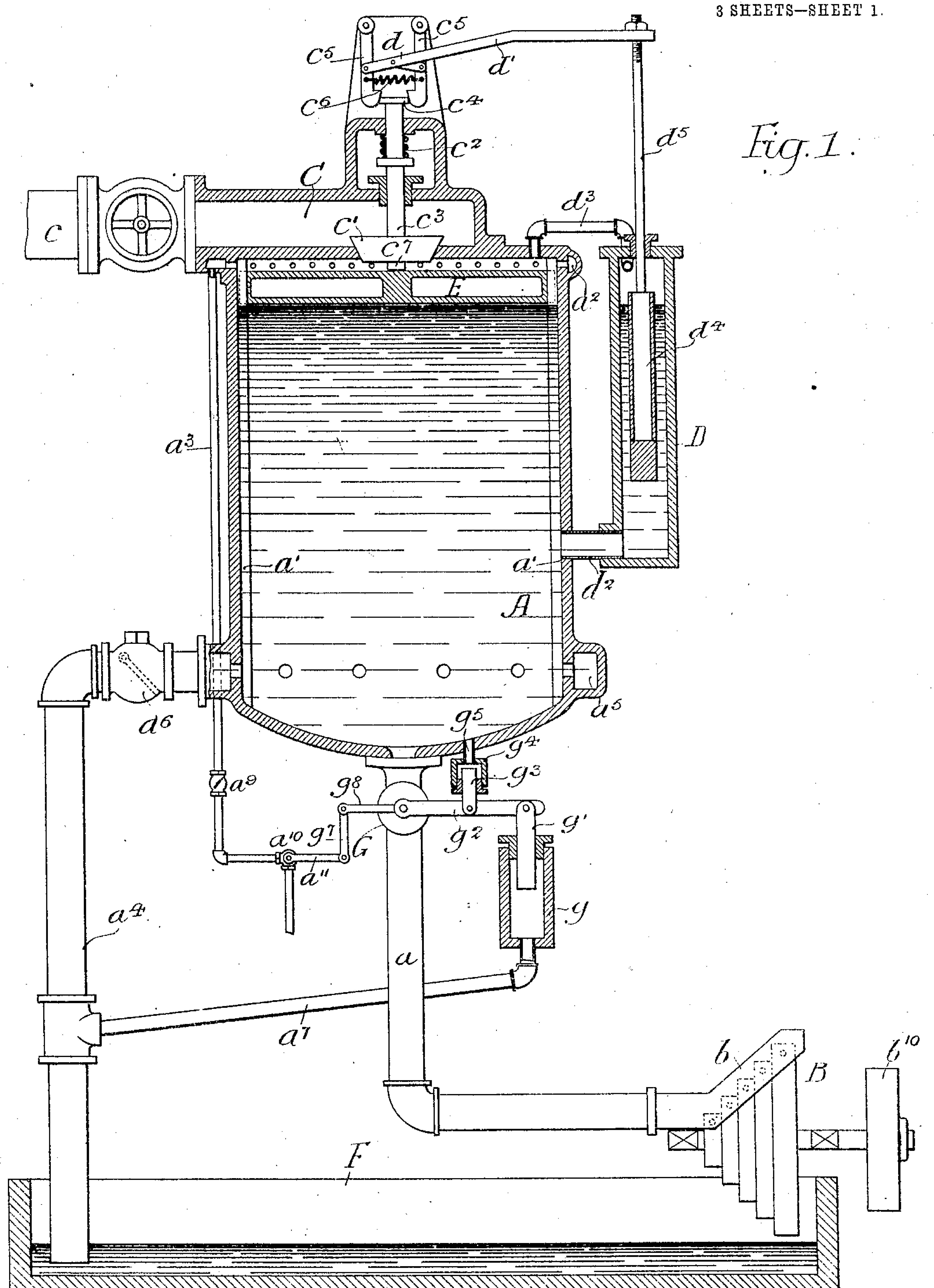
No. 889,359 PATENTED JUNE 2, 1908.

