

July 15 , 1924.

1,501,515

N. TESTRUP

METHOD AND APPARATUS FOR EVAPORATING LIQUIDS

Filed Aug. 9. 1920

8 Sheets-Sheet 1

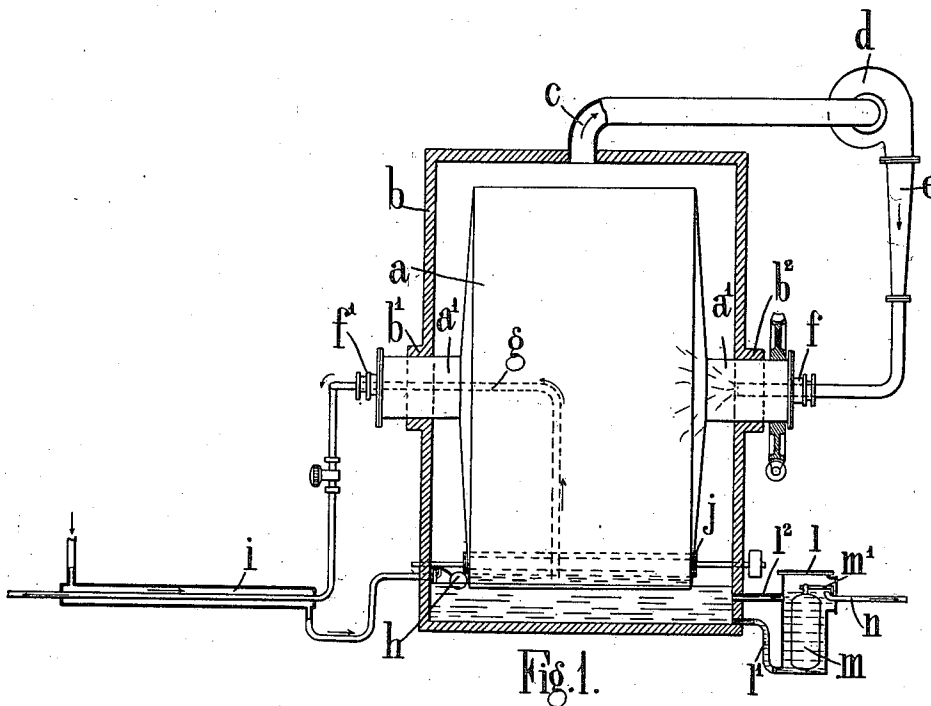
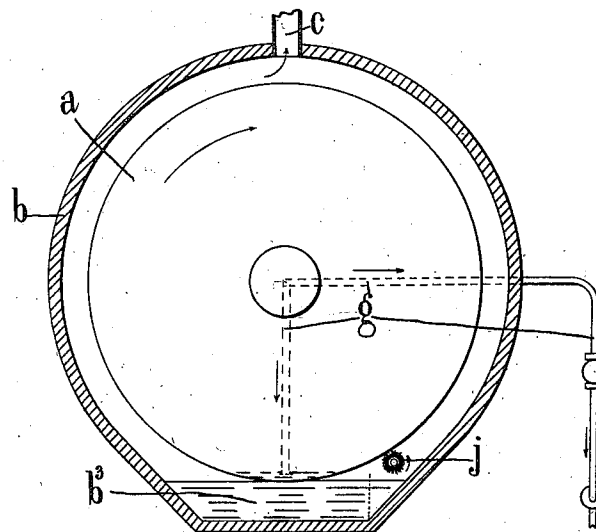


Fig.2.

Fig. 2. *Inventor*
N. Testrup,
By H. R. Herslake,
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July 15, 1924.

