P. KESTNER.

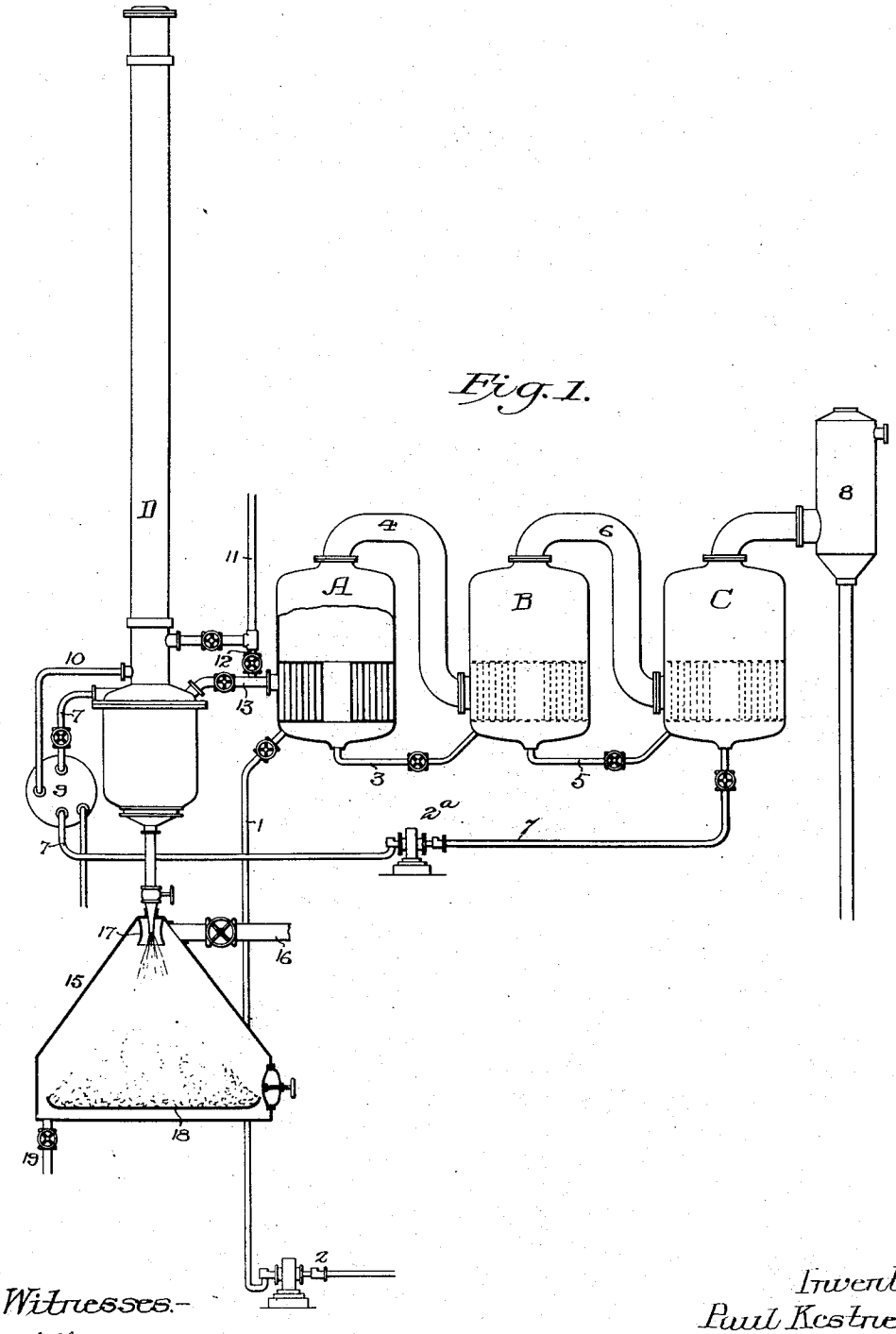
PROCESS OF EVAPORATING LIQUIDS.

APPLICATION FILED MAR. 13, 1909. RENEWED MAY 31, 1910.

997,502. Patented July 11, 1911.

2 SHEETS—SHEET 1.

Fig. 1.



