Dec. 19, 1939. J. O. NAUCLÉR 2,184,195

METHOD AND APPARATUS FOR DESTROYING FROTH

Filed June 6, 1936 3 Sheets-Sheet 1

Fig. 1.

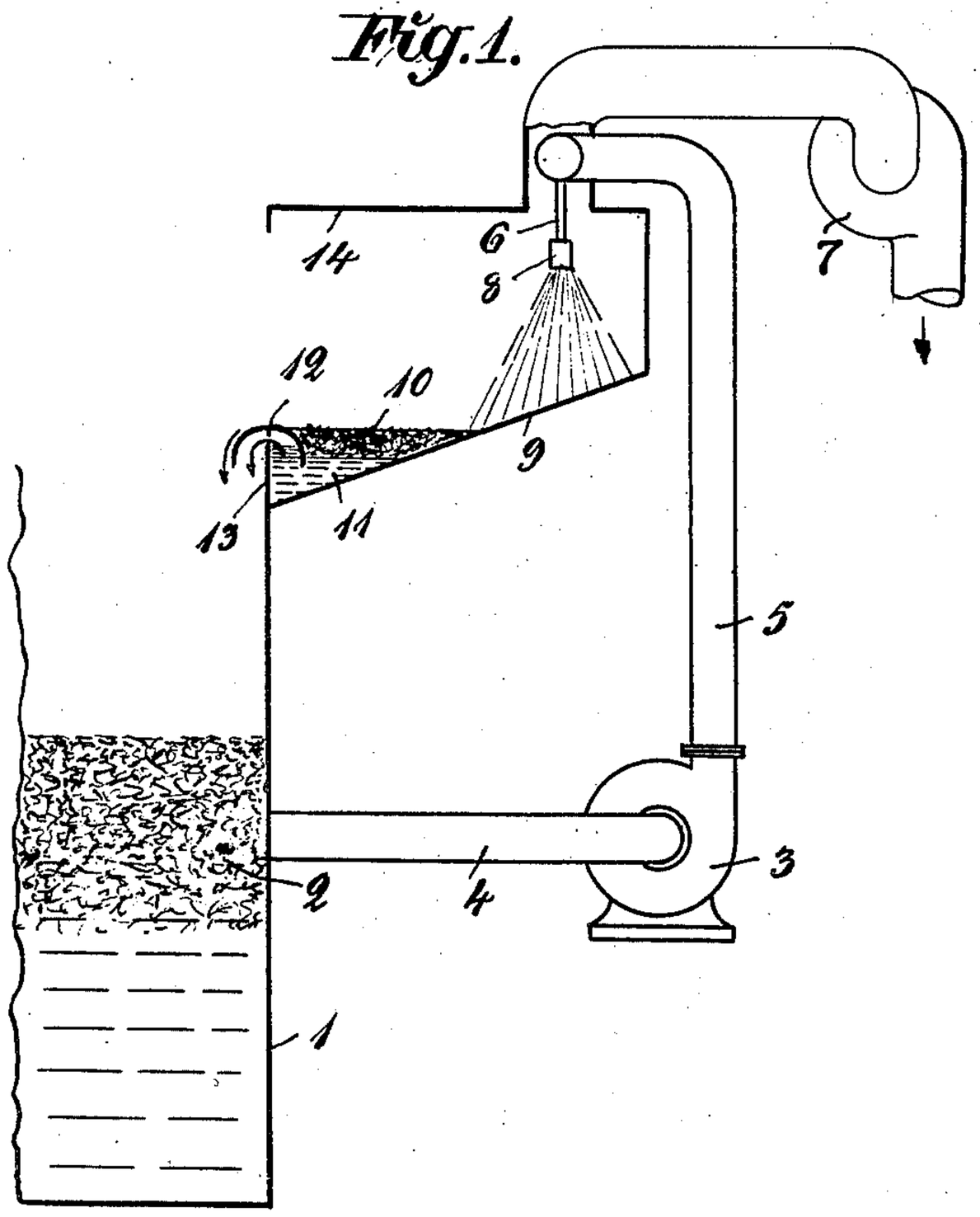


Fig. 2a.

