No. 671,674. Patented Apr. 9, 1901.

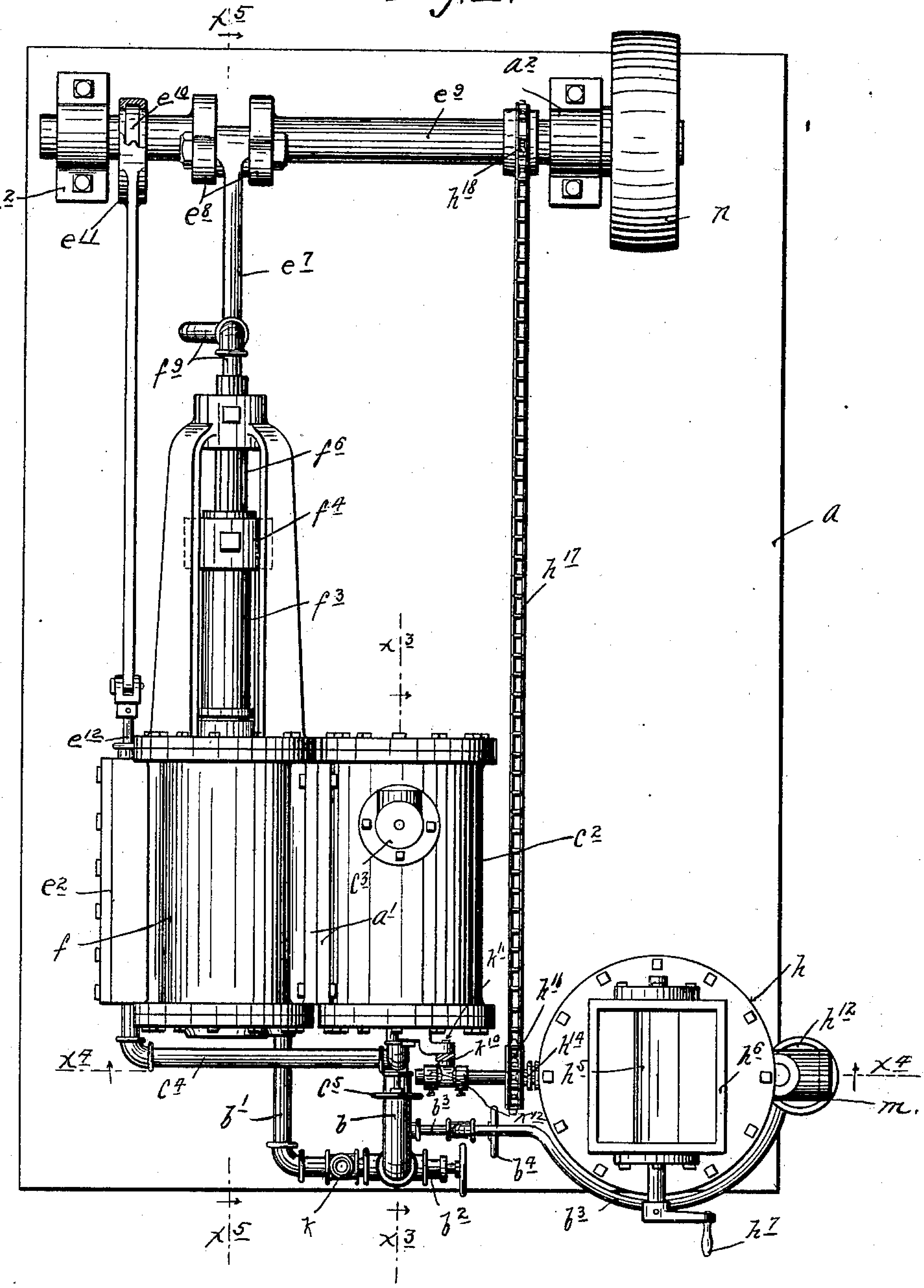
W. L. JUDSON.

APPARATUS FOR GENERATING AND UTILIZING ELASTIC FLUIDS.

(Application filed Nov. 14, 1899.)

(No Model.) 5 Sheets—Sheet 1.

Fig. 1.



