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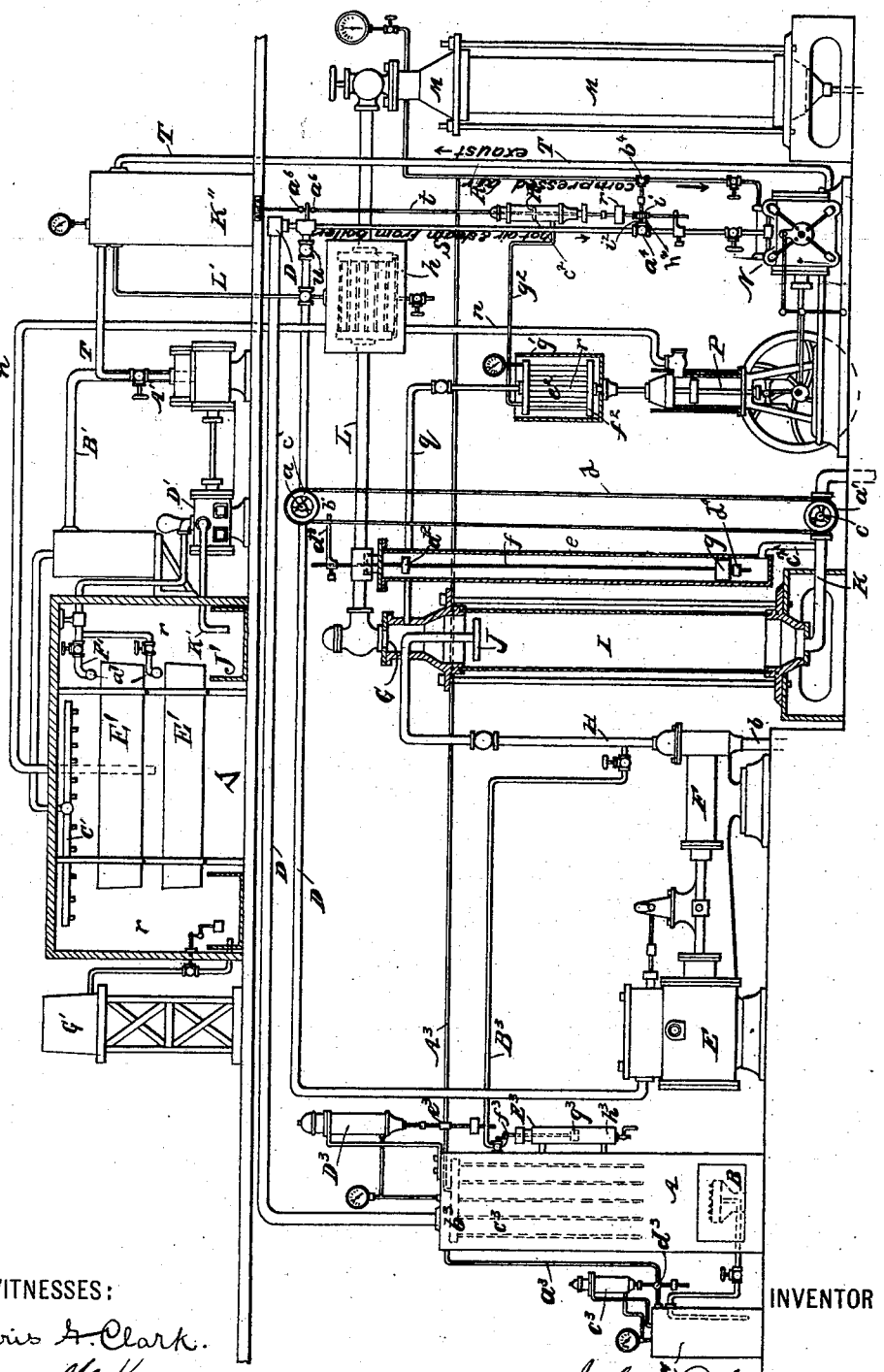
J. D. MORAN.