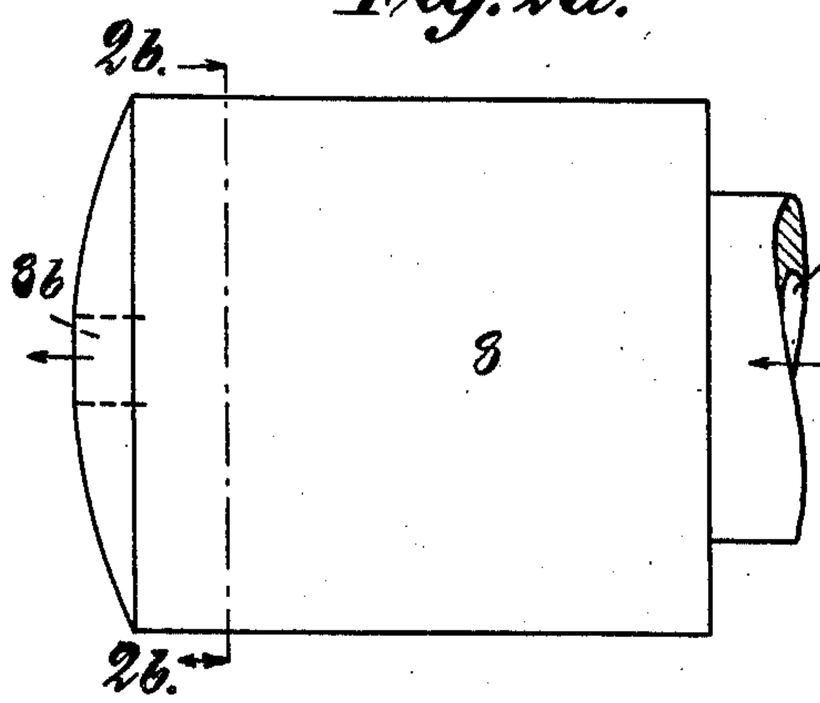
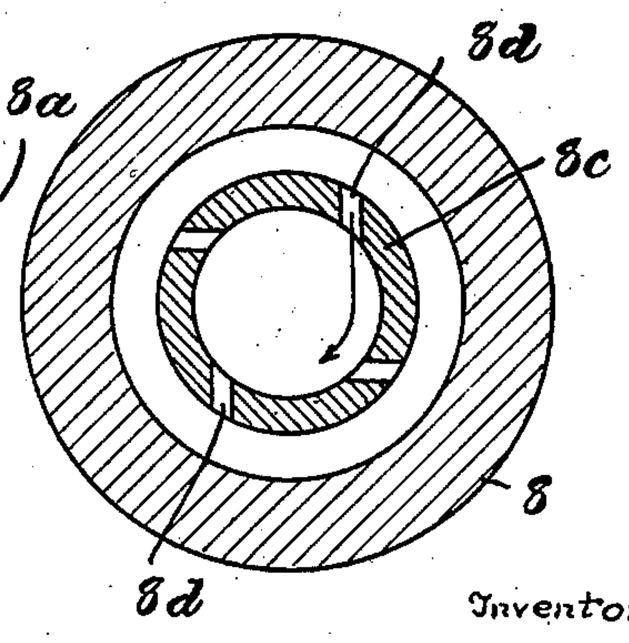


Fig. 2b.



Inventor

Johan Olof Naucler

By

Cameron, Kerkam + Sutton

Attorneys

Dec. 19, 1939. J. O. NAUCLÉR 2,184,195

METHOD AND APPARATUS FOR DESTROYING FROTH

Filed June 6, 1936 3 Sheets-Sheet 2

Fig. 3.

