March 6, 1962 E. T. BOOTH, JR., ET AL 3,024,009

CONDENSATION CAN

Filed May 8, 1944 2 Sheets-Sheet 1

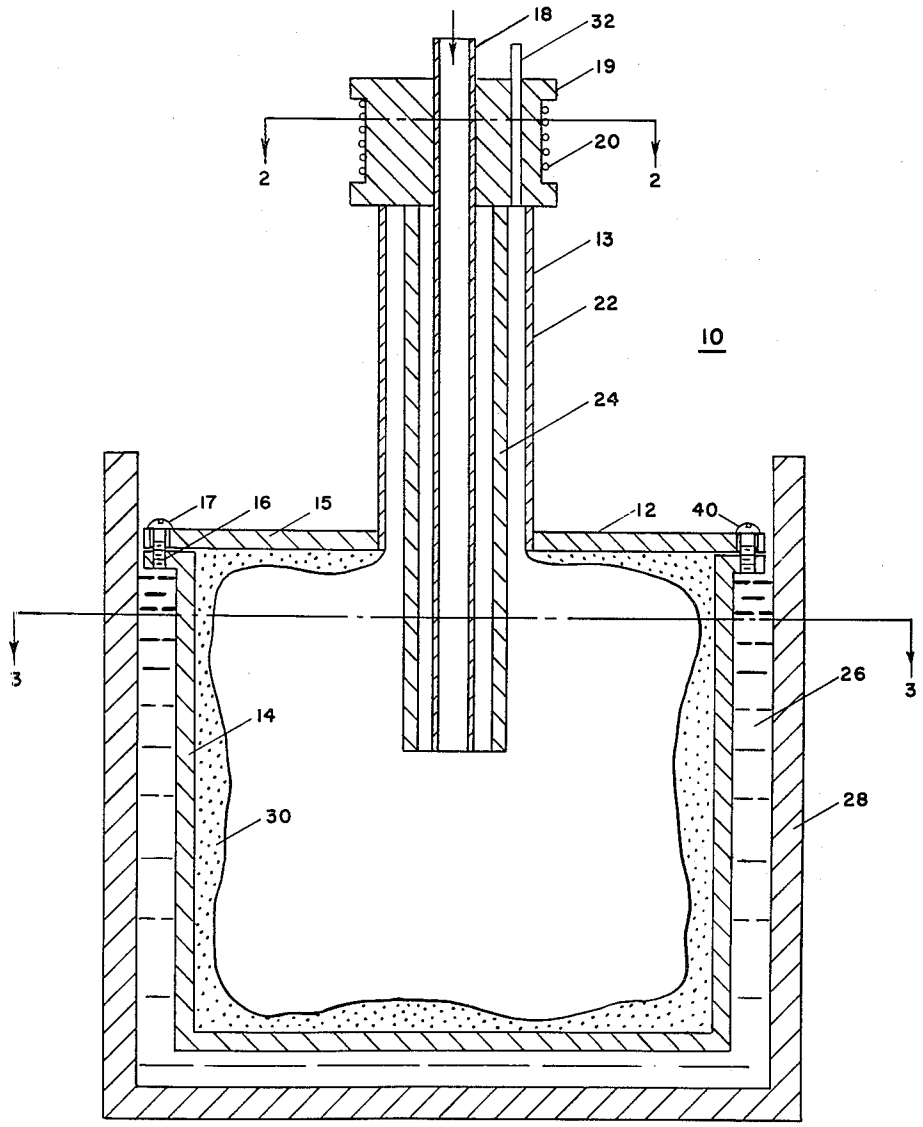


Fig. 1

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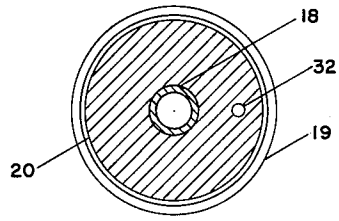