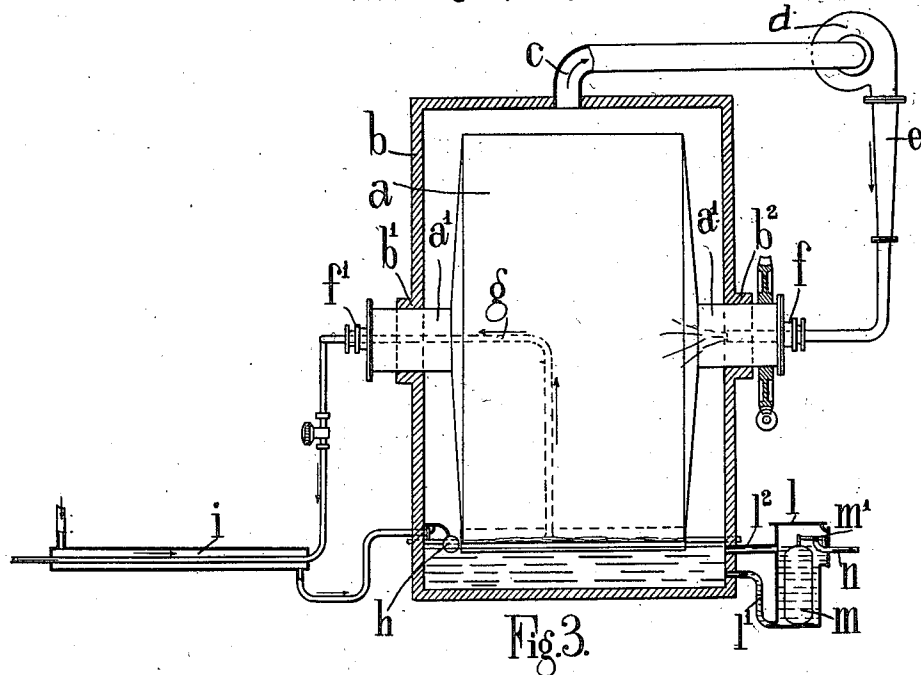
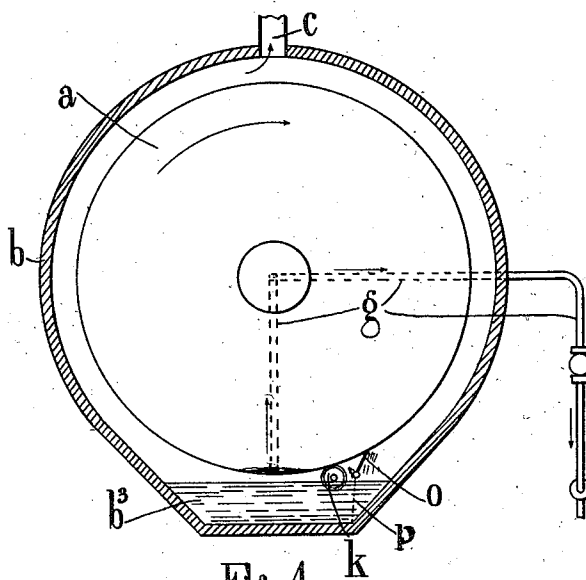
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8 Sheets-Sheet 2



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8 Sheets-Sheet 3

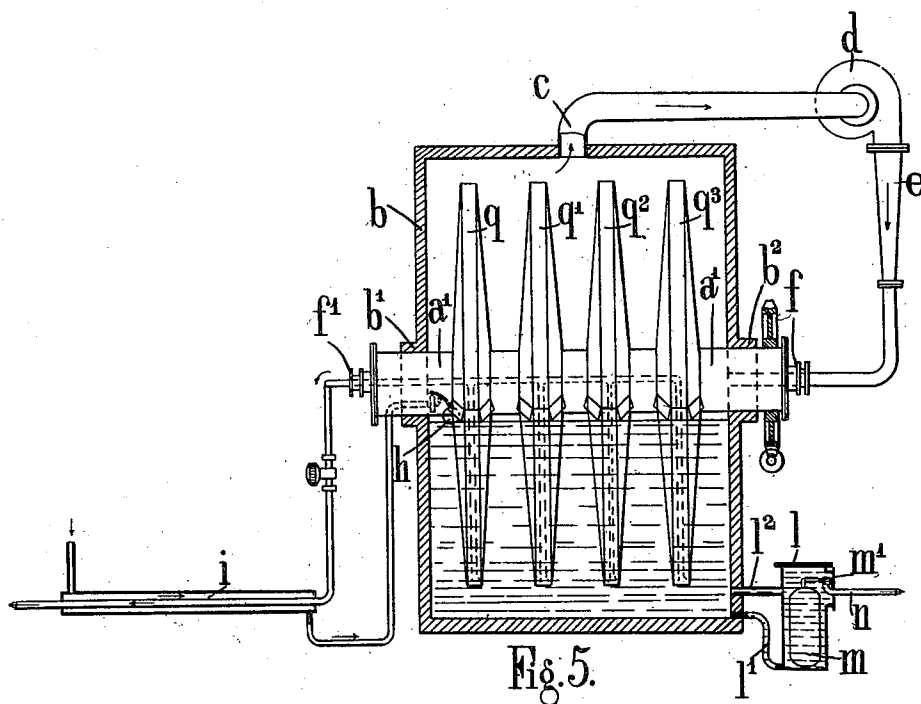


Fig. 5.