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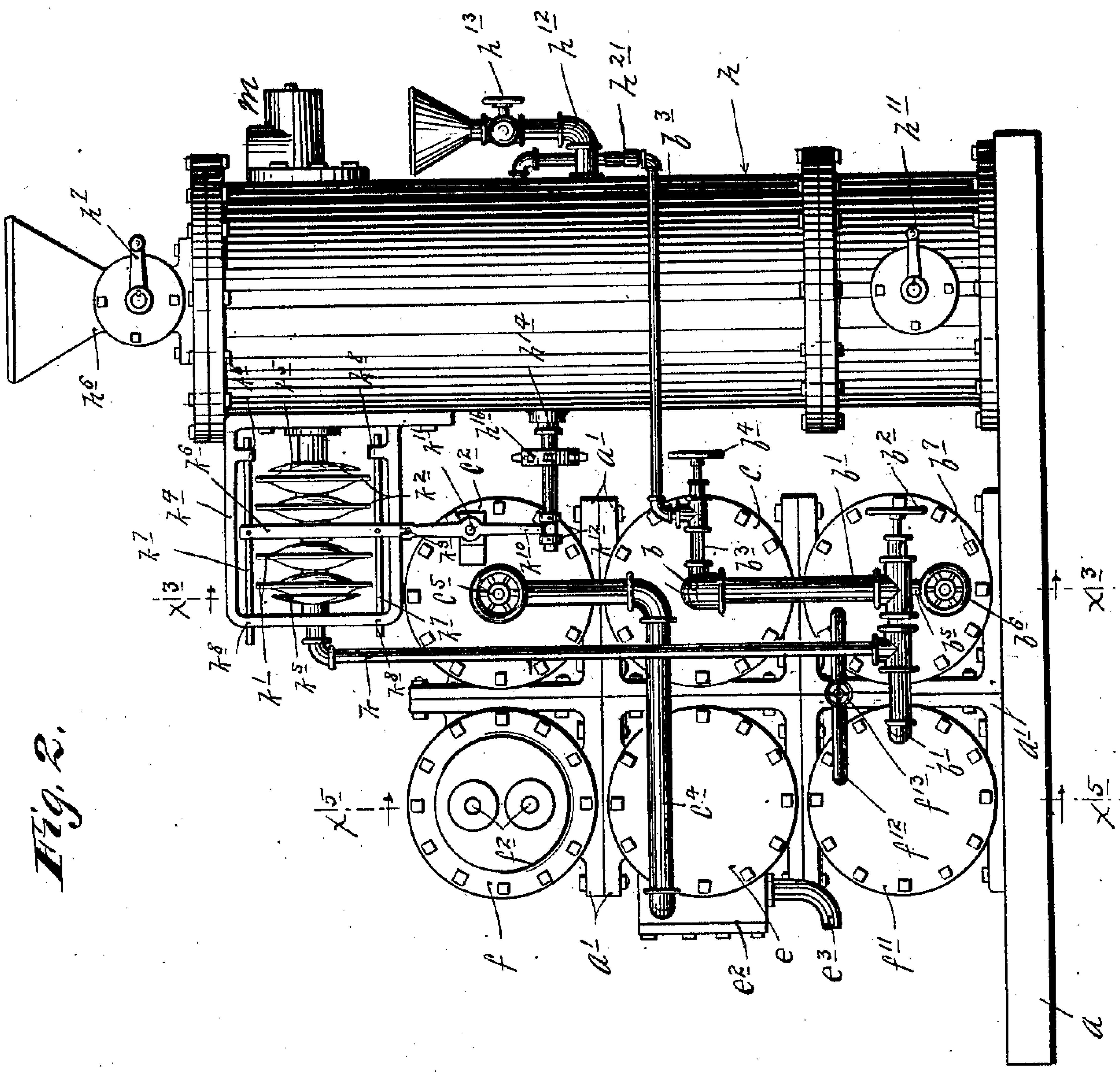

Fig. 2.

