No. 621,537. Patented Mar. 21, 1899.

O. P. OSTERGREN & M. BURGER.

APPARATUS FOR LIQUEFYING GAS.

(Application filed Oct. 13, 1898.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1

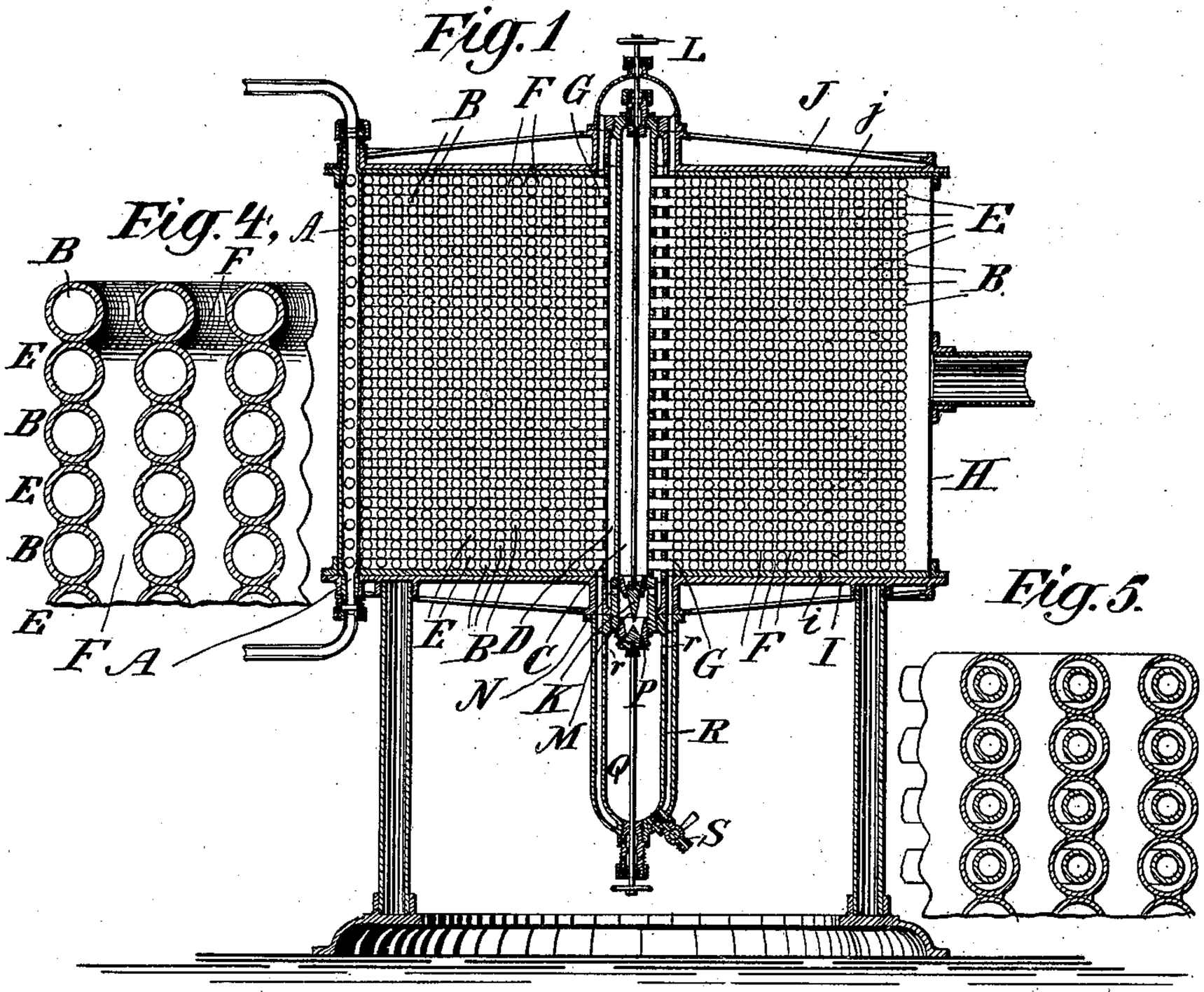
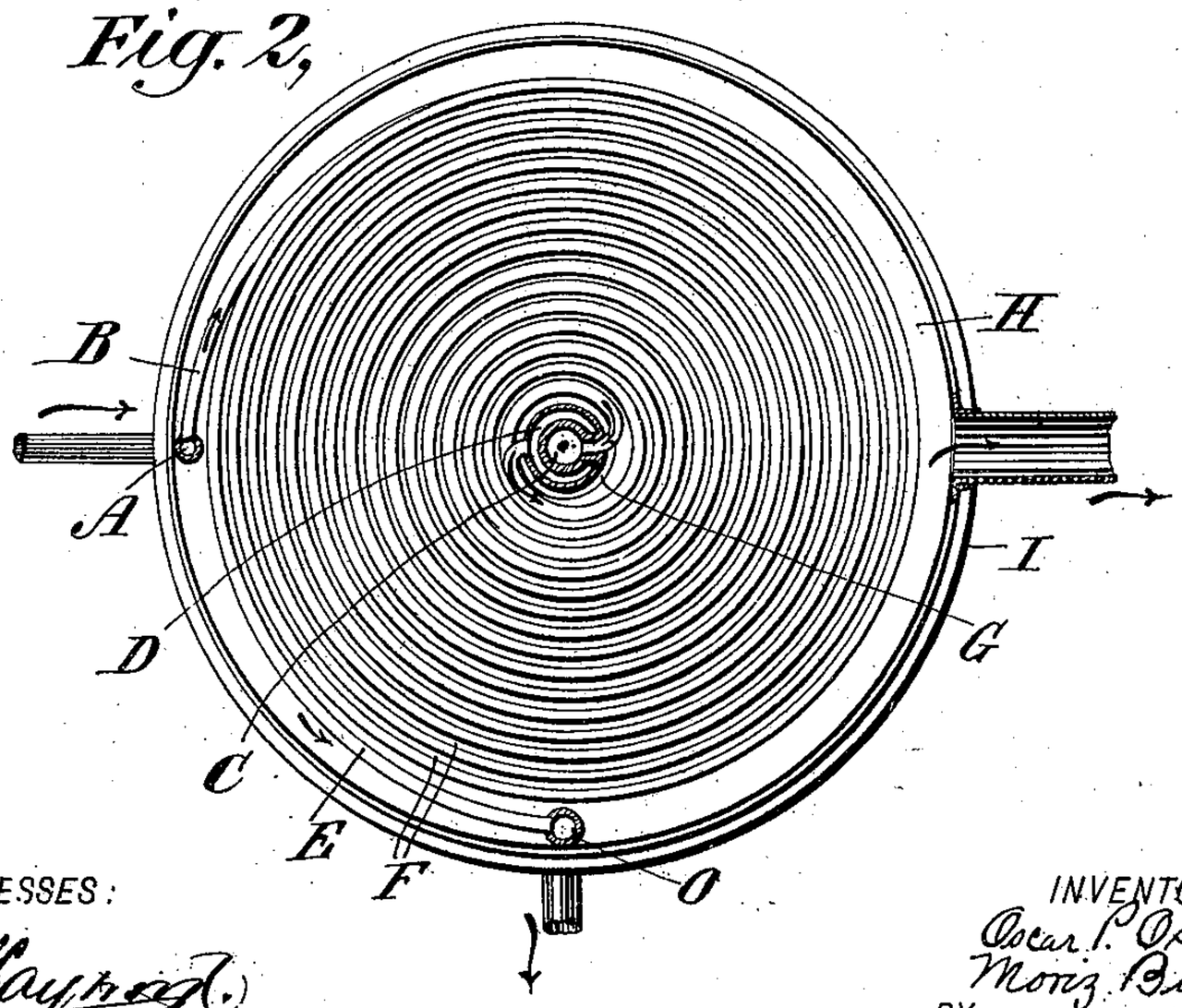