A. C. EASTWOOD.

POWER DEVELOPING APPARATUS.

APPLICATION FILED JUNE 29, 1906.

3 SHEETS—SHEET 1.



Witnesses:
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Inventor:
Arthur C. Eastwood
by his Attorneys,
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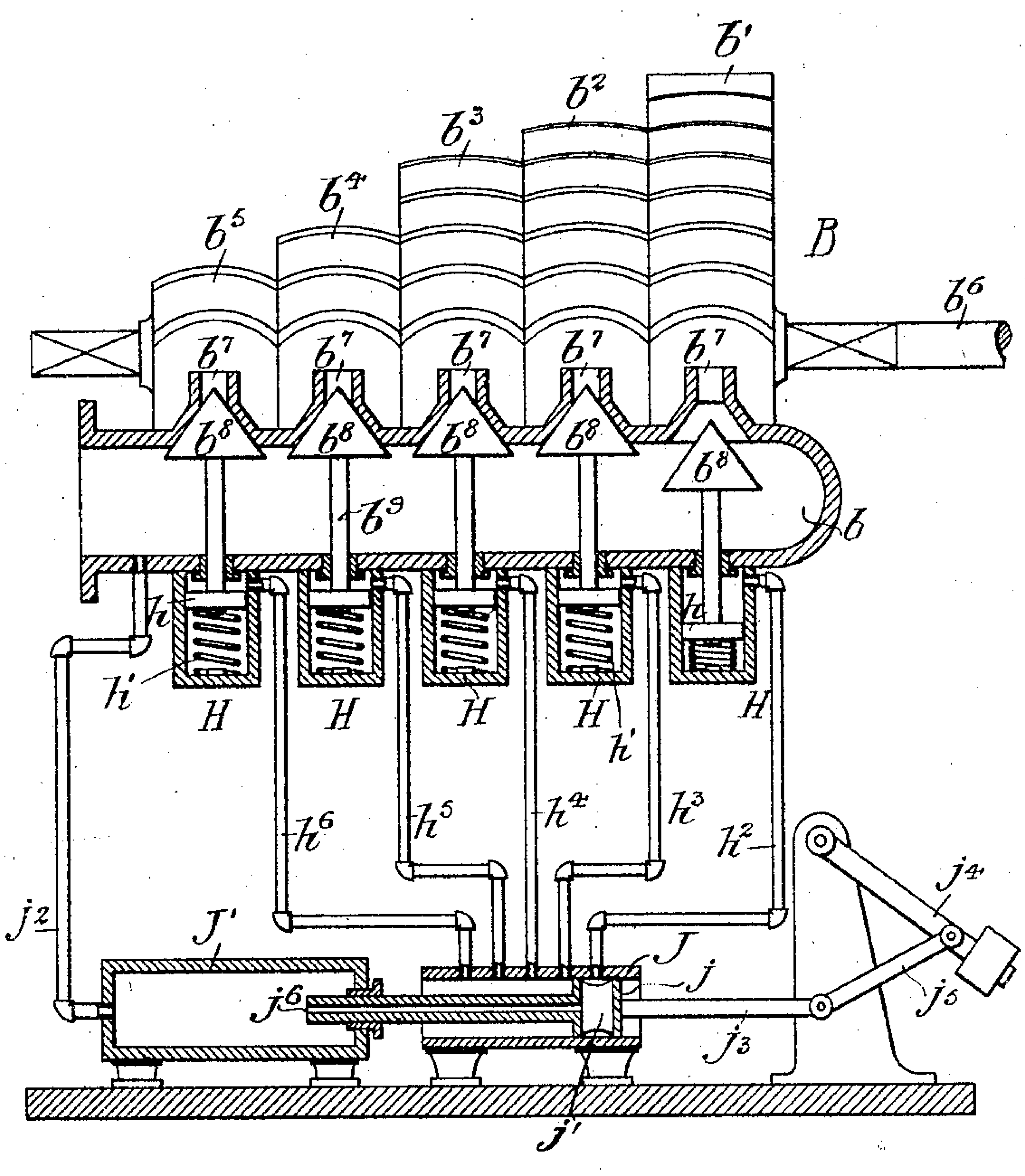
3 SHEETS—SHEET 2.