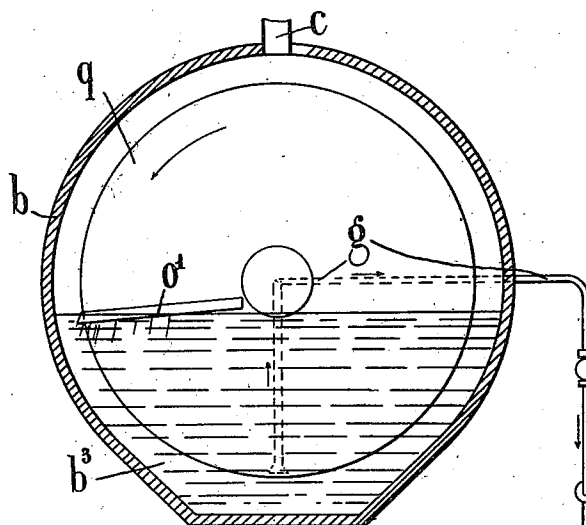


Fig. 6.

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8 Sheets-Sheet 4

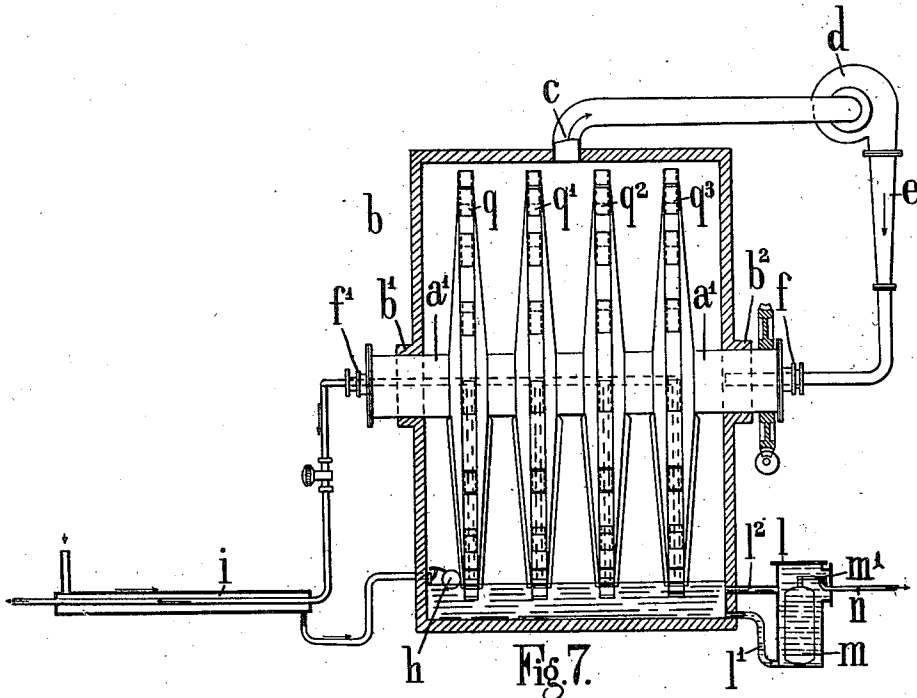
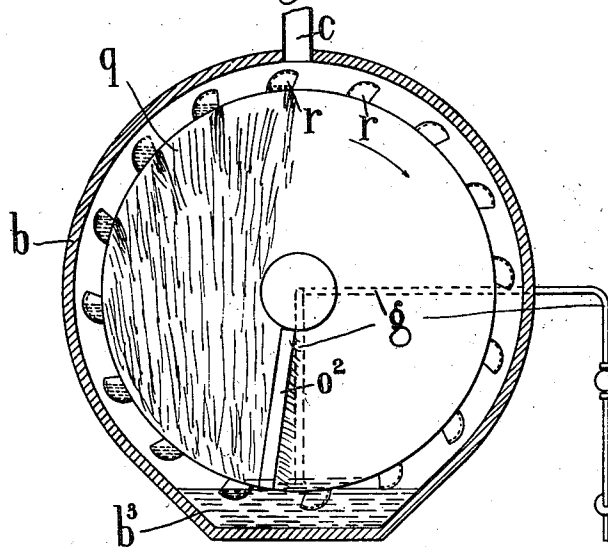


Fig. 8.