AIR COMPRESSING AND REFRIGERATING APPARATUS.

(Application filed Sept. 4, 1897.)

(No Model.)



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AIR COMPRESSING AND REFRIGERATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 648,422, dated May 1, 1900.

Application filed September 4, 1897. Serial No. 650,612. (No model.)

To all whom it may concern:

Be it known that I, JOHN D. MORAN, a citizen of the United States, and a resident of the city, county, and State of New York, have invented certain new and useful Improvements in Air Compressing and Refrigerating Apparatus; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawing, making a part of this specification, which is a vertical transverse sectional view of an apparatus made according to my invention.

This invention comprises certain new and useful combinations of parts whereby the operations of cooling and compressing air for use in ice-making, refrigerating, and for other industrial purposes are performed by practically-automatic mechanisms which are not liable to get out of order, are comparatively inexpensive and capable of effective use, and which do not require the high grade of skilled labor in their use and management which has heretofore been required with other apparatuses for similar purposes.

A is a boiler for containing water and air under pressure. This boiler is fired from an oil-burner or liquid-fuel furnace B, which is supplied with fuel from a tank C, which at its upper part connects by a pipe or conduit a^3 with the upper part of the boiler A. Extended from the upper part of the boiler is an air-inlet pipe or conduit A^3. To the inner end of this pipe, within the boiler, is provided a hollow header b^3, from which depend any desired number of tubes c^3, which are open at their lower ends, so that through them communication is established between the pipe A^3 and the interior of the boiler. At a lower part of the boiler is a water-inlet pipe or conduit B^3. The upper part of the interior of the oil-tank C—*i. e.*, the space above the liquid fuel therein—receives compressed air or compressed air and steam through the pipe a^3 from the upper part of the boiler. The superincumbent pressure of this air upon the fuel forces the same to the burner B in the operation of the apparatus. To regulate this pressure, which is preferably, but not necessarily, about thirty pounds per square inch, I provide to the pipe a^3 a pressure-regulator C^3, which when the pressure in the tank exceeds that which is desired operates a valve d^3 to close the pipe c^3, but which operates to open passage through said pipe when the pressure is reduced below that desired. This regulator C^3 may be substantially a duplicate of that hereinafter described with reference to pipes or conduits S and q^2, but as pressure-regulators are well known no specific description of any is here required. A pressure-regulator D^3 is provided to the pipe A^3 to operate a valve e^3 to close said pipe when the pressure in the boiler exceeds the desired degree and to open said pipe when the pressure falls and a further supply of air under compression is needed in the boiler. A water-regulator E^3 is provided to the boiler to actuate a valve f^3 in the pipe to admit water to the boiler when the water-level in the latter falls below the point desired and to close said pipe when for the time being the boiler is supplied with water to the requisite extent. This water-regulator E^3 may comprise a float g^3 in a vertical cylinder h^3, both ends of which communicate with the interior of the boiler, the float being connected by suitable means with the valve to be operated. As water-regulators of this type are well known, further description thereof is here unnecessary. The pipe or conduit A^3 connects the boiler with the compression-chamber I, herein presently described, and the pipe or conduit B^3 connects the boiler with the water-pipe H and pump F, hereinafter referred to and described.

From the upper part of the boiler A extends the pipe D, which connects at its opposite end with the valve-chest of a motor or pumping-engine E, the pump of which is shown at F. In this pipe D is a valve or stop-cock *a*. The outlet of the pump F connects, by the pipe H, with the compression-chamber I and is there provided with a spraying-head J. The inlet or supply pipe *b* of this pump is arranged in suitable relation with any appropriate source of water-supply. In the bottom of the compression-chamber I