Fig. 2.



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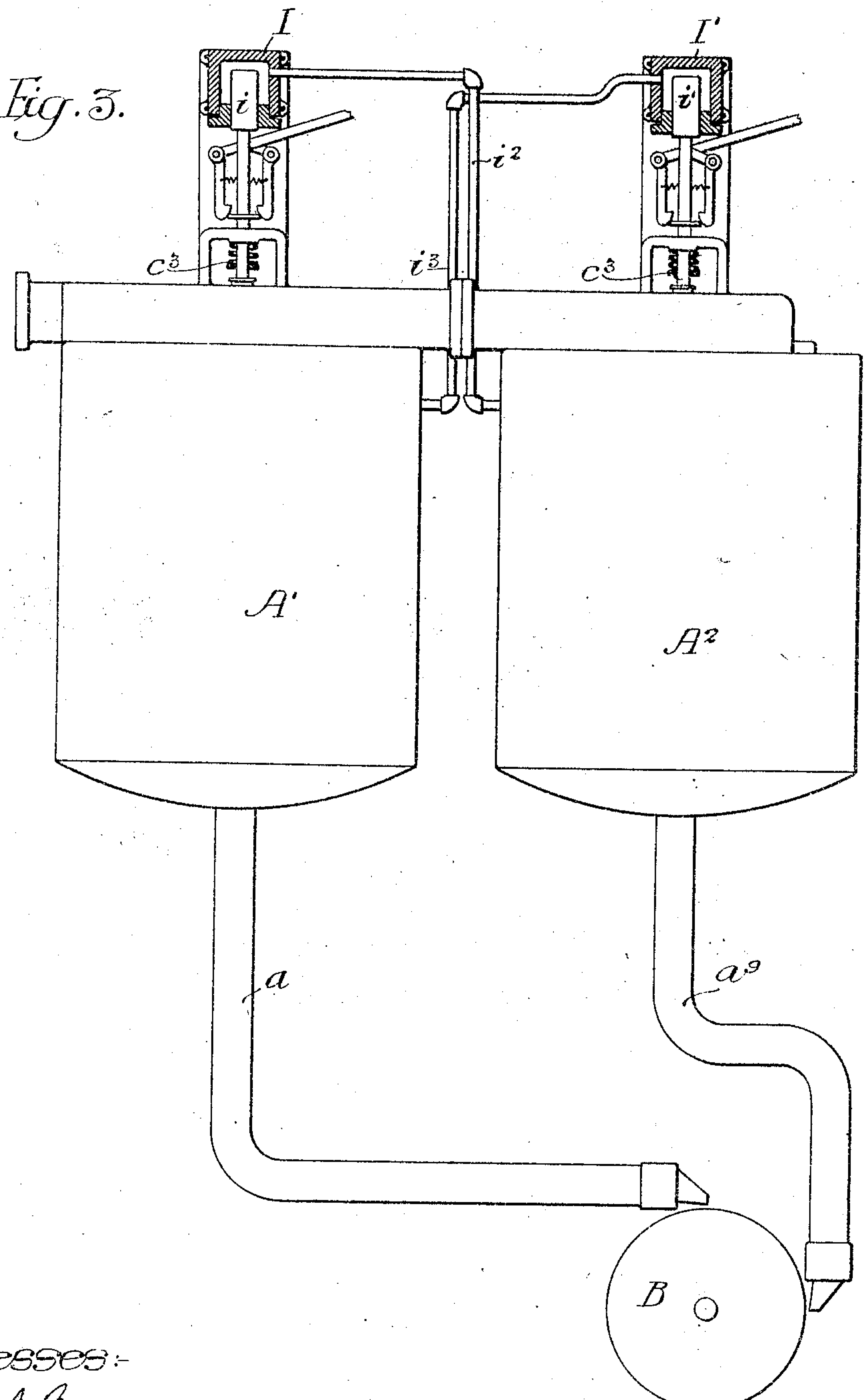
3 SHEETS—SHEET 3.