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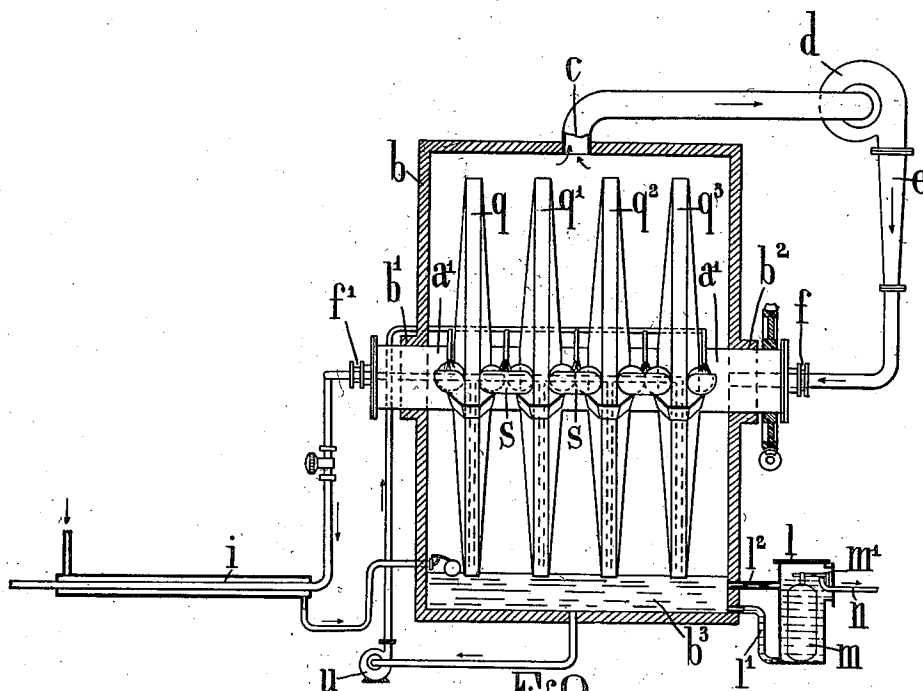
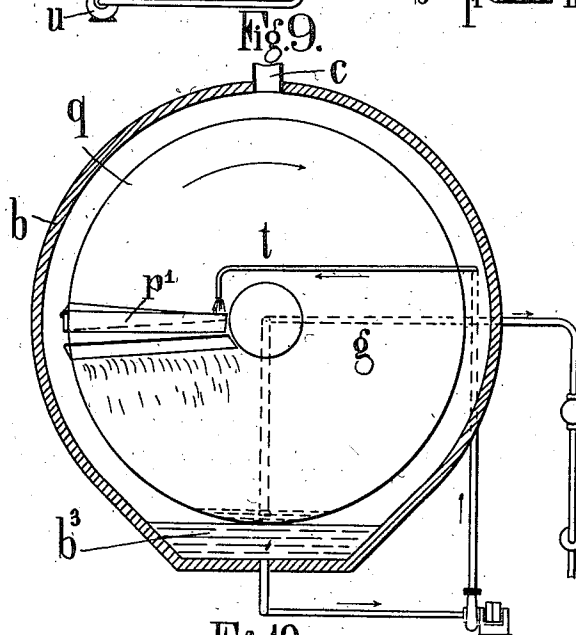


Fig. 10.

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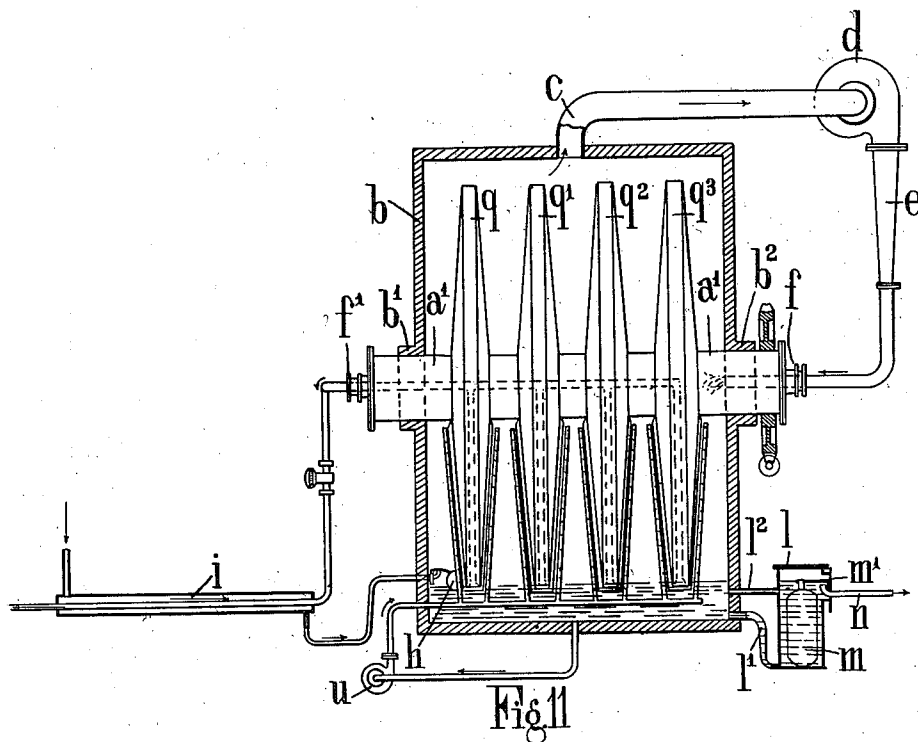
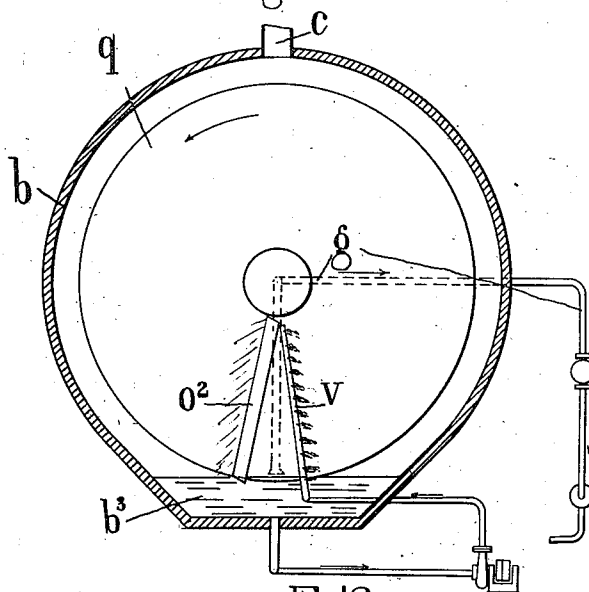