is a water-outlet pipe K, in which is a valve or stop-cock *c*. The hand-wheel *a'* of this latter is connected with the corresponding hand-wheel *c'* of the valve *a* of the pipe D by a band *d*, so that the two valves may operate simultaneously and in unison. Placed adjacent to the chamber I is a cylinder *e*, the lower end of which connects by a pipe c^{21} with the water-outlet pipe *k*. Placed in this cylinder and capable of a vertical movement therein is a rod *f*. The upper end of this rod projects beyond the cylinder and is provided with an arm *d'*, the outer end of which connects with the band *d*, so that the vertical movement of the rod actuates the two valves *c* and *a*. Working freely upon the rod *f* is a float *g*, which in rising is carried against a tappet d^2 on the rod and in its farther upward movement carries the rod with it, thereby actuating the arm *d'* to turn the valves *a* and *c* to close the pipe D and open the water-outlet pipe *k* and conversely when the float, and consequently the rod, descends by striking tappet d^4. By this means the operation of the motor E, and consequently that of the pump F, is stopped simultaneously with the outflow of the water from the chamber I only to be set in operation again when the valves are returned to their first position by the operation of the float, so that the operation of the chamber I is rendered automatic in further compressing successive charges of compressed air. At the top of the chamber I is a loaded check-valve G, which opens outward and which is arranged to yield at a predetermined pressure in the said chamber—say at two hundred pounds per square inch. From the valve-chest of this check-valve extends a pipe L to a compressed-air reservoir M. Interposed in the pipe L is a condenser *h* of any approved construction, but preferably composed of a system of tubes continuous with the pipe and surrounded by a case or box. In this any moisture in the air passed through the pipe L is condensed and deposited, thereby drying the air preliminary to its passage into the reservoir. The manner in which this condenser is kept at a requisite low temperature is hereinafter explained.

At N are two engines. In the drawing one of these engines is understood to be behind the other, and both are coupled to an air-compressor P to operate in unison in operating the same. One of these engines—that which is shown as connected with the pipe S—is operated by fluids under pressure from the boiler, while the other—that understood to be in the drawing secured behind that first mentioned—is operated by compressed air delivered to it from the reservoir through the pipe R. The air-compressor thus operated by the joint action of these two engines is constructed and arranged to receive air from a pipe *n* and to compress the same through a pipe *q* into the chamber I. In this pipe *q* is interposed a cooling-chest *r*, which may be of any approved structure, but which, as shown in the drawing, comprises a system of tubes e^2, with headers f^2, which form multiple passages interposed in and continuous with the pipe *q* and which are surrounded by a casing *g'*, the interior of which, surrounding the tubes e^2, is cooled in a manner hereinafter explained. The office of this cooler is to absorb heat developed in the air when compressed by the compressor P and thus in a proportionate degree to lessen the refrigerating work in the chamber I, presently to be described. One of the cylinders of the double engine which actuates the compressor P receives compressed air from the reservoir M through a pipe R, so that its engine is actuated thereby. The other of said cylinders receives compressed hot air, with whatever steam or vapor under pressure said hot air may contain, from the boiler A through a pipe S, which branches from the pipe D, so that the compressor P is worked by the conjoined action of the two engines, the one engine operated by cold compressed air from the reservoir M, the other by hot compressed air, &c., from the boiler A. The exhaust of the engine, operated by the cold compressed air from the reservoir, is through a pipe T.

At R' is a vertical cylinder through which plays a vertically-movable rod *t*, on which within the cylinder is a piston c^2. Connecting the cooler *r*, or in lieu thereof the pipe *q*, direct with the cylinder R', below the piston c^2 therein, is a pipe g^2. The rod *t* is loaded, as at r^2, to the determinate degree proportioned to the pressure desired within the chamber I—say to two hundred pounds. It is provided with a rack h^2, which gears with a pinion *i*, the shaft i^2 of which is so connected with two valves, one, a^4, in the pipe S, and the other, b^r, in the pipe R, that the vertical movement of the rod simultaneously operates the said valves to open or close passage through said pipes. The rod *t* is further provided with tappets a^6, which are so connected with the valve-stem of a valve *u* in the pipe D between the valve *a* and the connection of the pipe with the boiler that the vertical movement of the rod actuates said valve to open and close passage through the pipe D.

