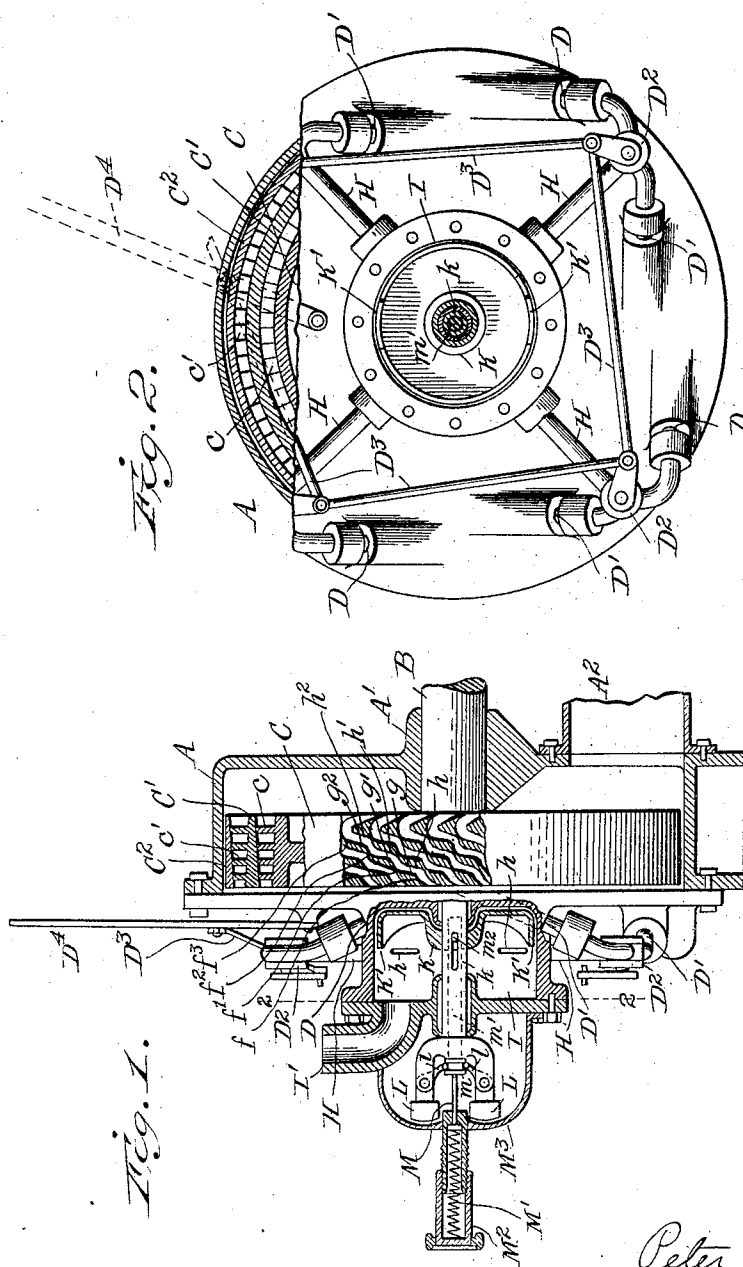


P. B. BELCHES.
ELASTIC FLUID MOTOR.
APPLICATION FILED JAN. 13, 1905.

2 SHEETS—SHEET 1.

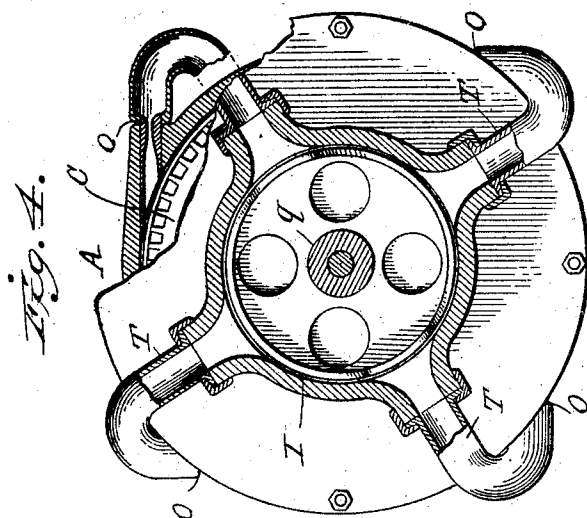
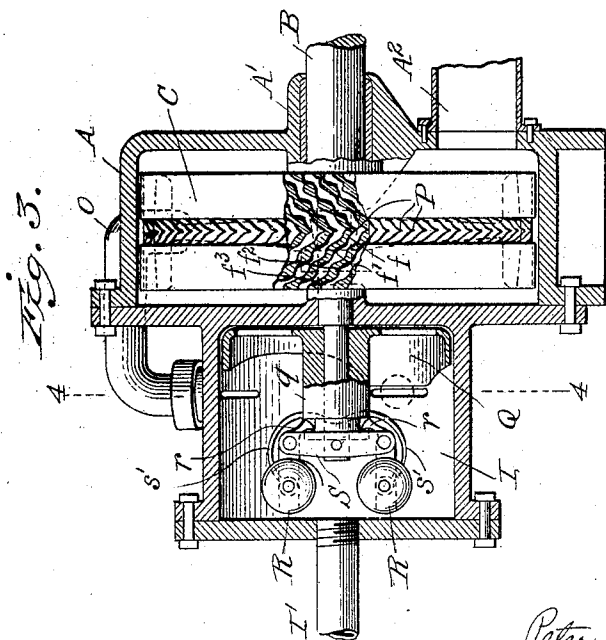