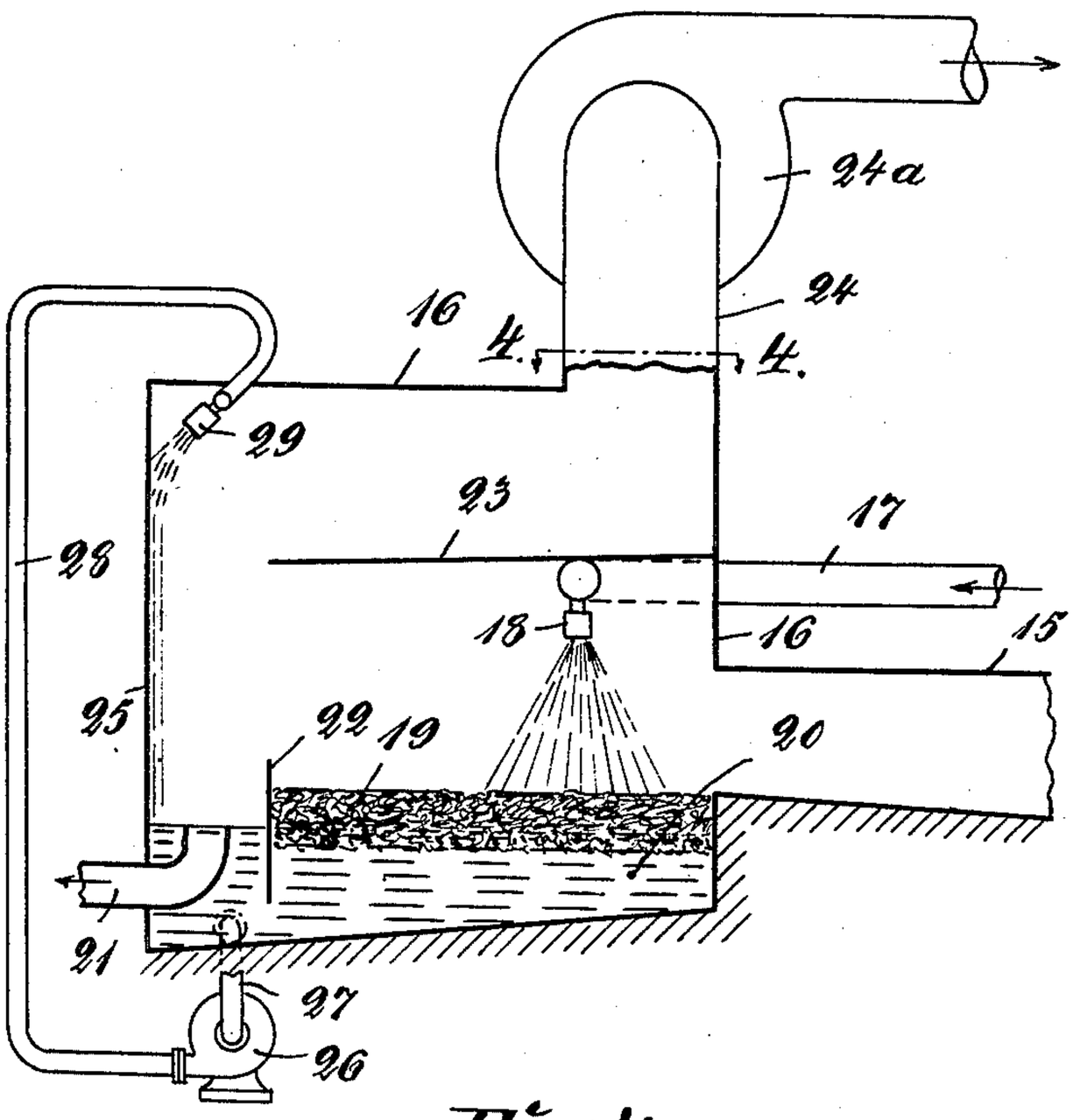
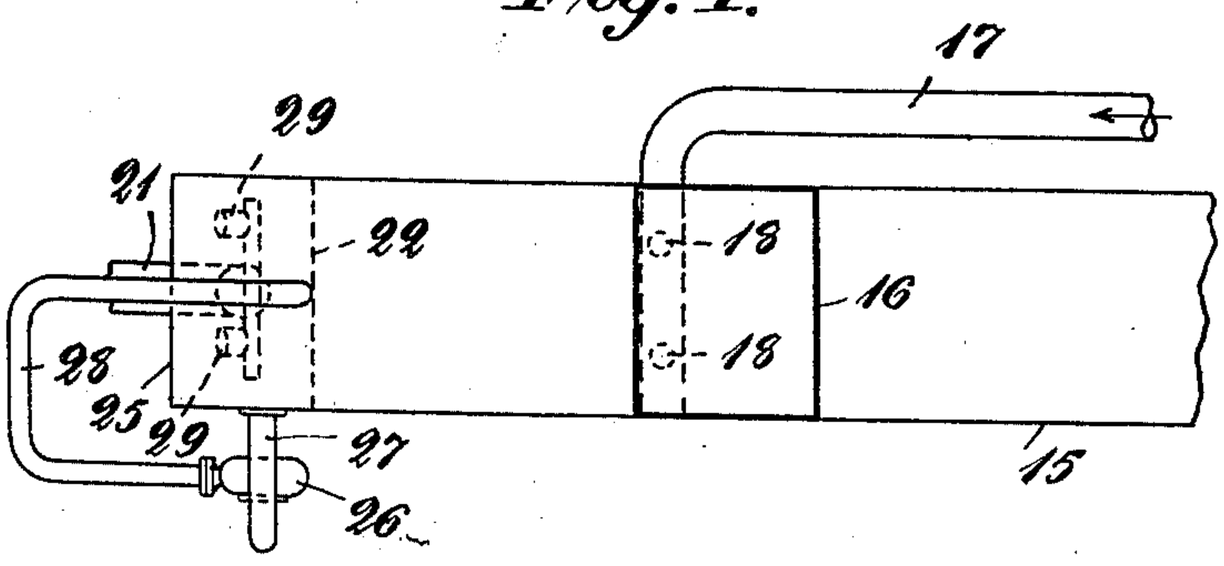


Fig. 4.