V is a refrigerating-room into which is conducted from the pipe T the cold exhaust-air from that one of the engines N which is operated by compressed air from the reservoir, as hereinbefore explained. With the interior of the refrigerating-room also communicates the pipe *n*, said pipe constituting the inlet or low supply pipe to said compressor.

It will be observed that air drawn from the refrigerating-room through the pipe *n*, being compressed through the pipe *q* into the water-compressing chamber I and there compressed to a degree which enables it to overcome the loaded check-valve G, passes thence under pressure to the reservoir M, from which it again emerges through the pipe R for reuse in the operation of the air-operated en-

gine and for refrigerating purposes in the refrigerating-chamber. The air being thus used over and over again and being itself refrigerated by the abstraction of heat therefrom consequent upon the work done by it in the operation of the air-operated engine combined with the compressor P and by whatever abstraction of heat may occur from other causes in the operation, as described, of the apparatus.

A′ is a steam or other suitable pump, the inlet to which is the pipe T, while its outlet or exhaust is the pipe B′, the opposite end of which is provided with a perforated air-distributing pipe or pipes C′. When it is desired to manufacture ice in the refrigerating-room, troughs E′ are provided in such relation with the distributing pipe or pipes C′ that water contained therein may be subjected to the direct action of the refrigerated air. Another pump D′ (which may be actuated by the same motive power as the pump A′) is arranged to supply water in regulated quantities to the troughs through suitable distributing-pipes F′, fitted with spraying devices a^7. Water may in the first instance be directed from a tank G′ and be drawn through suitable conduits into a trough J′ and with which the inlet or supply pipe K′ of the pump D′ is suitably connected.

Interposed in the pipe T is a trap K″, which receives any moisture deposited from the cold air in said pipe. From the upper part of this trap to the casing of the condenser *h* extends a pipe or conduit L′, by which cold air from the trap is passed in proper contact with the tubes of the condenser to maintain them at the low temperature requisite to the condensation of moisture from the air passed through the pipe L and the consequent drying of the same.

When air from the compressor P has been forced into the water-compression chamber I to the desired degree and pressure, the pump F is caused to force water into said chamber through the pipe H. This reduces the space within the chamber available for containing the air within the latter, with the result of still further compressing the air and of to some extent cooling the same by reason of the absorption of heat rendered sensible by reason of the compression of the air. When the degree of compression has reached the desired limit, the check-valve G yields, and the compressed and to some extent refrigerated air passes to the reservoir M for use in repetition, as hereinbefore explained.

It will be observed that in the operation of the apparatus as described the boiler is automatically supplied with its proper proportion of air under compression by the same means which compress the air into the compression-chamber I; that the supply to the reservoir M and to the engine for actuating the compressor and to the refrigerating-room is also automatic; that the pressure upon the liquid fuel in the tank C; requisite to the operation of the burner B in heating the boiler is derived from air under compression derived from the boiler and supplied to the latter, as just explained; also, that the water supplied to the boiler is derived from the supply afforded by the pump F when in operation to supply water to operate as a means for compressing air in the chamber I antecedent to the passage of the air to the reservoir. From the reservoir the air passes to the air-actuated engine to operate the compressor P. This compressor is also actuated by an engine operated by hot compressed air and aqueous elastic fluids from the boiler; also, that by means of the header b^3 and tubes c^3, connected with the pipe A^3, the air which enters the boiler under compression is caused to pass through the water on its way to the air-space in the upper part of the boiler and is thereby thoroughly saturated with aqueous vapor or steam, so that the hot compressed air and the steam together form the hot elastic fluid which, as hereinbefore explained in the working of the compressor P, operates one of the engines N, while the other is operated by the cold compressed air from the reservoir.