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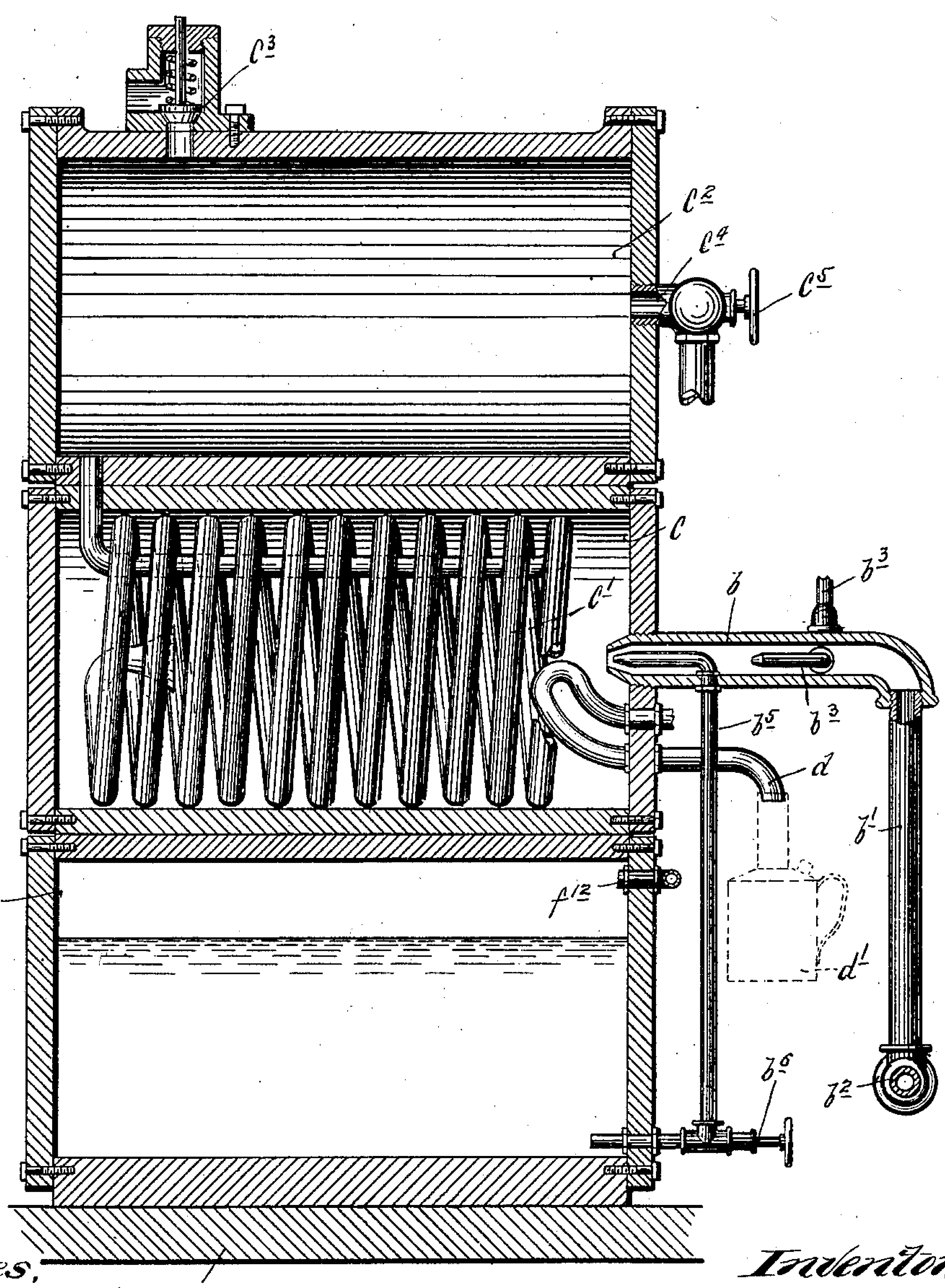
5 Sheets—Sheet 3.

Fig. 3.



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5 Sheets—Sheet 4.

Fig. 4.