Fig. 12. *Inventor*

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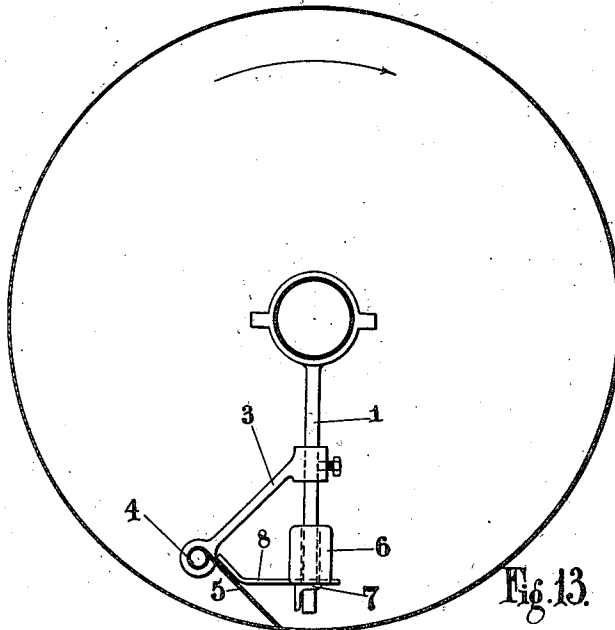


Fig. 13.

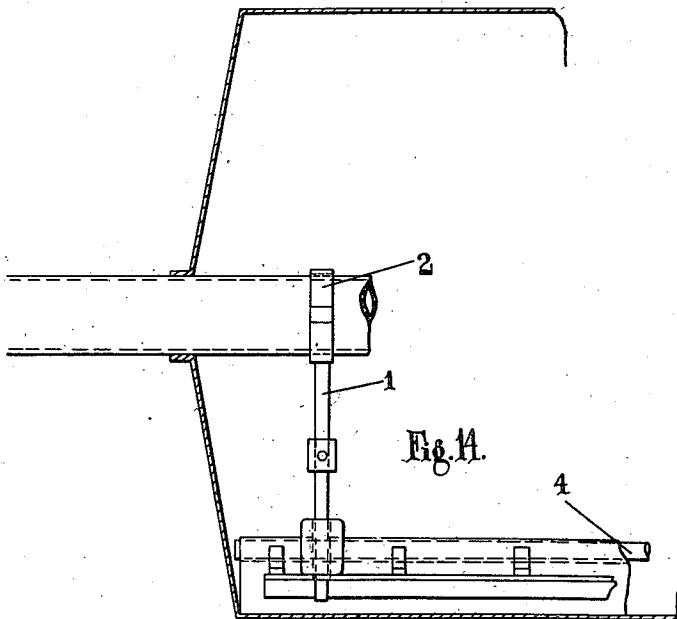


Fig. 14.

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July 15, 1924.