Inventor

Johan Olof Naucler

By

Cameron, Kerkam + Sutton

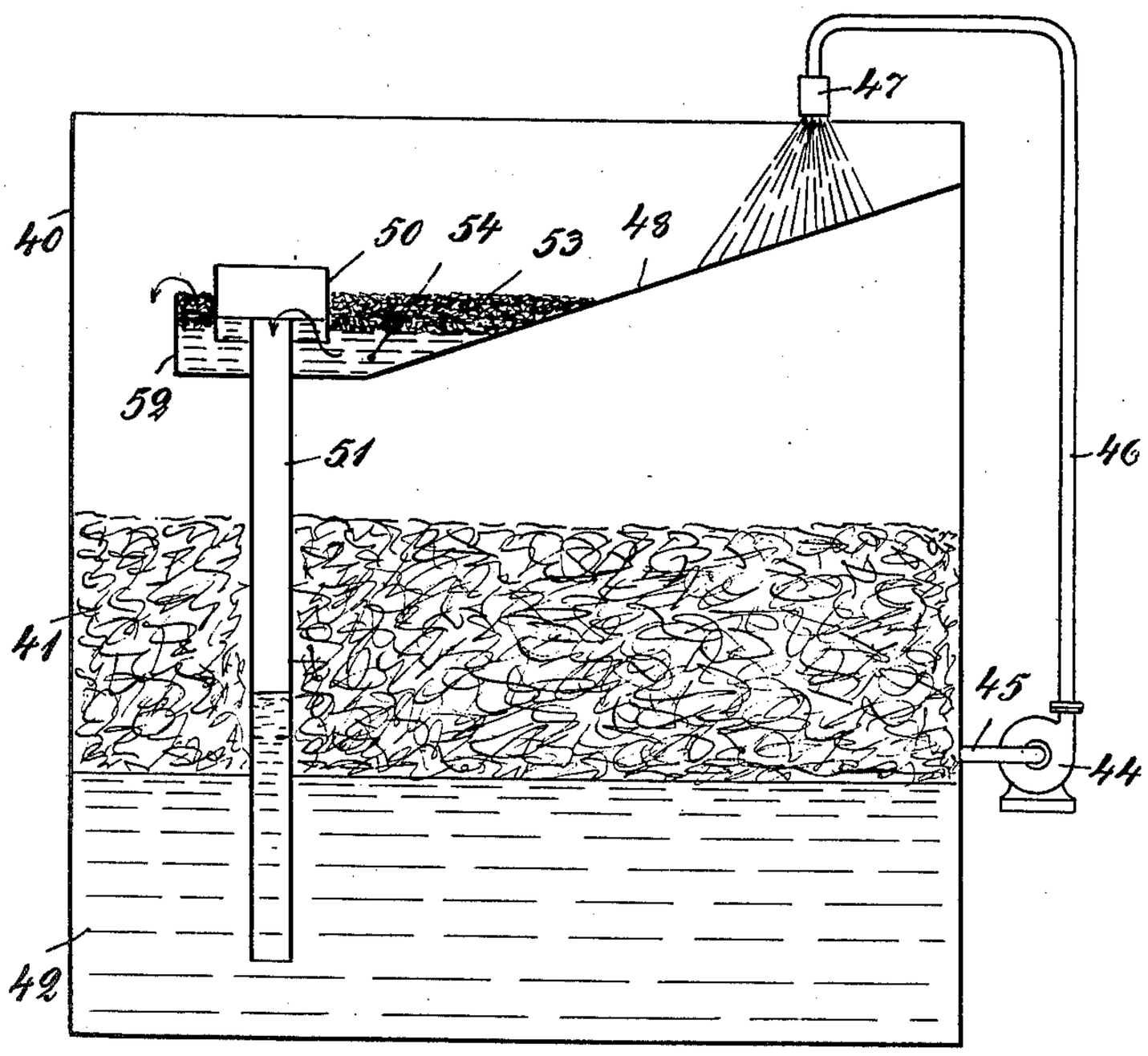
Attorneys

Dec. 19, 1939. J. O. NAUCLÉR 2,184,195

METHOD AND APPARATUS FOR DESTROYING FROTH

Filed June 6, 1936 3 Sheets-Sheet 3

Fig. 5.



