No. 896,460. PATENTED AUG. 18, 1908.

C. L. PRACHE & C. G. V. BOUILLON.

APPARATUS FOR EVAPORATING AND CONCENTRATING LIQUIDS.

APPLICATION FILED DEC. 13, 1905.

2 SHEETS—SHEET 1.

Fig. 1.

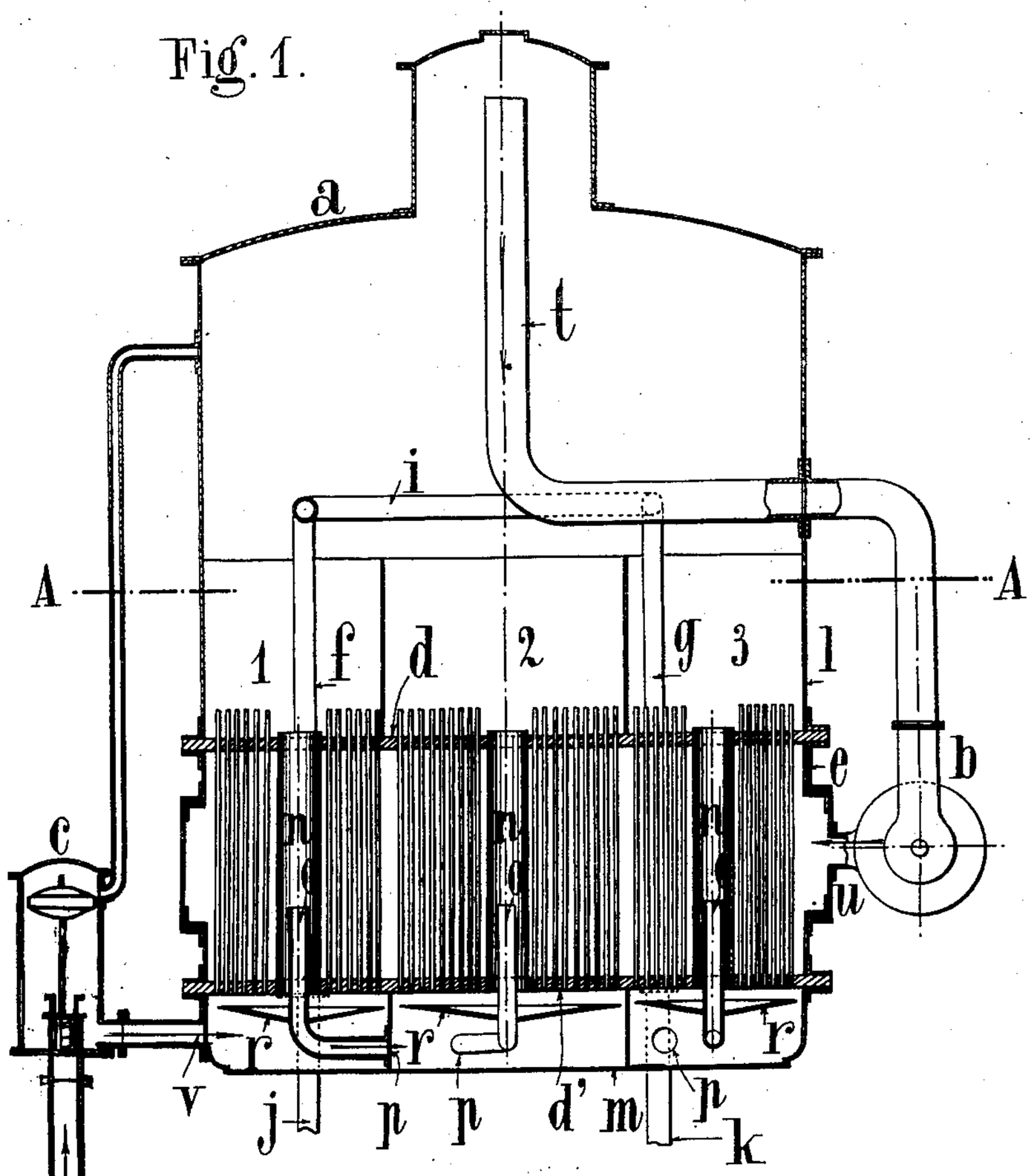
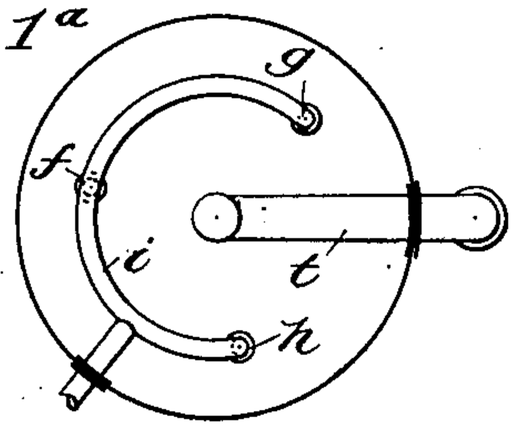