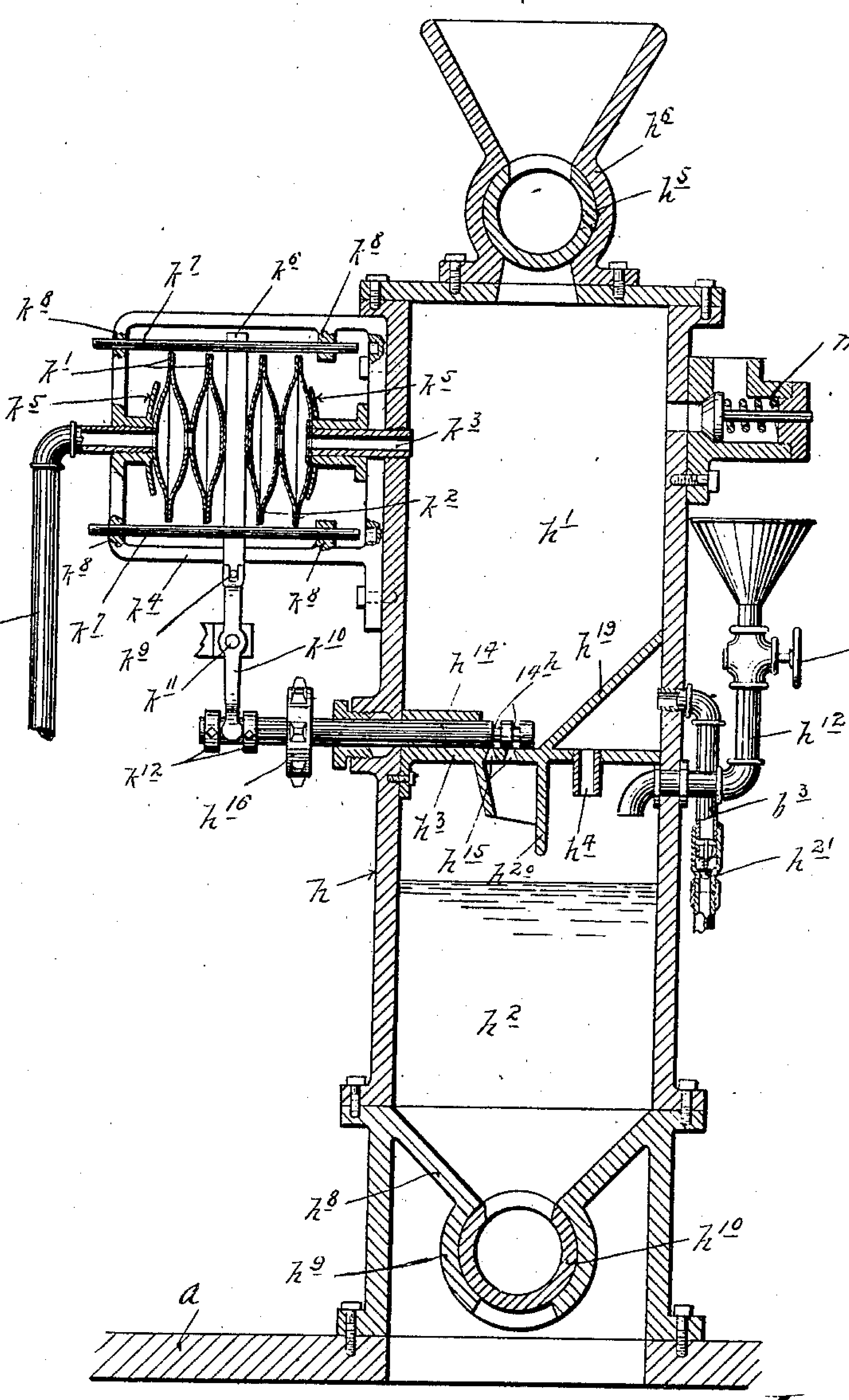

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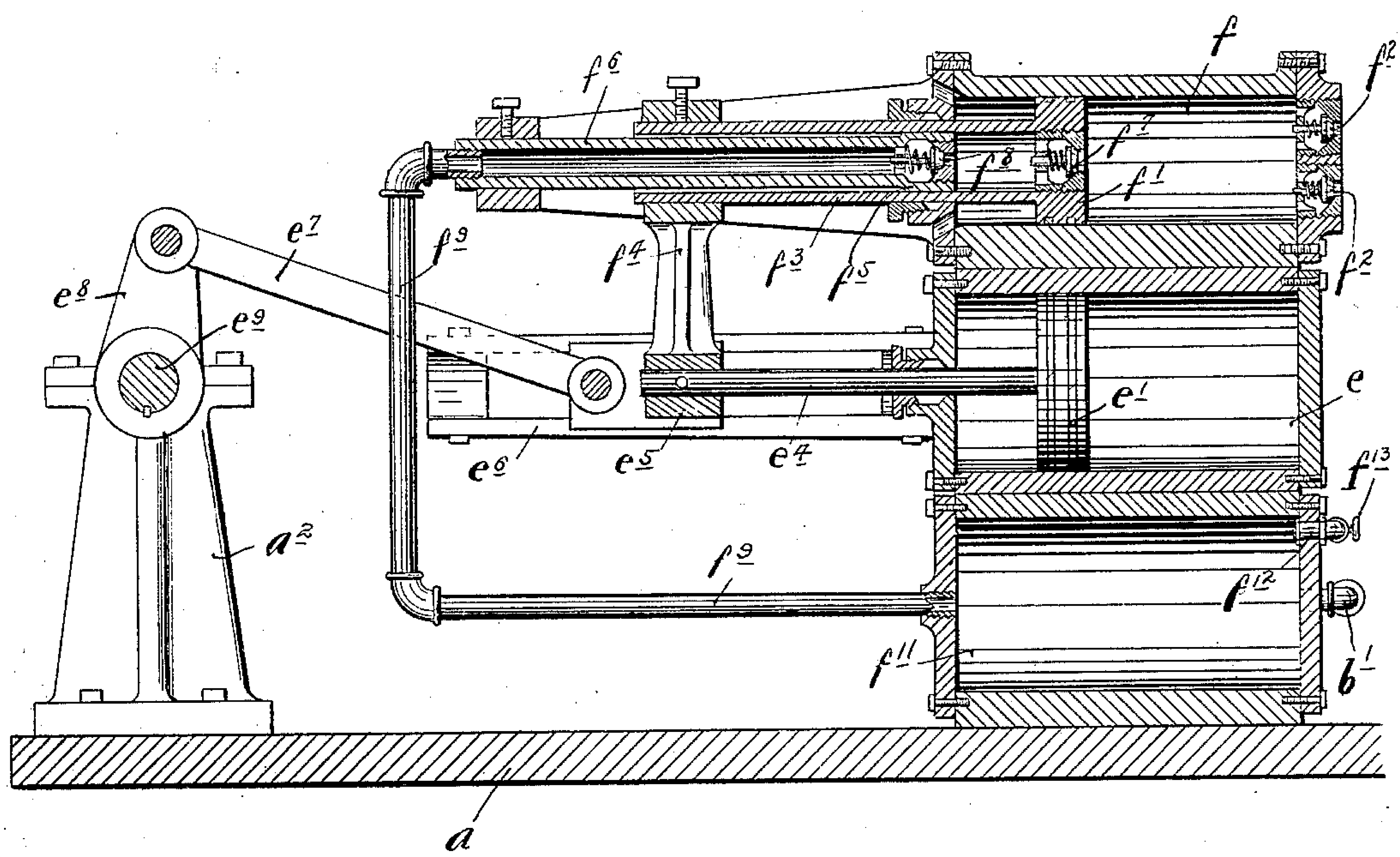
Fig. 5.



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UNITED STATES PATENT OFFICE.

