No. 668,033.

Patented Feb. 12, 1901.

L. K. BÖHM.

REFRIGERATOR CAR.

(Application filed Nov. 14, 1900.)

(No Model.)

3 Sheets—Sheet 1.

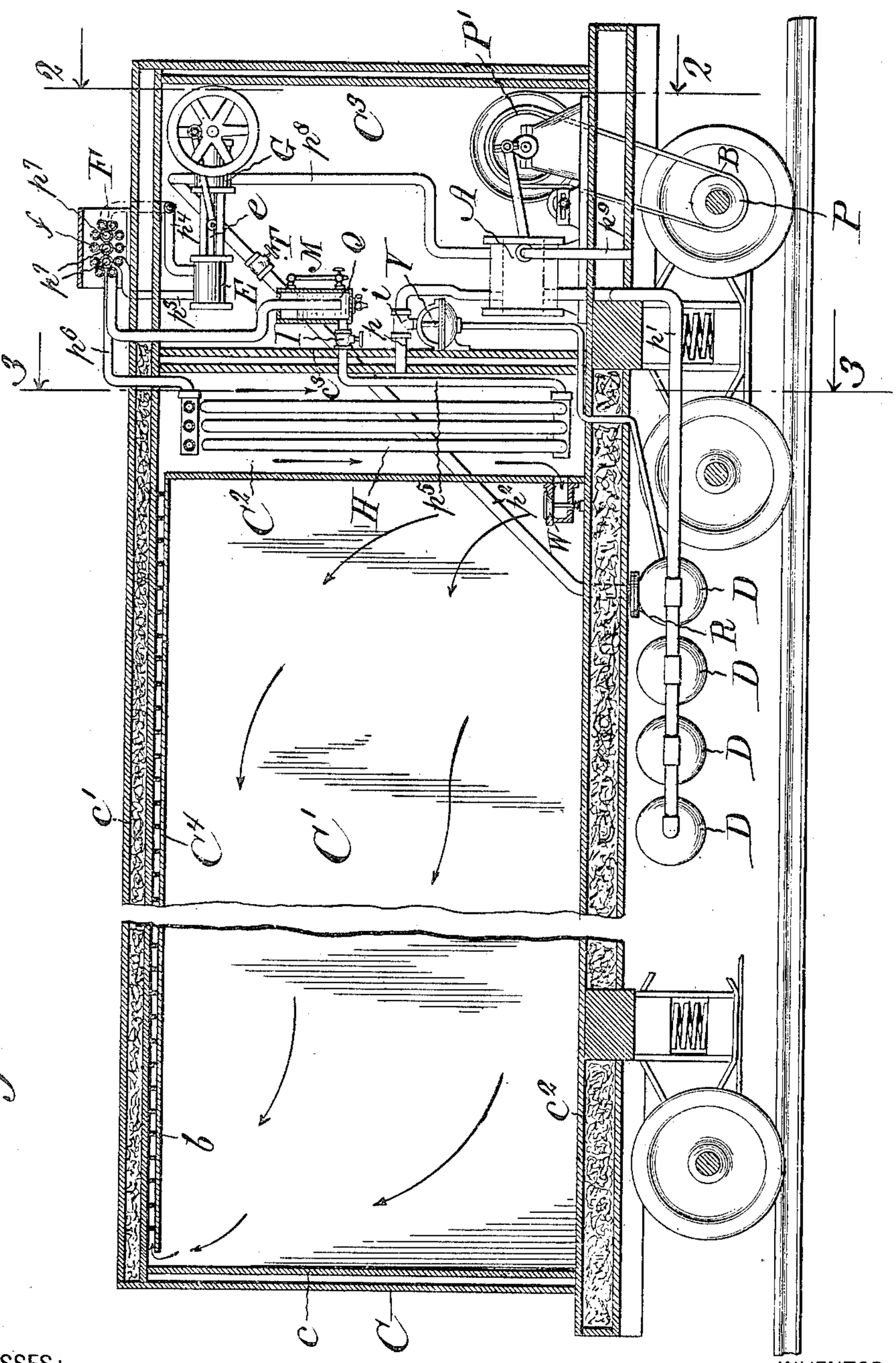


Fig. 1.

WITNESSES:

Evelyn Green.

Louise Weber.

INVENTOR

Ludwig K. Böhm.

No. 668,033.

