No. 673,774. Patented May 7, 1901.

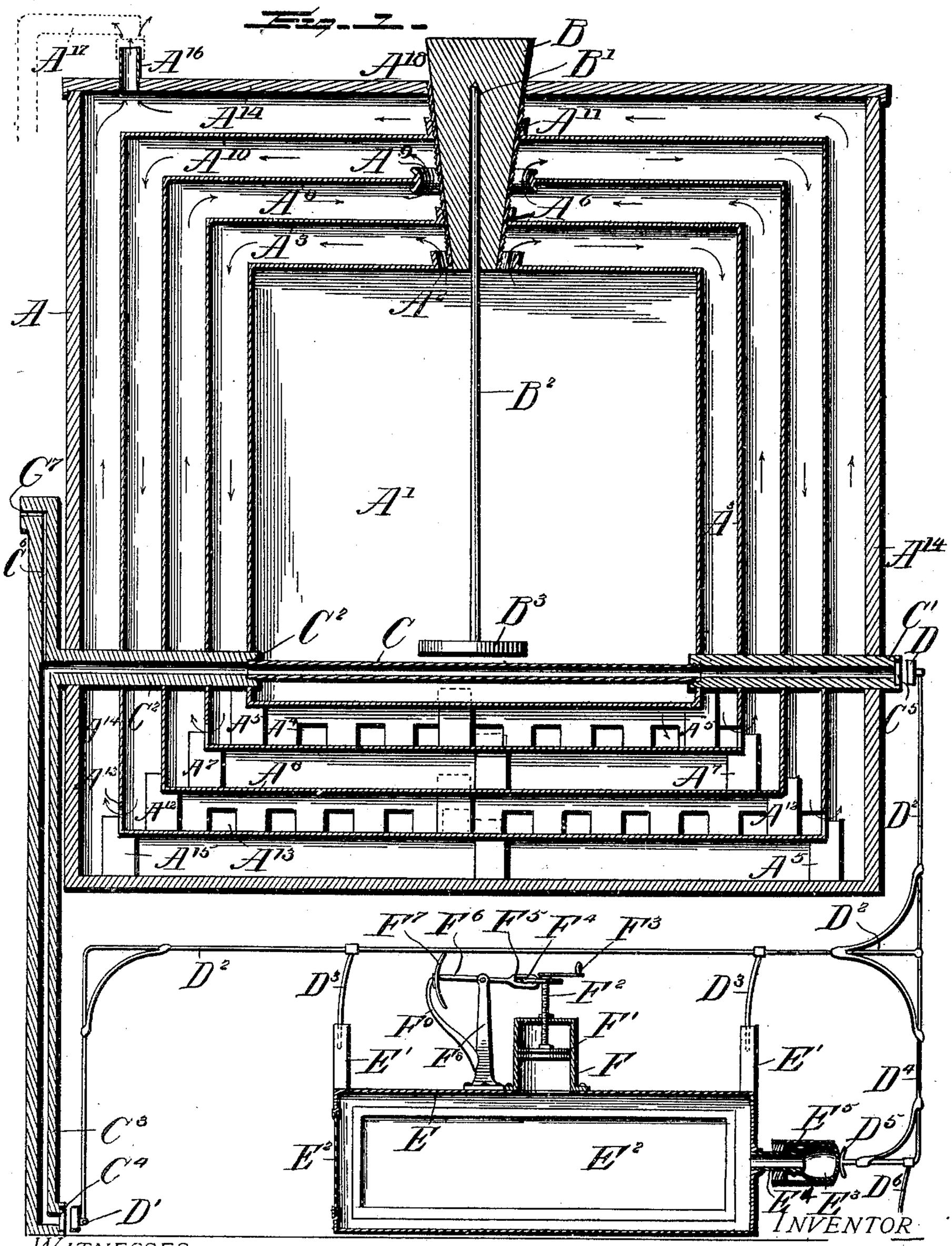
T. J. HATHAWAY.

LIQUID AIR APPARATUS.

(Application filed July 20, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.



