

E. A. NEWHALL.
 EVAPORATING APPARATUS AND METHOD OF OPERATING THE SAME.
 APPLICATION FILED MAY 9, 1917.

1,318,793.

Patented Oct. 14, 1919.

3 SHEETS—SHEET 1.

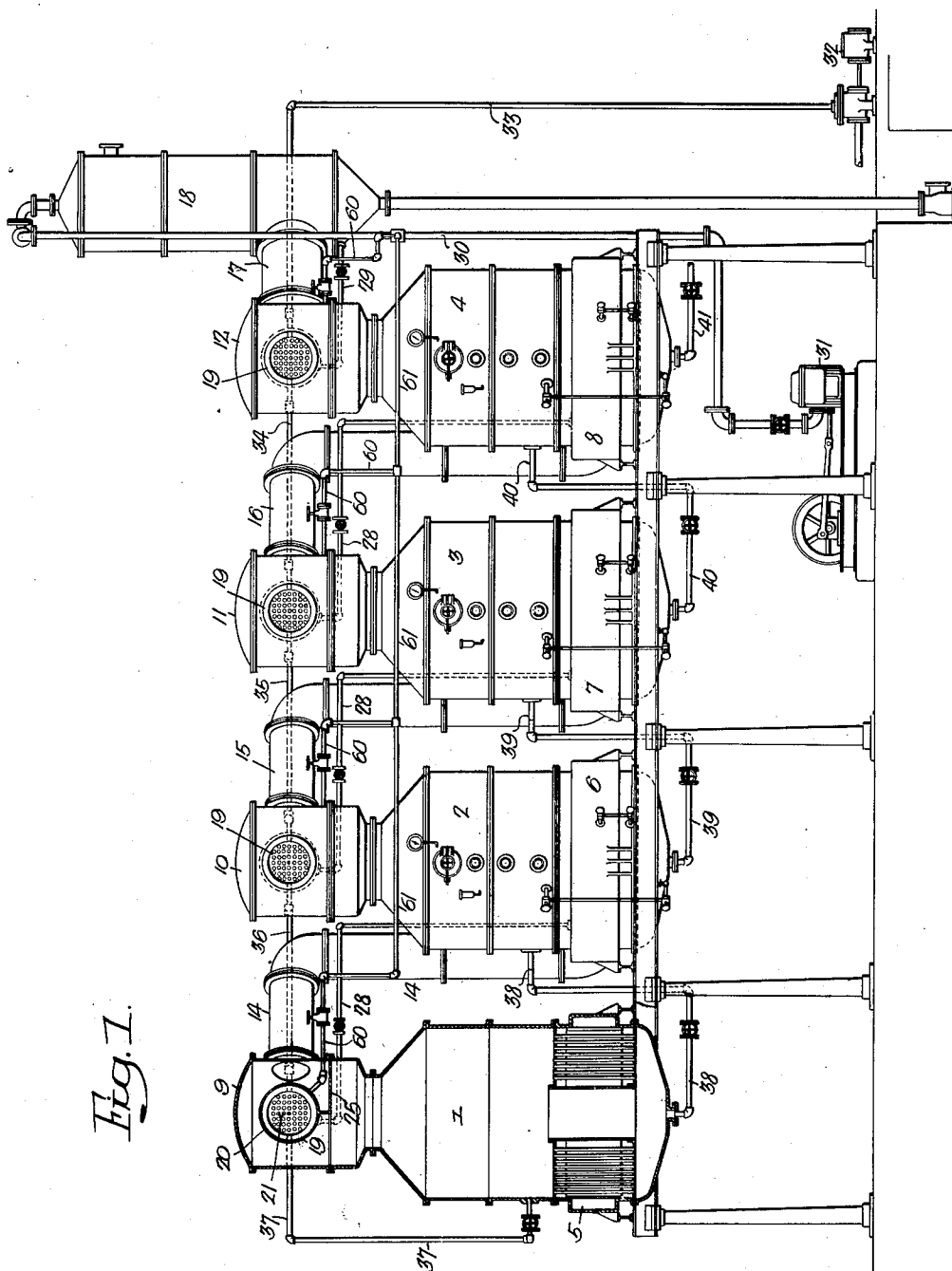


Fig. 1.

