Aug. 6, 1929. W. R. CHADBURN 1,723,329

APPARATUS AND PROCESS FOR PREVENTING CONTAMINATION OF CENTRIFUGALLY PURIFIED LIQUIDS

Filed Jan. 7, 1926 2 Sheets-Sheet 1

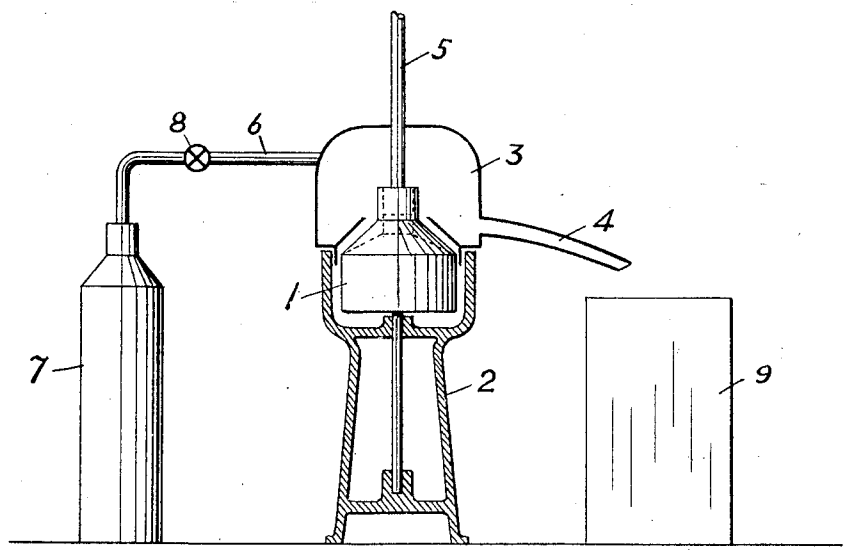

FIG. 1.

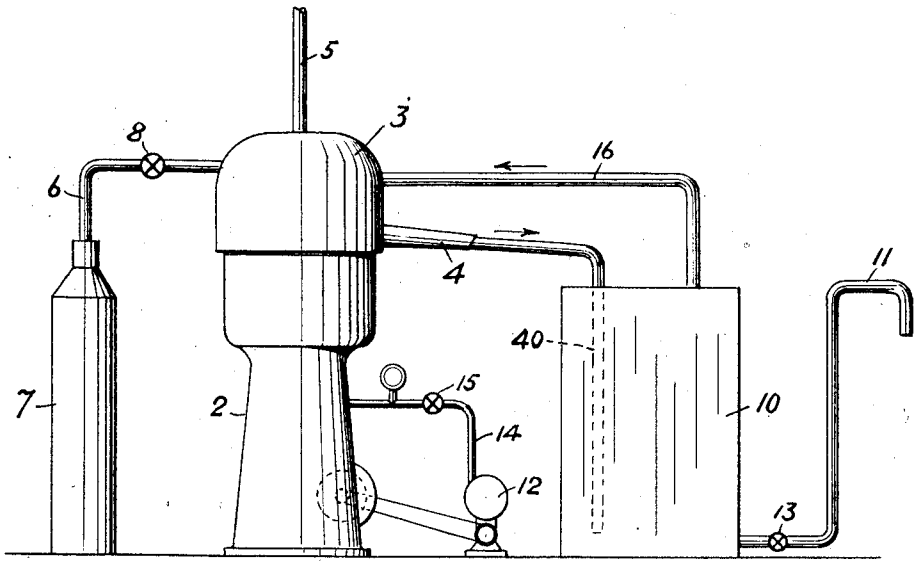

FIG. 2.