Fig. 2

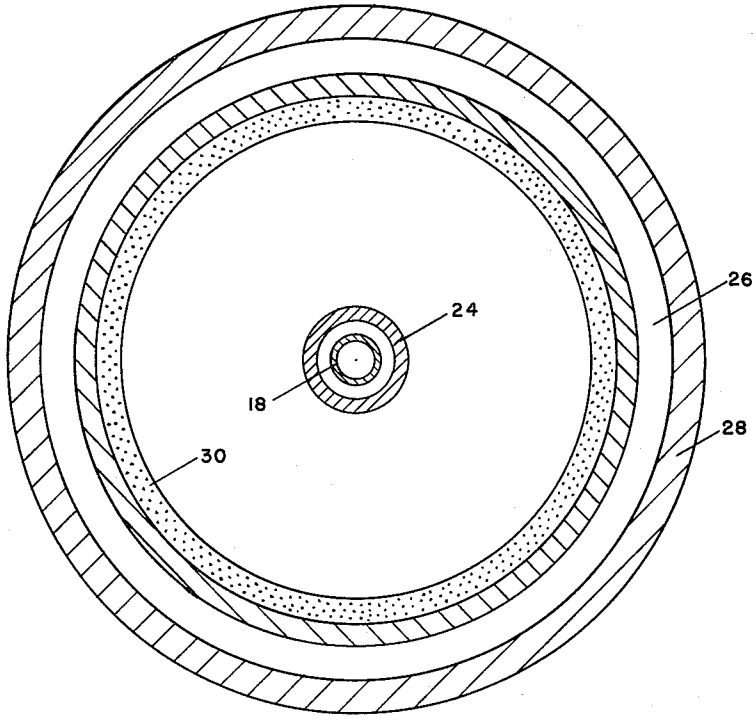


Fig. 3

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CONDENSATION CAN

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This invention relates to apparatus for condensing a vapor to a solid and more particularly to an improved type of freeze-out trap or condenser for condensing a vapor to a solid at relatively low back pressures. The problems involved in condensing a vapor to a solid differ in a number of significant respects from the problems involved in condensing a vapor to a liquid. When a vapor is condensed to a liquid by bringing the vapor into contact with a refrigerated surface, the liquid because of its mobility tends to flow under the influence of gravity to the lowest point on the refrigerated surface and hence may be easily removed from the condenser and collected in a suitable container. However, when a sublimate vapor is brought into contact with a refrigerated surface, the solid formed usually tends to adhere to the surface on which it is formed at the point of condensation and in most cases a separate operation is required to remove the solid from the surface. Thus conventional types of condensers cannot ordinarily be used satisfactorily for condensing a sublimate.

In many cases the layer of solid built up by condensation on a refrigerated surface has a lower thermal conductivity than the refrigerated surface and hence reduces heat transfer from the vapors to the surface, thus reducing the rate of condensation at that point on the surface. In order to obtain desired thermal efficiency in the condensation process and make the most effective use of the refrigerant surface available, it is desirable that the condenser be so constructed that the solid sublimate will deposit at a reasonably uniform rate over the entire area of the refrigerated surface. To the extent that the layer of deposited solid is of non-uniform thickness, portions of the refrigerated surface will operate at less than optimum efficiency.

If the sublimate vapors are merely led into a condensing chamber through a conduit, there is a tendency for the solid to deposit most heavily at the point where the vapors enter the chamber and thus the portions of the refrigerated surface immediately adjacent the inlet do most of the work of condensation and the areas remote from the inlet area are not used as effectively as they should be. As pointed out above, this non-uniform deposition of the solid results in uneconomical operation of the condensing system. Furthermore, continued deposition of the solid at the point where it enters the condensing chamber may partially block off or clog the inlet thus reducing the flow of vapors to the condenser and in some cases creating an undesirable back pressure in the inlet conduit.

It is an object of the present invention to provide an improved condenser for condensing vapors to form a sublimate.

It is a further object of the invention to provide a condenser of this type which is of simple construction and may be operated with high thermal efficiency.

It is still another object of the invention to provide a condenser which is so constructed that sublimate vapors coming into contact with the refrigerated surfaces of the condenser will deposit in a layer of relatively uniform thickness.

It is another object of the invention to provide a condenser which will maintain a relatively low back pressure on a sublimation system.

Other objects of the invention will be in part obvious and in part pointed out hereinafter.

The objects and advantages of the present invention may best be appreciated by reference to the accompanying drawing which illustrates a preferred embodiment of the invention, and wherein:

FIG. 1 is an axial vertical section through the condenser showing the condensing chamber and the construction and arrangement of the inlet conduit and associated parts;

FIG. 2 is a horizontal section taken on the line 2—2 of FIG. 1 and showing the heating element and outlet conduit; and

FIG. 3 is a horizontal section taken on the line 3—3 of FIG. 1.

Referring to the drawings the numeral **10** generally designates a condenser including a condensing chamber **12** and an inlet **13**. The condensing chamber **12** comprises a sublimate receiver or container **14** and a cover plate **15**, the receiver **14** being provided with a peripheral flange **16** as shown. Cover plate **15** is a held against flange **16** to form a gas-tight seal in any suitable manner such as by the bolts **17**.

Vapors to be condensed enter the condenser through an inlet conduit **18** which extends into the chamber **12** to approximately the geometric center of the chamber. The entering vapors are heated by a heating element **19** located in heating relationship with respect to the conduit **18** at a point outside of the chamber **12**. In the embodiment shown in the drawing the element **19** is electrically heated by a winding of resistance wire **20**, although it is apparent that any other suitable type of heating element might be used. The quantity of heat supplied should be sufficient to prevent condensation of the vapor before it leaves the inlet conduit **18** and passes into the interior of chamber **12**.

The element **19** is mounted on an inlet neck **22** which extends from the heating element to the cover plate **15**. Within the neck **22** and surrounding the conduit **18** there is provided a tubular radiation shield **24** to reduce loss of heat from the conduit **18** and prevent condensation of the vapor within the conduit. The shield preferably extends into the chamber **12** to the same extent as the conduit **18** and is maintained at an elevated temperature by heat supplied from the heating element **19**.