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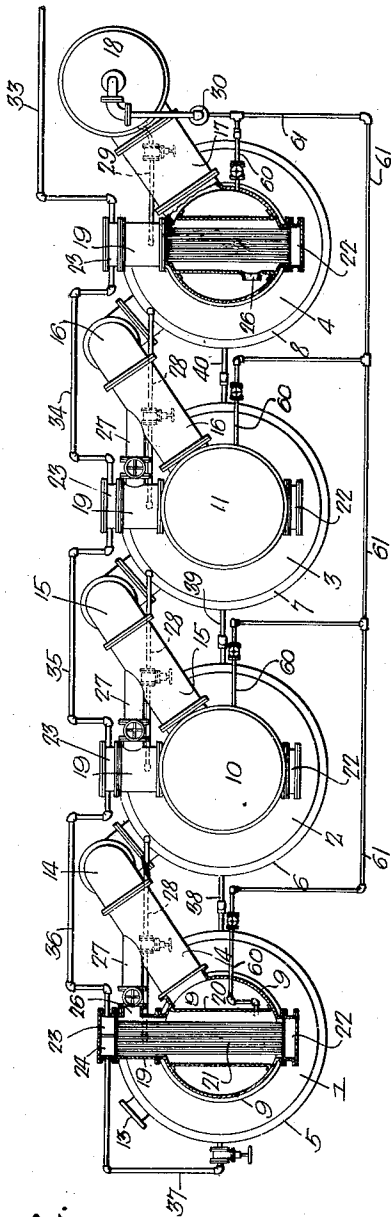


Fig. 2.

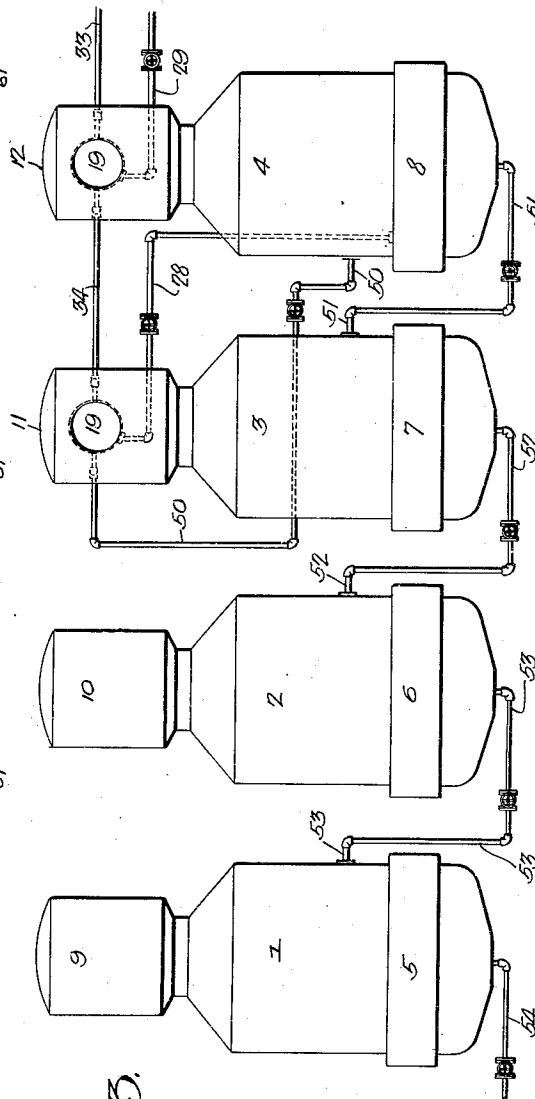


Fig. 3.