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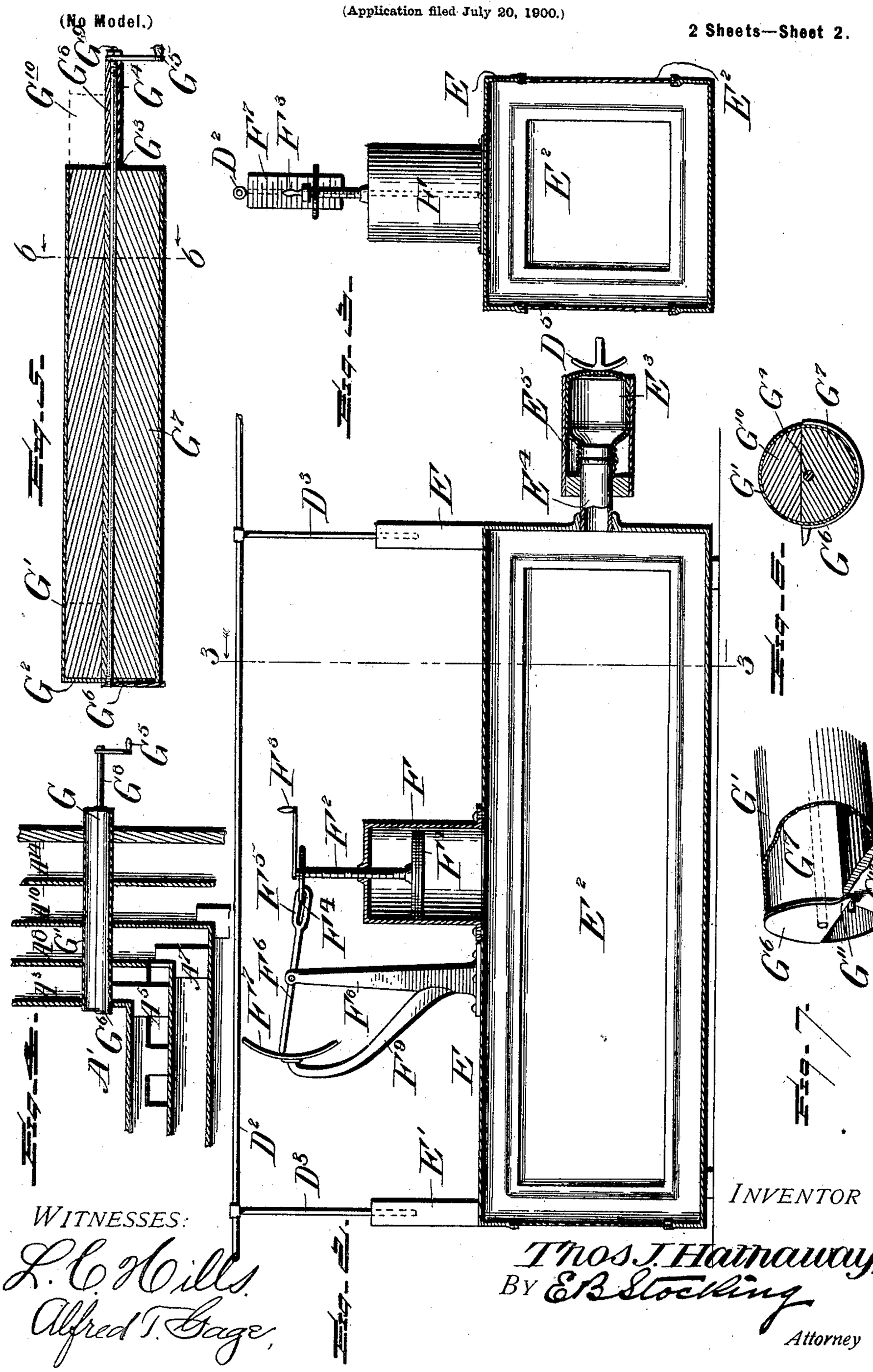

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

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UNITED STATES PATENT OFFICE.

THOMAS J. HATHAWAY, OF GULFVIEW, MISSISSIPPI, ASSIGNOR OF ONE-HALF TO LINCOLN H. CLEVENGER, OF SAME PLACE.

LIQUID-AIR APPARATUS.

SPECIFICATION forming part of Letters Patent No. 673,774, dated May 7, 1901.

Application filed July 20, 1900. Serial No. 24,254. (No model.)

To all whom it may concern:

Be it known that I, THOMAS J. HATHAWAY, a citizen of the United States, residing at Gulfview, in the county of Hancock, State of Mississippi, have invented certain new and useful Improvements in Liquid-Air Apparatus, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to liquid-air apparatuses, and particularly to a receptacle for the storage and distribution of liquefied air or other substances or the control of the evaporation thereof for refrigerating or cooling purposes.