It will be borne in mind that by the term "chamber I for containing air under compression" I intend to include any form or structure of such chamber provided either immediately or remotely with a valve or means for holding the air under compression to the degree of pressure required and then liberating the same for transit from said chamber; also, "pipe" as used herein is the equivalent of the words "conduit" or "passage," as affording conduct or passage to the fluids designed to pass therethrough.

What I claim as my invention is—

1. In an apparatus of the class mentioned the combination of the following elements, viz: a chamber for containing air under compression, a compressor for forcing air under compression into said chamber, means for forcing water into said chamber to further compress the air therein, an engine for operating said compressor, a reservoir for holding air under compression, a conduit for conducting air under compression from said chamber to said reservoir, a conduit for supplying air under compression from said reservoir to said engine to operate the same, and a motive power provided to operate conjointly with the said engine in operating the compressor, substantially as and for the purpose herein set forth.

2. In an apparatus of the class mentioned the combination of the following elements, viz: a chamber for containing air under compression, a compressor for forcing air under compression into said chamber, means for forcing water into said chamber to further compress the air therein, an engine for operating said compressor, a reservoir for holding air under compression, a conduit for conducting air under compression from said chamber to said reservoir, a conduit for supplying air under

compression from said reservoir to said engine to operate the same, a refrigerating-room, a conduit for conducting the cold exhaust-air from said engine to said room, a conduit for conducting the air from said room to the inlet of the compressor, and a motive power provided to operate conjointly with the said engine in operating the compressor, substantially as herein set forth.

3. In an apparatus of the class mentioned the combination of the following elements, viz: a reservoir for compressed air, an engine constructed and arranged for operation by compressed air from said reservoir, an air-compressor arranged to be operated by said engine, a refrigerating-room, a conduit for conducting the exhaust from said engine to said room, a conduit for conducting the air from said room to the said compressor, a compression-chamber constructed and arranged to receive air under compression from said compressor, a pump for forcing water into said chamber to further compress the air therein, a valve prearranged to yield when the pressure in said chamber has reached a limit, a conduit for conducting the air, thus compressed, back to the reservoir for repeated use and a motive power to coöperate with said engine in operating the compressor, substantially as herein set forth.

4. In an apparatus of the class mentioned the combination of the following elements, viz: a reservoir for compressed air, an engine constructed and arranged for operation by compressed air from said reservoir, an air-compressor arranged to be operated by said engine, a refrigerating-room, a conduit for conducting the exhaust from said engine to said room, a conduit for conducting the air from said room to the said compressor, a compression-chamber constructed and arranged to receive air under compression from said compressor, a pump for forcing water into said chamber to further compress the air therein, a motor for actuating said pump, a boiler for supplying elastic fluids to actuate said motor, means for automatically supplying water from said pump to said boiler, a valve provided to said chamber and prearranged to yield when the pressure in said chamber has reached a limit, and a conduit for conducting the air, thus compressed, back to the reservoir for repeated use, substantially as herein set forth.

5. In an apparatus of the class mentioned the combination of the following elements, viz: a reservoir for compressed air, an engine constructed and arranged for operation by compressed air from said reservoir, an air-compressor arranged to be operated by said engine, a refrigerating-room, a conduit for conducting the exhaust from said engine to said room, a conduit for conducting the air from said room to the said compressor, a compression-chamber constructed and arranged to receive air under compression from said compressor, a pump for forcing water into said chamber to further compress the air therein, a motor for actuating said pump, a boiler for supplying elastic fluids to actuate said motor, means for automatically supplying air under compression from said chamber to said boiler, a valve provided to said chamber and prearranged to yield when the pressure in said chamber has reached a limit, and a conduit for conducting the air, thus compressed, back to the reservoir for repeated use, substantially as herein set forth.