Fig. 1a



WITNESSES:
Jacob Roth
Elsa Newburg

INVENTORS
Charles Louis Prache and
Charles Gustave Victor Bouillon
BY
Goepel & Goepel
ATTORNEYS.

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2 SHEETS—SHEET 2.

Fig. 2

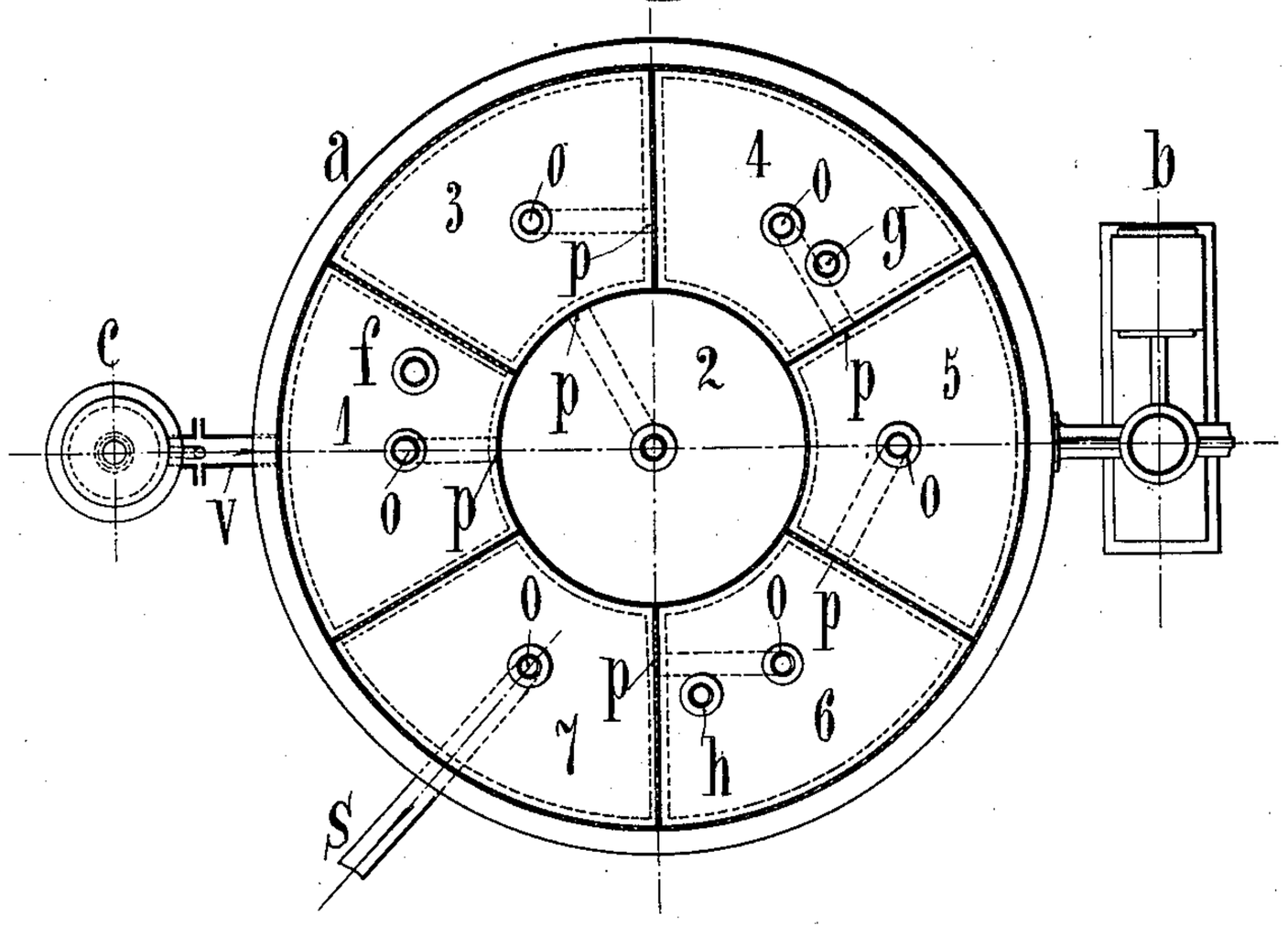
