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APPARATUS FOR EVAPORATING LIQUIDS.

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1,254,689. Patented Jan. 29, 1918.

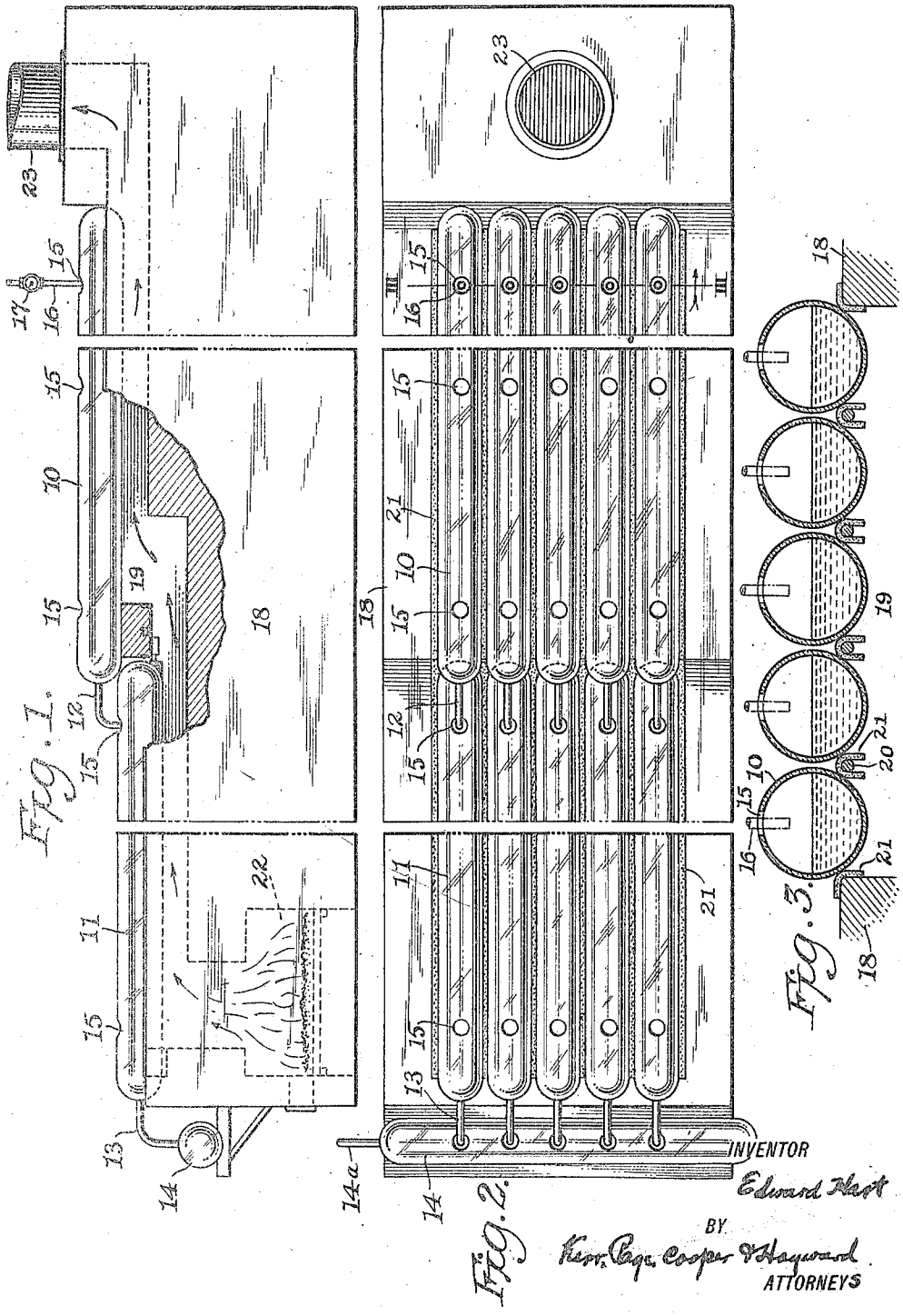


Fig. 1.

Fig. 2.

Fig. 3.

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Application filed November 15, 1917. Serial No. 202,189.

To all whom it may concern:

Be it known that I, EDWARD HART, a citizen of the United States, residing at Easton, in the county of Northampton and State of Pennsylvania, have invented certain new and useful Improvements in Apparatus for Evaporating Liquids, of which the following is a full, clear, and exact description.

This invention relates to evaporating or concentrating liquids, particularly acid liquids, and its chief object is to provide for the purpose a simple and effective apparatus which can be constructed and operated at low cost. To this and other ends the invention consists of the novel features and combinations hereinafter described.

A convenient and efficient embodiment of the invention is illustrated in the accompanying drawing, in which—

Figure 1 is a side view, with part of the setting broken away to show the arrangement of the flue or passage for the products of combustion.

Fig. 2 is a plan view.

Fig. 3 is a cross section, about on the plane indicated by the line III—III at the right of Fig. 2.