6. In an apparatus of the class mentioned the combination of the following elements, viz: a reservoir for compressed air, an engine constructed and arranged for operation by compressed air from said reservoir, a boiler for generating elastic fluids from water and air under pressure, an engine constructed and arranged for operation by said fluids from said boiler, an air-compressor constructed and arranged for operation by the conjoint action of the two engines, a refrigerating-room, a conduit for conducting the cold exhaust from the compressed-air engine to said room, a conduit for conducting the air from said room to said compressor, a compression-chamber constructed and arranged to receive air under compression from said compressor, a pump for forcing water into said chamber to further compress the air therein, means for automatically supplying to the boiler water from said pump and means for automatically supplying to the boiler air under compression from said chamber, a valve provided to said chamber and prearranged to yield when the pressure in said chamber has reached a limit, and a pipe for conducting the compressed air from the said chamber back to the reservoir for repeated use, substantially as herein set forth.

7. In an apparatus of the class mentioned the combination of the following elements, viz: a refrigerating-room for receiving cooled air, a chamber, I, for containing air under compression, a pump for forcing water to said chamber to compress and cool the air therein, a motor for operating said pump, a boiler for supplying an elastic fluid or fluids under pressure to operate said motor, a conduit for injecting water into said boiler by the operation of the pump aforesaid, a regulator for controlling such injection of water and means for circulating the air from the water-compressing chamber, I, through an expansion-engine the refrigerating-chamber and returning it to the said chamber, substantially as and for the purpose herein set forth.

8. In an apparatus of the class mentioned the combination of the following elements, viz: a refrigerating-room for receiving cooled air, a chamber, I, for containing air under compression, a pump for forcing water into said chamber to compress the air therein, a motor for operating said pump, a boiler for supplying heated compressed air and steam to operate said motor, a conduit for supplying air under compression from the chamber, I, to said boiler, a regulator for controlling

said injection of compressed air and means for circulating compressed and refrigerated air from said chamber to and through an expansion-engine the refrigerating-room and back to the chamber, substantially as herein set forth.

9. In an apparatus of the class mentioned the combination of the following elements, viz: a refrigerating-room for receiving cooled air, a chamber, I, for containing air under compression, a pump for forcing water into said chamber to compress the air therein, a motor for operating said pump, a boiler for supplying mingled steam and heated compressed air to operate said motor, a conduit for injecting water into said boiler from said pump, a regulator for automatically controlling said injection of water, a conduit for supplying air under pressure to said boiler from the chamber, I, a regulator for automatically controlling said supply of compressed air, and means for circulating compressed and cooled air from said chamber to and through an expansion-engine the refrigerating-room, substantially as herein set forth.

10. In an apparatus of the class mentioned the combination of the following elements, viz: a refrigerating-room for receiving cooled air, a chamber, I, for containing air under compression, a pump for forcing water into said chamber to compress the air therein, a motor for operating said pump, a boiler for supplying mingled steam and heated compressed air to operate said motor, a conduit for injecting water into said boiler from said pump, a regulator for automatically controlling said injection of water, a conduit for supplying air under pressure to said boiler from the chamber, I, a regulator for automatically controlling and regulating said supply of compressed air, means for transmitting air cooled and compressed from said chamber through an expansion-engine to the refrigerating-room, an apparatus placed in said room to distribute the air therein, a pump for passing the air through said apparatus, and means for reconducting the distributed air from the refrigerating-room to the chamber, I, substantially as herein set forth.

11. In an apparatus of the class mentioned the combination of the following elements, to wit: a refrigerating-room for receiving cooled air, a chamber, I, for containing air under compression, a pump for forcing water into said chamber to compress the air therein, a motor for operating said pump, a boiler for supplying steam and heated compressed air to operate said motor, a conduit for injecting water into said boiler from said pump, a regulator for automatically controlling and regulating said injection of water, a conduit for supplying air under pressure to said boiler from the chamber, I, a regulator for automatically controlling and regulating said supply of compressed air, a reservoir for receiving compressed air from the chamber, I, an air-compressor for forcing air under compression into said chamber, duplicate pumps for operating said compressor, a conduit for conducting steam and hot air from the boiler to operate one of said engines, a conduit for conducting compressed air from the reservoir to operate the other of said engines, a conduit for conducting the exhaust-air of the last-mentioned engine to the refrigerating-room and a conduit for conducting the air from the refrigerating-room to the inlet of the compressor which is operated by the two engines, substantially as and for the purpose herein set forth.