Inventor

Johan Olof Naucler

By

Cameron, Kerkam + Sutton

Attorneys

Patented Dec. 19, 1939 2,184,195

UNITED STATES PATENT OFFICE

2,184,195

METHOD AND APPARATUS FOR DESTROYING FROTH

Johan Olof Nauclér, Stockholm, Sweden

Application June 6, 1936, Serial No. 84,006
In Sweden June 14, 1935

12 Claims. (Cl. 183—2.6)

In many of the industries involving the use of liquids containing substances having a relatively high activity as to surface tension, considerable difficulty is frequently caused by the tendency of the liquid to become frothy. This difficulty is experienced for example in the manufacture of yeast and also in the cellulose, soap and dairy industries.

In order to meet it, two principal methods have hitherto been employed.

The first of these methods consists in the use of certain substances which tend to quench froth as, for example, certain of the higher alcohols, certain fats, mineral oils, etc., which substances have generally the property of spreading themselves over the surface of the liquid and thus giving it qualities which are unfavourable to the development of froth.

The second of the said methods is the use of certain mechanical forces, such as beating the froth by means of disintegrators, or blowing a stream of air or other gas on the surface of the froth, or spraying froth by means of air-pressure so that it beats on the surface of the main body of the froth or on impact-surfaces. Separators have also been used in which the froth was to be disintegrated by centrifugal force.

With reference to these methods, the general remark may be made that those which involve the use of substances such as alcohols, fats, etc., are expensive since it is usually impossible to recover the substances used. The other methods, which involve the use of more or less mechanical contrivances, have proved to be ineffective since the bubbles of froth have only been split up into smaller bubbles without separating the gas from the liquid. In addition, the consumption of power in the use of disintegrators and other mechanical devices is very considerable.

The object of the present invention is to provide a novel method and contrivances for the effective and economical destruction or quenching of froth.

The characteristic feature of the present invention is that the froth is passed through a suitable device, such as for example a spraying device, in such a manner that forces are developed mainly in the liquid constituent of the froth, which tend to disturb the existing state of equilibrium, so that, when the mass of froth leaves the said device, their efforts to recover their mutual equilibrium result in the destruction of the films of liquid forming the froth bubbles containing the gaseous constituents. By this, the separated gaseous constituents are transformed into a coherent mass, and the liquid constituent is finely divided like a spray in the said coherent mass. In applying the new method, the use of air, steam or the like is preferably avoided, though this not essential.

The power consumed in forcing the froth through the device effecting the said separation is comparatively small. The new method does not involve the use of complicated apparatus or appliances. The only essential point is that the necessary forces be developed and released.

The present invention provides an economical method by the use of a spraying device which produces a film or layer of liquid, and without requiring any considerable pressure for forcing the froth through the sprayer by which the froth can be almost completely destroyed. If this is not achieved the first time, the process may be repeated, some of the froth being always destroyed. Since it has been found that a pressure of 0.5 kg./cm.^{2} is usually sufficient so that the consumption of power is insignificant, the repetition of the process does not involve any economic inferiority as compared with the previously known methods.

The film or layer of liquid is rapidly transformed into drops or a stream or streams. It is advisable to collect this mass of liquid in such a manner that the production of new froth in the collecting vessel is prevented as far as possible. If the velocity of the liquid on entering the collecting vessel is too high, it should be reduced as much as possible. This may be achieved, for example, by allowing the particles of liquid to fall freely through the air when they leave the sprayer. The resistance of the air acts as a brake upon the velocity. It is also advisable that, when the particles of liquid are collected, they should be separated from any bubbles of gas which may have accompanied them. As the specific gravity of the bubbles is lower than that of the liquid, any such bubbles of froth will lie on top of the collected liquid so that a layer of froth will gradually be formed on the surface of the liquid, through which the particles of liquid will have to pass. In this way, a new admixture of liquid and froth will take place. In order to avoid this, the surface of the liquid on which the drops are collected after the spraying-process should be kept as far as possible free from froth. This may be accomplished in several ways. For example, a froth-scraper may be provided which scrapes off the layer of froth at suitable intervals. Another method is to re-

move both liquid and froth immediately after their collection from the place in which the sprayed liquid is collected. For this purpose, a suitable method is to use a comparatively long, inclined floor over which the sprayed substance is conducted to the place where it is to be collected. Any froth which may remain or be newly formed during or after the spraying or collection may be conveyed either back to the same sprayer or to another sprayer. The latter alternative is to be preferred if this froth, as is frequently the case, is different from the original froth as to size of bubbles, etc., and ought, in consequence of this difference, to be sprayed under different circumstances, with reference, for example, to pressure or rotation, than the original froth. The froth may also be passed, before it reaches the sprayer, through a separating chamber in which any liquid which may run from the froth has an opportunity to do so.