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2 SHEETS—SHEET 2.



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UNITED STATES PATENT OFFICE.

PETER BERKELEY BELCHES, OF HAYMARKET, VIRGINIA.

ELASTIC-FLUID MOTOR.

No. 796,395.

Specification of Letters Patent.

Patented Aug. 1, 1905.

Application filed January 13, 1905. Serial No. 240,945.

To all whom it may concern:

Be it known that I, PETER BERKELEY BELCHES, a citizen of the United States, residing at Haymarket, in the county of Prince William and State of Virginia, have invented certain new and useful Improvements in Elastic-Fluid Motors; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, and to the letters of reference marked thereon.

This invention relates to improvements in elastic-fluid motors commonly known as "turbine-engines" or engines wherein the torque is developed by the kinetic inertia of the elastic fluid exerted on or against a series of vanes constituting or carried by the rotary part of the engine.

The objects of the invention are to provide a structure wherein the relative efficiency may be maintained when using a greater or less quantity of elastic fluid, the power developed, however, being in proportion to the consumption.

As is well known in this class of engine, the efficiency drops rapidly under the action of a throttle or as the pressure at the nozzles is reduced, and consequently to maintain the efficiency the nozzle-pressure must be maintained. Owing to this condition, the governing or regulation of engines of this type is difficult, and it has been proposed to provide a series of nozzles with means for closing one or more of them in accordance with the power requirements.

In accordance with the present invention the number of nozzles is not material; but provision is made for periodically closing and opening the nozzle or nozzles, the relative open and closed periods varying in duration in accordance with the power requirements. Thus each nozzle operates at its maximum efficiency when in action, the work is distributed evenly between all the nozzles, and the balance of the wheel may be maintained.

Referring to the accompanying drawings, Figure 1 is a vertical section, partly in elevation and partly broken away, of a turbine-engine embodying the present improvements. Fig. 2 is a side elevation, partially in section, of the turbine shown in Fig. 1. Figs. 3 and 4 are views corresponding to Figs. 1 and 2, respectively, and showing a modified arrangement of the turbine.

Similar letters in the several figures indicate like parts.

The letter A indicates a casing for the vaned wheel C, and it preferably has a bearing A' for the drive-shaft B, upon which the said wheel is keyed or otherwise mounted to effect the rotation of the shaft. The casing is provided, as usual, with an exhaust-opening A², leading to a condenser or not, as is usual in this class of motors. Nozzles D D' are provided for directing the elastic fluid against the vanes of the wheel, and the number of such nozzles is optional, depending upon the design of the motor. As shown, four nozzles D and four nozzles D' are employed, the latter being reversely arranged to direct the elastic fluid against a reversely-arranged set of vanes, thus providing for practically the same efficiency with the motor running in either direction.

As shown in Figs. 1 and 2, the wheel C has the vanes arranged to take the steam on one side and deliver it on the opposite side of the wheel axially. In constructing this wheel one set of vanes—that lettered *c*—is preferably formed directly on the periphery, while the other set *c'* is formed on a ring C', adapted to encircle and be shrunk on the outer ends of the vanes *c*, and the spaces between the vanes *c'* are closed by a peripheral ring C², also preferably shrunk in place. From Figs. 1 and 2 it will be seen that the channels between the vanes are tapered or enlarged toward the exhaust side to compensate for the expansion of the steam.