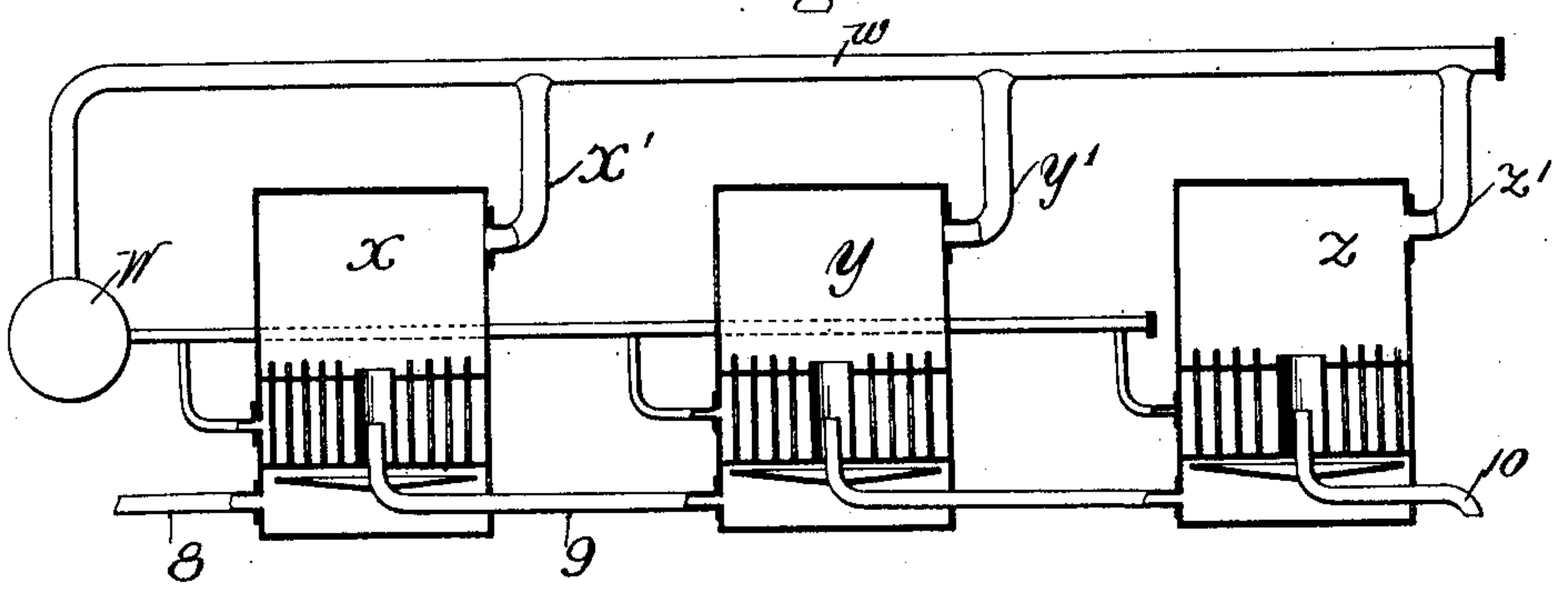


Fig. 3



WITNESSES

Jacob Roth

Elsa Newburg

INVENTORS

Charles Loring Prache and

Charles Gustave Victor Bouillon

BY

Jaquez & Jaquez.

ATTORNEYS

UNITED STATES PATENT OFFICE.

CHARLES LOUIS PRACHE AND CHARLES GUSTAVE VICTOR BOUILLON, OF PARIS, FRANCE.