12. In an apparatus of the class mentioned the combination of the following elements, viz: a chamber, I, for containing air under compression, an outlet-pipe, K, provided to said chamber, a valve or cock, *c*, provided to said pipe, a cylinder, *e*, communicating at the bottom with the chamber, a float, *g*, arranged for operation by the water in said cylinder, means for operating the valve, *c*, from the movement of the float, a pump for forcing water into the chamber to compress the air therein, a motor for operating said pump, a boiler for supplying steam and hot compressed air to operate said motor, a valve, *a*, for opening and closing communication between said boiler and said engine, a conduit for injecting water into said boiler from said pump, a regulator for controlling and regulating said injection of water, a conduit for supplying air under pressure to said boiler from the chamber, I, a regulator for automatically controlling and regulating said supply of compressed air and means for actuating the valve, *a*, from the float, *g*, in union with the valve, *c*, in the water-outlet of the chamber, I, substantially as and for the purpose herein set forth.

13. In an apparatus of the class mentioned the combination of the following elements, viz: a chamber, I, for containing air under compression, a pump for forcing water into said chamber to compress air therein, a motor for operating said pump, a boiler for supplying an elastic fluid or fluids under pressure to operate said motor, a conduit for injecting water into the boiler from said pump, a liquid-fuel burner for heating said boiler, a tank for supplying liquid fuel to said burner, and a conduit for conducting an elastic fluid under pressure into said tank to force fuel therefrom to the burner, substantially as and for the purpose herein set forth.

14. In a refrigerating apparatus the combination of the following elements, viz: a chamber, I, for containing air under compression, a pump for forcing water into said chamber to compress the air therein, a motor for operating said pump, a boiler for supplying an elastic fluid or fluids to operate said motor, a conduit for conducting air under compression to said boiler from said chamber, a liquid-fuel burner for heating said boiler, a tank for supplying liquid fuel to said burner, and a conduit for conducting an elastic fluid under

pressure to the tank above the fuel therein to force the fuel to the burner, substantially as and for the purpose herein set forth.

15. In an apparatus of the class mentioned the combination of the following elements, viz: a chamber, I, for containing air under compression, a pump for forcing air into said chamber to compress air therein, a motor for operating said pump, a boiler for supplying an elastic fluid or fluids under pressure to operate said motor, a conduit for conducting air under pressure to said boiler from said chamber, a liquid-fuel burner for heating said boiler, a conduit for conducting an elastic fluid or fluids from the boiler to the tank above the fuel in the latter to force by pressure the fuel to the burner, and a regulator for controlling said pressure in the tank, regardless of a greater pressure in the boiler, substantially as and for the purpose herein set forth.

16. In an apparatus of the class mentioned, the combination of the following elements, viz: a chamber, I, for containing air under compression, a pump for forcing air into said chamber to compress air therein, a motor for operating said pump, a boiler for operating said motor, a conduit for injecting water into said boiler from said chamber, and a regulator for controlling the height of water in the boiler regardless of the greater height of water in the chamber, substantially as herein set forth.

17. In an apparatus of the class mentioned the combination of the following elements, viz: a chamber, I, for containing air under compression and having an outlet-pipe and valve at its lower part, a pump for forcing water into said chamber to compress air therein, a motor for operating said pump, a boiler for supplying an elastic fluid or fluids under pressure to operate said motor, a valve or cock interposed between the boiler and the motor, a conduit for injecting water from the pump into the boiler a conduit for supplying air under compression to the boiler from the chamber, and means for simultaneously operating the two valves aforesaid to open the water-outlet from the chamber and shut off the supply of elastic fluid from the boiler to the pump, substantially as herein set forth.