Fig. 3.



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UNITED STATES PATENT OFFICE.

ARTHUR C. EASTWOOD, OF CLEVELAND, OHIO.

POWER-DEVELOPING APPARATUS.

No. 889,359. Specification of Letters Patent. Patented June 2, 1908.

Application filed June 29, 1906. Serial No. 324,102.

To all whom it may concern:

Be it known that I, ARTHUR C. EASTWOOD, a citizen of the United States, residing in Cleveland, Ohio, have invented certain Improvements in a Power-Developing Apparatus, of which the following is a specification.

My invention relates to an improved system of apparatus for developing power from steam or other gas under pressure, one object being to provide apparatus capable of using highly superheated steam at relatively high pressures without being subject to the various disadvantages at the present time usually encountered.

A further object of the invention is to provide such a combination of apparatus as will make it possible to obtain a large ratio of expansion of the motive fluid and at the same time secure a uniform angular velocity in the prime mover operated thereby, regardless of the reduction of the pressure of said motive fluid during its expansion.

Another object of the invention is to provide apparatus for developing power from gas under pressure whose main moving parts shall not require lubrication, and in addition I desire to provide a novel form of fluid operated rotary prime mover so designed as to maintain a constant angular velocity and operate at high efficiency regardless of variations in the pressure at which the motive fluid is supplied.

My invention is also intended to provide a system, having the above noted characteristics, with means for automatically controlling its operation under working conditions.

These objects I attain as hereinafter set forth, reference being had to the accompanying drawings, in which:

Figure 1, is a diagrammatic representation of the apparatus constituting my invention, the same being partly in section; Fig. 2 is a diagrammatic representation of the valve controlling mechanism for the prime mover, certain of the parts being shown in vertical section, and Fig. 3, is a diagrammatic representation somewhat similar to Fig. 1, though with certain parts omitted, illustrating my system as provided with two expansion chambers, in order that the operation of the prime mover may be continuous.

In general terms my system includes a chamber capable of being filled with liquid and connected to a source of supply of steam or other gas under pressure, as well as to a prime mover of the rotary type, there being provided means for controlling the admission of gas to, and its subsequent expansion in, the chamber, and also mechanism for controlling the flow of liquid from the chamber to the prime mover. This latter is so constructed that as the pressure on the liquid in the chamber decreases on account of the expansion of the gas, the supply of liquid is automatically shifted to parts of the prime mover rotating at a less peripheral, though at the same angular, velocity. I attain this result by constructing the prime mover with a series of rings of buckets or vanes of different diameters and by automatically directing the flow of liquid to that particular one of the rings having the proper peripheral velocity for producing the highest efficiency at the particular pressure of the liquid existing at any given time.

In the above drawings, A represents the expansion chamber whose lower portion is connected by means of a pipe a to the valve chest b of a rotary prime mover indicated at B. The chamber A contains a loosely fitting piston E of relatively light construction, designed to float on a body of liquid within said chamber and which is prevented from turning or getting out of a horizontal plane by means of guideways formed by ribs a'. Connected to the top of the expansion chamber is a valve chest C communicating through a pipe c with a steam boiler or other source of gas under pressure, and there is a valve seated opening between said valve chest and the expansion chamber, having a valve c'. Said valve has a stem c^3 on which acts a spring c^2 tending to keep the valve seated and there is also on said stem a head c^4 flanged so as to be capable of engagement by a pair of pivoted hooks c^5 carried on a suitable standard, preferably formed as part of the valve chest casing. A spring c^6 tends to draw together these two hooks, which also have pivoted to them two links d' and d, in turn pivoted together so as to form a toggle for forcing them apart.