APPARATUS FOR EVAPORATING AND CONCENTRATING LIQUIDS.

No. 896,460. Specification of Letters Patent. Patented Aug. 18, 1908.

Application filed December 13, 1905. Serial No. 291,578.

To all whom it may concern:

Be it known that we, CHARLES LOUIS PRACHE and CHARLES GUSTAVE VICTOR BOUILLON, citizens of the Republic of France, and residents of Paris, France, have invented a new and useful Apparatus for Evaporating and Concentrating Liquids, which apparatus is fully set forth in the following specification.

The present invention has for its object to provide a single-acting apparatus for the evaporation or concentration of liquids, this apparatus being characterized by the systematic circulation of the liquids to be concentrated in a single receptacle, these liquids, during their circulation and in view of their concentration, being raised to ebullition by the vapor that they emit in the apparatus, which vapor is sucked in a continuous manner and forced in the same manner, after compression, around the assemblage of tubes traversed by the liquids, in their systematic circulation.

In order that the invention may be readily and clearly understood the apparatus in accordance with the invention is illustrated by way of example in the accompanying drawing, in which:

Figure 1 is a vertical section through the apparatus. Fig. 1[a] is a diagrammatic horizontal section, on a reduced scale, through the upper part of the apparatus. Fig. 2 is a horizontal section on the line A—A of Fig. 1. Fig. 3 shows diagrammatically the application of the invention to an apparatus for multiple effect (a triple-acting apparatus for example).

The apparatus comprises broadly: the evaporation chest *a*. A rotary vapor compressor *b*. An automatic feed device *c*.

Evaporation chest.—Two horizontal circular tube plates *d d'*, are united one to the other by vertical tubes extending slightly beyond the tube plate *d* and by a cylinder *e* forming a heating chamber permitting of containing, outside the tubes, the vapor necessary for producing the evaporation of the liquids to be concentrated. The uncondensed vapors are discharged to the exterior by means of the pipes *f*, *g*, *h*, *i* as shown in Fig. 1[a]. The condensation waters are discharged to the exterior through the pipes *j k*. Another cylinder *l*, fixed upon the upper tube plate *d*, forms with the interior of the tubes and the bottom *m* of the apparatus, which is fixed to the lower tube plate *d'*, an ebullition chamber in which the liquid to be concentrated circulates. The outer faces of the tube plates *d* and *d'* are divided into an equal number of compartments by means of vertical radial partitions; seven compartments may be formed, for example, numbered 1 to 7. The partitions of the upper tube plate *d* are directed upwards and reach a certain height in the ebullition chamber. The partitions carrying the lower tube plate *d'* are directed downwards and form joints with the bottom *m*. A compartment of the upper tube plate being arranged just above that of the lower tube plate, the whole constituted by these two compartments forms with the interior of the tubes a single compartment in which the liquid to be concentrated circulates.

At the center of each of the compartments, a central vertical return-tube *n*, the diameter of which is larger than that of the other tubes, unites the two tube plates by their outer faces. This tube *n* extends beyond the upper tube plate *d* by an amount less than the projection of the small tubes. Inside each of the large tubes and at about one third its height from the lower tube plate *d'*, there is arranged a tube *o* of smaller diameter, communicating at *p* with the succeeding compartment. A horizontal baffle *r* carried by each tube *o* distributes the liquid to the periphery of the compartment after its arrival through *p*. The inlet for the liquid into one compartment is therefore the outlet for the liquid which has been concentrated in the preceding compartment. The admission of the liquid to the compartment No. 1 is controlled by an automatic feed device *c*. The discharge of the liquid concentrated to the desired degree takes place at *s*.

Continuous vapor compressor.—This is a rotary compressor or a compressor operating by jet action sucking the steam from the ebullition chamber through the pipe *t* and forcing it, after having compressed it, into the heating chamber through the pipe *u*.

Automatic feed apparatus.—This apparatus consists of a float controlling a balanced piston permitting of the admission of more or less of the liquid into the ebullition chamber (compartment No. 1).