The condenser is preferably made of a suitable heat conducting material which may be, for example, copper. The chamber **12** may be refrigerated in any suitable manner such as, for example, by partially immersing the chamber in a refrigerant **26** in a container **28**.

The operation of the condenser **10** is apparent from the above description. The entering vapors are heated by the heating element **19** and pass downwardly through the conduit **18** to the interior of chamber **12** where they are condensed to a solid **30** on the refrigerated walls of the chamber. The radiation shield **24** maintains the temperature of the vapors above the condensation temperature until after they have left the lower end of conduit **18** and hence eliminates the possibility of condensation of the vapors within the conduit and consequent building up of a back pressure in the conduit. Since the vapors are conducted to the center of the condensing chamber, the sublimate will deposit in a relatively uniform manner on the inner surfaces of the chamber. In this way the refrigerant and refrigerated surfaces are efficiently and economically utilized.

When the desired quantity of sublimate has been formed the condenser may be disassembled by removal of the cover plate **15** and the sublimate removed from the receiver **14**.

The condenser of the present invention may be operated at any desired pressure. Near the top of the neck 22 there is provided an outlet conduit 32 which may be open to atmosphere or may be connected to a source of high or low pressure. For example, the conduit 32 may be connected to a vacuum pump or other instrumentality for maintaining reduced pressure in the condenser and associated apparatus.

The condensing chamber 12 may be of any desired shape. It is probable that the most nearly uniform thickness of deposit would be obtained by introducing the vapors into the center of a spherical chamber. However, as a practical matter it will usually be desirable to construct the chamber in cylindrical form as shown or in rectangular form.

It is apparent that the structure described above can be used in a variety of ways for a variety of purposes. Thus, in cases where the sublimate vapors are associated with a non-condensible gas or vapor the condenser may be used as a separator and the uncondensed gases withdrawn through the conduit 32. Where continuous operation is desired, two or more condensers may be connected in parallel so that, for example, one condenser may remain in operation while product is being removed from the other. Other possible applications and arrangements of the condenser of the present invention will be apparent to those skilled in the art.

Since many embodiments might be made of the present invention and since many changes might be made in the preferred embodiment described above, it is to be understood that the foregoing description is to be interpreted as illustrative only and not in a limiting sense, except as required by the appended claims.

We claim:

1. Apparatus for condensing a vapor to a solid comprising in combination a closed condensing chamber having a relatively narrow neck leading thereto, a conduit extending through said neck into the interior of said chamber for conducting said vapor into said chamber, said conduit extending into said chamber substantially to the center of said chamber, a coaxial tubular shield surrounding said conduit and extending into said chamber to substantially the same point as said conduit, heating means in heating relationship with said conduit at a point outside said chamber to heat the vapors passing through said conduit and prevent them from condensing before they reach the interior of said condensing chamber, and means for refrigerating said condensing chamber to cause said vapors to condense therein and form a sublimate on the interior walls of said chamber.

2. Apparatus for condensing a vapor to a solid comprising in combination a closed condensing chamber having a relatively narrow neck leading thereto, a conduit extending through said neck and a substantial distance into the interior of said chamber for conducting said vapor into said chamber, a tubular shield surrounding said conduit and extending into said chamber to substantially the same point as said conduit, heating means supported by said neck and located in its entirety at a point remote from the condensing chamber walls for heating said shield and conduit to prevent condensation of said vapor within said conduit, and means for refrigerating said condensing chamber to cause said vapors to condense therein and form a sublimate on the interior walls of said chamber.

3. Apparatus for condensing a vapor to a solid comprising in combination a closed condensing chamber having a relatively narrow neck leading thereto, a conduit extending through said neck and a substantial distance into the interior of said chamber for conducting said vapor into said chamber, a tubular shield surrounding said conduit and extending into said chamber to substantially the same point as said conduit, said shield being spaced from said conduit to define a first annular space to reduce heat transfer between said conduit and said shield and being spaced from said neck to define a second annular space to reduce the heat transfer between said shield and said neck, heating means in heating relationship with said conduit at a point outside said chamber to heat the vapors passing through said conduit and prevent them from condensing before they reach the interior of said condensing chamber, and means for refrigerating said condensing chamber to cause said vapors to condense therein and form a sublimate on the interior walls of said chamber.

4. Apparatus for condensing a vapor to a solid comprising in combination a closed condensing chamber having a relatively narrow neck leading thereto, a conduit extending through said neck and a substantial distance into the interior of said chamber for conducting said vapor into said chamber, a tubular shield surrounding said conduit and extending into said chamber to substantially the same point as said conduit, said shield being spaced from said conduit to define a first annular space to reduce heat transfer between said conduit and said shield and being spaced from said neck to define a second annular space to reduce the heat transfer between said shield and said neck, heating means supported by said neck and located in its entirety at a point remote from the condensing walls of said chamber and in heating relationship with respect to said conduit for heating the vapors passing through said conduit to prevent them from condensing before they reach the interior of said condensing chamber, and means for refrigerating said condensing chamber to cause said vapors to condense therein and form a sublimate on the interior walls of said chamber.

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