In accordance with the present invention it is not designed to absorb the energy of the steam by a single deflection, but by a succession of deflections, in order to permit of a reduction in speed of the wheel without occasioning losses such as are inherent in motors where the energy is entirely absorbed by a single deflection—for instance, where the steam passes through succeeding series of alternately-arranged fixed and movable vanes, the entire kinetic inertia of the steam being absorbed at each stage and new kinetic inertia imparted by the expansion between stages. To attain the objects now desired, the impact-surfaces of the vanes are so formed that the steam is deflected by the first impact-surface only partially or at a slight angle from its course, and subsequent impact-surfaces deflect it more and more until it is preferably finally discharged rearwardly. Said impact-surfaces,

however, are separated from each other by reversely-curved surfaces, so as to separate the action into stages. In carrying out the invention in the form illustrated the rear face of each vane is formed into impact-surfaces $f f' f^2 f^3$, with reverse curves $g g' g^2$ between them, and the forward face of each vane is formed with stepped deflecting-faces $h h' h^2$, the result being to form a sinuous passage for the steam.

The curvature or angle of the impact and deflecting surfaces are such that the tending of the kinetic inertia of the steam against the impact-surfaces is to impart forward rotation to the wheel, while contact with the deflecting-surfaces at the rear of the passages expands the energy mainly in an effort to move the wheel axially, and as the wheel is immovable in this direction the tendency is to deflect the steam forwardly against the next impact-surface.

The nozzles D and D' are arranged reversely in pairs and are adapted to be fed by the same pipe, a valve D² for each pair being provided for directing the steam into one or the other set of nozzles. All the valves are preferably connected for simultaneous movement, as by connecting-rods D³, controlled by a lever or handle D⁴, Fig. 1.

The steam-pipes leading to the nozzles are indicated by the letter H, and they branch from a pressure-chamber I, preferably located axially of the motor and adapted to receive steam from any suitable source (not shown) through a pipe I'. The chamber I is cylindrical and contains a cut-off K, adapted to be rotated in unison with the turbine-wheel, preferably through an extension k of the drive-shaft. It is capable of a longitudinal movement on the shaft and is formed with axially-extending peripheral projections K'. Its position is such that normally it rotates at one side of the plane of the ports h of the pipes H; but when shifted longitudinally the projections K' move into the plane of the ports and operate to close each port in succession as the cut-off rotates. Thus during a portion of each rotation each port will be wide open, and during the intervening period it will be entirely closed.

Inasmuch as the projections K' enlarge toward their bases the extent of movement of the cut-off longitudinally of its axis will control the relative duration of the open and closed periods of the ports, and an extreme movement will cover and keep said ports closed during the entire rotation. With this arrangement each nozzle will do its share of work. Each will when active be under a full head of pressure, and consequently at its maximum; but the total weight of steam delivered may be regulated in exact accordance with the load on the drive-shaft. Obviously the cut-off may be moved axially by any ap-

proved mechanism. Thus, as shown, the arrangement is moved automatically, and a governor is employed for the purpose. Said governor may be arranged directly in the chamber I, as in Figs. 3 and 4, or outside of said chamber, as in Figs. 1 and 2. In the latter figures the centrifugal weights L are pivoted on arms carried by the end of the before-mentioned shaft extension and have lever-arms l working in sockets in the head m of a cut-off rod m' , extending through an axial bore in the shaft extension and connected to the pin m^2 on the cut-off. To hold the centrifugal weight in and the cut-off in normal position, a spring-pressed pin M bears on the head m and is held down by a spring M', confined beneath an adjustable cap M² on a casing M³, which latter may inclose both the spring and centrifugal weights, as illustrated in said figures.

The motor shown in Figs. 3 and 4 is not designed as a reversible motor, and hence but one series of nozzles O are shown. Said nozzles are arranged to discharge the steam at the center of the periphery of the wheel. The vanes in this instance project axially of the wheel, as before, but extend from a center line in opposite directions to the sides of the wheel. The passages and surfaces on each side of the center line are similar to those described in connection with Figs. 1 and 2; but at the meeting-point the vanes form an apex P, which is sharp, so as to split the jet of steam and direct the streams in opposite directions through the oppositely-arranged passages in the wheel. In the motor illustrated in these figures the cut-off and mechanism for moving it are both arranged in the chamber I. The cut-off itself (lettered Q) is similar to the cut-off K, before described, save that it is provided with a central sleeve q , having recesses in its upper end for the operating-arms q' of the weighted levers R. The latter are pivotally mounted in a frame S, carried by the end of the shaft extension, and a bow or other form of spring s' serves to keep the weights normally pressed toward each other and the cut-off out of line with the ports of the pipes T, leading to the nozzle. The number of nozzles is optional, as is also the number of projections on the cut-off; but the latter is preferably so arranged that at all times prior to the closing of all the ports there shall be a symmetrical distribution of the open and closed ports, so as to balance the pressure on the wheel.