In the apparatus illustrated the evaporation takes place in a plurality of series of horizontal evaporators 10, 11, arranged end to end but one above the other "in cascade," the several series (if more than one series is employed) being located side by side. I have shown only two evaporators in each series, but it will be understood that the precise number is in general immaterial and depends upon the specific use for which a particular apparatus is constructed. If the liquid to be evaporated is acid the evaporators or vessels 10, 11, which are in the form of elongated cylindrical tubes, are made of or at least lined with suitable resistant material. In most cases glass is the best and in the long run cheapest for the purpose. The upper evaporators are provided at their front ends with overflow pipes 12 leading from a point about midway between the top and bottom of the tube. The overflow pipes discharge into the next lower evaporators, and the lowest evaporators are provided with similar overflow pipes 13 discharging into a transverse manifold 14 located at the front of the furnace and provided with an escape pipe 14^a. It will thus be seen that the liquid in the several evaporators will rise no higher than the overflow pipes, thus keeping the evaporators no more than about half full and affording ample vapor space. The evaporators are also formed with openings, as 15, for the free escape of vapor and for the introduction of the liquid. The latter is delivered to the uppermost evaporators by means of pipes 16, which may be connected to a manifold (not shown) so that all will receive liquid from the same source. Each pipe 16 is provided with a valve 17, permitting the liquid supply to be accurately regulated.

The furnace 18 is preferably of masonry, and at its top is built with a shallow, flat flue 19 constructed in as many levels as there are transverse rows of evaporators, as clearly shown in Fig. 1. The flue is open at the top but is provided with a plurality of iron supporting bars 20, which are arranged longitudinally to support the evaporators and are cushioned, as are also the edges of the flue, by means of strips 21 of non-combustible felt or heavy paper, composed preferably of asbestos, laid loosely in place.

The fire box or grate chamber 22 discharges the products of combustion into the front end of the flue, through which latter the heated gases pass to the stack 23 at the rear end of the flue. The stack may be tall, so that the draft produced will be adequate to prevent escape of smoke and gases from the spaces between the evaporators in case such spaces are not perfectly sealed by the asbestos cushions 20.

The operation will be readily understood. The more or less dilute liquid enters the uppermost evaporators at a rate somewhat faster than it can be evaporated. The excess escapes into the next lower evaporators of the cascade and is finally delivered to the manifold 14, whence it is discharged by the pipe 14^a into any suitable receptacle, not shown. The evaporators being elongated, the liquid entering at one end of an evaporator has ample opportunity to mix thoroughly with the liquid (more or less concentrated) in the evaporator, before the overflow pipe at the opposite end is reached. The thorough mixing is important, and is due to several factors. First, the liquid entering any given evaporator is somewhat cooler than the liquid therein, thus causing a tendency of the incoming liquid to sink. Second, the convection currents are active and rapid because of the heating of the bottoms and the cooling effect of evaporation at the surface.

Third, when boiling is permitted the ebullition agitates the liquid more or less strongly. The result is that if the supply by way of the pipes 16 is properly regulated the liquid in each evaporator is thoroughly homogeneous by the time it reaches the outlet pipe, so that the liquid escaping is no more and no less concentrated than the liquid remaining.

The evaporators and the receiving manifold at the end are simply laid on their supports and the discharge orifices of the supply and outlet pipes are free, so that any of the several vessels can be easily removed and replaced. While the total quantity of liquid in the system may be quite large, the quantity in any particular vessel may be relatively small. Breakage of a vessel is thus not the serious matter that it is in the case of a large receptacle, and replacement of a broken part is correspondingly cheaper and easier.

If desired a dome may be arranged over the apparatus to collect the escaping vapors, but such provision is a well known expedient and hence need not be illustrated.

It is to be understood that the invention is not limited to the specific construction herein illustrated and described but can be embodied in other forms without departure from its spirit as defined by the following claims.

I claim:

1. In an evaporating and concentrating apparatus, in combination, a furnace having an elongated open-topped flue, a plurality of evaporators of elongated tubular form connected in cascade series and closing the top of said flue, and means for continuously supplying liquid to be evaporated to the upper end of the series in regulated amount.

2. In an evaporating and concentrating apparatus, in combination, a plurality of elongated tubular evaporators arranged horizontally in cascade series and provided at the top with liquid inlet and vapor escape openings, connecting pipes between the evaporators and arranged to maintain a body of liquid in each with vapor spaces above the liquid, means for supplying liquid to the upper end of the series, means for collecting the more or less concentrated liquid delivered at the lower end of the series, and means for heating the evaporators.

3. In an evaporating and concentrating apparatus, in combination, a furnace having an elongated open-topped flue, a plurality of supporting bars arranged longitudinally of said flue, non-combustible cushions on said bars, and elongated tubular evaporators resting on the cushions with their bottoms exposed and removable independently of each other.

4. In an evaporating and concentrating apparatus, in combination, a furnace having an elongated open-topped flue, a plurality of supporting bars extending longitudinally of the flue, end to end and in transverse rows, one row above the other, non-combustible cushions on the bars, a plurality of elongated tubular evaporators arranged in a plurality of cascade series and resting on said cushions with their bottoms exposed to the flue, means at the upper end of the cascade series for supplying liquid to be evaporated, and means at the lower end of the series for collecting the more or less concentrated liquid.

5. In an evaporating and concentrating apparatus, in combination, a plurality of elongated tubular evaporators arranged in transverse rows one row above another with the evaporators of one row alined with those of the row below, the evaporators being provided with vapor escape and liquid inlet openings in their tops; means for delivering liquid to be evaporated in regulated amounts to the appropriate openings in the uppermost evaporators; pipes connecting the outlet ends of the evaporators of one row to the inlet ends of the evaporators in the row next below, said pipes being arranged to receive liquid at points above the bottoms of the evaporators whereby to maintain bodies of liquid therein with vapor spaces above such liquid bodies; similar pipes similarly arranged for discharge of liquid from the lowermost row of evaporators; a receiving vessel for collecting the more or less concentrated liquid discharged from the last-mentioned pipes; and means for heating the evaporators.

In testimony whereof I affix my signature.

EDWARD HART.