Patented Feb. 12, 1901.

L. K. BÖHM.

REFRIGERATOR CAR.

(Application filed Nov. 14, 1900.)

(No Model.)

3 Sheets—Sheet 2.

Fig. 3.

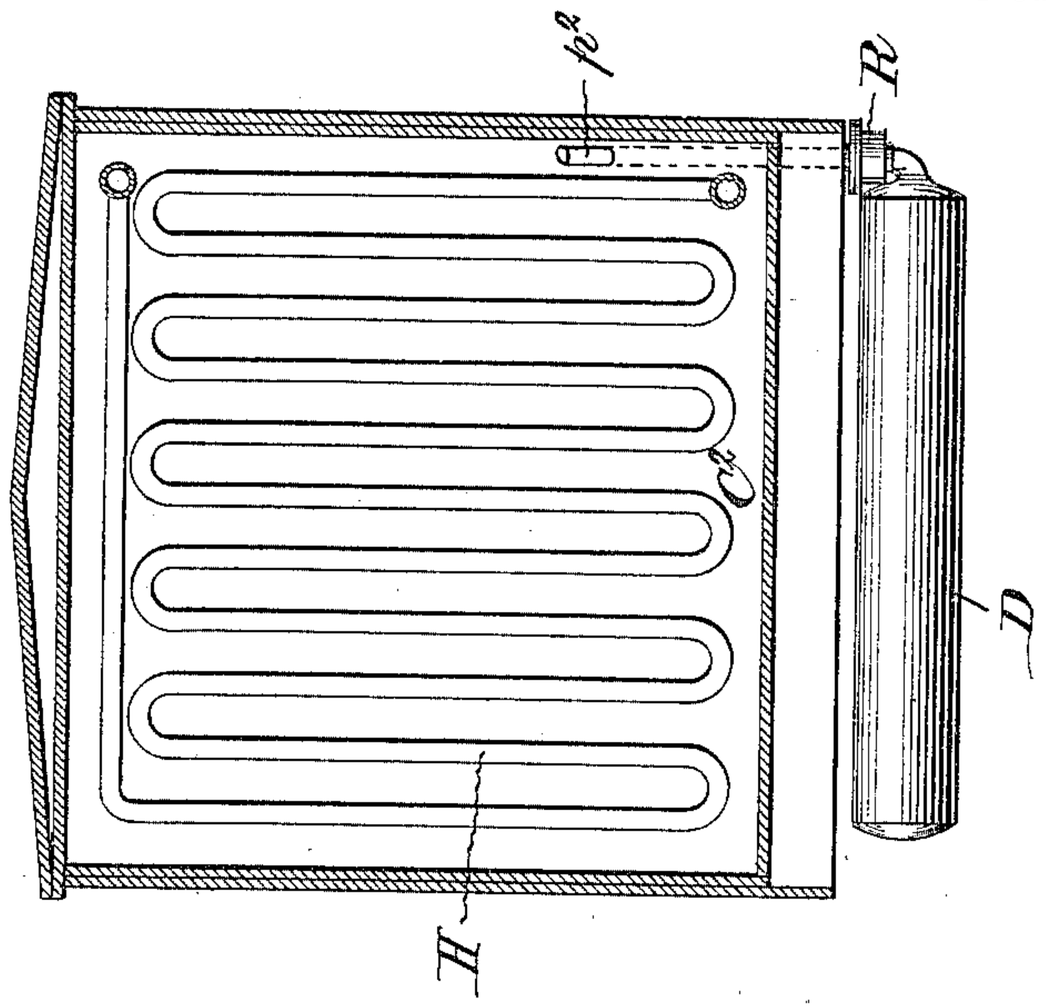
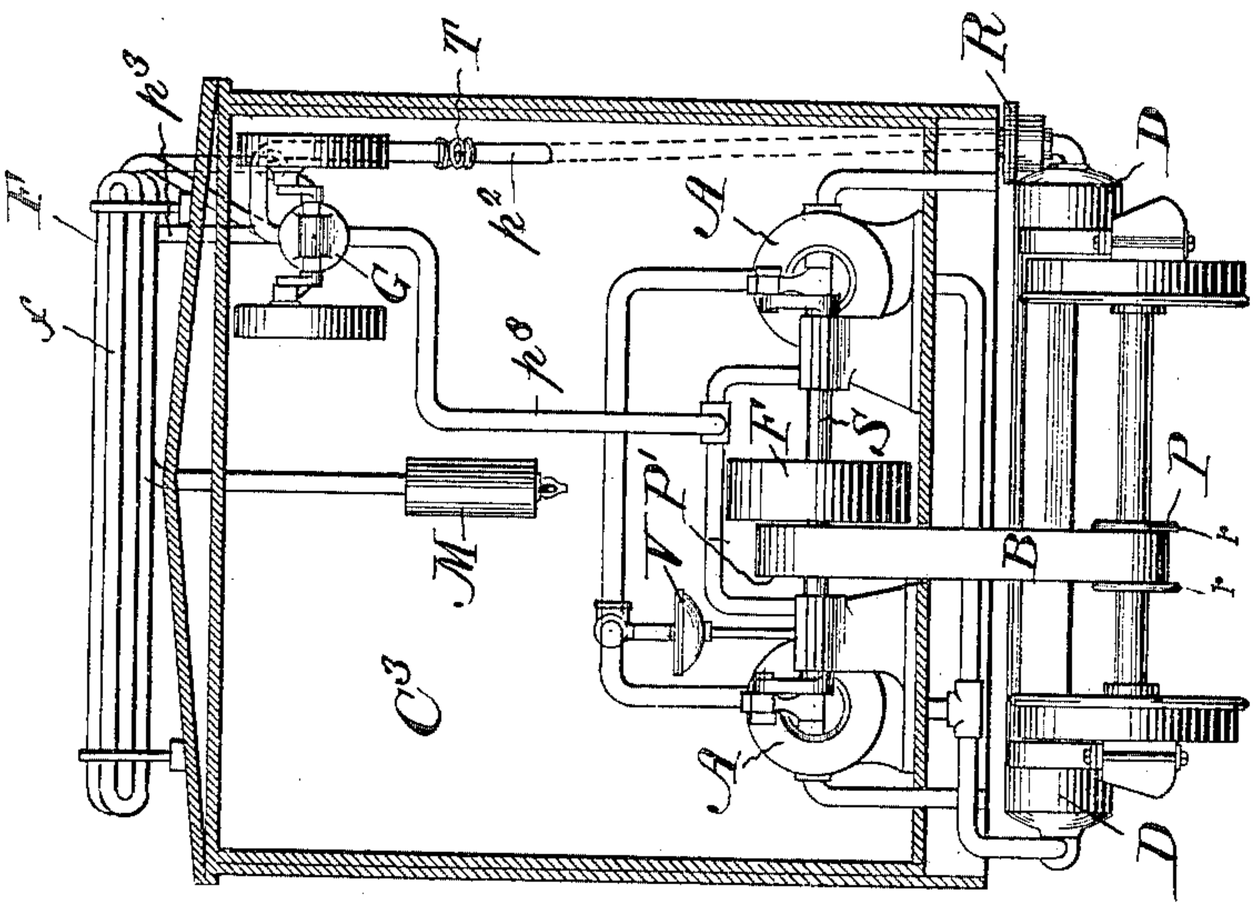


