June 10, 1941. D. D. PEEBLES 2,244,919

EVAPORATING APPARATUS

Filed Aug. 15, 1938

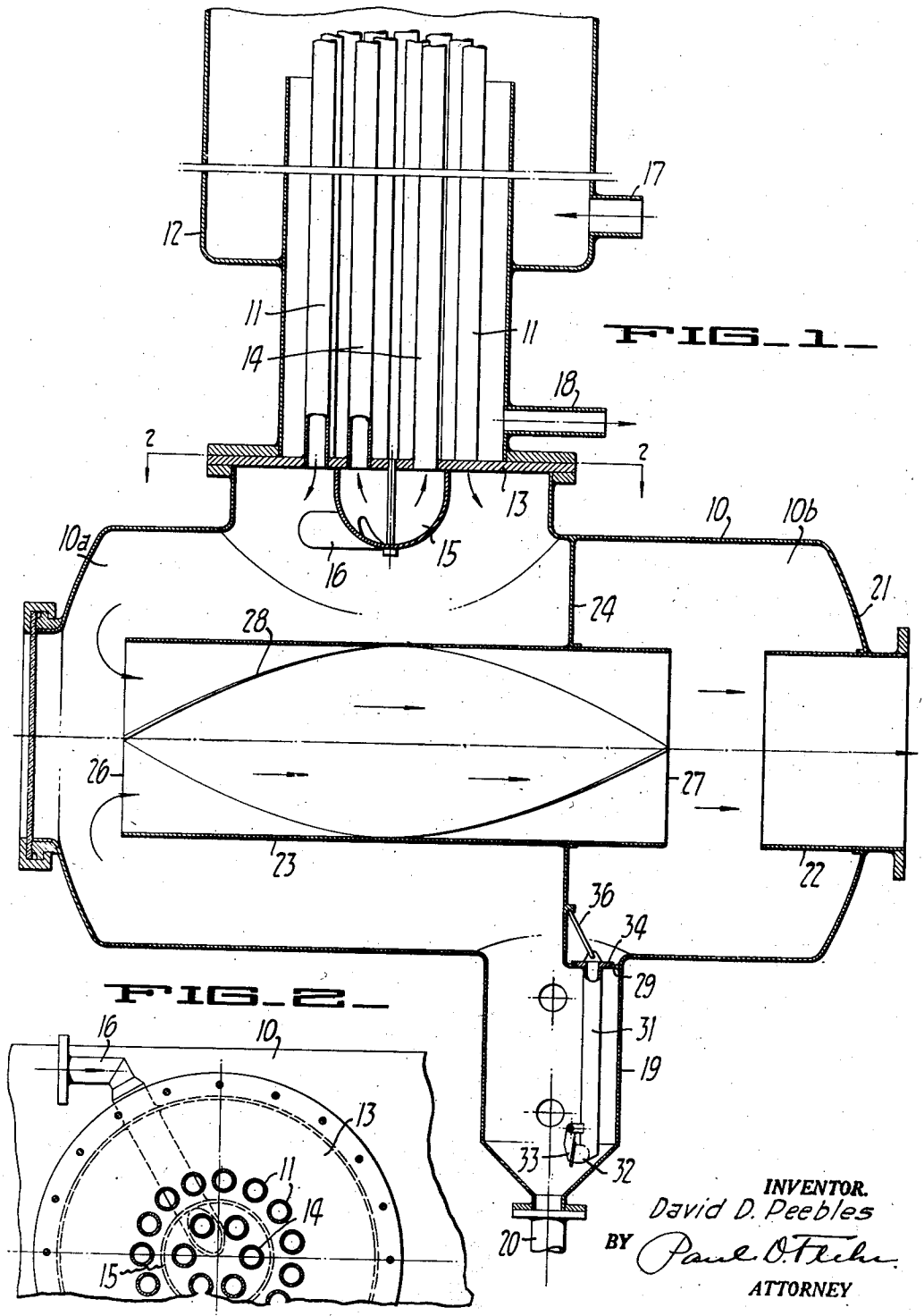


FIG_1_

FIG_2_

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EVAPORATING APPARATUS

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Application August 15, 1938, Serial No. 224,909

4 Claims. (Cl. 183—111)

This invention relates generally to evaporating equipment of the type making use of one or more entrainment separators for separating vapor from liquid concentrate and for collecting the liquid. Evaporating equipment of this type is disclosed and claimed in Peebles and Manning Patent No. 2,090,985.