Operation.—The liquid, which the feed apparatus allows to pass, enters the compartment No. 1 through the pipe *v*, becomes distributed around the baffle *r* and enters the tubes at the periphery where it begins to boil and to become vaporized under the influence of the direct vapor which is admitted into the heating chamber exclusively for starting, before the liquid to be concentrated has emitted sufficient vapor to be itself forced into the heating chamber. The liquid then falls outside the tubes upon the upper tube plate *d* accumulating there between the partitions of the compartment No. 1 until the moment at which its level reaches the upper part of the large tube *n*. The liquid then flows into the tube *n* and falls upon the baffle *r*, recommencing its circulation in the small tubes until the moment at which its level attains the upper extremity of the tube *o* into which it flows in order to pass through *p* into the compartment No. 2. The liquid already concentrated which flows into the conduit *n* opposes the ascent of the liquid entering the compartment; this action completes the office of the baffle *r* previously indicated. A part of the liquid which descends through the conduit *n* of compartment 1, falling upon the baffle, spreads horizontally over this latter and rises in the tubes of the zone adjacent to the central tube *n;* another part of this liquid will enter the tube *o* when the level of the liquid in the conduit *n* has risen above the extremity of this tube *o*. During starting, the discharge of the concentrated liquid from the apparatus is regulated in such a manner that in each conduit *n* the level of the liquid, is above the extremity of the corresponding tube *o* during the normal operation of the apparatus.

The heating of the different compartments of the apparatus and the consequent concentration of the liquid are produced by means of the vapor-compressor *b*, which collects the vapors from the upper part of the evaporation-chest or ebullition-chamber, and after compressing them forces them in compressed condition about the walls of the compartments. It is evident that this rise in pressure which takes place when the vapors are compressed by the compressor *b* is accompanied with a corresponding rise in temperature, and hence the vapors, when they arrive in contact with the walls of the different compartments, are heated to a much higher degree than when they are withdrawn from the ebullition-chamber. Accordingly the vapor-compressor serves to further heat the vapors and force them about the compartments in such a manner that the liquid in all of said compartments is subjected to great heat and is therefore concentrated to the required degree.

The rise of the liquid in the small tubes of the compartments is produced by the boiling of the liquid in said tubes, the bubbles of vapor which are formed in the midst of the liquid filling said tubes and in order to disengage themselves acquiring great speed in their vertical movement and by this movement drawing up the liquid itself. The liquid is thus projected vertically out of each tube in an intimate mixture with the vapor which has imparted to such liquid a part of its ascensional force. The liquid thus projected out of each tube falls back on the upper tube-plate and by the large central tube is conducted downwardly to the next compartment so as to produce the circulation of the liquid successively through all of the compartments.

The vapors which are compressed by the compressor and forced into the heating-chamber in order to heat the heating-tubes therein are condensed by contacting with said tubes and the water of condensation is conducted off from said heating-chamber through the pipes *j*, *k* previously described. The uncondensed vapors are discharged to the exterior of the apparatus through the pipes *f*, *g*, *h*, *i* previously mentioned. These pipes communicate with the heating-chamber at its upper part and are located within the ebullition-chamber, as shown in Fig. 1. By providing them the vapors are caused to circulate through the heating-chamber and then pass out of the apparatus, after which they can be put to a suitable use. As this means of escape for the vapors is provided the pressure in the heating-chamber does not become too great, nor is the work of the pump increased by compression of the vapors in the heating-chamber.

It should be clearly understood that when the apparatus is operating, the liquid which has already been concentrated by its passage through the tubes of the compartment 1, passes from this compartment into compartment 2 where it is again concentrated, and so on in succession up to compartment 7, from which the liquid concentrated to the desired degree is discharged from the apparatus; this circulation is rendered possible by the automatic establishment of a difference of level in the tubes *n* of the different compartments; the level of the liquid in the tube *n* of compartment 1 being higher than that in the tube *n* of compartment 2 and so on in succession, and this is so owing to the differences in density of the liquid as its concentration progresses. The circulation therefore continues to the compartment 7 from which the concentrated liquid is discharged.

As has been shown, the concentration of the liquid is effected by a single operation in a special apparatus by the methodical progress of the liquid and a single heating chamber. It is of course possible to utilize the

multiple effects already known industrially and by means of a simple conversion which is hereinafter indicated, to obtain, with these apparatus, an operation identical with that described above.