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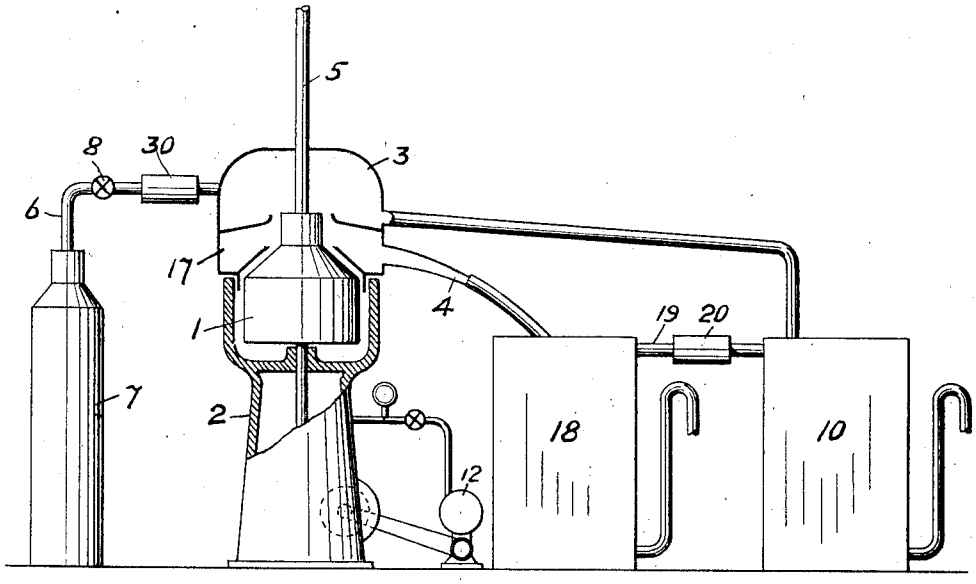

FIG. 3.

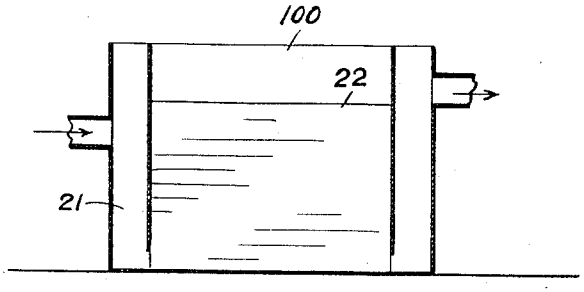

FIG. 4.

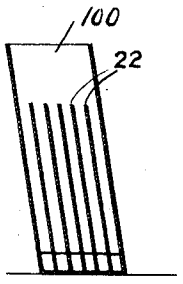

FIG. 5.

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Patented Aug. 6, 1929. 1,723,329

UNITED STATES PATENT OFFICE.

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APPARATUS AND PROCESS FOR PREVENTING CONTAMINATION OF CENTRIFUGALLY-PURIFIED LIQUIDS.

Application filed January 7, 1926, Serial No. 79,817, and in Great Britain January 27, 1925.

This invention relates to centrifugal liquid purifiers and is concerned with the degassing and stabilizing of the liquid treated in such machines.

In general, centrifugal purifiers are used for separating solids from a liquid and for separating two liquids mixed together. The purified liquid is ordinarily continuously leaving the centrifugal bowl and passes into a stationary casing or receiving pan generally placed around the centrifugal bowl, from which casing it passes out of suitably disposed spouts into the collecting vessels placed to receive it. In practice, it has been found that the liquid tends to become highly aerated.

When leaving the bowl, the liquids are generally very finely divided and pass to the casing in the form of a spray. It is evident that during this passage the liquid will be in the best condition to absorb gas or gases. It should further be noted that when the liquid or liquids leave the casing, a great amount of gas or gases is mechanically mixed into the liquid, and further that the rotating centrifugal bowl will cause some pressure in the casing. For this latter reason, a great amount of air leaves the casing or tinware through the outlet spouts. In many cases, this air contains a substantial volume of the liquid in a finely divided condition.