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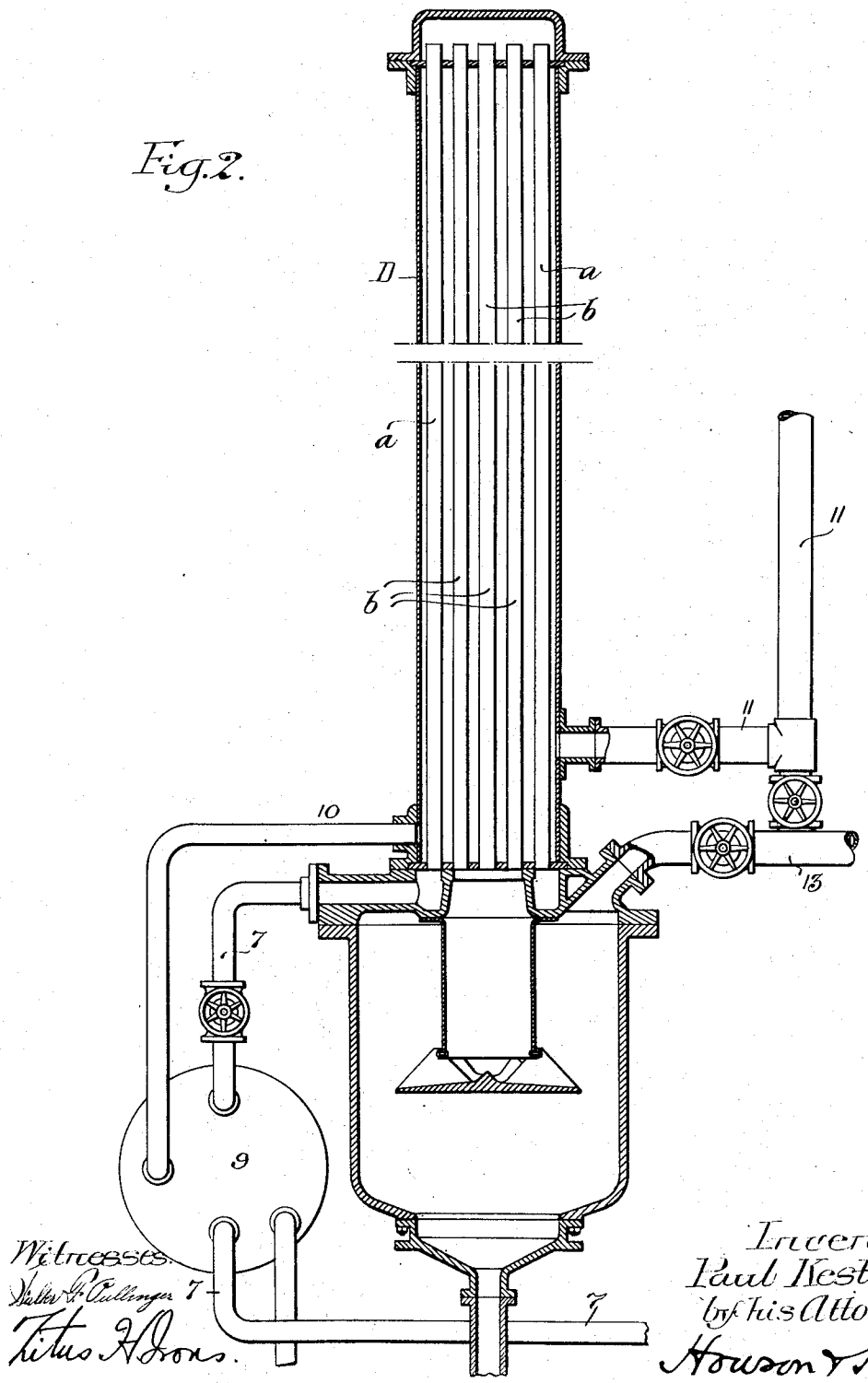
2 SHEETS—SHEET 2.

Fig. 2.



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UNITED STATES PATENT OFFICE.

PAUL KESTNER, OF LILLE, FRANCE.

PROCESS OF EVAPORATING LIQUIDS.

997,502. Specification of Letters Patent. Patented July 11, 1911.

Application filed March 13, 1909, Serial No. 483,112. Renewed May 31, 1910. Serial No. 564,140.

To all whom it may concern:

Be it known that I, PAUL KESTNER, a citizen of the Republic of France, and a resident of Lille, Department Nord, France, have invented an Improved Process of Evaporating Liquids, of which the following is a specification.