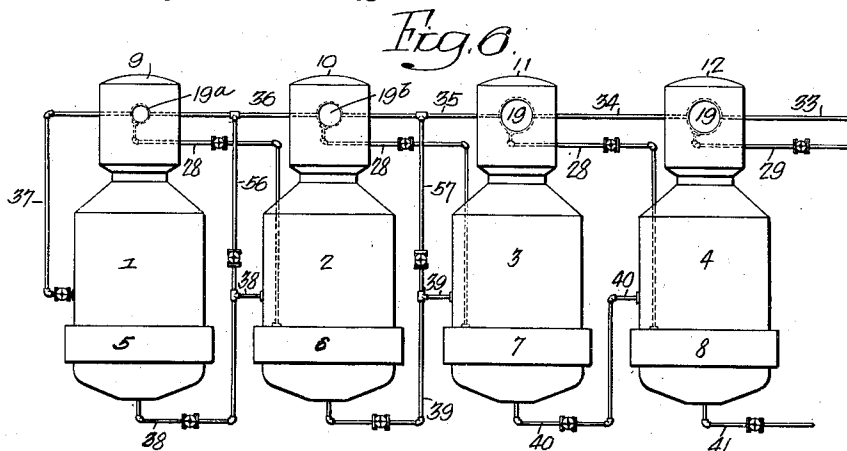
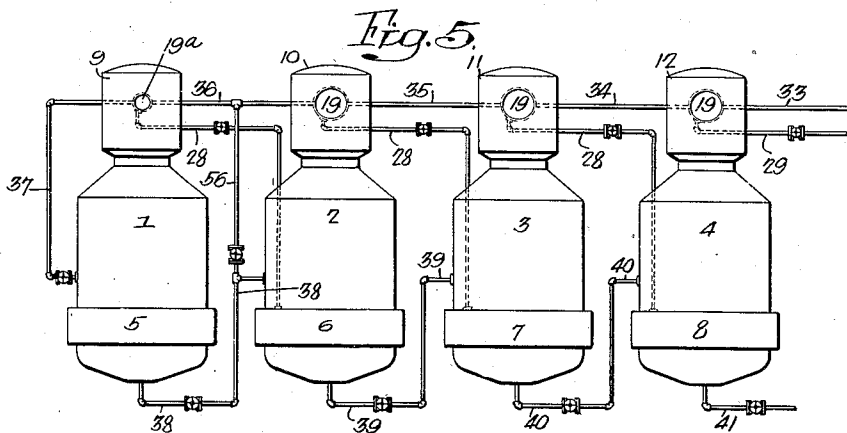
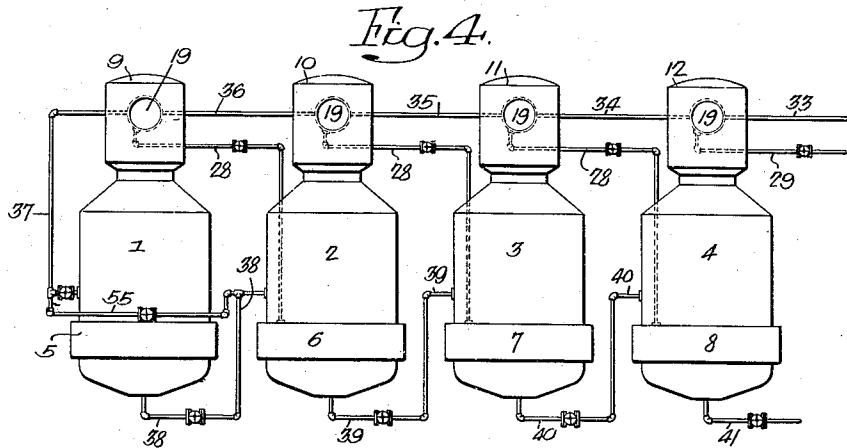
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UNITED STATES PATENT OFFICE.

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EVAPORATING APPARATUS AND METHOD OF OPERATING THE SAME

1,318,793.

Specification of Letters Patent.

Patented Oct. 14, 1919.

Application filed May 9, 1917. Serial No. 167,466.

To all whom it may concern:

Be it known that I, EZRA A. NEWHALL, a citizen of the United States, residing in Philadelphia, Pennsylvania, have invented
5 Evaporating Apparatus and Methods of Operating the Same, of which the following is a specification.

One object of my invention is to reduce the amount of heat required for the evaporation or concentration of a given body of liquid and more particularly to efficiently
10 utilize the heat present in a multiple effect evaporator, for raising the temperature of the liquid to be later evaporated with a view to lessening the amount of steam re-
15 quired for operating said apparatus.

It is also desired to provide a method of utilizing the latent heat of the vapors of an evaporating apparatus to provide the sen-
20 sible heat necessary to raise the temperature of the liquid to be evaporated prior to its introduction to the pans or evaporating compartments of the apparatus, with a view to increasing the efficiency thereof.

Another object of my invention is to provide an evaporating apparatus with means for reducing the amount of steam initially
25 required and for avoiding or reducing the losses of the liquid operated on due to its being carried by the vapors in the form of finely divided particles from one effect to the heating compartment of the next effect.