A cylinder D is supported adjacent to the expansion chamber A and is connected to the lower portion of the same through a pipe d^2 and to its upper portion through a pipe d^3, there being operative in said cylinder a hollow weighted piston d^4 provided with a rod d^5 adjustably connected to an elongation of the link or lever d'. The valve c' has a downwardly projecting lug c^7 designed to be engaged by the piston E in such manner that said valve will be opened by the piston when this latter is raised to its highest position, as by a body of water in the expansion chamber. Extending around the top of said chamber is an annular passage a^2 having a series of relatively small openings into the interior of the expansion chamber and connected to a pipe a^3 in which is a check valve a^9 and a stop valve a^{10}. This latter valve has an arm or lever a^{11} fixed to its stem and this is connected through a link g^7 to an arm g^8 fixed to the stem of another valve G hereafter referred to. A pipe a^4, communicating with a reservoir F, is also connected with a relatively large annular conduit a^5 extending around the lower portion of the expansion chamber A and also provided with a number of openings through which it communicates with the interior of said chamber.

An inwardly opening check valve a^6 is provided at the upper end of the pipe a^4 and there is also connected with said pipe a pipe a^7 leading to the bottom of a cylinder g. This cylinder has a plunger g' connected to an arm or lever g^2, which, like the arm g^8, is fixed to the stem of the valve indicated at G in the pipe a. There is also operative on said arm g^2 a plunger g^3, designed to be actuated by pressure exerted in the cylinder g^4 communicating through a pipe g^5 with the lower part of the expansion chamber.

With the various parts of the apparatus in the positions illustrated in Fig. 1, and the expansion chamber A full of water, the piston E is in engagement with the lug c^7 of the valve c'. A further flow of water into said chamber will raise said valve from its seat, against the action of the spring c^3, to such a height as to cause the flanged head c^4 on the valve stem to be engaged and held in an elevated position by the hooks c^5. This will permit steam or other gas under pressure to flow from the valve chest C and into the expansion chamber, thereby exerting pressure on the surface of the piston. This pressure is at once transmitted through the liquid in the chamber to the plunger g^3, which is moved out of its cylinder g^4 and caused to turn the lever arm g^2 into such a position as to open the valve G. The fluid in chamber A is now free to pass to the prime mover B, upon which it operates in a manner hereafter described.

As the level of the liquid falls in the expansion chamber, it will also fall in the cylinder D, so that the force tending to buoy up or float the weighted plunger d^4 will be gradually diminished until finally it is lowered to such an extent that the toggle formed by the two links d and d' will force apart the pivoted hooks c^5 and release the flanged head c^4 of the valve stem c^3. The valve c' is now free to close under the action of the spring c^2 and cut off of the motive gas therefore takes place.

The body of gas in the expansion chamber, however, continues after cut off to act expansively on the liquid therein, and forces this to the prime mover until such time as the force acting on the plunger g^3 is overcome by the atmospheric pressure acting on the larger plunger g' which, it may be noted, has a longer lever arm for its action on the valve G. When this point is reached (and this is a matter of design of the cylinders and plungers, as well as of the lever arm) the valve G is moved to its closed position and further flow of liquid to the prime mover B is prevented. The closing of valve G causes opening of the valve a^{10} through the medium of the lever arm g^8, link g^7 and arm a^{11}, so that water from a suitable source of supply flows through the pipe a^3 and enters the upper part of the expansion chamber through the openings from the conduit a^2, in the form of a fine spray.

Since the chamber A contains a body of steam under comparatively low pressure, this latter is condensed thereby causing a vacuum above the piston E so that water is sucked through the pipe a^4 into the expansion chamber through the conduit a^5 and its openings, until the piston E has been raised to a sufficient height to engage the lug c^7 of the valve c'. Such engagement opens this valve and causes another admission of steam, the pressure of which acting on the water in the chamber operates the plunger g^3. Consequently the valve G is opened and the valve a^{10} is closed, after which the above described cycle of operations is repeated.