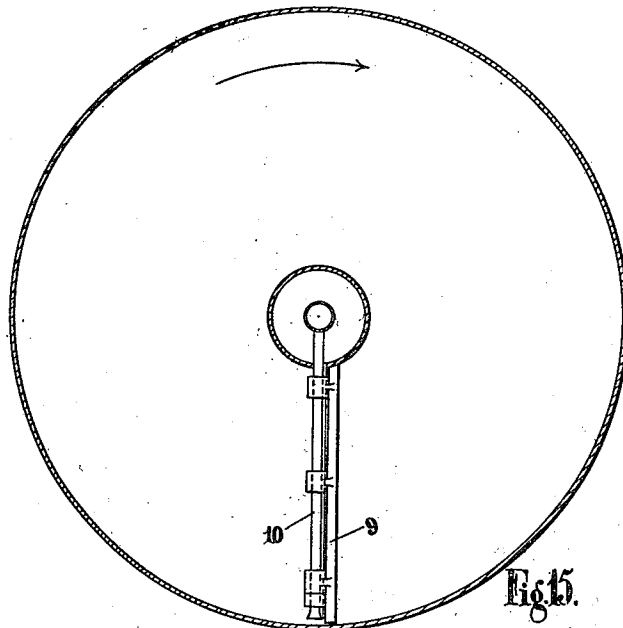
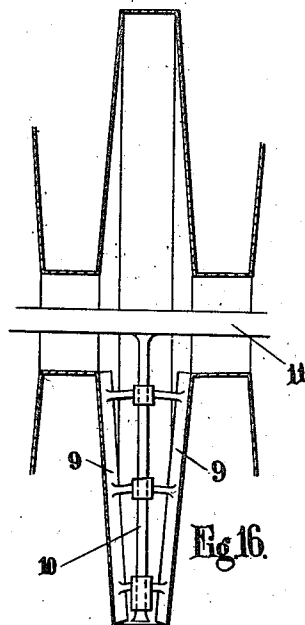
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METHOD AND APPARATUS FOR EVAPORATING LIQUIDS

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8 Sheets-Sheet 8



Inventor
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UNITED STATES PATENT OFFICE.

NILS TESTRUP, OF LONDON, ENGLAND, ASSIGNOR TO TECHNO-CHEMICAL LABORATORIES LIMITED, OF CLAPHAM PARK, LONDON, ENGLAND.

METHOD AND APPARATUS FOR EVAPORATING LIQUIDS.

Application filed August 9, 1920. Serial No. 402,320.

To all whom it may concern:

Be it known that I, NILS TESTRUP, a subject of the King of Great Britain and Ireland, and residing at 47 Victoria Street, London, S. W. 1, England, have invented certain new and useful Methods and Apparatus for Evaporating Liquids, of which the following is a specification.

This invention relates to improvements in connection with evaporation, distillation and similar operations, and especially those of the film type of Patent No. 1,150,713 of 1915 and has for its object to provide improved methods and means for effecting these operations.

In all evaporative apparatus at present in use difficulties of a more or less serious kind arise, due to "scale" being deposited upon the surfaces from which the evaporation takes place. These surfaces tend more or less rapidly to lose their evaporative efficiency as such deposits take place. This has led to the use of a wide variety of surface cleaning methods and devices. The evaporative surfaces of such evaporators are usually those of tubes forming the structure, and it is necessary to clean them at intervals when the tubes are out of service.

In application Serial Number 358,088 filed February 12, 1920, co-pending herewith it has been proposed to employ rotating drums or like surfaces as dryers of liquids containing solids in suspension or solution, and thus to obtain more or less dry solids, the reverse surfaces of the drum being heated by evaporated fluid after raising its vapour temperature and pressure to the required extent. It has now been found, however, that this type of device can be applied advantageously to the evaporation or distillation of liquids, the liquid film being maintained practically continuous over the evaporating surface.

Now the present invention consists in fluid evaporating or distilling means comprising sheet metal surfaces for the evaporation, carrying upon one side a liquid film and heated upon the other side by the vapour of evaporated liquid after its temperature and pressure have been suitably raised, together with scale removing means in contact with and movable relative to the evaporating surfaces.

The invention also consists in a suitably enclosed rotating hollow drum evaporator

upon the outer surface of which drum the liquid to be evaporated is spread as a thin film, and to which surface is applied at a suitable point a scraping or brushing device adapted to continuously remove any scale deposited during the evaporation effected by the vapour of evaporated liquid after its temperature and pressure have been suitably raised.

The invention further consists in combinations of such drum evaporators in stages suitably chosen in relation to the rise of boiling point of the liquid or the economy of the evaporating surfaces or both.

The invention also consists in suitably correlating and separating the ingoing and outgoing fluids.

The accompanying more or less diagrammatic drawings show by way of example several various embodiments of the invention.

In these drawings

Figures 1 and 2 show a plain cylindrical drum dipping into the liquid.

Figures 3 and 4 show a similar drum, but arranged with a feed roller to apply the liquid to its surface.

Figures 5 and 6 show a corrugated drum which is wetted by dipping into the liquid.

Figures 7 and 8 show a corrugated drum with buckets for distributing the liquid over the surface thereof.

Figures 9 and 10 show a corrugated drum with feed roller distributing means, and

Figures 11 and 12 show a corrugated drum with means for spraying the liquid over the surface thereof.

Figures 13, 14, 15 and 16 show the application of deposit removable means to the interior surfaces of the evaporating vessel.