Fig. 4.

Fig. 5.

Fig. 2.



WITNESSES:

D. F. Hayward.

Edw. B. Hawkins

INVENTORS

Oscar P. Ostergren.

Moriz Burger.

BY J. C. Chapin.

ATTORNEYS.

No. 621,537. Patented Mar. 21, 1899.

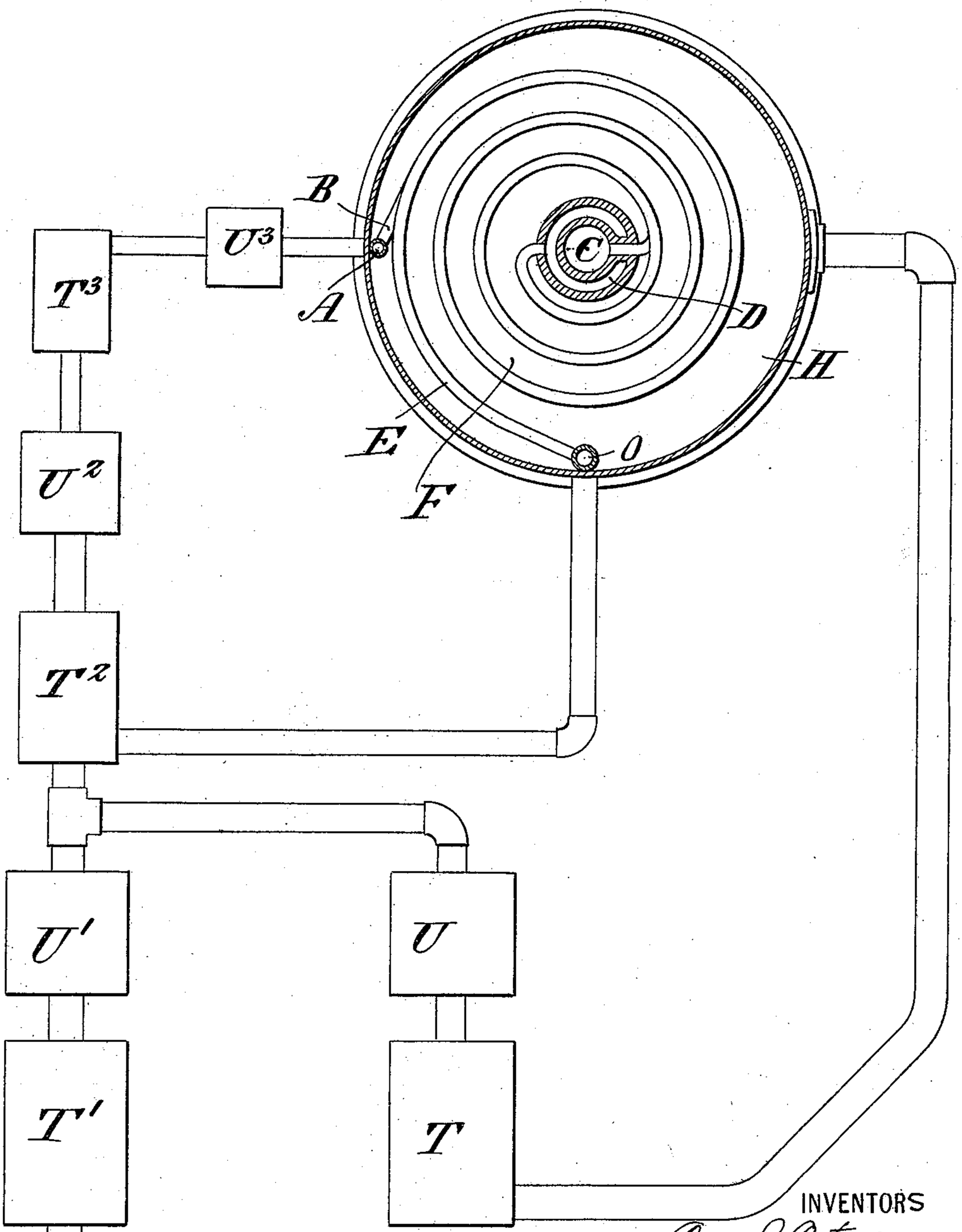
O. P. OSTERGREN & M. BURGER.

APPARATUS FOR LIQUEFYING GAS.

(Application filed Oct. 13, 1898.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 3.



WITNESSES:
D. F. Hayward
Edw B. Hawkins

INVENTORS
Oscar P. Ostergren,
Moriz Burger.
BY
J. C. Chapin.
ATTORNEY

UNITED STATES PATENT OFFICE.