In the evaporation of saccharine liquids and other materials containing dissolved organic matters, it is the usual assumption that it is dangerous to expose them at any time to a temperature as high as or exceeding that of boiling water, 100° C. For this reason, the use of apparatus such as open pans, operating at ordinary atmospheric pressure is being discontinued and vacuum apparatus is now generally in use for evaporating all such liquids. Under vacuum, the temperature of the evaporating liquids is, of course, relatively low and after a certain degree of concentration is attained, the liquid generally becomes too thick to flow readily so that final concentration beyond a syrupy stage must be effected in special discontinuous evaporators, such as a strike pan. I have discovered that this fear of high temperatures in evaporation is partly erroneous and that relatively high temperatures, even up to 130° C., can frequently be advantageously employed provided the time of exposure thereto be relatively short. In some measure, time of exposure and degree of temperature are reciprocal factors. Nearly all these liquids can be temporarily exposed to high temperature but it is not generally advisable that the period of such exposure be more than a couple of minutes. For such a short exposure, mass evaporation is obviously unsuitable since a large mass of liquid cannot be easily, quickly and uniformly superheated; particularly where it is of viscous or gummy consistency. Traveling film evaporation, however, allows such a quick and timed heating, and it is, therefore, preferably employed in the present invention. Working upon these principles allows the use of certain new and advantageous processes. The superheated liquid can be readily made liquid enough to flow through evaporator tubes as filmiform layers, even where the concentration is pushed to a high degree, while with the described short period of superheating time enough is not given to allow any material amount of crystallization in the case of sugar containing liquids. Crystallization is an operation requiring considerable time. And with a superheated liquid, the vapors evolved are hot enough to run vacuum evaporators working in the ordinary way. In the present invention, therefore, I preferably pass the liquid through a multiple effect evaporator working under successively increasing vacua until it is concentrated to a thick and syrupy consistence at the temperature prevailing in the last stage. This concentrated liquid, or syrup, I now transfer to a special effect working with heating vapor under plus pressure, and, consequently, at a higher temperature than 100° C., wherein I quickly evaporate it to any desired concentration, even as low as 3 to 10 per cent. water, traversing it rapidly over suitably heated surfaces. With sugar juices the final product may be a molten or semi-molten sugar. While any film evaporator may be used to perform this stage of my process, I prefer the "Kestner type" using the climbing and descending film, as set forth in my application, filed May 29, 1906, Serial No. 319,386. The vapors evolved from the concentrating or desiccating liquid in this plus pressure effect I employ to furnish heat to the first effect of the multiple effect apparatus. From this superheated effect, the finished material may, if desired, be discharged as a product which will become apparently dry at the ordinary temperature; or it may be discharged at any desired degree of concentration or desiccation short of this.

Under this invention I can provide a multiple effect evaporating apparatus in which I can materially increase the extent of concentration and reduce the quantity of water in the material treated to such an extent as to discharge it substantially dry, or so nearly so that such material becomes dry upon cooling.

My invention may be carried out in a number of ways, but I have shown in the accompanying drawings a diagrammatic view of one form of apparatus susceptible of use in the operation forming the subject of my invention, and this will be specifically referred to.

In the accompanying drawings: Figure 1, shows diagrammatically a multiple effect apparatus operating in a manner that will effect the desired process, and Fig. 2, is a vertical sectional view of a part of the apparatus shown in Fig. 1.

A, B and C represent ordinary vacuum pans working under successively higher vacuum, and D is a finished liquor pan constructed in accordance with that shown in my application for patent to which reference has been made, and as illustrated in Fig. 2. This apparatus is of the climbing film type, in which the material to be evaporated is caused to first ascend in a series of tubes *a* under the influence of vapor generated by heat supplied to said tubes, and then to descend in another series of heated tubes *b* and film coat the latter under the influence of the attendant vapor. I have discovered that if such an apparatus be employed as the final or finishing effect in the arrangement I now propose, that final concentration of the liquid under treatment can be carried to a very high degree.

In my present arrangement, the thin liquor is fed through a pipe 1 to the base of pan A (which at the commencement of the operation may be heated by live steam from a suitable source, subsequently used to heat the final or finishing pan); an ordinary pump as indicated at 2 may be employed as the liquor feeding means. The partially concentrated liquor from pan A flows to pan B through a pipe 3; the vapor generated therefrom passing from said pan A to the heating zone of pan B through a pipe 4, while liquor from pan B passes to pan C through a pipe 5 in the usual manner while the vapor from pan B passes to the heating zone of pan C through the pipe 6. The liquor from pan C, instead of being discharged from said pan as a finished product is now passed by suitable means, such as a pump 2^a, through a pipe 7 to pan D, which may be disposed ahead of pan A. The heat supplied to pan D in connection with the plus pressure therein superheats the liquid and causes it to film climb in the tubes *a* and subsequently descend in the tubes *b* in the manner set forth in my application before referred to. The vapor from pan C passes to a condenser 8 and may be drawn off in any usual or well known manner. Liquor from pan C is preferably heated before passing to pan D, and for this purpose I may interpose a heating element 9 in the pipe line 7 conveying such liquor, for the heating of which the water of condensation from the steam zone of pan D is directed to said element through a pipe 10.