In the above described process of purifying liquids in a centrifuge and discharging them into an adjacent receptacle, where the liquid, in finely divided form, tends to react with air to form an objectionable mixture, it is known to substantially displace atmospheric air in the receptacle with a neutral gas which does not tend to react chemically with the liquid, so that, concurrently with the discharge of the liquid from the centrifuge, the liquid will immediately and while in a finely divided condition penetrate a body of such neutral gas and thereby be protected, while in such finely divided condition, from contact with air and from such objectionable reaction. The present invention comprehends improvements in this known process, and comprises means adapted to carry out the known process. It also comprises means to remove objectionable gases with which the liquid may have been saturated, completely or partly, when admitted to the centrifuge and their replacement by an inert or desirable gas. It also comprises means adapted to carry out the improved process.

In the drawings:

Fig. 1 is a view, in side elevation, and somewhat diagrammatic, of a centrifugal apparatus provided with means for carrying out certain of the processes herein described.

Fig. 2 is a similar view of a modification.

Fig. 3 is a similar view of another modification.

Fig. 4 is a sectional elevation of an improved collecting vessel.

Fig. 5 is a cross-section of the collecting vessel shown in Fig. 4.

Figure 1 shows the simplest form of the invention. In this figure the centrifugal bowl 1 is rotating in a frame 2. The separator bowl is assumed to be one provided with a single outlet. The liquid leaves the bowl in a finely divided state and is collecting in the casing 3, provided with an outlet spout 4. The liquid to be treated is delivered to the centrifugal bowl through a pipe 5, preferably under a slight pressure head, which may be obtained by means of an elevated tank. The centrifuge is further connected to a reservoir 7 by a pipe line 6, the reservoir containing, suitably under high pressure, the gas which is to be absorbed by the liquid. In the figure the pipe line 6 is connected directly to the casing 3, a preferable but not necessary arrangement, since the gas to be introduced into the system may be delivered at other positions so long as precautions are taken to insure that the gas supply can pass to the casing 3. The pipe line 6 is provided with a valve 8 by which the gas supply can be regulated. This valve is suitably of such a design that it will automatically keep a suitable over-pressure in the stationary casing. In starting the operation, it is, of course, necessary, or at least desirable, to at first replace the atmospheric air in the system by the desirable gas. This is automatically done by opening the valve 8, as the desired gas then will displace the atmospheric air, which now leaves the system through the spout 4. Liquid is fed into the centrifuge as soon as the desired atmosphere of desirable gas is established in the stationary casing. When leaving the centrifugal bowl, the liquid is split up into a very great number of small globules. When passing into the casing 3, the liquid surface

in contact with the gas in the casing is very large and consequently a great amount of gas will be absorbed by the liquid in a short while. Further, due to the small dimensions of the globules, the absorbed gas will soon penetrate the globules. For the above mentioned reasons, a gas, previously absorbed by the liquid, will rapidly and practically completely leave the globules and mix with the desirable gas in the casing 3. As before described, the liquid, when leaving the casing, contains a great amount of gas mechanically mixed into the liquid. This gas is separated in the collecting vessel 9, placed below the outlet spout 4. If complete saturation should not have taken place during the passage through the casing 3, the liquid has the capacity of absorbing a further amount of the desirable gas, as the separation in the collecting vessel 9 will often take considerable time. During this time, further replacement of the undesirable gas will also take place. The arrangement according to Figure 1 is the simplest one, but has the disadvantage that a considerable quantity of gas must pass through the system and be discharged to the atmosphere after having passed through the centrifuge. The construction described can, however, suitably be used where the desirable gas is of no value, as, for instance, where exhausted gas from gasoline motors can be used.

In cases where a valuable gas, such as carbonic acid, oxygen or nitrogen in pure form must be used, the above mentioned system is preferably elaborated by the inclusion of some gas-economizing arrangements.