OSCAR P. OSTERGREN AND MORIZ BURGER, OF NEW YORK, N. Y., ASSIGNORS TO THE GENERAL LIQUID AIR AND REFRIGERATING COMPANY, OF NEW JERSEY.

APPARATUS FOR LIQUEFYING GAS.

SPECIFICATION forming part of Letters Patent No. 621,537, dated March 21, 1899.

Application filed October 13, 1898. Serial No. 693,465. (No model.)

To all whom it may concern:

Be it known that we, OSCAR P. OSTERGREN, a subject of the King of Sweden and Norway, and MORIZ BURGER, a citizen of the Confederation of Switzerland, residents of New York, county of New York, State of New York, have invented certain new and useful Improvements in Apparatus for Liquefaction of Gas, of which the following is a specification.

Our invention relates to an improved apparatus for refrigerating or liquefying aeriform fluids or gases, particularly atmospheric air; and it consists in an apparatus adapted to receive air or gas in a compressed and partially-cooled form, the said air or gas being caused to pass through a spiral coil or spiral coils from the periphery to the center of the apparatus, where it is received by a suitable collector. The said air or gas is rendered intensely cold in its passage, as above stated, by means of the action of the return currents of partially-expanded air or gas which are arranged after passing through various expansion-chambers in the middle of the apparatus and having been divided up to return through spiral channels running parallel to the beforementioned coils, the currents, however, flowing in a reverse direction or from the center to the periphery of the apparatus. After the gas or air has passed to the central collector it is divided into the several outgoing currents of different pressures by means of a series of successive expansions, a part of the gas being conveyed through a return-channel at each expansion and the remaining part again expanded until the final expansion takes place in a receiver at low pressure, where a portion of the gas or air becomes liquefied and may be drawn off as desired. As a result of these successive expansions the incoming air is subjected to a more perfect cooling action, thereby increasing refrigeration and effecting economy in the operation. Each of the return currents is conveyed to a compressor and through a compressing and cooling system until they are all again brought to the inlet end of the apparatus, together with such fresh supply of air as may be necessary to take the place of that which has been liquefied.

The object of our invention is to carry on a process of refrigeration and liquefaction on a practical and commercial basis, whereby gas or air may be liquefied and stored up in large quantities at a low cost.

Our invention further consists in certain novel details of construction and combination of parts, as shall hereinafter be more fully described.

We will now proceed to describe our invention with reference to the accompanying drawings, and will then point out the novel features in claims.

Figure 1 is a vertical section of an improved apparatus embodying our invention. Fig. 2 is a horizontal section therethrough. Fig. 3 is a diagrammatic view illustrating a system of compressors and coolers which may be employed. Fig. 4 is a detailed view on an enlarged scale. Fig. 5 is a detail view of a slightly-modified construction.

Similar letters of reference designate corresponding parts in all the figures.

A designates a stand-pipe arranged to communicate with a supply of air, gas, or aeriform fluid, which it is adapted to receive in a compressed and partially-cooled state.

B B designate a series of coils arranged in spiral form and communicating at their outer ends with the stand-pipe A and at the their inner ends with the central collector-pipe C.

D designates a chamber inclosed by a larger pipe, which surrounds the smaller collector-pipe C, the space between the two pipes constituting the said chamber.

E E designate a second series of coils also arranged in spiral form and disposed alternately with the coils B, all of the coils being substantially alike and superposed alternately one above the other in the same vertical plane, as shown in the drawings. The inner end of these second series of coils communicates with the chamber D and the outer ends with a discharge-pipe O.

As thus far described it will be seen that there are two series of coils constituting two channels, the one leading spirally from the inlet stand-pipe to the collector in the middle of the apparatus and the other leading spirally from the chamber D to the discharge-pipe.