The invention has for one object to provide a receptacle which will insure the minimum evaporation of the liquid therein and also to permit the withdrawal of such liquid from the receptacle or control and effect the evaporation of the liquid within the receptacle by raising the temperature thereof.

A further object of the invention is to provide regulating means coöperating with the receptacle for the purpose of admitting thereinto air of a normal atmospheric temperature to effect an evaporation of the liquefied air and also devices for controlling the operation of said regulator to insure a predetermined temperature in any desired apartment or room.

A further object of the invention is to provide a regulating-chamber in which a body of expansive fluid or liquid will be affected by the temperature of the compartment within which the regulator is located to actuate valve mechanism for the purpose of permitting the evaporation of liquefied air and the consequent cooling of the compartment.

Other objects and advantages of the invention will hereinafter appear in the following description, and the novel features thereof will be particularly pointed out in the appended claims.

In the drawings, Figure 1 represents a vertical cross-section through the receptacle and the regulator which coöperates therewith. Fig. 2 is a longitudinal section through the regulator. Fig. 3 is a vertical section through the regulator on line 3 3 of Fig. 2. Fig. 4 is a detail vertical section showing the application of a plug when the regulating device is disconnected from the receptacle. Fig. 5 is a longitudinal section of this plug. Fig. 6 is a vertical section on the line 6 6 of Fig. 5, and Fig. 7 is a detail perspective of the inner end of the plug.

Like letters of reference indicate like parts throughout the several figures of the drawings.

The letter A designates the receptacle adapted to contain the liquid air, which may be of any desired shape or configuration and within which there is centrally disposed the tank A′, in which the liquid air is contained. This tank is provided with an opening A^2 at its upper portion and is surrounded by a shell or case A^3, provided at its lower portion with openings or apertures A^4, which permit the evaporated liquid to pass around the outside of the walls of the tank A′, which is supported within the shell A^3 and spaced therefrom by means of blocks or seats A^5. The shell A^3 is closed at its upper portion above the opening A^2 from the tank A by means of a threaded flange engaging with a tubular sleeve forming the inlet to the tank, thus effecting a tight joint A^6. This arrangement of channels for the conveyance of the evaporated liquid around the main tank may be multiplied to any desired extent—for instance, as shown in Fig. 1, wherein the shell A^3 is in turn supported upon seats A^7, carried by a larger shell A^8, which shell is provided at its upper portion with an outlet-opening A^9, discharging into a space formed between the same and a corresponding larger shell A^{10}. The shell A^{10} is closed at its upper portion by means of a tight joint A^{11}, similar to the joint A^6, and is provided at its lower portion with seats A^{12} for supporting the shell A^8 and discharge-openings A^{13}, which permit the escape of evaporated liquid or air into a space extending between the shell A^{10} and the casing A^{14}. The shell is also spaced from this casing by means of seats A^{15}, and the casing is provided at its upper portion with an outlet or vent A^{16}, from which the evaporated substance may be conducted to any desired point for use in cooling or other purposes by means of a pipe-line A^{17}, as shown by dotted lines. The casing is provided with

a tight joint A^{18} at its point of connection with the tubular inlet. This inlet is designed to be normally closed by means of a plug B, of any desired non-conducting material, which is provided with a recess B′ to permit the reception of the graduated stem B^2, extending from the float B^3, located within the tank A′ containing the liquid A. It will be obvious that if this plug be removed the graduated stem B^2 will rise to such an extent as to indicate the quantity of liquid remaining within the tank, and when the plug is inserted the stem enters the socket therein and the float is depressed within the liquid and there held until the plug is again removed. The several parts of the tank, shells, and casing may be of any desired material, as the primary object thereof is to prevent the evaporation of the liquid within the tank A′ by reason of the temperature of the atmosphere surrounding the receptacle, and for that purpose non-conducting materials or packings found necessary, as is common in the art of refrigeration, may be dispensed with and the heat counteracted by the expanding air.