WHITCOMB L. JUDSON, OF CHICAGO, ILLINOIS.

APPARATUS FOR GENERATING AND UTILIZING ELASTIC FLUIDS.

SPECIFICATION forming part of Letters Patent No. 671,674, dated April 9, 1901.

Application filed November 14, 1899. Serial No. 736,991. (No model.)

To all whom it may concern:

Be it known that I, WHITCOMB L. JUDSON, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Apparatus for Generating and Utilizing Elastic Fluids; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention has for its object to provide an improved apparatus for generating and utilizing elastic fluids as a motive power under a continuous process.

To this end my invention consists of the novel devices and combinations of devices hereinafter described, and defined in the claims.

The invention is illustrated in the accompanying drawings, wherein like notations refer to like parts throughout the several views.

Figure 1 is a plan view of the apparatus. Fig. 2 is an end elevation of the same. Fig. 3 is a view in vertical section through a part of the apparatus, showing the closed combustion-chamber, the liquid-fuel burner, and some of the other parts, with some portions broken away and others removed, on the line x^3 x^3 of Figs. 1 and 2. Fig. 4 is a vertical section on the line x^4 x^4 of Fig. 1, showing the acetylene-gas generator, the controller, &c.; and Fig. 5 is a view in vertical section on the line x^5 x^5 of Figs. 1 and 2, showing the compressor, &c.

A series of six cylinders constituting elements of the apparatus are shown as provided with brackets a', adapted to abut with each other in the horizontal and vertical planes to afford a double tier of three rack-sections and cylinders, and when these rack-sections are securely bolted or otherwise fastened together and to a bed-plate a, extending under the entire apparatus, they constitute a rigid frame or support for the said cylinders. One of these cylinders—to wit, the central member in Fig. 3 of the drawings—is used as a closed combustion-chamber c and is in communication through a coil c' with the cylinder c^2, located directly over the same and which serves as a collecting-chamber for the elastic fluids generated within the combustion-chamber c, as will presently more fully appear. A burner b, adapted to burn a liquid fuel, such as commingled air and gas or oil, taps the combustion-chamber c, as best shown in Fig. 3. The commingling-chamber of said burner b is shown as tapped by an air-supply pipe b', equipped with a controlling-valve b^2. Said burner b is also tapped by a gas-supply pipe b^3, equipped with a suitable controlling-valve b^4, which is preferably of needle-like form. Said air-supply pipe b' and said gas-supply pipe b^3 lead from suitable sources of supply or storage, from which or through which the air and gas are supplied to the burner b under pressure. The orifices or diameters of the air and gas supply pipes are of the proper relative sizes to afford a supply of the said two elements in volumes of the proper relative proportions for the complete combustion of the air and gas by the burner. The said burner b is also tapped by a water-supply pipe b^5, which, as shown, leads from the lowermost member of the right-hand stack of cylinders, as shown in Fig. 2, and which is utilized as a water-storage receptacle b^7, wherein a supply of water is contained under pressure. The water-supply pipe b^5 is provided with a suitable controlling-valve b^6. A suitable igniter d is provided, which is shown as of loop-like form having its outer or open ends outside the shell of the combustion-chamber c and the crown of its loop in position to be struck or impinged upon by the inrushing gas and air from the burner-tip. One end of the igniter-tube d is shown as broken off. This end may be extended to any suitable point where it would open to the atmosphere. This loop d is in the form of a hollow tube and is adapted to the use of an ordinary plumber's blowpipe-lamp d' for heating the loop sufficiently to ignite the commingled air and gas when starting the apparatus.

From the statements already made it must be obvious that the commingled air and gas will be burned under pressure within the combustion-chamber c in the presence of water in a finely-divided condition forced therein under pressure in the form of a spray. Hence the intense heat from the burning gases will evaporate the water into steam more or less completely at and near the burner. The coil c' within the combustion-chamber is arranged with its axis substantially in line with the axis of the burner-tip, and said coil has its receiving end, which is preferably of bell-mouthed shape, at a point most remote from the burner-tip and in line therewith. The discharge end or extension from the coil c' taps the accumulating or collecting-chamber c^2. Hence the burning gases, steam, vapor, and particles of water, if any be left, will enter the open mouth of the coil c' and while traversing the length of the coil will be continuously subjected to the heat from the burning gases surrounding the coil. Hence in this part of the necessary travel for the fluids all the water will be converted into steam and, together with the other gases commingled therewith, will be superheated before reaching the collecting-chamber c^2. The collecting-chamber c^2 is provided with a suitable safety-valve c^3 and is tapped by a service-pipe c^4, equipped with a controlling throttle-valve c^5. As shown, the service-pipe c^4 leads to the valve-chest e^2 of an ordinary straight-line slide-valve reciprocating engine. The cylinder e of this engine is, as shown, the central member of the left-hand tier of cylinders. (Illustrated in Fig. 2 of the drawings.) The exhaust-pipe for the engine is shown at e^3 in Fig. 2. The engine-cylinder e is fitted with a suitable piston e', with rod e^4, connecting with cross-head e^5, mounted to reciprocate in suitable guides e^6, as best shown in Fig. 5. The cross-head e^5 is connected by rod e^7 with the crank e^8 on the shaft e^9 in the ordinary way. The shaft e^9 is supported in suitable bearing-pedestals a^2, rising from the bed-plate a and rigidly secured thereto. The slide-valve of the engine receives the proper motions for the distribution of the fluid to the engine-cylinder from a suitable valve-gear, such as a simple eccentric-gear or a gear of the ordinary link type. As shown, a simple eccentric-gear is employed, consisting of an eccentric e^{10} on the engine-shaft e^9 and an eccentric-strap e^{11}, working on said eccentric and connected to the valve-stem e^{12} of the engine distribution-valve, (not shown, but which works in the steam-chest e^2 in the ordinary manner.)

