2, connected by branch pipes G^3 G^4 with the steam-chests E of said cylinders to allow the motive agent to pass through the valves F to the peripheral buckets of the pistons D^2 D^3 to turn the same by live motive agent. In the branch pipe G^2 is a valve G^7 under the control of the operator, so as to open the connection between the main supply-pipe G′ and the said steam-chests whenever desired or to close the connection after the engine is started. Normally the steam-chests E of the cylinders A^2 A^3 are closed to the branch pipes G^3 G^4 by gravity-valves (S shown in Fig. 2) to prevent exhaust-steam from passing into the pipes G^3 G^4 while the engine is running with the cylinders A^2 A^3 as low-pressure cylinders, as above explained. When live motive agent, however, is turned on by opening the valve G^7, then the valves S swing into an open position to allow the motive agent to pass to the valves F of the said cylinders A^2 A^3. In order to actuate the valve G^7, the stem G^5 thereof is provided with a crank-arm G^6, connected by a link T with a crank-arm T′ on the upper end of a vertically-disposed shaft T^2, carrying at its lower end a handle T^3, having a locking-lever T^4, adapted to engage a notched segment T^5, as indicated in Figs. 1 and 3.

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

1. A rotary engine, comprising a cylinder, a piston mounted to turn therein and formed in its periphery with buckets arranged in pairs, a plurality of steam-chests grouped around said cylinder and each connected by an admission-port and an exhaust-port with said cylinder, and a valve mounted to turn in each steam-chest, to control the admission and exhaust of the motive agent to and from said cylinder and said buckets of the piston, substantially as shown and described.

2. A rotary engine, comprising a cylinder, a piston mounted to turn therein and formed in its periphery with buckets, a plurality of steam-chests grouped around said cylinder and each connected by an admission-port and an exhaust-port with said cylinder, and a valve mounted to turn in each steam-chest to control the admission and exhaust of the motive agent to and from said cylinder and said buckets of the piston, said valves being so arranged relatively to the buckets that one of the buckets is always under continuous pressure of steam from a steam-admission port, as set forth.

3. A rotary engine, comprising a cylinder, a piston mounted to turn therein and formed in its periphery with buckets, arranged in pairs alined around the periphery, the pairs of buckets being spaced apart, a plurality of steam-chests grouped around said cylinder and each connected by an admission-port and an exhaust-port with said cylinder, the distance between the inner ends of a pair of ports being approximately double the length of a pair of buckets to prevent suction or pressure from the exhaust back upon the piston, and a valve mounted to turn in each steam-chest to control the admission and exhaust of the motive agent to and from said cylinder and said buckets of the piston, said valves and ports of the steam-chests being so arranged relatively to the pairs of buckets that when a pair of buckets is receiving steam from one steam-chest, the ports of the other steam-chests are cut off from the corresponding buckets.

4. A rotary engine, comprising a high-pressure cylinder, a low-pressure cylinder, a main shaft mounted to turn centrally in said cylinders, pistons secured to said shaft and mounted to turn in said cylinders, each piston being formed in its periphery with buckets arranged in pairs, the pairs of buckets being spaced a distance apart, a plurality of steam-chests on each cylinder, each steam-chest being connected by an admission-port and an exhaust-port with the corresponding cylinder, and a valve adjustable in said steam-chest, for successively controlling the admission and exhaust of the motive agent to and from said buckets, the arrangement being

such that one pair of buckets of a piston is always under continuous pressure at a steam-admission port, as set forth.

5. A rotary engine, comprising a high-pressure cylinder, a low-pressure cylinder, a piston for each cylinder and having peripheral buckets, a plurality of steam-chests for each of the said cylinders, valves in the steam-chests for controlling the motive agent, means for setting the valves for the high-pressure cylinder, and a removable connection between said means and the valves for the low-pressure cylinder, substantially as shown and described.

6. A rotary engine, comprising a high-pressure cylinder, a plurality of low-pressure cylinders, a piston for each cylinder and having peripheral buckets, a plurality of steam-chests for each of said cylinders, valves for the steam-chests for controlling the motive agent, a lever for setting the valves for the high-pressure cylinder, a governor, a lever mounted to swing, and actuated from the said governor, and an adjustable connection between the said swinging lever and the lever for setting the valves for the high-pressure cylinder, for the purpose set forth.