It has also been found very advantageous, when possible, to expose the surface of the liquid or froth formed after collection, to the action of hot air or furnace gases. The evaporation which then takes place destroys any bubbles of froth which may remain. The surface of froth exposed to these hot gases should be constantly renewed, since, otherwise, the froth on the surface will dry and form a layer which prevents the destruction or evaporation of the mass of froth underneath.

The invention will now be further described with reference to the accompanying drawings, which illustrate three examples of apparatus suitable for carrying the invention into effect. In these drawings,

Figure 1 is a cross-sectional view of one form of apparatus embodying the invention;

Figure 2*a* is a view in side elevation of a sprayer suitable for use in connection with the invention;

Figure 2*b* is a cross-section through the sprayer of Figure 2*a* on the section line **2***b*—**2***b* of that figure;

Figure 3 is a cross-sectional view of another form of apparatus embodying the invention;

Figure 4 is a plan of the apparatus shown in Figure 3; and

Figure 5 is a cross-sectional view of still another form of apparatus embodying the invention.

Figure 1 illustrates the invention as applied in connection with a fermentation vat **1**. The froth is pumped from a suitable level **2** in the vat by means of a pump **3** through pipe-lines **4**, **5**, **6** to one or more sprayers **8**, from which the sprayed wort falls on to an inclined floor **9** which is placed at such a distance from the nozzle of the sprayer or sprayers **8** that the kinetic energy of the particles of liquid is reduced as a result of the braking effect of the air through which they fall. In this manner, any considerable formation of froth when the particles fall on to the floor is obviated. The liquid then runs down the inclined floor **9** to a preliminary collecting reservoir where any remaining froth is separated from the liquid in two layers **10** and **11** respectively. The froth flows over the screen **12** and the liquid over the overflow-rim or weir **13** back to the fermentation vat **1**. In order to prevent the escape of drops of liquid when the vat is aired, a screen-plate **14** is provided. It is obvious that several floors **9** may be arranged one above the other so that the sprayed substance flows over all or some of the floors before it reaches the place where it is collected. The distance travelled by the particles of liquid before reaching the preliminary collecting reservoir may also be increased by constructing the floor in the form of a spiral ribbon. The kinetic energy of the particles of liquid may also be neutralised by a stream of gas moving in the opposite direction to the particles and produced by means of a fan **7** or the like.

In quenching froth in fermentation processes and other processes in which the liquid from which the froth is derived is of comparatively low viscosity and "runs off" the froth relatively easily, it is often advantageous to turn the sprayer directly on to the froth which is to be quenched, since, in these cases, the falling drops of liquid contribute to the destruction of the thin films of liquid in the froth. In the case of liquids with a higher viscosity, which run off the froth more slowly, for example, the so-called black lye in the manufacture of sulphate cellulose, it is often necessary to take particular care that the sprayed gas-free lye is not again mixed with froth. In this case, the particles of liquid are collected on a constantly renewed surface of liquid.

The sprayer may, as is shown in Figures 2*a* and 2*b*, consist of a nozzle **8** with a pipe **8***a* through which the froth is to pass, a spray-hole **8***b* and a ring-shaped nozzle fitting **8***c*. The pipe **8***a* opens into the cylindrical space formed by the fitting **8***c* in front of the hole **8***b* through tangential slits **8***d* so that the froth acquires a rapid rotary motion about the common axis of the space and the mouth of the nozzle. The froth will then issue from the nozzle in the form of a rapidly rotating, relatively thin layer of froth, angularly disposed to the axis of the nozzle. Under the influence of centrifugal force, this layer will spread outwardly in the form of a vortex, gradually decreasing in thickness, until the forces created in the froth layer fracture the films of liquid forming said bubbles and said liquid coalesces into drops.