Fig. 2.



WITNESSES:

Evelyn Spreen

Louise Weber

INVENTOR

Ludwig K. Böhm.

No. 668,033.

Patented Feb. 12, 1901.

L. K. BÖHM.

REFRIGERATOR CAR.

(Application filed Nov. 14, 1900.)

(No Model.)

3 Sheets—Sheet 3.

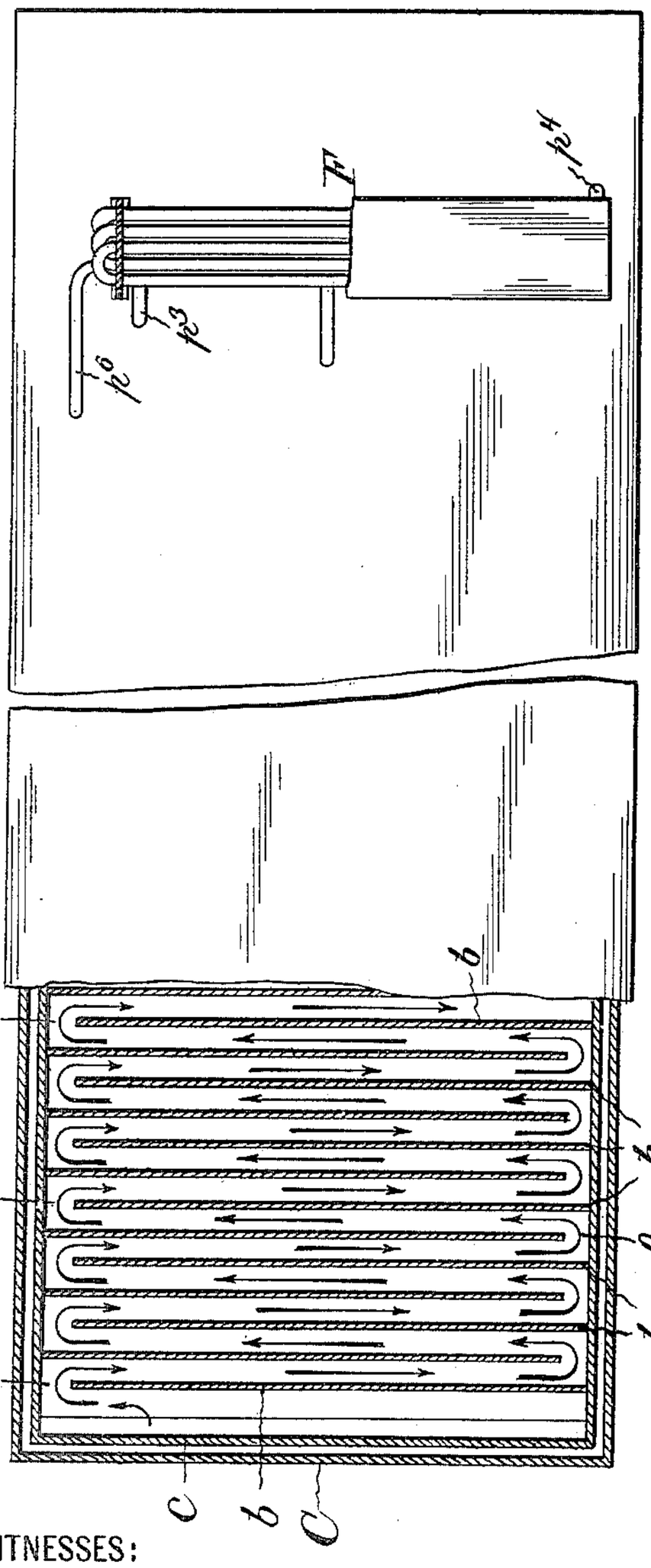


Fig. 4.

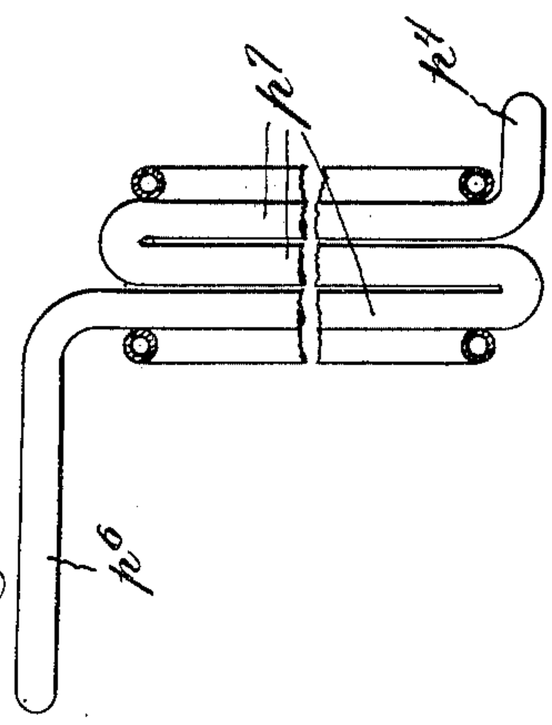


Fig. 5.

WITNESSES:

Evelyn Green.

Louise Weber.

INVENTOR

Ludwig K. Böhm.

UNITED STATES PATENT OFFICE.

LUDWIG K. BÖHM, OF NEW YORK, N. Y.

REFRIGERATOR-CAR.

SPECIFICATION forming part of Letters Patent No. 668,033, dated February 12, 1901.

Application filed November 14, 1900. Serial No. 36,439. (No model.)

