March 26, 1940. P. HADAMOVSKY 2,194,654

APPARATUS FOR LIQUEFYING GASES

Filed Feb. 19, 1938

Fig. 1

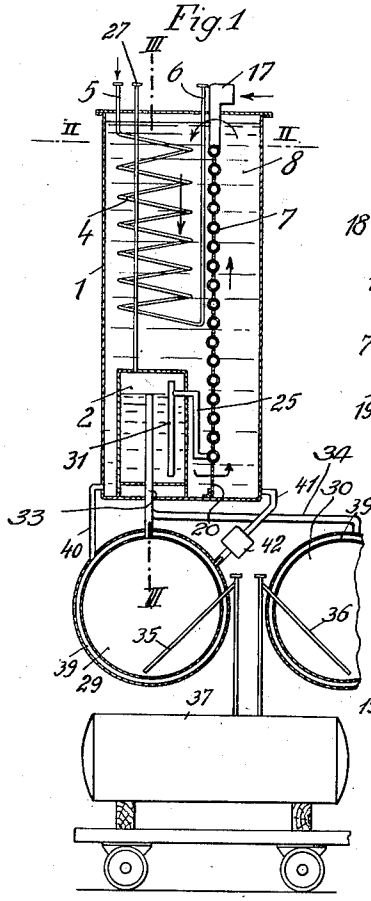


Fig. 3

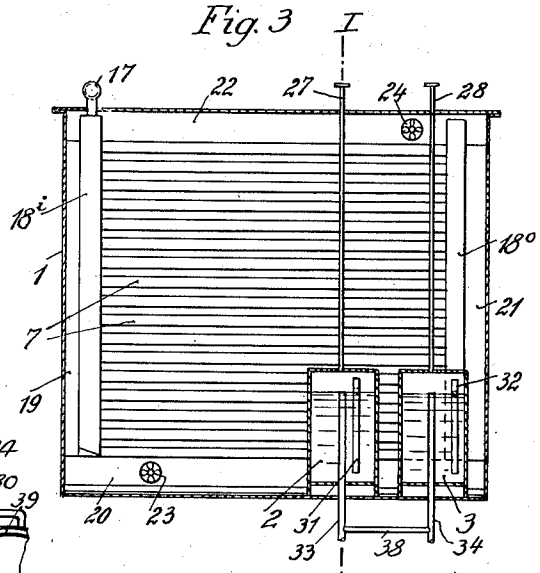


Fig. 2

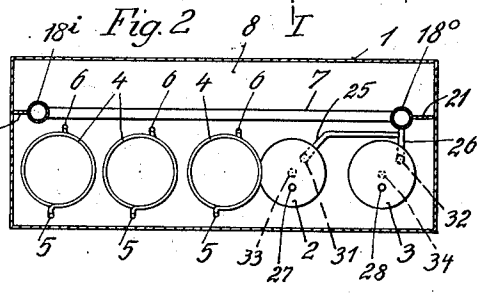


Fig. 8

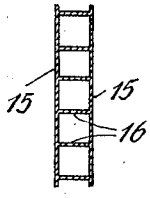


Fig. 7

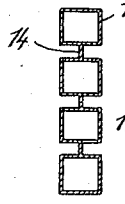


Fig. 6

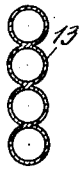


Fig. 5

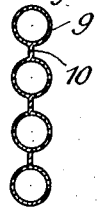


Fig. 4

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APPARATUS FOR LIQUEFYING GASES

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Application February 19, 1938, Serial No. 191,375
In Germany May 11, 1936

8 Claims. (Cl. 62—122)

My invention relates to an apparatus for liquefying gases.

It is an object of my invention to so design an apparatus of this type that, under otherwise equal conditions, its size is considerably reduced.

To this end, in combination with a vessel, and a heat-transmitting fluid in the vessel, I arrange means for cooling the heat-transmitting fluid in the vessel, and a partition wall by which the vessel is subdivided into two compartments. The partition wall comprises ducts for the passage of the gas which is to be liquefied and defines at least two apertures arranged at different levels in the partition wall, for connecting the two compartments.

