

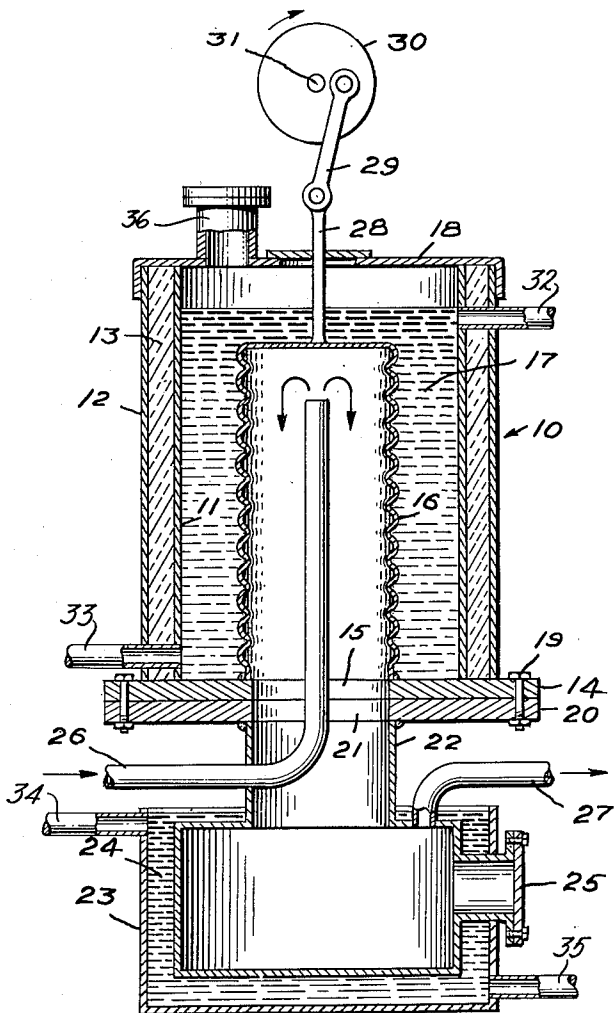
Jan. 15, 1952

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2,582,250

CONDENSER AND METHOD OF CONDENSING

Filed Oct. 6, 1947



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UNITED STATES PATENT OFFICE

2,582,250

CONDENSER AND METHOD OF CONDENSING

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Application October 6, 1947, Serial No. 778,168

7 Claims. (Cl. 62—172)

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This invention relates to a lyophilizing condenser and to a method of condensing.

Lyophilization is the process of preparing in dry form substances, particularly biological substances and the like, such as blood plasma, antitoxins, toxins, and serums, by removing the water content thereof at low temperatures under high vacuum. Typically, the substance remains in the frozen state during the dehydration process as a result of the cooling effect of the evaporation of water under high vacuum.

Lyophilizing systems commonly include a low temperature condenser in the line leading from the zone in which water vapor is removed from the frozen material to the vacuum pump. Because of the low temperature and pressure maintained in the condenser, the water vapor deposits upon the condensing surfaces in the form of ice. The deposited film of ice rapidly increases in thickness, and, because of its insulating qualities, soon interferes materially with the efficiency of the condenser.

Various ways have been devised for removing ice from the condensing surfaces. In some prior systems the apparatus is shut down, the ice on the condensing surfaces is melted and the resulting water is removed before the apparatus can be returned to service. In other prior systems, the ice is continuously removed from the condensing surfaces by mechanically operated blades that scrape the ice from the condensing surfaces.

An object of the present invention is to provide a condenser that may be continuously operated in a lyophilizing system for long periods of time without requiring shut-downs for the removal of ice.

Another object is to provide such a condenser wherein ice is removed from the condensing surfaces almost as soon as it is formed and is not allowed to build up to a thickness that would lower condenser efficiency.

Another object is to provide a lyophilizing condenser having no scraper shaft penetrating the walls of the condenser and giving rise to leakage about the shaft.

Other objects are to provide a condenser of the type in question that is economical and simple to manufacture and operate, that is highly efficient in operation, and that requires a minimum of attention and maintenance.