To all whom it may concern:

Be it known that I, LUDWIG K. BÖHM, a citizen of the United States of America, and a resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Refrigerator-Cars, of which the following is a specification.

This invention has reference to refrigerator-cars of that type in which no ice is used for the production of cold air. This class of refrigerator-cars derives power for the production of cold air from the wheel-axle of the car and therefore is independent of any outside source or means of producing cold. In these cars the power derived from the axle of the car is utilized for compressing and storing a power fluid, usually air, which is employed for the compression and liquefaction of a volatile fluid—for instance, chlorid of ethyl—which is expanded, producing thereby cold, and then recompressed and reëxpanded, and so on, so that cold is produced continuously. It is important in this class of cars that no cooling-water is employed for the condensation of the volatile fluid. Heretofore the volatile fluid was condensed by water contained in a tank which occupied a good deal of space and added unnecessarily to the dead-weight of the car. Further, condensers were constructed in which both the condensing and expanding coils were contained in a condenser-tank which was filled with cold water, so that the same quantity of water was used for a long time or brine was pumped through a closed condenser-box or the return ammonia-gas was led in pipes through the condenser-tank, cooling thereby the water therein and reducing thus the quantity of cooling water to a minimum.

My invention consists in a novel construction of a condenser in which the above enumerated devices are dispensed with, and particularly no water-tank or condenser-box is employed.

The invention further consists in the arrangement of parts composing the apparatus.

The circulation of the cold air and of the expanded volatile fluid must be such as to utilize the cold produced to its utmost advantage. This desirable result is obtained in my improved refrigerator-car, as will be fully described farther down.

The invention is illustrated in the accompanying drawings, in which—

Figure 1 represents the car in longitudinal sectional elevation. Fig. 2 is a cross-section of the car on line 2 2 of Fig. 1. Fig. 3 is a cross-section of the car on line 3 3 of Fig. 1. Fig. 4 is a top view of the car with one end broken away, showing the cold-air-return passage and in top view the condenser on the other end; and Fig. 5 is a detail view of one end of the condenser.

Similar letters of reference denote like parts in all the drawings.

The car C, Fig. 1, is built of non-conducting walls *c*, a non-conducting roof *c'*, and a non-conducting floor c^2. Any known construction of wall may be employed. I prefer, however, to have at least one layer of felt in the roof above the non-conducting material, because it has been found in handling liquid air that felt isolates very well against radiant heat. This layer of felt is not absolutely necessary and is not shown in the drawings. The car is divided into three compartments—C', which is the space in which the goods to be transported are stored; C^2, which contains the refrigerator proper, and C^3, which contains the compressors. Above the compartment C^3 there is located the condenser on top of the roof. The compartments C' and C^2 are separated by a plain wall, while the compartments C^2 C^3 are separated by a non-conducting wall c^3. The roof of the car is constructed in a novel manner, as is shown in Figs. 1 and 4. Right below the ceiling proper of the car there is provided another ceiling C^4, leaving a space between this ceiling C^4 and the compact non-conducting wall of the roof. This space contains thin iron bars *b*, arranged in the manner shown in detail in Fig. 4 and filling up the space from bottom to top, but leaving alternately an opening *o* on the sides, so that these bars have not the full length of the width of the car. In this manner a return-passage for the cold air drawn from the storage-compartment C' is created, forming a serpentine channel, which is of exceptional length.

The compartment C^3 contains the air-com-

pressors A, which may be of any approved construction. The power required for driving the air-compressors is derived from the wheel-axle of the car by means of a pulley P and belt B. The belt runs up through the bottom of the car into the compartment C^3 and drives there a pulley P', which is secured to the shaft S, carrying the fly-wheel F, and running in bearings substantially supported on the bottom of the car, as shown in Figs. 1 and 2. The pulley P is provided with rims *r* for the purpose of preventing the belt from slipping when the car turns on curves of the track. Two air-compressors are shown in Fig. 2. The air enters the compressors through the pipe *p*, which leads from the refrigerator-compartment. After being compressed, the air passes through the discharge-pipes *p'* into the air-storage cylinders D, located below the car. The discharge-pipes *p'* are provided with check-valves of common construction for the purpose of preventing the return of the air from the storage-cylinders to the compressors. Four such cylinders are shown in Fig. 1. They are connected one with another, so that they form one single reservoir. The compressed air in these cylinders is the power fluid for driving a compressor, which compresses and liquefies a volatile fluid, and the compressed air is stored in these cylinders, so that motive power for the liquefaction-pump is available at times when the car is not running. The pressure at which the air is stored in these cylinders is about one hundred and fifty pounds. At this pressure sufficient air is stored for driving the liquefaction-pump for a considerable length of time when the car is not running. In order to prevent the pressure in these cylinders from becoming too great, a diaphragm-valve V of usual construction is provided, which connects the conducting suction-pipe *p* and the cylinders, as shown in Fig. 1. The valve is adjusted to about one hundred and fifty pounds of pressure. It will act when the pressure rises a little above that point.