The cylinder f, located directly above the engine-cylinder e, is utilized as the main cylinder of an air-compressor. (Best shown in Fig. 5.) Said cylinder f is of course held in a fixed position with the construction already noted and is provided with suitable intake-valves f^2. Said cylinder f is fitted with a movable piston f', having a hollow rod f^3, which is taken hold of at its outer end by an arm f^4, projecting radially from the cross-head e^5 of the engine and rigidly secured both to said cross-head e^5 and said piston-rod f^3. Hence the piston f' will receive reciprocating motion from the cross-head e^5 of the engine. Said hollow piston-rod f^3 is fitted with a fixed piston f^5, having a hollow rod f^6, which forms a section of the delivery-pipe from the compressor. The movable hollow piston-rod f^3 forms the secondary cylinder or compression-chamber of the compressor and is provided with a transmitting-valve f^7 for receiving the air from the primary or main cylinder f. The fixed piston f^5 is provided with a suitable delivery-valve f^8. Hence under the action of the parts marked f to f^8, inclusive, and just hereinbefore noted it is obvious that the outer movement of the piston f' will draw the air into the cylinder f, that the return stroke of the piston f' will compress the air and force the same through the transmitting-valve f^7 into the secondary cylinder formed by the hollow piston-rod f^3, and that on the outward stroke of the piston f' the air previously caged within the hollow piston-rod f^3 will be compressed and forced out through the delivery-valve f^8 of the fixed piston f^5 through its hollow rod f^6 into the delivery-pipe from the compressor. The parts of this compressor may of course be so proportioned that the load will be the same in both directions of the piston's travel. The delivery-pipe f^9 from the compressor extends to the air-storage cylinder f^{11}, which, as shown, is located directly below the engine-cylinder e and side by side with the water-cylinder b^7. The said air-cylinder f^{11} and said water-cylinder b^7 are connected at their upper zones by a pipe f^{12}, having a valve f^{13}, which pipe serves to render the air-pressure available on the top of the water, thereby equalizing the pressures in the air and water cylinders. The water-supply pipe b^5 taps the water-cylinder b^7, and its delivery-nozzle is located at the most innermost position within the commingling-chamber of the burner b, or, otherwise stated, the air and gas are first commingled and then made to move past the tip of the water-nozzle, and hence an injector action is produced. With this construction and relation of the parts it is obvious that the air-pressure on the top of the water will constitute a force feed for the same in case the pressure within the combustion-chamber c is less than the air-pressure on top of the water; but even if the pressure within the combustion-chamber c should rise to a balance with the air-pressure the induction or ejector action of the commingled air and gas on the water-delivery nozzle at the burner will be sufficient to insure the feed of the water.

For the supply of the gas which is to be commingled with the air at the burner an acetylene-gas generator is illustrated, and this acetylene-generator is shown as of suitable form for effecting the generation by feeding pulverized carbid to the water. By reference to Figs. 2 and 4 of the drawings it will be seen that a suitable casing h is divided into an upper carbid-chamber h' and a lower or water chamber h^2 by a horizontal partition h^3. Said partition h^3 is not gas-tight, but is provided with one or more perforations h^4 for rendering the pressure equal in all parts of the generator. Said generator is provided at its upper end with a suitable charging-valve

h^5, having a casing h^6 with hopper-like mouth, and this valve h^5 is of the hollow rotary type and is provided with a handle h^7 outside the casing for manipulating the valve. With this form of valve-casing the carbid can be introduced into the chamber h' through the cap of the same without permitting the escape of the gas. In a similar manner the water-chamber is provided with a hopper-like bottom h^8, terminating in a valve-casing h^9, fitted to the corresponding rotary valve h^{10}, having a handle h^{11} for removing the slaked carbid or debris from the bottom of the water-chamber without permitting the escape of the gas. The water-chamber h^2 is shown as provided with a charging-pipe h^{12}, with funnel-mouth and equipped with a hand-valve h^{13}.