Figure 2 shows a suitable form of one such arrangement. The design differs from that shown in Figure 1 in the following respects. The outlet spout 4 is connected to a collecting vessel 10 provided with a delivery pipe 11. The collecting vessel 10 is suitably provided with means automatically maintaining the liquid level at a suitable height. According to the drawing, this is effected by means of a liquid seal, but, of course, other known regulating means can be used. A vacuum pump 12 is provided for withdrawing the atmosphere in the system when starting. During this air-exhausting period the valve 8 in the pipe line 6 and the valve 13 in the pipe line 11 should be closed. As soon as a vacuum indicator shows a sufficiently low pressure, that is, when the atmosphere air is sufficiently exhausted, the above mentioned valve 8 is opened. Should one operation of this kind be insufficient for obtaining an atmosphere sufficiently free from air, the procedure may be repeated. In this way, an atmosphere practically free from air can be obtained. In the drawing, a rotating vacuum pump 12 driven from the centrifuge is shown, but other types of vacuum pumps producing a sufficiently low vacuum may be employed for the purpose. If large quantities of water with sufficiently high pressures are available, a water jet ejector pump will be found suitable. The pipe line 14 connecting the vacuum pump with the centrifuge is provided with a valve 15, by which the pump may be shut off, when the desired degree of vacuum has been established. If a repeated air-withdrawal operation is necessary, the valve 15 is preferably closed in order to prevent the desirable gas from being immediately sucked out. The valve 15 is preferably made to automatically shut off the pump from the system as soon as the difference between the atmospheric pressure and the absolute pressure in the system has reached a certain degree. It will be understood that the bearing immediately below the centrifugal bowl is, of course, spring-supported in any of the usual ways and that any such spring bearing affords a surrounding annular opening between the bearing and the frame which permits free communication between the receptacle surrounding the bowl and the enclosure within frame 2 below said bearing. In some cases it may be suitable to arrange as follows for obtaining the desired atmosphere. The system is completely filled with oil, which is then drawn away from the system at the lowest point, at the same time allowing the desirable gas to flow into the system. This method can be used when treating, for instance, a lubricating oil.

In order to prevent air from being sucked into the system during the evacuation period and for economizing with gas during the separation, the frame is preferably completely closed. Bushings, from which shafts are protruding, are for this reason provided with packing boxes. The drain pipe at the bottom of the bowl frame, which in ordinary separators carries away liquid dripping down from the tinware, must also be closed. When using only a small pressure in excess of atmosphere, this pipe can be closed by a liquid seal, but when using higher pressure there should be provided other mechanical devices which allow the collected liquid to escape continuously but prevent the gas from leaking out to the surrounding atmosphere.

As soon as the desired atmosphere is obtained, the valves 8 and 13 are opened and liquid is fed into the separator. The separated liquid is then led to the collecting vessel 10, from which it is delivered to another container as soon as the level in the vessel has reached a certain height. During the time the liquid is kept in the vessel 10, the mechanically enclosed gas escapes from the liquid and collects in the vessel above the liquid level. If the pipe line 4 is placed between the casing 3 and the collecting vessel 10, as shown in full lines in the drawing, the gas collected in the top of the collecting vessel 10 can flow back to the casing 3 through the same pipe line used for carrying the liquid from the casing 3

to the collecting vessel 10. Should such an arrangement be impossible, a special pipe line 16 can be fitted for allowing gas to flow from the collecting vessel 10 to the casing 3. This arrangement is necessary, especially when the pipe line from the centrifuge is connected to to collection vessel 10 below the liquid level, by means of an extension 40 of pipe 4.

In the above description, it has been assumed that the casing of the centrifuge is provided with only one compartment. In cases where two liquids are to be separately and continuously delivered from the centrifuge, two compartments must, of course, be provided, as, for instance, when treating transformer oil containing a great quantity of water. Figure 3 shows an arrangement, which suitably can be used for such purposes. The compartment 17 is connected to a collecting vessel 18, which suitably is of the same construction as the vessel 10 in Figure 2 and is provided with similar means for regulating the liquid level. In the case where the pipe line and the collecting vessel are connected together above the liquid level in the vessel, the gas separated out in the vessel can be brought back to the compartments of the casing through the same pipe line. This arrangement is, however, not suitable for all purposes, as it has been found that very strong gas currents between the upper compartment 3 and the bottom compartment 17 can be produced by such an arrangement. These gas currents attain a great velocity in the space formed between the bowl and the partition between the two compartments of the casing or tinware, and in some instances it has been found that these gas currents can draw off with them lighter liquid from the compartment 3 down to the heavier liquid in the compartment 17. In other cases the gas currents may have the opposite direction and will then carry liquid from the latter compartment to the former. In order to prevent this re-mixing of liquids it is desirable to connect the spaces above the liquid level in the collecting vessels by the pipe line 19. When separating water from transformer oil, it is absolutely necessary that the oil should be free from water, and in such cases it is desirable to provide a moisture-absorbing arrangement 20 in the pipe line 19. It is also practicable to arrange a water absorber 30 in the pipe line 6 delivering the desirable gas from the gas container 7 to the centrifuge.