These objects and other advantageous ends
35 I secure as hereinafter set forth, reference being had to the accompanying drawings, in which,

Figure 1 is a side elevation partly in section and to some extent diagrammatic, illustrating my invention as applied to a multiple
40 effect evaporator;

Fig. 2 is a plan partly in section further illustrating the apparatus shown in Fig. 1; and

45 Figs. 3 to 6 inclusive are diagrammatic views illustrating various modifications of my invention.

In the above drawings, 1—4 represent the pans or individual effects of a multiple effect
50 evaporator having heating drums 5—8 and including auxiliary casings or catch-alls 9—12. The heating drum 5 of the first effect has an inlet 13 for steam and its catch-all 9 is connected to deliver vapor through
55 a pipe 14 to the heating drum 6 of the

second effect 2. Similarly other pipes 15 and 16 connect the catch-alls 10 and 11 of the effects 2 and 3 with the heating drums 7 and 8 of the effects 3 and 4, and a pipe 17 connects the catch-all 12 of the fourth
60 effect to a condenser 18.

In each of the four catch-alls 9—12, is mounted an economizer 19 consisting of a horizontally extended and preferably cylindrical shell 20 extending at one end out-
65 side of the evaporator and having tube sheets in which are mounted the ends of a series of tubes 21. These latter at one end all connect with a chamber 22 and at the opposite end part of them connect with a
70 chamber 23 and the other part with a chamber 24. A partition 25 extends across the lower part of each of the catch-alls so as to serve as a baffle and deflect around the
75 economizer casing 20, the vapors arising from the lower part of the effect and flowing toward the vapor outlet pipe 14.

In addition there is preferably a valved branch pipe 27 from each of the vapor pipes 14, 15 and 16 to the interior of each of the
80 shells or casings 20 for the reception of a portion of the vapors so as to permit these to circulate around the tubes 21 of the several economizers. Obviously the pipes 27 may be omitted and the vapor admitted
85 to the casings 20 through a suitable opening in a part of its body within the catch-all as indicated at 26 in the effect 4.

Each of the economizer shells or casings 20 has a pipe 28 connected to deliver liquid
90 condensing therein to the steam space of the heating drum of the next effect, although the economizer of the last effect has its casing connected through a pipe 29 to the vapor receiving space of the condenser 18.
95

The condenser is connected through a pipe 30 with an air pump 31 and in that form of my invention shown in Figs. 1 and 2, the liquor to be evaporated or concentrated is delivered by a pump 32 through a
100 pipe 33 to the chamber 23 of the economizer of the fourth effect and the second or outlet chamber 24 is connected by a pipe 34 to the receiving chamber of the economizer of the effect 3. Likewise the liquid
105 space of the economizer of the effect 3 is connected by a pipe 35 with the economizer of the effect 2, the latter in turn being connected by a pipe 36 with the economizer of the effect 1 and having its second chamber
110

24 connected through a pipe 37 to deliver liquid into the liquid-receiving space of the first effect 1. Obviously the detail construction of the economizers is immaterial since the liquid may be made to flow through each of them in any number of passes or in any desired manner without departing from my invention.

The lowest portion of the first effect is connected through a pipe 38 with the liquid receiving space of the second effect 2 and the lowest part of the latter is connected through a pipe 39 with the liquid-receiving space of the effect 3, whose lowest portion is connected by a pipe 40 to the liquid receiving space of the effect 4. The lowest part of the latter has connected to it a pipe 41 whereby the concentrated liquor may be delivered to any desired apparatus or storage receptacle.

In addition to the above I connect to each economizer an air pipe 60 and through a main 61, connect these pipes to the suction pipe 30 of the air pump; thereby keeping the economizers free of air and non-condensable gases as well as improving the circulation and action of the steam or water vapor.

Under conditions of operation, steam at a suitable pressure is delivered to the steam inlet 13 of the first effect, the condenser 18 is put in operation and raw liquor, usually in a cold condition, is delivered by the pump 32 through the pipe 33 to the economizer 19 of the fourth effect. After flowing through the tubes of the latter, said liquor passes through the pipe 34 to the economizer of the third effect, thence through the pipe 35 to the economizer of the second effect and thereafter through the pipe 36 to the economizer of the first effect, from which it is delivered through the pipe 37 to the liquid boiling space of said effect.