A feed-shaft h^{14} is mounted in a suitable bearing, with its outer end projecting beyond one of the side walls of the casing h and with its inner or screw-threaded end located directly over a pair of ports or passages h^{15}, formed in the partition h^3. The grooves of the feed-shaft are square in cross-section. The shaft h^{14} is provided with a sprocket h^{16}, which is engaged by a chain h^{17}, working over a sprocket h^{18} on the engine-shaft e^9, as best shown in Fig. 1. The top of the grooved part of the feed-shaft h^{14} is exposed to the carbid, and a deflecting-plate h^{19} is shown in the carbid-chamber for directing the carbid to the grooves of the feed-shaft. The partition h^{19} is not gas-tight and may extend less than completely across the chamber h'. The ports h^{15} in the partition h^3 are of less length than the diameter of the shaft. They should extend about one-fourth the diameter of the said shaft. With this construction it is obvious that if the feed-shaft h^{14} be moved lengthwise in its bearing the annular flanges between the grooves 14^h of the same may be made either to entirely cover and close the ports h^{15} or to expose a greater or less portion of said ports to the said grooves 14^h. Hence by moving the feeding-shaft h^{14} the feed of the carbid may be either entirely cut off or be graduated, as desired. The grooves 14^h are preferably corrugated or roughened, so as to produce a forced feed of the carbid. The rotation thereof causes a frictional engagement with the carbid and forces the same downward. When once set, it is of course obvious that under the rotary motion thereof the feed from the shaft h^{14} will be uniform until the shaft is again moved lengthwise. A splash-guard h^{20} protects the water from working back to the carbid-chamber.

The gas-supply b^3, hitherto noted as tapping the burner, connects with the acetylene-gas generator for affording the supply of gas. This gas-supply pipe b^3 is shown as equipped with a check-valve h^{21} near the generator.

It is of course obvious that the air and gas should be delivered to the commingling-chamber of the burner at equal pressures. To accomplish this result, I provide an automatic controller, which is subject to the air-pressure on the one side and to the gas-pressure on the other for movement in opposite directions and is itself provided with connections to the feed-screw h^{14} for shifting the same to stop or vary the feed of the carbid, and thereby the generation of gas from the acetylene-generator, until the pressures are equalized. Water may be supplied to the cylinder b^7 by any ordinary or suitable means. (Not shown.) As shown, this controller is in the form of a double bellows-diaphragm, two of which (marked k') are subject to the air-pressure through a pipe k, which leads from the storage-cylinder f^{11}, tapping the pipe b', and the other two of which (marked k^2) are subject to the gas-pressure through the pipe k^3, which taps the upper chamber h' of the acetylene-generator. This bellows-diaphragm is mounted in a suitable framework k^4. The outer leaf of each outer member of the two pairs of diaphragms is anchored to a suitable fixed base-plate k^5. This permits the other leaves of each pair of diaphragms to be free for movement under the expansion of the diaphragms from the air or gas. A bar k^6 extends between the innermost members of each pair of the diaphragms k' and k^2 and takes hold of a pair of parallel rods k^7, which extend through suitable guides k^8 in the framework k^4. These parts k^6 and k^7 constitute a cross-head, which is subject to the action of the two pairs of diaphragms for reciprocating the same in opposite directions. The rod k^6 has slot-and-pin connection, as shown at k^9, with the upper end of a shipper-lever k^{10}, which is centrally pivoted to some fixed support by a pin k^{11}. The fork end of the shipper-lever k^{10} works between collars k^{12}, fixed to the outer end of the feed-shaft h^{14}. With this construction it is obvious that the movement of the cross-head k^6 k^7 under the action of the diaphragms k' k^2 will rock the shipper-lever k^{10}, and thereby slide the feed-shaft h^{14} lengthwise in its bearing. Hence if the acetylene gas is being too rapidly generated, so as to give an excessive gas-pressure beyond the air-pressure at the points of delivery to the burner, the pair of diaphragms k^2, subject to the gas-pressure from the acetylene-generator, will move the cross-head k^6 k^7 toward the left with respect to Fig. 4, thereby moving the feed-shaft h^{14} inward to cut off or decrease the feed of the carbid. As quickly as the pressures have been equalized at the burner the air-diaphragms k', subject to the air-pressure, will return the cross-head k^6 k^7 to its midway or balanced position, thereby, through the shipper-lever k^{10} throwing the feed-shaft h^{14} outward to afford the normal feed of carbid. The acetylene-generator is provided with a suitable safety-valve z.

The parts of the apparatus illustrated have now been specified, and the action of the different groups of parts is probably clear from the detailed description. It may be of service, however, to give a brief summary of the general operation of the apparatus as an entirety.