This liquefier-partition wall, or condenser, replaces the usual condenser coils, with their large diameter, and occupies a minimum space. In addition, it provides for an efficient circulation of the heat-transmitting fluid in the two compartments of the vessel.

It is another object of my invention to reduce still further the overall size of my apparatus.

To this end, in combination with the means aforesaid, I provide at least one container in the vessel for storing the liquefied gas.

I am aware that this has already been proposed, but not in combination with the liquefier-partition wall, so that the condenser coils remained and not only occupied space but also interfered with the circulation of the heat-transmitting fluid, which the liquefier-partition wall according to my invention does not do.

Further objects and features of my invention will appear from the following detailed description in connection with the accompanying drawing, showing by way of example and schematically one embodiment of the invention, viz—

Figure 1 is a schematic cross section, on line I—I in Figure 3, through a cooling and liquefying plant having the invention applied thereto.

Figure 2 is a schematic plan view, and

Figure 3 a schematic longitudinal section, on line II—II in Fig. 1.

Figures 4, 5, 6, 7 and 8 are cross sections of various forms of ducts in the liquefier-partition wall, or condenser.

Similar numerals refer to similar parts throughout the several views and figures.

Referring now to the drawing in greater detail, it will be seen in Fig. 3 that two containers 2 and 3 for storing the liquefied gas are arranged in a vessel 1 besides coils 4, with an inlet 5 and an outlet 6 for the cooling fluid. 7 is the liquefier-partition wall referred to, which, as shown in Figure 1, subdivides the vessel 1 into a larger compartment at the left in which the cooler coils 4 and the containers 2 and 3 are positioned, and a smaller compartment at the right. The partition comprises a set of horizontal pipes 9 connected by strips 10, as illustrated in Figure 4, an inflow header 18*i* and an outflow header 18*o*, and in this manner it is formed as a condenser for the gas to be liquefied, whereby it is rendered possible to reduce the size of the vessel 1 compared to ordinary plants of this kind, with their large condenser coils, and to accommodate the containers 2 and 3. Due to this reduction in the volume of the vessel 1, the amount of heat-transmitting fluid, normally salt-water or brine 8 which has to be circulated in the vessel 1 is reduced considerably.

Modified constructions of the partition wall 7 are represented in Figures 5 to 8. According to Figure 5 the tubes 13 are directly connected, for example, by welding while Figure 6 indicates a form in which corrugated sheets 11 are connected to form ducts of rhomboid cross section. According to Figure 7 tubes of a square cross section 12 are connected with each other by plates 14. It will be understood that any other suitable form of partition walls may be used within the scope of my invention as will appear to one skilled in the art. For instance, according to Figure 8, the condenser 7 may consist of two plates 15 held in a spaced relationship by means of interposed spacers or strips 16. The spacers 16 may at the same time serve to guide the gases in the space between the plates. In this manner, on the one hand, the condenser 7 subdivides the vessel 1 into two compartments, which coils could not do, and, on the other hand, the efficiency of its ducts, or pipes, is practically equal to that of coils with respect to heat transfer.

The vessel 1 may have any suitable form, for instance it may be oval, circular or polygonal, more particularly in a rectangular form as shown, and one or more partitions 7 in the form of condensers may be provided. The liquefier-partition, or condenser, 7 may also be modified as desired, and I am not limited to the embodiment shown in Figure 1, with its inlet header 18*i* for distributing the gas entering (for example, from an electrolyser) at 17 over the pipes of the condenser 7 at the inlet end, and the header 18*o* at the outlet end.

Nor am I limited to the structure which will now be described.