It will be obvious that the method of the present invention may also be carried out by the use of froth spraying or spreading devices other than that just described, so long as they are capable of projecting the froth into the atmosphere in such a way as to impart to the individual froth bubbles motion in divergent directions so as to stretch the froth layer until the bubbles burst.

Figures 3 and 4 show an apparatus by means of which any froth remaining after the process of spraying may be destroyed with the aid of hot gases, for example, furnace-gases.

The furnace-gas enters a spraying-chamber **16** through a pipe **15**. Froth passes through a pipe **17** to a sprayer **18**, through which it is sprayed into the hot furnace-gas. Any froth **19** remaining after spraying accumulates on the surface of the liquid **20** which is collected at the bottom of the spraying-chamber. An outflow **21** is provided for the liquid. This outflow may be constructed as an overflow adjacent a froth-screen **22** which holds back the froth where it is exposed to the effect of the furnace gases and prevents it from leaving the spraying chamber with the liquid. The chamber **16** is provided with a splash-separator, for example, a splash-screen **23**, which prevents splashes and drops of liquid from the sprayer from leaving the chamber with the hot furnace-gases. The furnace-gases leave through an outlet **24**. Since the volume of the furnace-gases is usually smaller when they leave

the spraying chamber than when they enter it, it is advantageous that they should be moved through the chamber by suction, for example, by means of a fan 24*a*. In the first place, less power is required if the gases are sucked through than if they are pushed through and, secondly, a fan placed in rear of the spraying chamber acts efficiently as a splash-separator. Since the furnace-gases are hot and are not saturated with moisture, it may easily happen that particles of liquid are deposited, for example, on the wall 25 of the spraying-chamber 16 and dry hard there. In order to prevent this, the wall may be so copiously sprayed (for example, by means of a pump 26 and pipe-lines 27, 28 and nozzle 29) with liquid taken, for example, from the reservoir 30, that all risk of such drying is obviated. The bottom of the chamber 16 and the screen 23 are inclined towards the outlet 21.

The apparatus shown in Figure 5 comprises a container 40 in which froth 41 has been formed from a liquid 42. The mass of froth is conveyed by means of a pump 44 through pipes 45, 46 to a sprayer 47. The particles into which the froth has been split by the process of spraying are collected on an inclined floor 48. From this floor, the liquid. together with any remaining bubbles of froth 53, flows down to a separator, consisting of a froth-screen 50 and an overflow-pipe 51 The froth-screen is so adjusted that it rises above the surface of the froth and reaches below the surface of the liquid so that it prevents the froth 53 from accompanying the liquid 54 to the overflow-pipe 51 which conveys the liquid back to the lower part of the container 40. A separate outlet 52 is provided for the mass of froth. The inclined floor 48 should be so long that any bubbles of froth remaining in the liquid reach the surface of the latter before it runs down through the layer of froth 53. In this way, it is easier to separate liquid and froth into layers. The overflow-pipe 51 should reach so far down that its outlet is below the surface of the liquid 42. In order to facilitate the pumping of the froth it may be advisable to increase its specific gravity. This is easily accomplished by pouring on to it or mixing with it some of the liquid from which it has been formed.

It has been found advantageous to pump the froth by means of suction pumps with a greater capacity than that of the sprayer to which they convey the froth. The use of several sprayer-nozzles as, for example, in the apparatus shown in Figures 3 and 4, is advantageous, because the destruction of froth can be adjusted to varying circumstances and, in addition, the nozzles can be cleaned without stopping the plant. The sprayer- nozzles need not necessarily be arranged in parallel as is shown in Figure 4. On the contrary, it may often be advantageous, especially when it is required to remove froth-forming ingredients as completely as possible, to pass the froth through a number of nozzles arranged in series, which nozzles may be either of similar or different construction from one another, for example, with reference to the size of the spraying-outlets and/or the rapidity of the rotary motion.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. Apparatus for destroying and quenching froth formed from liquids comprising a container for froth and the liquid from which it is formed, a spraying device so constructed and arranged as to induce rotation of the froth in passing therefrom, means including a pump for conveying the froth from said container to said spraying device and forcing the froth through the latter under pressure, an inclined surface located below the spraying device for collecting the liquid constituent of the froth issuing therefrom and any froth which may remain, and a froth-screen so constructed and arranged as to separate the liquid and froth collected by said inclined surface.