In order that the liquid delivered from the expansion chamber to the prime mover may be utilized under the most efficient conditions, I construct this latter in a special manner and provide it with valve mechanism, preferably constructed as illustrated in Fig. 2. In this figure, b' to b^5 inclusive represent a number of rings of buckets or vanes fixed to a suitable supporting shaft b^6 to which is attached a pulley b^{10} for driving any desired load.

For delivering the fluid under pressure to the rotatable element of the prime mover, I provide a series of nozzles b^7, one for each of the rings of the vanes or buckets, as shown. These nozzles each have a normally closed controlling valve b^8 and communicate directly with the valve chest b. For each valve there is a stem b^9 provided with a piston h which in each case operates in a cylinder H and is provided with a spring h' acting upon it in such manner as to tend to hold its particular valve b^8 upon its seat.

Suitably mounted adjacent to the valve chest is a tubular casing J open to the atmosphere at both ends and having a piston j provided with an annular groove j' and provided with a prolongation forming a plunger j^6. Entering the casing J at suitable points are a number of pipes h^2 to h^6 inclusive and these are respectively connected to the various cylinders H so as to deliver fluid under pressure to them in such manner as to cause each piston h to compress its spring h' and consequently open the valve b^8 attached thereto.

The tubular portion j^6 of the piston j enters a cylinder J′ connected by a pipe j^2 to the valve chest b, whereby liquid under pressure is supplied, not only to said cylinder J′, but also to the annular groove of the piston j through the tubular plunger j^6 and so to that particular one of the pipes h^2, etc., whose inlet happens to be in the same plane as that of said annular groove.

A weighted lever j^4 is connected through a link j^5 and a rod j^3 to the piston j in such manner as to oppose movement of the latter in one direction and to assist it in the other direction, or, in other words, so as to tend to force the tubular plunger j^6 into the cylinder J′ and to oppose its movement out of said cylinder. The weight on said lever may be adjusted in order to vary the force acting on the piston j, as desired. It will be noted that said piston is so proportioned as to permit the various pipes h^2, etc., to be open to the atmosphere when they are not covered by it and it will be understood that, if desired, the weighted lever j^4 may be replaced by a suitable spring without in any way departing from my invention.

When the liquid under pressure from the expansion chamber first enters the valve chest b, it will be seen that all of the valves b^8 are closed. A portion of said liquid, however, passes through the pipe j^2 to the cylinder J′ and forces the plunger j^6 outwardly against the action of the weighted lever j^4. This latter is so adjusted that the maximum pressure of the liquid will move the said plunger with its piston j until the annular groove is opposite the inlet of the pipe h^2, and as a consequence, liquid is free to pass from the valve chest b through the pipe j^2, plunger j^6, pipe h^2, to the first one of the cylinders H, in which latter it acts upon the piston h so as to move it against the action of the spring h'. Such movement opens the valve b^8 opposite the vanes or buckets b', so that liquid under pressure is delivered to the same. The diameter and other proportions of this particular ring of buckets is such that the liquid delivered from its nozzle b^7 acts upon it at the highest efficiency for that particular pressure, and the said nozzle will remain open as long as the pressure remains within certain limits in the expansion chamber A. As, however, this pressure falls after the cut off of the steam takes place, the pressure on the end of the plunger j^6 is correspondingly diminished, so that the weighted lever j^4 forces this into the cylinder J′ and at the same time moves the piston j so that its annular groove communicates with the inlet of the pipe h^3. As a result, it will be seen that the pipe h^2 is put in communication with the atmosphere, so that the spring h' of the first cylinder closes the valve b^8 controlling the flow of liquid to the ring b' of buckets, and at the same time liquid is free to flow through the pipes h^3 from the cylinder J′ to the second cylinder H. The piston in this cylinder is then moved to compress its spring h' and the second valve b^8 will open, thereby delivering the liquid to the ring b^2 of buckets, which, as in the case of the first ring, is of such a diameter as to give the highest efficiency when operated by liquid at the then-existing pressure.