A pipe 26, with a vertical extension 32, conducts the condensate from the outlet header 18o to the container 3, and a branch pipe 25, with a vertical extension 31, extends from the pipe 26 to the container 2. The extensions 31 and 32 are open at the top and at the bottom, so that the liquefied gas, for instance, chlorine, is delivered to the base of each container while non-condensed gaseous admixtures to the chlorine escape at the top of each extension and are abducted by vent pipes 27 and 28. Overflow pipes 33 and 34 are arranged in the respective containers, and connected below the bottom of the vessel 1 by a pipe 38. The overflow pipes 33 and 34 open, respectively, into storage tanks 29 and 30 arranged just below the containers so that the liquefied chlorine is not heated by the ambient air while flowing to the tanks. Each tank has a cooling jacket 39, as shown for the tank 29, which is connected to the compartments at the left and at the right of the condenser 7 in the vessel 1 by pipes 40 and 41, respectively. Syphons 35 and 36 are provided in the respective storage tanks, for delivery to a tank truck 37.

The condenser 7 is supported in the vessel 1 by a frame having vertical members 19 and 21, and horizontal members 20 and 22. The frame members are strips of sheet metal and are soldered or welded, or otherwise connected, to the headers 18i and 18o, and to the topmost and the lowermost pipe of the condenser 7, respectively, on the one hand, and to the inner side of the vessel 1 on the other hand.

For circulating the liquid in the two compartments, as indicated by the arrows in Fig. 1, at least one aperture is provided above and below the condenser 7. In the example illustrated, an aperture 23 is made in the lower horizontal frame member, and an aperture 24 is made in the upper horizontal frame member 22, the two apertures being arranged near opposite ends of the respective members. Impellers may be inserted in the apertures, and be driven by any suitable means, not shown, for positive circulation of the fluid 8.

The operation of the plant is as follows: The cooling medium. Such as for example ammonia, enters into the coils 4 at 5 and after passage through the same flows off at 6. It is clear that the brine 8 will be cooler in the left hand compartment of the vessel 1 in Figure 1 than in the right hand compartment so that it tends to rise in the right and to fall in the left hand compartment of the vessel 1 which compartments communicate with each other through the apertures 23 and 24. The brine is caused to circulate in the vessel 1 in a counter-clockwise direction. Thus an efficient exchange of heat will take place between the condenser 7 and the coils 4 and the gas in the condenser tubes which are preferably slightly inclined will be condensed and flow through the outflow header 18o and connecting pipes 24, 25, 26 into the containers 2 and 3 which due to their arrangement in the vessel 1 are always immersed in the cold brine so that any heating and evaporation of liquefied chlorine is practically avoided. The chlorine level rises very slowly in the containers and the liquid is allowed to flow off in the same measure through the pipes 33 and 34 the upper ends of which determine the level of the liquid in the containers. The discharge openings or pipes 33 and 34 may be laterally arranged, if desired.

The chlorine now flows by gravity through the pipes 33 and 34 into the storage tanks 29 and 30 which, as described, are located immediately underneath the containers 2 and 3, so as to discharge the liquid substantially at the very low temperature, to which it has been cooled in the vessel 1 into the tank truck 37, through the siphon pipes 35 and 36, without requiring application of pressure.

The pipes 33 and 34 being connected by the pipe 38, valves—not shown—may be provided for alternating discharge of the containers 2 and 3.

The storage tanks 29 and 30, require good heat insulation, as the condensate often is in the tanks 29 and 30 for several days. In order to prevent re-evaporation of the condensate, the tanks 29 and 30 are preferably cooled by the cold brine, by the double walls 39 which are connected with the vessel 1 by the pipes 40 and 41 and the jackets 39 are supplied with circulating brine by one or more pumps as at 42.

My apparatus, in addition to its smallness, has the advantage that the resistance to the circulation of the heat-transmitting fluid in the vessel is much reduced as compared with the usual condenser coils, so that the fluid is freely circulated, whereby the cooling effect is increased and a higher demand of cooling action can be easily met with. In view of the small amount of brine which is required even for a large output and the low weight of liquefying apparatus following therefrom, the apparatus can be mounted, for instance, in the second floor of a building. In this case, the liquid chlorine can be delivered to the storage tanks and from the storage tanks into the tank trucks by gravity.