Still another object is to provide a method of condensing substances that pass directly from the gaseous to the solid state wherein the condensed solid material is readily removed from the condensing surfaces.

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In accordance with the invention, the condenser typically includes a condensing chamber, means providing flexible condensing surfaces exposed to gas within said chamber, gas inlet means and gas outlet means communicating with said chamber, and means for flexing said condensing surfaces.

In an illustrative embodiment, the condenser takes the form of a device wherein a metallic Sylphon bellows provides a portion of the walls of the condensing chamber and also provides the flexible condensing surfaces. The bellows is flexed by mechanical means to break the ice from the interior walls of the bellows. A sump for receiving the flake ice is positioned below and in communication with the bellows. Conduit means leading gas, principally water vapor, from the evaporator or sublimator extends into the bellows and a conduit connects the sump with the evacuating device.

The foregoing and other aims and advantages of the invention will be in part apparent and in part pointed out in the following description of one embodiment as shown in the accompanying drawing wherein the single figure is a vertical sectional view of a lyophilizing condenser embodying the principles of the invention.

Referring to the drawing, the condenser shown has a main cooling jacket 10 having double side walls 11 and 12 including therebetween the insulating layer 13. The side walls of the jacket are supported upon a base plate 14 having a central opening 15. A Sylphon bellows 16 is welded to the base plate about the opening 15. The bellows is preferably of metallic construction and is closed at the top. In the space 17 between the bellows 16 and the jacket 10 a refrigerating liquid, preferably one having a temperature of -40° C. or lower, is received for the purpose of cooling the bellows. Refrigerating liquid is introduced into the space 17 through the inlet pipe 33 and overflow therefrom leaves through the outlet pipe 32. The jacket is provided with a cover 18 which may be of insulating material to minimize absorption of heat from the outside. A manhole 36 is provided in the cover 28.

Secured to the underside of the base plate 14 by means of bolts 19 is another similar plate 20. A gasket may be pressed between the plates to insure a gas-tight fit. The lower plate 20 has a central opening 21 that registers with the opening 15 of the base plate 14. A sump or ice receiver 22 is secured by a gas-tight joint to the plate 20 and a cooling jacket 23 surrounds the

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sump and is adapted to maintain a refrigerant 24 in contact with the sump. Refrigerant is circulated through the cooling jacket 23, it being admitted through inlet 35 and discharged through outlet 34. The sump may be provided with a man-hole 25 through which accumulated ice may be removed.

Gas from the evaporating zone is introduced to the condenser through inlet pipe 26 that passes through the neck of the sump and is bent upwardly and extended axially into the bellows 16 to a point near the top. The gas outlet pipe 27 is connected to the evacuator and non-condensed gas leaves the apparatus through this pipe.

A mechanical device is advantageously employed for flexing and supporting the bellows in the illustrated embodiment, but it will be evident to those skilled in the art that other suitable flexing devices may be employed within the teaching of the present specification. The flexing device shown includes a rod 28 welded to the top of the bellows and extending through a hole in the jacket cover 18. A pitman 29 connects the rod 28 with a crank 30 rotating on shaft 31 to impart a vertical oscillating motion to the bellows 16.

In operation, the jackets 10 and 23 are filled with refrigerant, the crank 30 is rotated, and the evacuator, connected to pipe 27, draws gas from the evaporator, connected to pipe 26, through the apparatus in the direction of the arrows. It will be understood that the vacuum pump is of sufficient capacity to maintain a very low absolute pressure in the condenser, such pressure preferably being less than 2 or 3 mm. of mercury and even being less than 1 mm.

Water vapor from the inlet pipe impinges on the inner flexing walls of the bellows and condenses thereon in the form of a film of ice. Before the film of ice can develop a substantial thickness, the flexing of the bellows cracks the film and exfoliates thin laminae of ice which drop into the sump 22, thus continuously exposing fresh surfaces for the condensation of additional water vapor. The sump 22 may be cleaned as necessary through the manhole 25.