The alternate series of coils B B and E E,

superposed in parallel lines, as before stated, are soldered or otherwise secured together, and will thus, as shown more fully in detail Fig. 4, form a continuous spiral vertical wall. The coils are so disposed that between each turn of all the series constituting the wall a space will be left forming a third spiral channel F, which starts from the space G, inclosed by the first turn of the spiral around the pipe D, terminating at the end of the said spiral, and discharges into the collector H. The collector H is here shown as comprising a cylindrical casing surrounding all the coils and supported by a suitable base-plate I. A cap J is provided to inclose the upper portion.

i j designate packing arranged between the lowermost coil and the base-plate I and the topmost coil and the cap J in order to insure an air-tight joint.

K designates a valve fitted to the lower end of the central collector-pipe C and controlling the passage of gas or air therefrom. The valve may be operated by a hand-wheel L, secured to the end of the valve-rod which passes through the collector-pipe.

M designates a chamber which will receive the gas or air passing through the valve K and from whence it may pass through the ports N into the chamber D.

P designates a valve fitted to the lower end of the chamber M and communicating with a receiver Q. The valve is operated by a hand-wheel secured to the valve-rod which passes through the receiver to the exterior thereof.

R designates a chamber surrounding the receiver and communicating with the channel F through the space G. Ports *r r* connect the interior of the receiver with the chamber R.

The operation of the apparatus is as follows: Air or other gaseous fluid in a compressed and partially-cooled form is received in the stand-pipe A, from whence it passes through the coils B B to the collector C. From the collector C it is expanded into the chamber M, (through the valve K,) and a portion thereof will then pass through the ports N into the chamber D and through the coils E to the discharge-pipe O. Upon opening the valve P a certain portion of the highly-compressed and intensely-cold air or gas will be expanded into the receiver Q, when liquefaction will take place, and the liquefied gas or air will fall to the bottom thereof, to be drawn off by a suitable cock there provided. That portion of the air or gas which does not liquefy after passing the valve P will pass through the ports *r r* into the chamber R, to the space G through the spiral channel F into the collector H. The return passage of the air or gas through the coils E B and the channel F will produce an intense coldness, and these outgoing channels completely surrounding the incoming spiral and acting through contact directly on the metal wall of the same will have an exceedingly effective action on the incoming current of compressed air or gas to lower the temperature of same.

By reason of the spiral arrangement of all the channels the apparatus is rendered perfectly self-insulating, the hottest ends of both the incoming and outgoing currents being at the periphery, and an enormous cooling-surface is obtained in a compact form without any loss through conduction or radiation.

A system of compressors and coolers which may be employed is shown diagrammatically in Fig. 3, in which view the arrangement of the spiral coils is also shown diagrammatically in an exaggerated manner in order to more clearly illustrate same.

T′ is intended to represent a compressor for compressing air or gas at atmospheric pressure, and T a compressor for drawing the air or gas from the collector H. U U′ are their respective coolers. The air or gas coming from the collector H will be at about atmospheric pressure or less. T^2 is a compresor for drawing the air or gas from the discharge-pipe O of the coils E E, &c. The compressor T^2 receives the air or gas from said discharge-pipe and compresses it, together with the partially-compressed air or gas from T U T′ U′, and from thence it passes through the required coolers and compressors, as U^2 T^3 U^3, to the stand-pipe A.

It will of course be understood that we do not limit ourselves to the system of compressors and coolers just described, as any arrangement which will compress and cool to a desired amount the air or gas to be liquefied and which will draw off the air or gas from the collector and coils and recompress same may be used in combination with our improved apparatus.

In Fig. 5 we have shown a slightly-modified construction of our apparatus, in which the two series of coils B B and E E are arranged within the other instead of alternately one above the other.

Further description or illustration of such an arrangement is unnecessary, as the construction is obvious from a glance at the drawings.

What we claim is—

1. In a condenser for an air or gas refrigerating and liquefying apparatus, the combination of two spiral concentric channels, one arranged above the other in the same vertical plane, one of said channels arranged to carry the ingoing currents of aeriform fluid, and the other of said channels arranged to carry the outgoing currents of expanded fluid, another spiral channel arranged intermediate of the coils of the first-mentioned spiral channels, and arranged to carry outgoing currents of further expanded fluid, a plurality of expansion-chambers with which said channels are connected, and connections between said expansion-chambers substantially as specified.