In the preferred construction the cut-off does not make a sliding contact with the walls of its chamber; but a very small clearance between the two is provided to prevent friction.

Obviously the vanes and passages may extend radially, as well as axially, and in some instances it is preferred to nickel-plate and polish both the nozzles and vanes.

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

1. An elastic-fluid motor embodying a vaned wheel, a nozzle for directing the elastic fluid against the vanes, a rotary cut-off rotated by the rotation of the wheel and operating to periodically cut off the flow of fluid to the nozzle and means for varying the duration of the cut-off period.

2. An elastic-fluid motor embodying a vaned wheel and nozzle for directing the elastic fluid against the vanes, a rotary cut-off valve rotated by the wheel and operating to periodically cut off the flow of fluid to the nozzle and means for moving said cut-off valve independently of its rotation to vary the cut-off period.

3. An elastic-fluid motor embodying a vaned wheel and nozzle for directing the elastic fluid against the vanes, a rotary periodically-operating cut-off valve rotated by the wheel and movable longitudinally of its axis of rotation to vary the period of cut-off; substantially as described.

4. In an elastic-fluid turbine, the combination with the vaned wheel and nozzle, of a cut-off valve rotated in unison with the wheel and movable longitudinally of its axis, said cut-off valve having a projection for periodically closing the admission to the nozzle during each rotation of the wheel and cut-off.

5. In an elastic-fluid turbine, the combination with the vaned wheel and nozzle, of a rotary cut-off valve movable longitudinally of its axis and having a projection for closing the admission to the nozzle during a portion of the revolution only and a centrifugal governor for moving the cut-off valve longitudinally of its axis.

6. A control device for elastic-fluid turbines embodying a cut-off valve movable in one plane to periodically close and open the nozzle-passages and also movable in a direction to vary the duration of the open and closed periods.

7. A control device for elastic-fluid turbines embodying a rotary cut-off valve having a cut-off face of increasing area longitudinally of its axis, means for rotating said cut-off valve to periodically close and open the admission to the turbine-nozzle and means for moving the cut-off valve axially to vary the relative duration of the periods.

8. In an elastic-fluid turbine the combination with the vaned wheel, nozzles, pressure-chamber arranged axially of the wheel and with which the nozzles communicate and the shaft extension projecting into said chamber, of the rotary cut-off mounted on said shaft

extension and having a projection forming a cut-off face adapted to periodically close the passages leading to the nozzles; substantially as described.

9. In an elastic-fluid turbine, the combination with the vaned wheel, nozzles, pressure-chamber arranged axially of the wheel and with which the nozzles communicate and the shaft extension projecting into said chamber, of a rotary cut-off mounted on said shaft extension and free to move longitudinally, said cut-off having a tapering projection forming a cut-off face and means for moving the cut-off longitudinally.

10. In an elastic-fluid turbine the combination with reversely-arranged nozzles and a wheel adapted to be rotated in either direction, of a cut-off rotated by said wheel and adapted to control the flow through either set of nozzles; substantially as described.

11. In an elastic-fluid turbine the combination with the reversible wheel and reverse-nozzles, of a longitudinally-movable rotary cut-off valve rotated by the wheel in either direction and having a projection forming a cut-off face and means for moving the cut-off valve longitudinally to control the supply of pressure to the nozzles.

12. In an elastic-fluid turbine, the combination with a nozzle, of a wheel having vanes each of which vanes is provided with a series of impact-surfaces of successively-increasing pitch and reverse-bends between said surfaces.

13. In an elastic-fluid turbine, the combination with a nozzle, of a wheel having vanes, each of said vanes having one face formed into a series of impact-surfaces of successively-increasing pitch and the other face formed into a series of deflecting-surfaces for directing the fluid against the impact-surfaces.

14. In an elastic-fluid turbine the combination with a nozzle, of a wheel having vanes with the spaces between them closed to form passages through the wheel, the proximate surfaces of said vanes being formed the one into a series of impact-surfaces the pitch of which increases successively and the other into a series of deflecting-surfaces for deflecting the fluid intermediate the impact-surfaces.

15. In an elastic-fluid turbine, a wheel having peripheral vanes, an encircling ring mounted on the said vanes and supported thereby, vanes mounted on the outer face of said ring, and a second encircling ring mounted on the outer ends of said last-mentioned vanes; substantially as described.

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