The flexible condensing surface of the apparatus of the present invention may take other desirable forms. For example, a flexible coiled pipe through which refrigerant is circulated may be used as a condenser. Also, other means than is shown may be employed to flex or vibrate the condenser such as electrical, magnetic, or fluid flexing means.

From the foregoing description it will be seen that the present invention provides a condenser for use in low temperature, high vacuum drying systems that has high efficiency and excellent heat transfer characteristics and wherein the ice removal problem is solved in a very satisfactory manner.

We claim:

1. A condenser for low temperature, high vacuum condensation which comprises a substantially closed flexible envelope providing a condensing chamber sealed with relation to the external atmosphere and having an internal condensing surface, said envelope being constructed and arranged to substantially maintain its shape under a pressure drop of at least about one atmosphere thereacross, means providing a sump communicating with said envelope, gas inlet and gas outlet means communicating with said envelope, means for cooling said envelope, and

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means external to said envelope for flexing said envelope.

2. A lyophilizing condenser comprising a substantially closed bellows providing a condensing chamber sealed with relation to the external atmosphere, said bellows being constructed and arranged to substantially maintain its shape under a pressure drop of at least about one atmosphere thereacross, sump means communicating with said chamber, gas inlet and gas outlet means communicating with said bellows, a jacket surrounding said bellows for the reception of a cooling medium, and mechanical means external to said bellows for flexing said bellows.

3. A lyophilizing condenser comprising a substantially closed bellows providing a condensing chamber sealed with relation to the external atmosphere, said bellows being constructed and arranged to substantially maintain its shape under a pressure drop of at least about one atmosphere thereacross, sump means communicating with said chamber, gas inlet and gas outlet means communicating with said bellows, a jacket surrounding said bellows for the reception of a cooling medium, a jacket surrounding said sump for the reception of a cooling medium, and mechanical means external to said bellows for flexing said bellows.

4. A lyophilizing condenser comprising a substantially closed bellows providing a condensing chamber sealed with relation to the external atmosphere, said bellows being constructed and arranged to substantially maintain its shape under a pressure drop of at least about one atmosphere thereacross, sump means communicating with said chamber, gas inlet and gas outlet means communicating with said bellows, means for cooling said bellows, and mechanical means external to said bellows for flexing said bellows.

5. A method of condensing substances that condense directly to the solid condition which comprises conducting a gas comprising a substance that condenses directly to the solid state into contact with a flexible condensing surface in a confined zone maintained at sub-atmospheric pressure and at a temperature to deposit solid material thereon, and breaking said solid material from said surface by changing the contour of said surface by the application externally of said zone of forces external to said zone.

6. A condenser for low temperature, high vacuum condensation which comprises a substantially closed condensing chamber sealed with relation to the external atmosphere and having a flexible wall section constructed and arranged to substantially maintain its shape under a pressure drop of at least about one atmosphere thereacross, means for cooling the flexible wall section of said condensing chamber, gas inlet means and gas outlet means communicating with said condensing chamber, and means external to said condensing chamber for flexing the flexible wall section thereof.

7. A lyophilizing condenser comprising a generally cylindrical vertical metallic bellows, a member hermetically sealing the upper end of said bellows, sump means hermetically sealed to the lower end of said bellows and communicating with the interior of said bellows through an opening of substantially the same diameter as said bellows, a gas inlet pipe extending through and sealed in a wall of said sump, the inner end of said pipe extending upwardly through said orifice and terminating adjacent the upper end of said bellows, a gas outlet pipe communicating

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with said sump, a man-hole communicating with said sump and having a removable cover, a jacket surrounding said bellows for the reception of a cooling medium, a jacket surrounding said sump for the reception of a cooling medium, and mechanical means external to said bellows and connected to said member sealing the upper end of said bellows to impart limited vertical reciprocating movement to said member.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,878,759	Copeman	Sept. 20, 1932
2,066,302	Reichel	Dec. 29, 1936
2,406,682	Hayes	Aug. 27, 1946