The several parts of the receptacle heretofore described only permit a very slight evaporation of the liquid, as the surrounding air-chambers filled with the evaporated liquid prevent the temperature of the atmosphere from affecting the main body; but it is found desirable to provide the vent or outlet A^{16} in order to prevent any damage to the apparatus from the continued expansion which will always occur when a liquid of very low temperature, such as liquefied air, is stored within the receptacle. For the purpose of insuring a more rapid evaporation of this liquid, and thus effecting the cooling of a compartment to a greater extent, a warm-air tube C is inserted in the lower portion of the tank A′ and is connected with the sides of the casing by means of an inlet-tube C′, of suitable non-conducting material, and a similar outlet-tube C^2 at the opposite side, by means of which a circulation of air at the temperature of the surrounding atmosphere is effected through the body of the liquefied air, thus causing an expansion and evaporation thereof. The outlet-tube C^2 is extended in any desired manner—for instance, with a downward arm C^3, provided at its lower end with a valve-seat C^4, while the inlet-tube is provided with a similar seat C^5, which seats when closed prevent the entrance of the air at the temperature of the compartment into the tube C. In connection with this air-circulating device a supply-tube C^6 is provided, which has a small opening C^7 extending to the aperture of the circulating-pipes in order to supply air at the temperature of the atmosphere for counteracting the contraction within the pipes C, C′, and C^2, and thus permit the ready operation of the valves controlling these pipes. It will be observed that if this contraction occurs when the valves are closed, a partial vacuum will be effected and prevent the operation of the valves by the ordinary mechanism.

The valves for controlling the warm-air-circulating pipes hereinbefore described may be of any desired structure or configuration and for the purpose of illustration are shown in Fig. 1 with a valve D to control the inlet-pipe C′ and a valve D′ to control the outlet from the pipe C^3. These valves are carried by a framework of any suitable construction—for instance, of light wire or similar material, as shown at D^2, which is held by spring-standards D^3, adapted when in their normal position of rest to close the valves D and D′. The spring-standards D^3 are supported by any suitable means—for instance, by posts E′ rising from the expansion-chamber E of the regulator. The chamber may be formed of wood or other suitable material and is provided at its sides or ends with thin metal panels E^2, through which the temperature of the surrounding atmosphere will be transmitted to the body of expansive fluid or liquid contained within the regulator. This fluid or liquid may be of any desired character to expand to a predetermined degree upon the increase of temperature, and if a very low temperature be desired the chamber may be filled with liquid air. The chamber is also provided at one end with a flexible diaphragm E^3, connected with the body of expansive liquid by the tube E^4 and contained within the cylindrical case E^5, supported upon said tube. This case prevents a lateral expansion of the diaphragm E^3 and causes the same to expand longitudinally of the cylindrical case. Extending downwardly from the frame D^2 is an arm D^4, provided with a contact-plate D^5, held in contact at all times with the diaphragm E^3 by means of the spring-standards D^3 and, if desired, a spring supporting-standard D^6 in connection with the depending arm D^4. It will be apparent that the expansion of the liquid within the chamber E will through the medium of the diaphragm E^3 open the valves D and D′ and place the spring-standards under tension. This permits a circulation of air at the temperature of the atmosphere through the liquid-air tank and produces an evaporation by which the temperature of the compartment is reduced. When this reduction reaches the desired extent for which the regulator is arranged, the contraction of the liquid within the chamber E permits the spring-standards to close the valves D and D′.

For the purpose of regulating the temperature at which the expansive liquid shall operate to open or close the valves I have provided a pressure device consisting of a cylinder F, communicating with any desired portion of the chamber E—for instance, the top, as shown—within which cylinder a piston F′ is provided, having a stem F^2 threaded into the closed end of the cylinder F and suitably swiveled upon the piston. This stem is pro-

vided at its upper end with a crank-handle F^3 of any preferred construction and below the same with the disk or ring F^4, adapted to engage the forked inner end F^5 of a pivoting indicating-arm F^6, which traverses the surface of a dial F^7, containing suitable designating characters for the different degrees of temperature. The pivoted arm F^6 is supported at the upper end of a standard F^8, while the dial may be supported by means of a branch arm F^9 extending from one side of the standard. It will be apparent that as the piston F′ is depressed within the cylinder F a greater compression of the expansive liquid will be effected, and the valves consequently operated through the mechanism hereinbefore described to effect a much lower degree of temperature by permitting the evaporation of the liquid air within the tank A′. The regulating device is shown in Fig. 1 for the purpose of illustration as located below the receptacle containing the liquefied air; but it will be apparent that it may be carried by said receptacle or detachably connected thereto, so that the receptacle may be changed when found desirable, as the means of connection and operation of the several parts herein shown are given as one method of effecting the results to be attained.