As the pressure in the expansion chamber continues to fall, the valves b^8 of the various remaining nozzles are successively opened and then permitted to close, so that each ring of buckets receives liquid at the pressure giving the highest efficiency for its particular diameter. It will, of course, be noted that while the expansion chamber is being filled with water, there is no flow of liquid to the prime mover B, and while there are a number of ways of providing for a continuous flow of liquid under pressure through this latter, I have shown in the present instance, in Fig. 3, a plurality of expansion chambers A′ and A² so arranged that they will operate alternately, one delivering liquid under pressure to the prime mover B while the other is taking in a supply of water to fill its expansion chamber. In order to secure this particular sequence of operations, I provide means whereby, as long as there is any fluid above a predetermined pressure in one expansion chamber, it will be practically impossible for the admission valve c' of the other to open, and one way of securing this result is to provide cylinders I and I′, respectively having plungers i and i' directly connected to the valve stems c^3 of the valves c'.

The cylinder I is connected to the upper portion of the expansion chamber A² through a pipe i^2, while the cylinder I′ is connected to the upper portion of the expansion chamber A′ by means of a pipe i^3. Consequently, if the admission valve c' of the expansion chamber A′ be open or if there be any pressure existing in said chamber, this will be exerted upon the plunger i', which will act to keep closed the valve connected to its valve stem c^3. When, however, pressure in this chamber has fallen to a predetermined point, the upward pressure of the piston in the expansion chamber A² will cause opening of its admission valve c', as previously described, and liquid under pressure will then be delivered to the prime mover B through the pipe a^{90}. In the meantime the chamber A′ is being filled with liquid until finally its piston engages the lug c^7 of the valve stem, but is prevented from opening the valve c' because of the pressure in the cylinder I. When, however, the pressure in the chamber A^3 has fallen to a predetermined point, this pressure in said cylinder I has similarly decreased so that the valve c' is shortly free to open and admit gas from the valve chest C.

It is to be noted that owing to the condensation of steam in the chamber A, a vacuum is produced capable of raising water twenty-five feet or more from the reservoir F to said chamber, and since the prime mover B may be placed with its discharge approximately at the level of the water in said reservoir, the elevation of said expansion chamber produces an additional effective head proportional to such elevation above the prime mover.

It is, of course, obvious that more than two expansion chambers could be provided to supply liquid to the prime mover; for, as above described, in order to secure their proper return it would only be necessary for the admission of steam to each chamber to be controlled by the pressure in a preceding chamber.

I claim as my invention:

1. A system consisting of a source capable of supplying liquid under a varying pressure, a prime mover comprising a shaft, a plurality of rings of buckets or vanes of different diameters carried by said shaft, with means for automatically directing the liquid from said source to different ones of said rings of vanes as its pressure varies, substantially as described.

2. A rotary prime mover having connected to it a source of fluid under a varying pressure, said prime mover including a plurality of rings of vanes or buckets of different diameters, and automatic means for supplying liquid to that ring of buckets or vanes which will give the highest efficiency at the then existing head or pressure, substantially as described.

3. In a rotary prime mover designed for operation by a fluid under varying pressure, the combination of a series of rings of buckets or vanes of different diameters, and means controlled by the pressure of the fluid for selecting the ring of buckets or vanes to which liquid is to be supplied, substantially as described.

4. In a system for developing power, the combination of a chamber for containing a body of liquid, a piston in the chamber capable of floating on the liquid therein, a liquid-operated prime mover connected to the chamber, means for supplying gas under pressure to said chamber and causing it to act on said piston therein, a device whereby the piston is caused to control such supply of gas, and pressure controlled means for governing the discharge of said liquid, substantially as described.

5. In a power generating system, a rotary prime mover constructed to be operated by fluid under varying head, and provided with a series of rings of buckets or vanes of various diameters, a valve controlling the supply of fluid to each of the rings of buckets or vanes, and a valve controlled by fluid pressure and constructed to automatically open the valve supplying fluid to that ring of buckets or vanes which will give the highest efficiency at a given pressure, substantially as described.