Considering a triple-acting apparatus, by way of example, Fig. 3 of the accompanying drawing shows diagrammatically the transformation that it must undergo in order to permit of its single-action operation in the same conditions as the apparatus illustrated in Fig. 1. In this figure, x, y, z represent the three chests: x', y' and z' represent the outlets for the vapor proceeding to a collector w which is the suction member of the compressor W forcing the vapor compressed in each of the heating chambers of the chests x, y, z. The unconcentrated liquid enters the first chest x at 8, circulates in the manner which has been explained relatively to compartment No. 1 of the single chest (Fig. 1); it issues at 9 and enters the second chest y where it is submitted to a similar circulation, becomes rather more concentrated and passes into the chest z, finally issuing concentrated to the desired degree at 10, either through a siphon, extraction pump or other appropriate means.

Having thus described our invention, we claim as new and desire to secure by Letters Patent:

1. An apparatus for evaporating and concentrating liquids, comprising a casing, a plurality of compartments arranged in series in said casing and to which the liquid successively passes, and means for collecting the vapors formed by the boiling of the liquid in said compartments and forcing the same under pressure directly and simultaneously about said compartments in such a manner as to heat the latter.

2. An apparatus for evaporating and concentrating liquids, comprising a casing, a plurality of heating-compartments in the lower part of said casing to which the liquid successively passes, an ebullition-chamber above said compartments and communicating with all of the same, and means for withdrawing the vapors from said ebullition-chamber and compressing the same and then forcing such vapors about said compartments.

3. In an apparatus for evaporating and concentrating liquids, the combination of a casing, a circular series of heating-compartments in the lower part of said casing, each compartment including a plurality of tubes through which the liquid circulates, an ebullition-chamber above said compartments into which the vapors issue from said tubes, and means to withdraw the vapors from said chamber and force the same under pressure about the tubes of all said compartments.

4. In an apparatus for evaporating and concentrating liquids, the combination of a casing, horizontal tube-plates in said casing forming between them a chamber, vertical tubes in said chamber connecting said tube-plates, partitions disposed above and below said tube-plates and dividing the casing into a plurality of compartments each of which communicates with a number of said tubes, means to connect said compartments in series, means to introduce the liquid into one of said compartments, and means to withdraw the vapors from the upper portion of the casing and force them into the chamber in which said tubes are disposed.

5. In an apparatus for evaporating and concentrating liquids, a casing, superposed horizontal tube-plates arranged therein, tubes connecting said tube-plates, partitions above and below said tube-plates and constituting compartments each of which communicates with a number of said tubes, a return-tube in each compartment connecting said tube-plates, pipes connecting said compartments at their lower portions and extending upwardly into said return-tubes, and a baffle-plate arranged below the tubes in each compartment.

6. In an apparatus for evaporating and concentrating liquids, in combination, a casing, superposed horizontal tube-plates arranged therein, tubes connecting said tube-plates, a plurality of compartments each of which communicates with a number of said tubes, a large return-tube n in each compartment extending between said tube-plates, pipes o connecting said compartments in series and extending upwardly into said return-tubes, and a baffle-plate r carried by each of said pipes below the lower tube-plate.

7. In an apparatus for evaporating and concentrating liquids, in combination, a casing, superposed horizontal tube-plates therein, tubes connecting said tube-plates and extending above the upper tube-plate, and return-tubes also connecting said tube-plates but which extend above said upper tube-plate to a less extent than said first-named tubes.

8. In an apparatus for evaporating and concentrating liquids, in combination, a casing, horizontal tube-plates arranged therein, one above the other, tubes connecting said tube-plates, radially-disposed vertical partitions above and below said plates and constituting compartments each of which communicates with a number of said tubes, a large return-tube connecting the tube-plates in each compartment, a pipe extending upwardly into each such return-tube and communicating with the adjacent compartment at a point below the lower tube-plate, a feed-device communicating with one of said compartments at its lower portion, a compressor,

a suction-pipe leading from said compressor into the upper portion of said casing above said compartments, and a pipe through which the vapors are forced from said compressor into the chamber formed between said tube-plates.

In testimony whereof we have signed this specification in the presence of two subscribing witnesses.

CHARLES LOUIS PRACHE.
CHARLES GUSTAVE VICTOR BOUILLON.

Witnesses:
EMILE LEDRET,
HANSON C. COXE.