After the operation of pan D has commenced, the direct supply of the heating medium to pan A is cut off and said heating medium circulates around the tubes of pan D only, while pan A is heated from pan D by means of the vapor separated from the finished liquor, which by reason of the superheating of said liquor is of a temperature sufficiently high for the purpose. It is this feature that I desire to cover broadly; that is to say, the utilization of the vapor from pan D in which the final concentration of the material under treatment is carried out, for the heating and preliminary evaporation in pans A, B and C of the thin liquor fed to pan A and circulated through the other pans of the multiple effect under successively lower pressures. In practice I have conducted this evaporation to such a point as to secure almost complete dehydration of the material operated upon, and have secured a liquid mass that becomes substantially dry and solid when discharged from the evaporator D and cooled. The apparatus D may be slightly different from that disclosed in my pending application before referred to, though working upon the same principle, in that the central tube or tubes within the same may carry the ascending film or films of liquor undergoing evaporation, while the outer tubes carry the descending films.

The pan D is supplied with steam from a pipe 11, and in order to supply pan A with steam for the purpose of heating the thin liquor initially passed thereto, I may provide a by-pass 12 leading from said live steam conduit to a pipe 13 which conveys vapor from the separator chamber of pan D to the steam zone of pan A, and it will be understood that such by-pass may be cut out as soon as the full operation of the complete apparatus is effected.

In the present instance I have shown the material discharging from the high pressure evaporator into a vacuum chamber such as illustrated in my companion application relating to the desiccation of vegetable extracts. Below the high pressure evaporator, therefore, I may provide a shell or casing 15 which is connected at 16 to any suitable form of exhaust apparatus whereby a high or nearly complete vacuum may be maintained within said shell or casing. The liquid from the evaporator is discharged into the shell or casing and allowed to expand therein. Much of the contained water flashes into vapor which is drawn off by the exhaust means, while the residual solid material is collected in the form of spongy vermicular bodies, which may be subsequently comminuted to form a light fluffy powder, capable of indefinte preservation and of reforming the original extract upon the addition of water. In order that the exhaust means may have no tendency to withdraw the material, the latter is preferably discharged into the casing through an element 17 which serves as a deflector and is disposed in such position that the liquid issuing therefrom is below the line of the suction outlet.

As moisture is liable to collect on the inner walls of the shell or casing 15 in which desiccation takes place, which if al-

lowed to come in contact with the material within such chamber would destroy its value as a dry product, I preferably arrange in the bottom of the chamber a pan 18 to receive the desiccated material; which pan is supported above the bottom of the shell or casing. Any moisture collecting on the walls of said casing therefore may pass to the bottom of the same out of contact with the desiccated material and may be discharged through a valved outlet 19.

I claim:

1. The process of concentrating liquids containing dissolved organic matter, which consists in passing the same through a series of evaporating pans working under successively higher vacuum, discharging said liquid to an evaporating pan working with heating vapor above 100° C. and rapidly passing the liquid therethrough.

2. The process of concentrating liquids containing dissolved organic matter, which consists in passing the same through a multiple effect under successively increasing vacua, then further evaporating said liquid as a traveling film in a hotter evaporator and passing the vapor formed in the hotter evaporator to the heating elements of the vacuum apparatus.

3. The process of concentrating liquids containing dissolved organic matter, which consists in passing the same through a multiple effect under successively increasing vacua, then passing said liquid to a series of tubes, superheating said tubes whereby the liquid fed thereto is caused to film and rise and fall in columns out of contact with each other, discharging the descending columns of said liquid, and passing the vapor separated therefrom to the pans of the multiple effect.

4. The process of concentrating liquids containing dissolved organic matter, which consists in passing the same through a series of evaporating pans working under successively higher vacuum, discharging said liquid to an evaporating pan working with heating vapor above 100° C., rapidly passing liquid therethrough, and subjecting such liquid to preliminary heating after it leaves the vacuum pan and before it is passed to said final pan.

5. The process of concentrating liquids, which consists in passing the same through a series of evaporating pans successively decreasing in temperature, discharging said liquid to an evaporating pan working at a temperature above 100° C., and rapidly passing the liquid therethrough.

6. The process of evaporating liquids, which comprises passing such liquid through a multiple effect apparatus under successively decreasing pressure and temperature, and then further evaporating and rapidly passing said liquid through an evaporator hotter than the last stage of the preceding evaporation.

7. The process of concentrating liquids, which consists in passing the same through a multiple effect apparatus, then further evaporating said liquid as a traveling film in an evaporator heated at a temperature greater than the last pan of the multiple effect apparatus, and passing the vapor formed in the hotter evaporator to the heating elements of the multiple effect apparatus.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

PAUL KESTNER.

Witnesses:

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LÉON PECKEL.