The volatile fluid which I prefer to use in producing cold in refrigerator-cars is chlorid of ethyl, because its boiling-point is 12.5° centigrade, and therefore it is very easily compressed, and while passing the condenser does not require much cooling. About fifteen pounds of pressure is required for the compression of chlorid of ethyl, and since the pressure in the air-storage cylinders rises up to one hundred and fifty pounds it is necessary to provide an automatic pressure-reducing valve R. From the pressure-reducing valve the air passes through the pipe p^2 and may enter an equalizing-reservoir (not shown in the drawings) before it passes into the liquefaction-pump. A valve T, for turning on and off the compressed air, is provided near the air-cylinder of the liquefaction apparatus.

The apparatus for compressing the chlorid of ethyl consists of two cylinders—the air-cylinder G and the volatile-fluid compressor E. Both cylinders are connected by a common piston-rod *e*, Fig. 1, which connects with the crank on the fly-wheel. This construction is usually employed in machines to be mounted where space is limited, and therefore it need not be described in detail. Accepted that the chlorid of ethyl is introduced into the system, then the same enters the volatile-fluid compressor E through the pipe p^4. After being compressed the fluid passes through the discharge-pipe p^3 into the condenser F, located above the compartment C^3 on the roof of the car. The condenser is of novel construction. It consists of a system of pipes *f*, arranged so as to leave space inside for the passage of some other pipes. After leaving the condenser the liquefied gas goes down into the reservoir Q, provided with a manometer and a valve at the bottom through which dirt and old oil are drawn off occasionally. On the side of the reservoir there is a conducting-pipe p^5, through which the liquid gas enters into the refrigerator H, consisting of a system of pipes which extend through the width of the car. In pipe p^5, near the reservoir Q, there is a valve I, by means of which the flow of liquid gas is regulated. The refrigerator, consisting of quite a number of pipes, represents a large area for cooling the surrounding air. By adjusting the valve I so that a lower pressure is maintained in the pipes H than in the vessel Q the expansion of the liquid gas is obtained, producing thereby the cold in the well-known manner. It is in this compartment that the air is cooled. From the refrigerator a narrow conducting-pipe p^6 leads into several pipes located within the condenser, which are of larger diameter than the pipe p^6, representing thus a large area. The narrow pipe p^6 acts as a contraction or a valve permanently adjusted, and therefore checks somewhat the flow of the gas from the refrigerator into the pipes p^7, and when the gas leaves the pipe p^6 and enters into the large pipes p^7 then a further expansion of the gas takes place, still lowering thereby somewhat the temperature of same. The gas when leaving the refrigerator is still pretty cold, and by the additional lowering of its temperature in the pipes p^7 the condensation of the gas flowing from the compressor through the condensing-pipes is facilitated. The condenser-pipes, into which the compressed gas flows from the compressor, get warm, and being in contact with the inside pipes p^7, through which the cold exhaust fluid flows, are cooled thereby. The condenser is located on the roof of the car and mounted so that the atmospheric air freely circulates, cooling thereby the outside surface of the condensing-pipes, especially when the car is in motion, because then draft is created. In the described manner the condenser is cooled without any water on the out-

side surface by the air and on the inside surface by the cold pipes p^7, which are in contact therewith. From the pipes p^7 the gas returns to the compressor E through the pipe p^4 and is again compressed and discharged through pipe p^3, running again in the described manner through the system, whereby a continued circulation of the volatile fluid is effected. The compressor E, drawing in the gas, produces a partial vacuum in the system, by means of which the volatilization of the chlorid of ethyl is greatly facilitated, and by means of the valve I the supply of liquid gas for the refrigerator may be so regulated that this partial vacuum is created and maintained. It is plainly seen that this method of circulating and cooling the gas by means of its own expansion in the pipe p^7 presents great advantages. The novel condenser may certainly be constructed differently in so far as the pipes p^7 may be so arranged that they surround the condenser-pipes; but the construction shown in the drawings is preferable.