6. In a power generating system, the combination of a chamber having an outlet, means for admitting a liquid to said chamber, means for admitting steam against the liquid in the chamber to force the latter therefrom, and automatic means for cutting off the admission of steam and permitting the expansion of that already in the chamber, with means for condensing the steam after it has expanded, substantially as described.

7. In a power generating system, the combination of a chamber, means for admitting liquid to said chamber, means for admitting steam against said liquid to force the latter from said chamber, automatic means for cutting off the supply of steam and permitting the expansion of that already admitted, a hydraulic motor connected to be operated by the liquid forced from said chamber, and automatic means for causing the motor to operate at a substantially constant angular velocity in spite of the reduction of pressure due to the expansion of said steam, substantially as described.

8. The combination of a prime mover consisting of a series of rings of buckets or vanes, a nozzle and a valve for each ring, means for operating the valves, a master valve for controlling the operation of said valves, means for supplying fluid under varying pressure to said nozzles, and means for operating the master valve to cause it to permit successive opening of the nozzle valves as the pressure varies, substantially as described.

9. A system including a chamber, means for supplying gas or vapor under pressure thereto, a prime mover, means for supplying liquid to the chamber, means for automatically cutting off the supply of gas or vapor after a predetermined amount of the same has been admitted to the chamber, with means for automatically controlling the flow of liquid to said prime mover, said latter means having an actuating device independent of the cutting off means and being arranged to act between the chamber and the prime mover, substantially as described.

10. A system including a chamber connected respectively to sources of supply of gas or vapor under pressure and liquid, a fluid motor also connected to the chamber, a device for automatically admitting gas or vapor to the chamber when this is full of liquid, said device being provided with means

for cutting off said admission of gas or vapor after a definite amount of liquid has been discharged from the chamber, and pressure-controlled means for governing the flow of liquid from the chamber to the prime mover, substantially as described.

11. The combination of a chamber connected to sources of supply for gas or vapor under pressure and liquid respectively, a free piston within the chamber, a gas admission valve placed to be opened by said piston when a predetermined amount of liquid has entered the chamber, means for holding said valve open, means for automatically causing closing of the valve when a predetermined amount of liquid has been discharged from the chamber, with means for controlling such discharge of liquid, and a motor connected to be actuated by the discharged liquid, substantially as described.

12. The combination of a chamber, sources of supply of steam and water respectively connected thereto, a steam admission valve, a piston in the chamber for opening said valve, mechanism for causing closing of the valve when a predetermined amount of liquid has been discharged from the chamber, means for controlling such discharge of liquid, and means for condensing the steam in the chamber, with a motor connected to be actuated by the discharged liquid, substantially as described.

13. The combination of a chamber connected to sources of supply of gas under pressure and liquid respectively, means controlling the inlet of said gas, a discharge pipe for the chamber, a valve in the same, and two pistons operative on said valve, cylinders for the pistons, one of said cylinders being connected to the chamber, substantially as described.

14. The combination of means for supplying liquid under varying pressure, a prime mover having a series of rings of vanes of different diameters, a valve chest connected to said source having means for directing liquid to the various rings, a fluid operated valve for each ring of vanes, and pressure controlled means for causing liquid to be delivered to a ring of large diameter when the pressure of said liquid is high and successively to rings of smaller diameter as the pressure decreases, substantially as described.

15. The combination with a source for supplying liquid under varying pressure, of a rotary motor having rings of buckets of different diameters, and automatic pressure controlled means for directing liquid to a large diameter ring when its pressure is high, and to rings of smaller diameter when its pressure diminishes, substantially as described.

16. The combination with a source for supplying liquid under varying pressure, of a prime mover having rings of vanes of different diameters, a valve controlled nozzle for each ring, and means for controlling said valve for the nozzles including a plunger, a cylinder therefor connected to said liquid source, means tending to move said plunger against the pressure of the liquid in the cylinder, a valve operated by said plunger, and cylinders for operating the nozzle valves respectively connected to said plunger controlled valve, substantially as described.

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

ARTHUR C. EASTWOOD.

Witnesses:

WILLIAM E. BRADLEY

JOS. H. KLEIN.