18. In an apparatus of the class mentioned the combination of the following elements, viz: a chamber, I, for containing air under compression and having an outlet pipe and valve at its lower part, a pump for forcing water into said chamber to compress air therein, a motor for operating said pump, a boiler for supplying an elastic fluid or fluids under pressure to operate said motor, a valve or cock interposed between the boiler and the motor, a cylinder, *g*, which communicates at its lower portion with the corresponding part of the chamber, a float placed in said cylinder, a vertically-movable rod placed in said cylinder and arranged to be operated by the ascensive movement of the float, a band arranged to simultaneously operate the outlet-valve of the chamber and the valve interposed between the motor and the pump, and means for transmitting motion from the float-actuated rod, a conduit for injecting water from the pump into the cylinder and a conduit for supplying air under compression from the chamber to the boiler, substantially as herein set forth.

19. In an apparatus of the class mentioned the combination of the following elements, to wit: a chamber I, for containing air under compression, an air-compressor for forcing air under compression into said chamber, an engine for operating said compressor, a source of supply of water under pressure to said chamber, a reservoir for supplying air under compression to operate said engine, a conduit for supplying air under compression to said reservoir, a condenser interposed in said conduit to eliminate moisture from the compressed air during its passage to the reservoir, a second engine coupled to the said compressor, a boiler for supplying an elastic fluid or fluids to said second engine, valves arranged to control the inlet-pipes of both engines, a regulator for controlling said valves to operate the same in unison, a conduit from the compressor to said regulator to actuate the latter, a room for containing the articles, material, or substance to be frozen or refrigerated, a conduit for conducting the cold exhaust-air from the compressed-air engine to said room, and means for returning the air from said room to the compressor, substantially as herein set forth.

20. In an apparatus of the class mentioned, the combination of the following elements, viz: a chamber, I, for containing air under compression, and having an outlet pipe and valve at its lower part, a pump for forcing water into said chamber to compress air therein, a motor for operating said pump, a boiler for supplying steam and hot air under pressure to operate said motor, a conduit for connecting said boiler and chamber, a valve placed in said conduit to control passage therethrough, a conduit for supplying water from the pump to the boiler, a regulator for controlling the height of water in the boiler regardless of a greater height of water in the chamber, a conduit for supplying air under compression to the boiler from the chamber, a regulator for controlling the pressure of such air within the boiler regardless of a greater pressure in the chamber, a liquid-fuel burner for heating the boiler, a tank for supplying such fuel to said burner, a conduit for conducting fluids under pressure from the boiler to said tank above the contents thereof to force the latter to the burner, a regulator for controlling the pressure of such fluid within said tank regardless of a higher pressure of the fluids within the boiler, an outlet pipe and valve at the lower part of the chamber, means for automatically operating said valve in unison with that in the conduit which

connects the boiler with the pump, when the water in the chamber has reached the maximum height therein, a reservoir for holding air under compression, a conduit for conducting air under compression from the chamber to said reservoir, an engine constructed and arranged for operation by compressed air from said reservoir, a conduit connecting the reservoir with said engine, a valve placed in the said pipe to control passage therethrough, an air-compressor constructed and arranged for operation by said engine, a conduit connecting the compressor with the chamber, a refrigerating-room, a conduit connecting the exhaust of the compressed-air engine with said room, a conduit connecting said room with the compressor, a second engine coupled to the compressor to assist in the operation thereof, a conduit connecting with the boiler to supply steam and heated compressed air to said second engine to operate the same, a valve placed in the said conduit, a regulator arranged to actuate the said valve and that in the inlet-conduit of the compressed-air engine to simultaneously operate the same, and a conduit from the compressor to the regulator to actuate the latter to control passage of fluids to operate the two engines by means of air compressed by the compressor, the whole organized and arranged for joint use and operation, substantially as herein set forth.

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