If it be desired to disconnect the regulating device and valves from the receptacle, the inlet and outlet pipes may be removed and their place filled by means of a plug G, as shown in Fig. 4. This can be effected by turning the receptacle upon its side and unscrewing the inlet or outlet pipes and inserting the plug in their place. This plug is also used when the receptacle is to be shipped, filled with air, and the regulating device afterward applied when it is desired to govern the evaporation of the air. The plug E, as shown in Figs. 5 and 6, consists of a shell or casing G′, having one-half of its inner end closed, as shown at G^2. At the outer end of the plug a cross-bar G^3 extends, and within this cross-bar G^3 and closed end G^2 a valved opening-rod G^4 is pivoted, which rod may have a handle G^5, as shown. This rod carries at its inner end a valve G^6 and also a core or filling G^7 of any suitable material, preferably non-conducting in character. Between the cross-bar G^3 and the end of the valve-rod G^4 a sleeve G^8 is applied, while upon the end of the valve-rod a tension-nut G^9 may be used to draw the valve G^6 closely to its seat. When the plug is to be used solely for plugging purposes, a removable segment or block G^{10} is inserted above the block G^7, carried by the valve, so as to make a complete core within the case G′, whereby the valve-rod may be repeatedly turned and the valve operated without effecting any opening into the tank A′. If it should be desired to withdraw some of the liquid from the tank, this can be effected by removing the segment G^{10} and operating the valve so as to bring the block G^7 into the upper portion of the casing G′, thus leaving the lower portion of the casing open as an outlet for the liquid. The parts when in this position are shown in Fig. 7, and the valve G^6 is provided with a finger G^{11}, adapted to engage a pin G^{12}, which limits the movement of the valve when it has reached its full open position. When the valve and block G^7 are shifted into the position shown in Fig. 5, the outlet from the tank is effectually closed, and any tampering with the receptacle may be further prevented by the insertion of the plug G^{10}.

In the foregoing description it will be seen that the operation of this invention involves the evaporation of the liquefied air by the circulation through said liquid of a current of the air at an atmospheric temperature which is always a great deal higher than that of the liquid air. It will also be seen that by means of the valves the circulation of air may be controlled through the medium of the regulator, and these valves may be so operated as to maintain a compartment at a predetermined temperature proper for the purposes in view, whether refrigeration or the cooling of dwelling apartments. The escape of evaporated liquid or the air in a partially-expanded condition occurs through the outlet-pipe, by which the current of intensely cold vapor may be carried through pipes for refrigerating purposes or allowed to escape for a similar object. It is also essential in a device of this character that the body of liquid should be so thoroughly protected from the influence of the atmosphere at a normal temperature that the same can be safely handled and transported, and for that reason the tank is surrounded by a series of air-spaces forming a circuitous path through which the partially-vaporized air passes, and thus provides a thorough protection against undue expansion of the main body of liquid air and permits the evaporation of the same to be controlled by the valves on the circulation-pipes.

The details of construction and configuration of the several parts of the invention may be altered without departing from the spirit of the invention as defined by the appended claims, and the materials used may be altered as found most expedient for the objects in view. In the present illustration the conducting-pipes have been shown as formed of wood, which being a non-conductor of heat or cold has been chosen for the present illustration.

Having described my invention, what I claim is—

1. A liquid-air receptacle comprising a storage-tank provided with an opening at its upper portion, a series of inclosing shells surrounding said tank and forming a series of expansion-passages communicating with a vent or outlet opening, and a removable circulation-tube extending from one side of the

case to the other through said shells and the lower portion of the tank; substantially as specified.

2. A liquid-air apparatus comprising a receptacle provided with means for the escape of evaporated liquid, a circulation-tube passing through said receptacle and communicating with the atmosphere, and an automatically-operated valve for controlling said tube; substantially as specified.

3. A liquid-air apparatus comprising a receptacle provided with means for the escape of evaporated liquid, a circulation-tube passing through said receptacle and communicating with the atmosphere, an automatically-operated valve for controlling said tube, and a regulating device for operating said valve; substantially as specified.

4. A liquid-air apparatus comprising a receptacle provided with means for the escape of evaporated liquid, a circulation-tube passing through said receptacle and communicating with the atmosphere, an automatically-operated valve for controlling said tube, and a thermostatic regulating device for operating said valve; substantially as specified.