With the apparatus as illustrated it is assumed that the throttle-valve c^5 for the engine will be under the constant charge of an attendant, in the same way as an ordinary locomotive, for adapting the elastic-fluid supply to the load on the engine. To start the apparatus into action, the acetylene-generator may be started in the ordinary or any suitable way to afford the gas-supply. The air-pressure for starting may be secured either by manipulating the engine by hand or by the use of a hand-pump in the same way as many gas-engines. The air and gas at the burner having been ignited with the use of the plumber's blowpipe-lamp, the operation will then be continuous as soon as the engine is started into action by opening the throttle c^5 in the engine-supply pipe. The engine then of course operates the compressor, and the latter affords the continuous supply of air to the air-cylinder and through the same to the burner and through the cross-pipe f^{12} to the water in the water-cylinder. The acetylene-generator supplies the gas, and under the action of the diaphragm-controller the generation of the acetylene gas is so regulated that the gas and the air are delivered to the burner at equal pressures. Assuming the delivery pipes and nozzles for the air and gas to have been properly proportioned, it follows that the air and gas will be delivered to the burner in the proper relative volume for complete combustion. For example, when using acetylene gas the air should be at least fourteen times as much in volume as the gas. The air-pressures on the water and the injector action from the commingled air and gas under pressure on the water-delivery nozzle insure the feed of the water to the combustion-chamber c, as hitherto noted.

Of course it will be understood that many changes might be made in the details of the construction disclosed without departing from the spirit of my invention. It will be further understood that the parts when the apparatus is put into use should be properly proportioned for coöperation to the ends desired. No attempt has been made to give the exact mathematical proportions in the accompanying drawings, as those are matters within the skill of the engineering craft. It will be further understood that in practice an automatic governor would preferably be provided for the engine.

What I claim, and desire to secure by Letters Patent of the United States, is as follows:

1. The combination with a commingling-chamber, of supply devices for delivering air and gas, under pressure, to said commingling-chamber, and a controller subject to said air and gas pressure for movement in opposite directions, and provided with connections for varying the supply of one of said elements with respect to the other, for equalizing the pressures of the air and gas at the point of delivery to said commingling-chamber, substantially as described.

2. The combination with a commingling-chamber, of an air-supply device and a gas-generator for delivering air and gas, under pressure, to said commingling-chamber, and a controller subject to the air-pressure for movement in one direction and to the pressure of gas from said generator for movement in the other direction, and connections operative by said controller for varying the quantity of gas generated, whereby the pressures of the air and gas will be automatically equalized at the point of delivery to said commingling-chamber, substantially as described.

3. The combination with a closed combustion-chamber, of a burner adapted to burn a liquid fuel in said chamber, such as commingled air and gas, independent air and gas supply devices for delivering air and gas, under pressure, to the commingling-chamber of said burner, and a controller subject to said air and gas pressure, for movement in opposite directions, to vary the supply of one of said elements (air or gas) in respect to the other, for equalizing the pressures of air and gas, at the point of delivery to the commingling-chamber of the burner, substantially as described.

4. The combination with a commingling-chamber, of supply devices having delivery tips or nozzles, tapping said commingling-chamber of the proper areas for the desired relative proportions of air and gas, and a controller subject to said air and gas pressures, for movement in opposite directions, to equalize the pressures at the points of delivery to the delivery-chamber, and thereby maintain the proper proportions of the elements to be commingled, substantially as described.

5. The combination with an engine, of a closed combustion-chamber wherein the elastic fluids are generated to supply the engine, a burner adapted to burn liquid fuel, such as commingled air and gas, an air-compressor operative by said engine and affording a supply of air, under pressure, to said burner, a gas-generator affording a supply of gas, under pressure, to said burner, and a controller subject to the air-pressure on one side and to the gas-pressure on the other, and provided with connections for varying the generation of gas, whereby the air and gas will be delivered to the commingling-chamber of the burner at equalized pressures and in the proper proportions, and the apparatus will run under a continuous process, when the engine is in action, substantially as described.

6. The combination with the burner and devices for supplying air, under pressure, thereto, of the gas-generator adapted to generate a gas by the chemical reaction between solid and liquid gas-producing substances, such as calcium carbid and water, a controller subject to said air-pressure on one side and subject to the gas-pressure from said

gas-generator on the other side, and a feed device operated by said controller for bringing said solid and liquid elements into contact with each other in the gas-generator, substantially as and for the purposes set forth.

7. The combination with an engine, of a closed combustion-chamber, wherein the elastic fluids are generated to supply said engine, a burner adapted to burn a liquid fuel in said combustion-chamber, such as air and gas, under pressure, an air-compressor driven from said engine, for supplying air to said burner, an acetylene-gas generator, for supplying gas to said burner, a feed device in said generator operated from said engine-shaft to afford a continuous, uniform feed as set, a controller subject to said air-pressure on one side and to said gas-pressure on the other side, and connections from said controller to said feed device of said gas-generator, operative to variably set the same to vary the quantity of feed or stop the feed, as may be required to equalize the air and gas pressures at the burner, substantially as described.

8. The combination with the engine, the closed combustion-chamber, the liquid-fuel burner, the engine, the compressor driven from the engine and supplying air to the burner, and the gas-generator supplying gas to the burner, of the controller for equalizing air and gas pressures at the burner, which controller is in the form of a diaphragm subject on one side to the air-pressure and on the other to the gas-pressure and provided with connections for controlling the generation of the gas, substantially as described.

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

WHITCOMB L. JUDSON.

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