In carrying this invention into effect in one of the forms given by way of example, I take a drying drum *a* of the known type and having a hollow spindle *a'* and enclose it in a casing *b* provided with an outlet pipe *c* for the steam connected to a compressor *d* adapted to raise its temperature and pressure, to say from 3° C. to 5° C. above the boiling point of the liquid. The delivery *e* of the compressor *d* is connected through a suitable stuffing box *f* to the inside of the drum. The drum is mounted on suitable bearings *b'*, *b''* in the casing and provision is made for withdrawing

the condensed water therefrom, say by the syphon pipe *g*, which passes through another stuffing box *f'*.

The lower part of the casing *b* is formed as a reservoir *b'* for the ingoing liquid which is admitted by a float controlled valve *h* after being regeneratively heated by the outgoing condensate in the heat interchanger *i*. The drum *a* at its lower side dips into the liquid in the reservoir *b'* so that as it rotates its surface continuously carries over a thin film of the liquid.

A scale removing device *j* is conveniently placed about the lowest part of the drum, and this device may be arranged to act in a partitioned off part of the reservoir. The scale removing device is shown as a simple revolving brush which is suitable where the scale is soft, as is usually the case where a small difference in temperature is employed between the evaporating and heating surfaces. Or again, a rubber or like strip suitably supported may be used or where necessary a metal scraper may be employed as hereinafter described. In some cases, especially where a large amount of scale forming material exists in the liquid to be evaporated, provision may be made for continuously removing the scale from the apparatus.

The drum is driven at such a speed as will provide for the maintenance of a uniform film of liquid thereon and as the liquid is concentrated in the apparatus it is removed by means of the specific gravity controlled valve in the vessel *l* positioned at the side of the casing *b*. The vessel *l* communicates with the bottom and the upper portion of the reservoir *b'* by means of pipes *l'* *l''* and it contains a float *m* connected to the end of the lever *m'* which controls a valve giving access to the discharge pipe *n*.

In the arrangement shown in Figures 3 and 4, the drum *a* does not actually dip into the liquid and a contacting roller *k* dipping into the liquid is provided to spread the liquid upon the drum.

A metal scraper *o* which may be hinged to the top of a perforated partition *p* is resiliently pressed against the surface of the drum and acts to remove the scale or other deposited matter therefrom. In other respects this arrangement is similar to the one shown in Figures 1 and 2 and similar letters of reference for the various parts are employed therein.

In Figures 5 and 6 the plain cylindrical drum is replaced by a corrugated surface made up of a series of four hollow disc-like members *q*, *q'*, *q''* and *q'''* mounted upon and communicating freely with the interior of the hollow drum spindle *a'*.

The drum is enclosed in a casing *b* as hereinbefore described the lower portion of

which forms a reservoir in which the liquid is maintained at a suitable level by means of the float valve *h*.

The liquid level in this case is of such a height that it will effectively wet or apply a film of liquid to the sides of the disc like members or corrugated surfaces of the drum and in close proximity to this level scrapers *o'* suitably connected to the casing are provided in contact with the whole of the surface for removing scale therefrom. Apart from the foregoing differences this arrangement resembles those previously described and similar reference letters are employed to indicate the different parts.

Figures 7 and 8 show a corrugated drum arrangement in which the liquid is distributed over the evaporating surface by means of a plurality of buckets *r* attached to the periphery of the hollow disc-like members. Scrapers *o''* suitably connected to the casing in a substantially vertical or other convenient position are provided for cleaning the sides of the discs and in other respects the apparatus resembles those previously described.

In Figures 9 and 10 substantially horizontal rollers *p'* are provided for applying the liquid film to the disc surfaces, the rollers operating in channels or troughs *s* connected to the interior of the casing so as to lie between the disc-like members and fed with the liquid by means of pipes *t* connected to the discharge of a liquid circulating pump *u* which draws its supply from the reservoir *b'* in which a suitable level is maintained.

In the arrangement shown in Figures 11 and 12, the liquid is applied to the heating surface by spray pipes *v* receiving their supply from a circulating pump *u* and scrapers *o''* are provided for cleaning the surface adequately before the application of the liquid film thereto.

The drum may be in some cases of a hard and polished material, or it may again have a somewhat rough outer surface. The surface of the drum may have metal gauze, or even absorbent material upon it.

It is found that with this evaporator complex liquors, such as waste sulphite lyes, can be evaporated efficiently and all the serious difficulties of scaling at present existing are avoided as the evaporating surfaces can be kept continuously free from scale.