While I have herein shown and described certain preferred embodiments of my invention, I wish it to be understood that I do not confine myself to all the precise details herein set forth by way of illustration, as modification and variation may be made without departing from the spirit of the invention or exceeding the scope of the appended claims.

I claim:

1. In an apparatus for liquefying gases, in combination a vessel, a heat-transmitting fluid in said vessel, means in said vessel for cooling said heat-transmitting fluid, at least one container for storing the liquefied gas, arranged in the said vessel so as to be cooled by said heat-transmitting fluid and a partition wall by which said vessel is divided into two compartments which are connected by at least two apertures in said partition wall, said partition wall comprising ducts for passage of the gas which is to be liquefied.

2. In an apparatus for liquefying gases, in combination a vessel, a heat-transmitting fluid in said vessel, means in said vessel for cooling said heat-transmitting fluid, at least one container for storing the liquefied gas, arranged in the said vessel so as to be cooled by said heat-transmitting fluid, a partition wall by which said vessel is divided into two compartments which are connected by at least two apertures in said partition wall that comprises ducts for passage of the gas to be treated and a pipe connection between said ducts and said container which is substantially longer than the distance between said ducts and said container.

3. In an apparatus for liquefying gases, in combination a vessel, a heat-transmitting fluid in said vessel, means in said vessel for cooling said heat-transmitting fluid and a partition wall by

which said vessel is divided into two compartments which are connected by at least two apertures in said partition wall, said partition wall comprising a plurality of tubes for the passage of the gas which is to be liquefied and means for connecting said tubes to form a substantially impermeable partition wall.

4. In an apparatus for liquefying gases, in combination a vessel, a heat-transmitting fluid in said vessel, means in said vessel for cooling said heat-transmitting fluid and a partition wall by which said vessel is divided into two compartments which are connected by at least two apertures in said partition wall, said partition wall comprising a plurality of tubular channels for the passage of the gas which is to be liquefied and sheet metal plates connecting said tubes to form a substantially impermeable partition wall.

5. In an apparatus for liquefying gases, in combination a vessel, a heat-transmitting fluid in said vessel, means in said vessel for cooling said heat-transmitting fluid and a partition wall by which said vessel is divided into two compartments which are connected by at least two apertures in said partition wall, said partition wall comprising at least two plates and strips between these plates for forming tubular channels for the passage of the gas which is to be liquefied.

6. In an apparatus for liquefying gas, in combination a vessel, a heat-transmitting fluid in said vessel, means in said vessel for cooling said heat-transmitting fluid, at least one container for storing the liquefied gas, arranged in the said vessel so as to be cooled by said heat-transmitting fluid, a partition wall by which said vessel is divided into two compartments which are connected by at least two apertures in said partition wall that comprises ducts for passage of the gas to be treated and a pipe connection between said ducts and said container comprising a tube extending nearly to the bottom of said container and projecting with its open upper end above the level of the liquid in the storage container.

7. In an apparatus for liquefying chlorine gas, in combination a vessel, a heat-transmitting fluid in said vessel, means in said vessel for cooling said heat-transmitting fluid, at least one container for storing the liquefied gas, arranged in the said vessel so as to be cooled by said heat-transmitting fluid, a partition wall by which said vessel is divided into two compartments which are connected by at least two apertures in said partition wall that comprises ducts for passage of the gas to be treated, and a pipe connection between said ducts and said container which is substantially longer than the distance between said ducts and said container.

8. In an apparatus for liquefying chlorine and gases of a similar physical nature, in combination a vessel, a heat-transmitting fluid in said vessel, means in said vessel for cooling said heat-transmitting fluid, at least one container for storing the liquefied gas, arranged in the said vessel so as to be cooled by said heat-transmitting fluid, a partition wall by which said vessel is divided into two compartments which are connected by at least two apertures in said partition wall that comprises ducts for passage of the gas to be treated, and a pipe connection between said ducts and said container which is substantially longer than the distance between said ducts and said container.

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