2. Apparatus for destroying and quenching froth formed from liquids comprising a container for froth and the liquid from which it is formed, a spraying device so constructed and arranged as to induce rotation of the froth in passing therefrom, means including a pump for conveying the froth from said container to said spraying device and forcing the froth through the latter under pressure, means for collecting the liquid constituent of the froth issuing therefrom and any froth which may remain, means for conveying hot gases into the space into which the froth is sprayed, a fan operative to move the hot gases over the froth collecting in said space, and means including a second pump and at least one more spraying device for washing the interior walls of the space through which the hot gases pass.

3. Apparatus for destroying and quenching froth formed from liquids comprising a container for froth and the liquid from which it is formed, a spraying device so constructed and arranged as to induce rotation of the froth in passing therefrom, means including a pump for conveying the froth from said container to said spraying device and forcing the froth through the latter under pressure, means for collecting the liquid constituent of the froth issuing therefrom and any froth which may remain, means for conveying hot gases into the space into which the froth is sprayed, a fan operative to move the hot gases over the froth collecting in said space, means including a second pump and at least one more spraying device for washing the interior walls of the space through which the hot gases pass, and a baffle positioned in the path of the hot gases for separating particles of entrained liquid from said gases.

4. In a method for destroying or quenching froth formed from liquids and for collecting the liquid resulting from the destruction of the froth, the steps of forcibly spraying the froth without the aid of liquid or gas additional to the liquid and gas comprising the froth into an atmosphere, and gradually reducing the velocity of the liquid constituent of the froth resulting from the destruction of the froth bubbles before being collected.

5. In a method for destroying or quenching froth formed from liquids and for collecting the liquid resulting from the destruction of the froth, the steps of forcibly spraying the froth without the aid of liquid or gas additional to the liquid and gas comprising the froth into an atmosphere, and gradually reducing the velocity of the liquid constituent of the froth resulting from the destruction of the froth bubbles before being collected by permitting it to fall a relatively long distance through the atmosphere.

6. A method according to claim 5 wherein the atmosphere through which the liquid constituent resulting from the destruction of the froth bubbles is permitted to fall a relatively long distance

is blown counter to the direction of fall of said liquid constituent.

7. In a method for destroying or quenching froth formed from liquids and for collecting the liquid resulting from the destruction of the froth, the steps of forcibly spraying the froth without the aid of liquid or gas additional to the liquid and gas comprising the froth into an atmosphere comprising a heated gaseous medium such as flue gas, and gradually reducing the velocity of the liquid constituent of the froth resulting from the destruction of the froth bubbles before being collected.

8. A method for destroying or quenching froth formed from liquids which comprises projecting the froth into an atmosphere in the form of a rapidly rotating, spreading layer of froth, and permitting said layer to spread in said atmosphere until the forces created in the layer of froth by said rotation and spreading fracture the films of liquid forming the froth bubbles and the said liquid coalesces into drops.

9. A method for destroying or quenching froth formed from liquids which comprises projecting the froth into an atmosphere with a rapid rotational movement and permitting the centrifugal forces due to rotation to fracture the films of liquid forming the froth bubbles and the said liquid to coalesce into drops, while blowing said atmosphere counter to the general direction of movement of said drops therethrough.

10. A method for destroying or quenching froth formed from liquids which comprises imparting to the froth a rotation within a confined space, releasing the froth from said confined space in the form of a rapidly rotating, relatively thin layer of froth angularly disposed with respect to the axis of rotation, and permitting said layer to spread under the action of centrifugal force without contact with physical objects until the films of liquid forming the froth bubbles fracture and the said liquid coalesces into drops.

11. A method for destroying or quenching froth formed from liquids and for collecting the liquid resulting from destruction of the froth which comprises imparting to the froth a rotation within a confined space, releasing the froth from said confined space in the form of a rapidly rotating, relatively thin layer of froth angularly disposed with respect to the axis of rotation, permitting said layer to spread under the action of centrifugal force without contact with physical objects until the films of liquid forming the froth bubbles fracture and the said liquid coalesces into drops, and then collecting said drops, including the step of rapidly removing the same from their place of original collection to substantially prevent the reformation of froth due to impingement of the moving drops upon the collected liquid.

12. Apparatus for destroying or quenching froth formed from liquids comprising a container for froth and the liquid from which it is formed, a spraying device so constructed and arranged as to induce rotation of the froth in passing therethrough and to deliver the froth therefrom in the form of a rotating, spreading layer, means including a pump for conveying froth from said container to said spraying device and forcing the froth through the latter under pressure, and means for collecting the liquid resulting from destruction of the froth bubbles and any froth which may remain undestroyed after issuance from said spraying device.

JOHAN OLOF NAUCLÉR.