It is an object of the invention to generally improve apparatus of the above character, whereby efficient separation is obtained between vapor and liquid discharged from the evaporating tubes, and whereby liquid is delivered to an outlet conduit with a minimum amount of liquid storage.

More particularly it is an object of the invention to provide an entrainment separator suitable for evaporating equipment, which will be characterized by novel means for establishing a rotating column of vapor within the separating chamber, together with adequate means for removing liquid thereby separated from the vapor.

Further objects of the invention will appear from the following description in which the preferred embodiment of the invention has been set forth in detail in conjunction with the accompanying drawing.

Referring to the drawing:

Fig. 1 is a side elevational view, in cross-section, illustrating evaporating apparatus incorporating the present invention.

Fig. 2 is a cross-sectional detail taken along the line 2—2 of Fig. 1.

The apparatus illustrated in the drawing consists of a receiver 10, which in this instance is in the form of a cylindrical drum disposed in a horizontal position. The upper side of the receiver 10 is adapted to receive a mixture of vapor and liquid from the evaporating tubes 11. These tubes are shown surrounded by a heating jacket 12, and have their lower ends attached to the tube sheet 13. With an evaporator of the type disclosed and claimed in my co-pending application Serial No. 223,683, filed August 8, 1938, tube sheet 13 also connects with the up-flow tubes 14. The lower ends of these tubes communicate with a chamber 15, which in turn connects with the liquid inlet pipe 16. The upper ends of the evaporating tubes 14 can communicate with the upper ends of the down flow tubes 11, by means of a suitable transfer chamber as disclosed in said co-pending application. Pipe 17 is for introduction of steam into the heating jacket, while pipe 18 is illustrated for removal of condensate.

The lower side of the receiver 10 connects with an outlet conduit 19, the end of which connects with the liquid discharge pipe 20, or a pipe leading to the intake of a liquid pump. One end wall 21 of the receiver 10 is provided with an opening within which is disposed the short conduit section 22. The outer end of this conduit section is flanged for attachment to a vapor removal pipe. The vapor pipe may connect with the heating jacket of another evaporating stage, or may connect directly to a condenser.

Within the receiver 10, and substantially in alignment with the axis of the conduit section 22, there is an open ended conduit 23. This conduit extends through and is secured to a partition wall 24, which in effect divides the interior of the receiver 10 into two compartments 10*a* and 10*b*. Therefore vapor discharged from the down flow tubes 11 into chamber 10*a*, must flow longitudinally through the conduit 23, before entering the vapor outlet conduit 22. The open inlet 26 of conduit 23 is to one side of the line of discharge from the downflow tubes 11, so that any jetting from the lower ends of these tubes can not directly enter conduit 23. The open outlet end 27 of conduit 23 is spaced a substantial distance from the adjacent end of the conduit 22, for a purpose to be presently explained.

Means are provided within the conduit 23 whereby a substantially rotary motion is imparted to vapor flow. The simple means illustrated consists of a baffle wall 28, which extends diametrically across the interior of the conduit 23, and which also extends from one end of the conduit to the other. This baffle wall is twisted substantially 180° upon itself, thereby imparting rotary motion to flow through the conduit.

In operating the separator described above, a substantial amount of liquid is removed in the compartment 10*b*, and must be drained from this compartment into the outlet conduit 19. Provision is made for such drainage without interfering with the necessary pressure differential between this compartment and the compartment 10*a*. Thus at the lower end of the wall 24, immediately overlying the interior of outlet 19, there is a ledge 29, which serves to isolate the interior of outlet 19 from the compartment 10*b*. Extending through this ledge 29 there is a liquid drain pipe 31, and the lower end 32 of this pipe has a laterally faced opening. A pivoted valve member 33 is biased by gravity to normally close the lower end of pipe 31, and to act as a check to prevent back flow of vapor or liquid from the interior of outlet 19 into pipe 31. The upper end of pipe 31 is provided with an annular flange 34, to rest upon ledge 29. A bale 36 or like device is also shown attached to the upper end of pipe

31, and by lifting upon this bale the pipe can be raised through the opening provided in ledge 29, and thus removed from the receiver 10 for cleaning.