5. In a liquid-air apparatus, the combination of a tank, a series of inclosing shells surrounding the same and spaced from each other by supports at their bottoms to form a passage for evaporated liquid and provided with openings alternately disposed at their top and bottom, and an outlet-vent in the outer shell, an inlet passing through the shell to the inner tank at its upper portion, and a circulation-tube extending through the shells and the lower portion of the tank and open at each end; substantially as specified.

6. In a liquid-air apparatus, the combination of a tank, a series of partitions surrounding the same and spaced from each other to form a passage for evaporated liquid and provided with openings alternately disposed at their top and bottom, a tubular inlet communicating with the tank and joined to the alternate shells or partitions, and a plug adapted to close said inlet; substantially as specified.

7. In a liquid-air apparatus, the combination of a tank, a series of partitions surrounding the same and spaced from each other to form a passage for evaporated liquid and provided with openings alternately disposed at their top and bottom, a tubular inlet joined to the alternate shells or partitions, a plug adapted to close said inlet, and a float within said tank having a graduated stem adapted to fit within a recess in said plug when inserted; substantially as specified.

8. In a liquid-air apparatus, the combination of a tank and discharging means therefor, of a circulation-pipe communicating with the atmosphere and extending through said tank, valves controlling the opposite ends of said pipe, and an air-inlet in said pipe to prevent the formation of a vacuum therein; substantially as specified.

9. In a liquid-air apparatus, the combination with a liquid-tank, of air-circulating pipes for producing evaporation within said tank, simultaneously-operated valves at the opposite ends of said circulating-pipes, a regulator adapted to operate said valves in one direction, and means for closing said valves when released from the regulator; substantially as specified.

10. In a liquid-air apparatus, the combination with a tank, of a closure-plug comprising a casing, a pivoted valve thereon having a core located within said casing, and means for rotating said valve and core; substantially as specified.

11. In a liquid-air apparatus, the combination with a tank, of a closure-plug comprising a casing, a pivoted valve thereon having a core located within said casing, means for rotating said valve and core, and a removable core-block adapted to fill the space within said casing between said valve-rod and core carried thereby; substantially as specified.

12. In a liquid-air apparatus, the combination of a tank, a series of shells surrounding the same and having openings at opposite ends to form a circuitous path for the evaporated liquid, supporting-seats for spacing said shells from each other, an air-circulating pipe extending through said tank and communicating with the atmosphere, and means for closing the ends of said pipe; substantially as specified.

13. In a liquid-air apparatus, the combination of a tank, a series of shells surrounding the same and having openings at opposite ends to form a circuitous path for the evaporated liquid, supporting-seats for spacing said shells from each other, a circulating-pipe extending through said tank and communicating with the atmosphere, means for closing the ends of said pipe, and means controlled by the temperature of the surrounding atmosphere for automatically actuating said pipe-closing means; substantially as specified.

14. In a liquid-air apparatus, the combination of a tank, a series of shells surrounding the same and having openings at opposite ends to form a circuitous path for the evaporated liquid, supporting-seats for spacing said shells from each other, a circulating-pipe extending through said tank and communicating with the atmosphere, valves at the ends of said pipe, a regulator and an operating-arm for said valves connected with said regulator; substantially as specified.

15. In a liquid-air apparatus, the combination of a tank, a series of shells surrounding the same and having openings at opposite ends to form a circuitous path for the evaporated liquid, supporting-seats for spacing said shells from each other, a circulating-pipe extending through said tank and communicating with the atmosphere, valves at the ends of said pipe, a regulator and an operating-

arm to simultaneously move the valves at each end of the circulating-pipe; substantially as specified.

16. In a liquid-air apparatus, a receptacle comprising a casing, a tank centrally disposed therein, a series of shells spaced in said tank by seat-blocks and open alternately at their upper and lower portions to form a circuitous channel, an air-circulating pipe extending through the tank, and means for controlling the entrance of air into said pipe relative to the temperature of the apartment; substantially as specified.

17. In a liquid-air apparatus, the combination with a liquid-tank, of an air-circulating pipe for producing evaporation within said tank, valves adapted to control the entrance and exit to said pipe, a regulator connected with said valves to operate the same simultaneously relative to the movement of an expansive medium; substantially as specified.

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

THOMAS J. HATHAWAY.

Witnesses:
O. P. WIMMER,
A. MURRAY.