7. A rotary engine, comprising a high-pressure cylinder, a low-pressure cylinder, a piston for each cylinder and having peripheral buckets, a shaft on which the pistons are mounted, a plurality of steam-chests for each of the said cylinders, valves in the steam-chests for controlling the motive agent, a lever loosely fulcrumed on the shaft, links connecting said lever with crank-arms on the stems of the several valves of the high-pressure cylinder, and a removable connection between the said lever and the stems of the valves of the low-pressure cylinders.

8. In a rotary engine, a piston provided with peripheral buckets arranged in pairs and alined around the periphery, opposing front and rear walls of each bucket of a pair being concave and intersecting each other at an angle forming the bottom of the bucket.

9. A rotary engine comprising a cylinder, a piston mounted to turn therein and formed in its periphery with buckets arranged in pairs, the buckets of each pair being in alinement around the periphery, and the pairs of buckets being spaced apart, the peripheral surface of the piston between adjacent pairs of buckets being provided with a packing, each bucket of a pair having its front and rear walls concave, the concave walls intersecting each other at an angle forming the bottom of the bucket, a plurality of steam-chests grouped around said cylinder and each connected by an admission-port and an exhaust-port with said cylinder, and a valve mounted to turn in each steam-chest to control the admission and exhaust of the motive agent to and from said cylinder and said buckets of the piston.

10. A rotary engine, comprising a high-pressure cylinder, a low-pressure cylinder, a piston for each cylinder and having peripheral buckets, a shaft on which the pistons are mounted, a plurality of steam-chests for each of the cylinders, valves in the steam-chests for controlling the motive agent, a lever loosely fulcrumed on the shaft, links connecting said lever with crank-arms on the stem of the several valves of the high-pressure cylinder, a link provided with a hook-opening adapted to removably engage a wrist-pin on the said lever and connections between the said link and the valves for the low-pressure cylinder, the link being provided with a spring-bolt for closing the hook-opening when the link is disconnected from the wrist-pin, for the purpose specified.

11. A rotary engine comprising a series of cylinders arranged in pairs, one of the cylinders being a high-pressure cylinder, and the remaining cylinders low-pressure cylinders, a piston for each cylinder and having peripheral buckets, a shaft extending through the several cylinders and on which the pistons are mounted, a plurality of steam-chests for each of the cylinders and connected by ports or passages with the corresponding steam-chests of the adjacent cylinder, valves in the steam-chests for controlling the admission and exhaust of the motive agent, levers fulcrumed loosely on the shaft, one at each end of the series of cylinders and one located in the space between the pairs of cylinders, links connecting the said levers with crank-arms on the stems of the respective valves of the several cylinders, connections between the said levers whereby they may be actuated in unison to simultaneously adjust the several valves, a steam-supply pipe connected with the steam-chests of the high-pressure cylinder, and means for supplying some of the low-pressure cylinders with live motive agent, for the purpose set forth.

12. A rotary engine, comprising a high-pressure cylinder, a plurality of low-pressure cylinders, pistons mounted to turn in said cylinders, steam-chests provided with valves for controlling the admission and exhaust of the motive agent to and from said cylinders, a steam-supply pipe connected with the steam-chests of the high-pressure cylinders, a branch pipe leading from the main supply-pipe and connected by pipes with the steam-chests of some of the low-pressure cylinders to supply the said cylinders with live motive agent to start the pistons in said cylinders, a valve in said branch pipe and under the control of the operator, and gravity-valves located within the steam-chests of said low-pressure cylinders and normally closing communication between the said steam-chests and the pipes connected with the said branch pipe, for the purpose set forth.

13. A rotary engine, comprising a high-pressure cylinder, a plurality of low-pressure cylinders, pistons mounted to turn in said cylinders, steam-chests provided with valves for controlling the admission and exhaust of the motive agent to and from said cylinders, a

steam-supply pipe connected with the steam-chests of the high-pressure cylinders, a branch pipe leading from the main supply-pipe and connected with the steam-chests of some of the low-pressure cylinders to supply said cylinders with live motive agent to start the pistons in said cylinders, valves for normally closing connection between the steam-chests of said low-pressure cylinders and the said branch pipe, a valve in said branch pipe, a crank-arm on the stem of said valve, and a vertically-disposed shaft having a handle at one end and a crank-arm at the other end connected by a link with the crank-arm on the stem of said valve, for the purpose set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EDWARD ARCHIE STEWART.

Witnesses:

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