The exhaust-air which leaves the cylinder G is still pretty cold, and in order to utilize this cold it is conducted through the pipe p^8 down on the air-compressor, which is provided with a jacket, and from there the exhaust-air passes through pipe p^9 into the atmosphere. Other means for cooling the air-compressor, however, may be provided.

As above-mentioned, the air to be compressed is drawn from the refrigerator-compartment in which the air is coldest and driest. Therefore it requires less power for compression and less cooling than when atmospheric air would be employed.

The refrigerator-room is provided in the lower portion of its inner wall with an outlet and air valve W, through which the cold air issues into the storage-compartment C′ of the goods to be transported. This valve has for its purpose to prevent air being drawn from the compartment C′ into the air-compressor. The valve W is very light and opens easily for the passage of the cold air into compartment C′. In fact, a piece of leather or wood hinged to the wall above the opening will answer for this purpose. The suction-pipe p of the air-compressor drawing air from the refrigerator-room causes a circulation of the air in the car, and as the air in the compartment C′ cannot enter the refrigerator-compartment C^2 through the valve U this air is forced to pass through the space of the double ceiling and the serpentine channel created therein by the bars b, keeping in this way the ceiling cool. After leaving the serpentine channel the air reënters the refrigerator-compartment and passes through same and compartment C′ in the direction of the arrows, as shown in Fig. 1, completing thus the circulation of the air, and since it is always cooled while passing through the refrigerator-compartment it will continuously cool the goods in the storage-compartment.

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

1. In a refrigerator-car a refrigerating apparatus comprising a volatile-fluid compressor, a condenser in connection therewith and composed of a system of pipes arranged annularly on the roof of the car, a liquid-fluid reservoir, connecting with the condenser, a valve near the bottom of the reservoir regulating the flow of the liquid fluid, a refrigerator connected with the reservoir, a narrow pipe leading from same and issuing into a system of large cooling-pipes located within the condenser and a pipe connecting the cooling-pipes with the fluid-compressor, as specified.

2. In a refrigerator-car, a refrigerating apparatus comprising a chlorid-of-ethyl compressor, a condenser in connection therewith and composed of a system of pipes arranged annularly on the roof of the car, a chlorid-of-ethyl reservoir connecting with the condenser, a valve near the bottom of the reservoir regulating the flow of the chlorid of ethyl, a refrigerator connected with the reservoir, a narrow pipe leading from same, and issuing into a system of large cooling-pipes located within the condenser and a pipe connecting the cooling-pipes with the chlorid-of-ethyl compressor, as specified.

3. In a refrigerator-car, a refrigerator-compartment in combination with a storage-compartment built of heat-non-conducting walls and floor and a heat-non-conducting roof consisting of the compact non-conducting roof proper, and a hollow ceiling connected with its inside surface and provided between the compact non-conducting roof proper and the ceiling with iron bars arranged so that a serpentine-shaped air-passage is formed, an air-entrance located at one end connecting with the storage-compartment, an air-issue at the other end issuing into the refrigerator-compartment and an inlet for the cold air in the lower portion of the wall separating the storage-compartment from the refrigerator, as specified.

4. In a refrigerator-car a refrigerating apparatus comprising a volatile-fluid compressor, a condenser in connection therewith and composed of a system of pipes arranged annularly on the roof of the car, a liquid-fluid reservoir, connecting with the condenser, a valve near the bottom of the reservoir regulating the flow of the liquid fluid, a refrigerator connected with the reservoir, a narrow pipe leading from the refrigerator and issuing into a system of large cooling-pipes located within the condenser and a pipe connecting the cooling-pipes with the fluid-compressor, in combination with a storage-compartment built of non-conducting walls and

floor having a compact non-conducting roof provided inside with a hollow ceiling with air-entrance from the storage-compartment an air-issue into the refrigerator-compartment and an air-compressor with suction-pipe connecting with the refrigerator-compartment and an air-expansion engine connected with the volatile-fluid compressor, as specified.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

LUDWIG K. BÖHM.

Witnesses:
EVELYN GREEN,
LOUISE WEBER.