2. In a condenser for an air or gas refrigerating and liquefying apparatus the combina-

tion of two spiral concentric channels, each comprising a series of spiral coils, the coils of each series being arranged alternately with each other and in the same vertical plane, and another spiral channel arranged intermediate of the coils of the first-mentioned spiral channels, one of said channels arranged to carry the ingoing currents of aeriform fluid, and the others of said channels arranged to carry the outgoing currents of expanded aeriform fluid, a plurality of expansion-chambers with which said channels are connected, and connection between said expansion-chambers, substantially as specified.

3. In a condenser for an air or gas refrigerating and liquefying apparatus the combination of two series of spiral channels consisting of coils, the coils of each series arranged alternately with each other, a spiral channel arranged intermediate of the coils of the first-mentioned spiral channels, a plurality of expansion-chambers with which the said channels are connected, and valves controlling the connection between the said expansion-chambers substantially as specified.

4. In a condenser for an air or gas refrigerating and liquefying apparatus, the combination with a spiral channel for incoming currents of aeriform fluid under pressure and a plurality of expansion-chambers, connected together, and with one of which the inner end of said channel is connected, of a plurality of spiral channels, concentric with the first-mentioned spiral channel, for outgoing expanded air of successively lower pressures, said spiral channels being connected with successive expansion-chambers, substantially as specified.

5. In a condenser for an air or gas refrigerating apparatus, the combination with a spiral channel for incoming currents of aeriform fluid under pressure, a plurality of expansion-chambers connected together, and with one of which the inner end of said channel is connected, and valves for controlling the connection between the said expansion-chambers, of a plurality of spiral channels, concentric with the first-mentioned spiral channel for outgoing expanded air of successively lower pressures, said spiral channels being connected with successive expansion-chambers, substantially as specified.

6. In a condenser for an air or gas refrigerating apparatus, the combination with a spiral channel for incoming current of aeriform fluid under pressure, a plurality of expansion-chambers, connected together, and with one of which the inner end of said channel is connected, and valves for controlling the connection between the said expansion-chambers, of a plurality of spiral channels concentric with the first-mentioned spiral channel for outgoing expanded air of successively lower pressures, said spiral channels being connected with successive expansion-chambers, means whereby said air or gas may be collected as liquefied and drawn off when desired, substantially as specified.

7. In an apparatus for refrigerating and liquefying gas or air the combination with a spiral channel for incoming currents of aeriform fluid under pressure, a plurality of expansion-chambers connected together, and with one of which the inner end of said channel is connected, and a plurality of spiral channels concentric with the first-mentioned spiral channel for outgoing gas or air of successively lower pressures said spiral channels being connected at their inner ends with successive expansion-chambers of a system of compressors and coolers whereby the expanded gas or air is conducted away from the last-mentioned channels, compressed and cooled and returned to the first-mentioned channel and means for compressing and cooling fresh gas or air to take the place of that liquefied, substantially as specified.

8. In a condenser for an air or gas refrigerating and liquefying apparatus the combination with a series of spiral channels for incoming currents of compressed aeriform fluid, of a series of spiral channels for outgoing currents of expanded aeriform fluid, the said channels carrying the outgoing currents being arranged to completely surround the channels carrying the incoming currents, a plurality of successive expansion-chambers for different pressures connected together, and to the inner ends of the several channels, substantially as set forth.

9. In a condenser for an air or gas refrigerating and liquefying apparatus the combination of a stand-pipe, a central collector, a series of spiral coils connected at their outer ends with the stand-pipe and at their inner ends with the collector, an expansion-chamber, a communication between the collector and the expansion-chamber, another series of spiral coils arranged alternately with the first series, and in the same vertical plane therewith, said coils being connected at their inner ends with said expansion-chamber and at their outer ends with a common return-pipe, another expansion-chamber, communicating with the aforesaid expansion-chamber, and another spiral channel arranged intermediate of each turn of the spiral coils, the inner end of said channel being connected to the last-mentioned expansion-chamber, substantially as specified.

Signed at New York, N. Y., this 30th day of September, 1898.

OSCAR P. OSTERGREN.
MORIZ BURGER.

Witnesses as to Ostergren:
J. C. CHAPIN,
S. M. GARDENHUE.
Witnesses as to Burger:
B. BERNNARD,
S. W. VANDIVERT.