Obviously when the apparatus is in operation, vapor from the boiling liquid of each effect passes through the pipe 27 or other suitable opening or connection and heats the tubes in the casing 20 of the economizer in its particular catch-all, ultimately condensing and being conducted through the pipe 28 into the heating drum of the next effect.

As a result of this method of procedure, the relatively cold liquor is first acted on by the heat of the relatively low temperature vapors delivered from the last effect, and as it passes successively through the economizers of the third and second effects, its temperature is successively increased until it finally flows into the liquid boiling space of the first effect at a temperature but little below that required to cause it to boil, a portion of the latent heat of the vapor flowing from the effect in which any particular economizer is mounted being con-

verted into sensible heat which increases the temperature of the liquor.

It is obvious that the capacity of the apparatus is also increased since the economizers provide additional heating surface and vapors condensed in them must be replaced by additional evaporation in their respective effects in order to evaporate the required volume in the next succeeding effect.

As is understood by those skilled in the art, liquid after being concentrated or evaporated in each of the effects, to a predetermined extent is passed through the pipe 38, 39 or 40 as the case may be, to the next effect and is finally delivered in a highly concentrated condition through the pipe 41. By means of the above method and apparatus I find that there is a material reduction in the amount of heat required for the evaporation or concentration of a given body of liquid, this being due partly to the prevention of heat radiation due to the mounting of the economizers within the casings of the effects and partly to the efficient utilization of the heat of the vapors to successively raise the temperature of the liquid to be evaporated or concentrated. Moreover, owing to the peculiar arrangement of the economizer casings and their associated parts within the catch-alls of the several effects, there is a reduction in the amount of liquor mechanically carried by the vapors from the liquor space of one effect to the heating drum of the next effect.

While the arrangement of piping and apparatus shown in Figs. 1 and 2 will give good results for certain purposes, I may under certain conditions provide economizers in certain only of the effects. Thus in Fig. 3, for example, I have shown a system of apparatus in which there are but two economizers 19, mounted in the third and fourth effects of the evaporator respectively, and in such case the condensed vapor from the economizer of the effect 3 would be delivered through the pipe 28 to the heating drum 8 of the effect 4 and the water from the economizer of this latter effect would be delivered through the pipe 29 to the condenser.

As before, the cold raw liquor is delivered through a pipe 33 to the economizer in the fourth effect and from the latter through the pipe 34 to the economizer in the third effect, after which it flows through a pipe 50 to the boiling- or liquid receiving space of the fourth effect. From the lowest point of this fourth effect it will be delivered or forced through a pipe 51 to the liquid boiling space of the effect 3, thence through a pipe 52 from the lowest point of this effect to the liquid receiving space of the effect 2 and from the lowest point of this latter to the liquid receiving space of the effect 1,

from whose lowest portion concentrated liquor is delivered or discharged through a pipe 54.

In Fig. 4, I have shown an arrangement of apparatus identical with that of Figs. 1 and 2, except that the pipe 55 is connected between the pipe 37 and the pipe 38 so that a portion of the liquid flowing from the economizer 19 of the first effect may be delivered to the liquid receiving space of said effect and the remainder to the corresponding compartment of the second effect.

In that form of my invention shown in Fig. 5, the apparatus and connections are similar to that of Fig. 1, except that the economizer 19^a of the first effect is of smaller dimensions than the economizers in the other effects, and a by-pass connection 56 is made from the pipe 36 to the pipe 38, so that under operating conditions the liquor to be evaporated, after flowing through the economizers of the effects 2, 3 and 4, is divided, a part flowing through the economizer 19^a and thereafter being delivered through the pipe 37 to the liquid boiling space of the effect 1, and the remainder passing through the pipe 56 to the pipe 38 and into the liquid boiling compartment of the effect 2, where it is concentrated with the partially concentrated liquid delivered through the pipe 38 from the effect 1.

In the case of the arrangement shown in Fig. 6, the connections and apparatus are the same as in Fig. 5, except that a by-pass 57 is provided between the pipe 35 and the pipe 39, in addition to which the economizer 19^b of the effect 2 is of smaller capacity than the economizer of the effect 3, but larger than the economizer 19^a of the first effect.