Operation of the apparatus described above can be reviewed as follows: Vapor is removed from the conduit 22, as by means of a condenser, and pipe 20 connected to a suitable liquid pump. Assuming now that the apparatus is in operation and that vapor together with entrained liquid droplets are being discharged from the downflow tubes 11, a part of this liquid is immediately separated from the vapor and is drained down into the lower outlet conduit 19. The vapor together with the remaining entrained liquid is caused to flow with considerable velocity through the conduit 23, and the rotary motion imparted to the flow through this conduit causes further separation of entrained liquid. The liquid removed in the conduit 23 passes from the opening 27 into the compartment 10*b*, and compartment 10*b* also collects a certain amount of remaining entrained liquid which is thrown outwardly from the vapor, as the vapor expands from the discharge end of conduit 23. All of the liquid collected in chamber 10*b* flows down into the pipe 31, and forms a column of liquid upon the check valve 33. When a sufficient liquid head has accumulated upon check valve 33, this valve will open automatically to permit drainage of liquid into the lower end of outlet 19, to intermingle with liquid drainage from the compartment 10*a*. At all times there will be some remaining liquid head upon valve 33, due to the pressure head required to move this valve to open position. Thus it is possible to maintain the necessarily lower pressure in chamber 10*b*, as compared to the vapor pressure in chamber 10*a*, without a back flow of vapor through the pipe 31.

The apparatus described above will afford efficient separation, and at the same time there is a minimum amount of storage of removed liquid. The apparatus has found useful application with evaporating equipment handling liquid food products sensitive to heat treatment, such as milk or milk products, fruit juices, and the like. When handling such materials strict cleanliness and sterile conditions must be maintained. With my equipment it is a simple matter to clean and sterilize the interior of the separating apparatus, and as previously pointed out the drainage pipe 31 can be readily removed for cleaning and sterilizing.

I claim:

1. In evaporating apparatus of the character described having a receiver comprising a horizontally disposed casing, a vertically disposed partition serving to divide the interior of the receiver into two compartments, an open-ended conduit extending through said partition to establish communication therebetween, and means for discharging vapor and entrained liquid into said one of said compartments; a liquid outlet chamber depending from said casing in open communication with said one compartment, and means including a check valve for draining liquid from said other compartment into said liquid outlet chamber.

2. In apparatus of the character described having a receiver comprising a horizontally disposed casing, a vertically disposed partition serving to divide the interior of the receiver into two compartments, an open ended conduit extending through said partition to establish communication therebetween, and means for discharging vapor and entrained liquid into said one of said compartments; a liquid outlet chamber depending from said casing in open communication with said one compartment, a drain pipe extending from said other compartment into said outlet chamber, and check valve means in said pipe for maintaining a head of liquid therein, whereby to provide a liquid seal between said compartments and prevent disturbance of the pressure differential therebetween while providing for mingling of the drainage therefrom.

3. In apparatus of the character described having a receiver comprising a horizontally disposed casing, a vertically disposed partition serving to divide the interior of the receiver into two compartments, an open-ended conduit extending through said partition to establish communication therebetween, and means for discharging vapor and entrained liquid into said one of said compartments; a liquid outlet chamber depending from said casing in open communication with said one compartment, said chamber being positioned beneath said partition to underlie a portion of both said compartments, and drainage means extending from said other compartment into said outlet chamber including a check valve for maintaining a head of liquid in said drainage means.

4. In apparatus of the character described having a receiver comprising a horizontally disposed casing, a vertically disposed partition serving to divide the interior of the receiver into two compartments, an open-ended conduit extending through said partition to establish communication therebetween, and means for discharging vapor and entrained liquid into said one of said compartments; a liquid outlet chamber depending from said casing in open communication with said one compartment, a drain pipe extending from said other compartment into said outlet chamber, and check valve means in said pipe for maintaining a head of liquid therein, whereby to provide a liquid seal between said compartments and prevent disturbance of the pressure differential therebetween while providing for mingling of the drainage therefrom, and a drainage pipe removably seated in a wall of said other compartment and extending downwardly into said outlet chamber.

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