An apparatus which is quoted by way of example only was provided with an ordinary steel plate, bent and welded into a tube. The film in this case was picked up at the speed of about twenty revolutions per minute, and was a practically perfect film free from splashing or other inconvenience; some results obtained were as follows:—

When evaporating ordinary water works

water with scrapers on maximum efficiency was obtained continuously and when evaporating a saturated solution of gypsum with scrapers on the same maximum efficiency was continuously obtained. When evaporating water works water with scrapers off, the efficiency after eight hours is approximately one-sixth less than the maximum, and when evaporating saturated solution of gypsum with scrapers off, the efficiency in four hours is reduced from about 8 to 5 and after further eight hours to about 4½.

From the foregoing it appears that the cheapest possible surface can be used for carrying out the process and that maximum evaporation can be obtained continuously whatever be the material evaporated, also, that the apparatus may be the simplest conceivable for the purpose with nothing moving except the revolution of the drums.

In some cases matter may be carried over in the form of vapour or in suspension in the vapour, which will deposit upon the interior surface of the evaporating vessel and thus diminish its efficiency.

Under such circumstances, scrapers as shown in Figures 13 and 14 may be applied to the interior surface of a plain cylindrical rotating drum, said scrapers comprising guides 1 suspended from straps 2 riding upon the trunnion tube A¹. The said guide rods carrying adjustable brackets 3 having a longitudinal fulcrum bar 4 upon which the scraper 5 is hinged. The guide bars also carry slidably mounted weights 6 resting upon a longitudinal bar 7, attached by levers 8 to the scraper 5 and by means of which the scrapers are held in contact with the interior surface of the drum.

Figures 15 and 16 show one section of corrugated drum with interior deposit removal means which take the form of scrapers 9 arranged in a substantially vertical direction and supported upon a stand pipe 10 reaching to near the bottom of the section and communicating with the condensate outlet pipe 11, by which the condensed vapour is removed from the apparatus.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. A method of reducing the temperature difference required for transmitting heat through a partition for vaporizing liquids by the heat of their own vapour raised in temperature by compression, comprising continuously dislodging by relative movement of deposit removal means and said partition any material deposited on the latter from a thin film of said liquid or the vapour thereof.

2. A method of reducing the temperature difference required for transmitting heat through a partition for vaporizing liquids by the heat of their own vapour raised

in temperature by compression, comprising continuously dislodging from both sides of said partition, by deposit removal means, any material deposited thereon.

3. Apparatus for carrying out a method of reducing the temperature difference required for transmitting heat through a partition for vaporizing liquids by the heat of their own vapour raised in temperature by compression, comprising in combination a moving heat transmitting partition, means for applying a thin film of liquid matter thereto, means for withdrawing, compressing and returning to the other side of said partition vapour evolved from said film and means for dislodging any deposit formed upon the surfaces of said partition.

4. Apparatus for carrying out a method of reducing the temperature difference required for transmitting heat through a partition for vaporizing liquids by the heat of their own vapour raised in temperature by compression, comprising in combination a moving heat transmitting partition, means for applying a thin film of liquid matter thereto, moving mechanism for withdrawing from one side and returning, at a higher temperature and reduced volume, to the other side of said partition vapour evolved from said film and means for dislodging deposited matter from both sides of said partition.

5. Apparatus for carrying out a method of reducing the temperature difference required for transmitting heat through a partition for vaporizing liquids by the heat of their own vapour raised in temperature by compression, comprising in combination a rotatable heat transmitting partition, means for applying a thin film of liquid matter thereto, a mechanical compressor for withdrawing vapour evolved from said film and returning it at a higher temperature as heating medium for said partition and means for keeping the partition free from deposit.

6. Apparatus for carrying out a method of reducing the temperature difference required for transmitting heat through a partition for vaporizing liquids by the heat of their own vapour raised in temperature by compression, comprising in combination an enclosing chamber, a closed vessel rotatable therein, means for applying a thin film of liquid matter to the outer surface of said vessel, means for withdrawing from said chamber vapour evolved from said film and returning it to the interior of said vessel in a compressed and hotter condition and means for removing deposit from the outside and inside surfaces of said vessel.

7. An apparatus for expelling vapour from liquid material by the re-utilization of latent heat, comprising a rotatable heat transmitting partition, means for applying

a film of liquid material onto the surface of said partition, means for collecting the vapour given off by the said film of material, means for raising the temperature of
5 said vapour by compression and returning it as the heating medium to the other side of said partition and means for dislodging deposit from both sides of said partition.

8. An apparatus for economizing heat
10 when evaporating liquid matter comprising in combination an enclosing chamber, a rotatable closed vessel in the form of a drum in said chamber, a mechanical compressor,

a conduit connecting said chamber to the inlet of said compressor, a conduit connecting the discharge from said compressor to the interior of said drum, means for spreading a film of liquid matter on the exterior of said drum, means for evacuating from
20 said drum liquid of condensation and means for removing any material deposited upon the interior or exterior of said drum.

In testimony whereof I have signed my name to this specification.

NILS TESTRUP.