Under operating conditions therefore, the liquor under treatment divides after flowing through and being heated in the economizer 19 of the effects 3 and 4, so that part flows through the pipe 57 to the liquid boiling space of the effect 3 while the remainder passes through the economizer 19^b and thereafter divides between the pipe 56 in the economizer 19^a. As a result, highly heated liquid from this latter economizer is delivered to the liquid boiling space of the effect 1 and the partially concentrated liquid from this effect with the hot raw liquor from the pipe 56 is supplied to the effect 2. The liquor delivered from this to the pipe 39, mixed with the partially heated liquor delivered from the pipe 57, is then successively delivered to and acted on by the two last effects 3 and 4.

It is to be understood that the various figures of drawing are designed to illustrate merely the general arrangement of apparatus and piping and for this reason are largely diagrammatic, it being understood that in every case there are provided the attachments and auxiliary apparatus neces-

sary to cause the circulation of the liquid described as well as to control the flow of said liquid and of the vapor, permit observation of the progress of the operation and of the performance of the apparatus, etc.

It is also to be noted that the liquid condensing in each economizer is led to the next lower effect where it gives up heat to assist in the operation of the same.

It will be understood that the heated liquid delivered to the first effect is at a temperature but slightly below its temperature of boiling within that effect so that only sufficient steam is consumed to bring its temperature to the particular boiling point due to the pressure existing in that effect, in addition to the steam necessary to vaporize said liquid.

Owing to the mode of operation described, there is a material saving of the steam required to concentrate a given quantity of liquid. It is also to be noted that while in some cases it is preferable to feed the liquid as shown in Fig. 1, from the economizer in the last effect successively through a number of economizers to that in the first effect and thereafter concentrate said liquor by delivering it successively from the first or highest temperature effect to the last effect, I may, as shown in Fig. 3, after heating said liquor in one or more economizers, beginning with that of the last effect, cause the liquid to flow in a direction counter to that of the vapor by feeding it successively from the fourth to the first effects as indicated.

I claim:—

1. The method of operating a multiple effect which consists in causing liquid to receive heat from the vapor given off by at least one effect; dividing the heated liquid and further heating a portion thereof; boiling said portion to partially concentrate the same; mixing said latter liquid with unevaporated but partially heated liquid; and subsequently boiling the mixture to further concentrate the same.

2. The method of operating a multiple effect which consists in feeding to the first effect a body of raw liquor to be evaporated; thereafter evaporating said liquor in the first and succeeding effects; and feeding additional raw liquor to one of the effects other than the first.

3. The method of operating a multiple effect which consists in feeding to the first effect a body of raw liquor to be evaporated; thereafter evaporating said liquor in the first and succeeding effects; mixing raw liquor with the partially evaporated liquor from the first effect; and delivering the mixture to the second effect.

4. The combination of an evaporator including a catch-all and a vapor delivery pipe; an economizer mounted in said catch-all; a conduit connecting the vapor delivery

pipe and the vapor receiving space of said economizer; a conduit for conducting liquor to the economizer; and a second conduit for conducting liquid from the economizer to the liquid receiving compartment of the evaporator.

5. The combination of a series of evaporators; economizers mounted in vapor receiving portions of said evaporators respectively; means for causing liquid to successively flow through said economizers to the liquid receiving space of one of the evaporators; and means for by-passing liquid around one of the economizers and its evaporator.

6. The combination of a series of evaporators; economizers mounted in the vapor receiving portion of said evaporators respectively; means for causing liquid to successively flow through said economizers to the liquid receiving space of one of the evaporators; and means for by-passing liquid around one of the economizers and its evaporator, at least one of said economizers being of smaller capacity than the others.

7. The combination of an evaporator; an economizer mounted in said evaporator so as to be heated by vapor therefrom and extending outside of the same; a conduit connecting the outside part of the economizer

with the vapor outlet pipe of the evaporator; and means for causing liquid to pass successively through the economizer and the evaporator.

8. The combination with a multiple effect of economizers respectively mounted in a plurality of the effects and each having a portion extending outside of its effect; means for delivering liquid to the economizers and from said economizers to the liquid boiling compartment of at least one of the effects; vapor pipes connecting the effects; and a conduit from each vapor pipe to the outside part of the adjacent economizer.

9. The combination with a multiple effect of a series of economizers including casings respectively mounted within the individual effects and tubes in said casings; conduits for causing liquid to flow successively through the tubes of said economizers; conduits for delivering condensed liquid from the casings to the steam spaces of the next lowest effects respectively; and means for causing the liquid from the last economizer to be successively evaporated in the effects.

In witness whereof I affix my signature.

EZRA A. NEWHALL.