If, on the other hand, the pipe lines are connected to the collecting vessels below the liquid surface, special pipe lines, such as 16 in Fig. 2, must be arranged in order to bring the gas, separated in the vessels, back to the compartments 3 and 17 of the tinware casing.

In order to economize with the desirable gas, it is advisable to give the collecting vessel such dimensions that the liquid leaving them is free from mechanically enclosed gas. In order to reduce the dimensions of the collecting vessels when using separators of great capacity, an arrangement according to Figures 4 and 5 is desirable. These figures may be assumed to illustrate a collecting vessel which may be substituted for the vessel 10 of Fig. 2 or the vessels 10 and 18 of Fig. 3. The liquid is conducted to a compartment 21 of the collecting vessel 100. From the compartment 21 the liquid flows through a number of thin layers formed by partitions 22 in the main part of the vessel. If these partitions form angles with a vertical line, the effect is highly increased. When using collecting vessels without partitions, the gas bubbles, coming into the tank at the bottom, must pass through a considerable depth of liquid in order to come to the surface. When using partitions as shown in Figures 4 and 5, the distance the gas bubbles have to pass is only the vertical distance between two adjacent partitions. As soon as the bubbles arrive at the lower surface of the upper partition, they follow the surface upwards to the gas chamber, and there is no risk of the gas getting mixed with the liquid. Instead of using a rectangular vessel with straight partitions, cylindrical vessels with conical partitions can be used as well.

The connection of the casing or casings of the centrifuge to a collecting vessel or collecting vessels in order to separate away the gas from the liquid is distinctly preferred, but is not always necessary. In many cases it suffices to provide the outlet spouts with liquid seals. In such cases a great amount of mechanically enclosed gases will leave the system together with the liquids. In some cases this may be considered advantageous for the following reasons. As previously pointed out, it is necessary that the atmosphere should be in a sufficiently pure condition and further that during the passage through the casing the liquid can give off undesirable gas mixed with the desirable. In order to prevent the desirable gas from becoming mixed with undesirable gas to too great an extent, means must be provided for carrying the undesirable gas away from the system. Of course, this can be effected by leading away a certain amount of desirable gas from the system, which will then bring with it a certain amount of undesirable gas. The percentage of undesirable gas in the atmosphere in the system will be constant as soon as the same amount of undesirable gas has been carried away as is taken up from the separated liquid. In order to regulate the percentage of undesirable gas, a valve or valves can be provided, through which a certain amount of the gas is carried away from the system. The efficiency of the above described arrangement can be increased by keeping a considerable pressure in excess of

atmospheric pressures in the separating system, as the liquid absorbs more gas at higher pressure than at lower. When the liquid leaves the system, in which certain excess pressure is maintained, it will give off a considerable amount of the absorbed gas. This gas will then carry away the undesirable gas still remaining in the liquid.

If the use of separating vessels is preferred, an absorption device for the undesirable gas should be provided in some part of the system. In this case, the gas from the separating vessels should be carried away to a container, which may be connected to the pipe line delivering the inert or desirable gas to the system. The container between the separating vessel and the pipe line is, of course, not absolutely necessary. In this pipe line, an absorption device is suitably placed. Should a complete saturation be desired, but found unobtainable in one single operation, it is of course necessary to repeat the treatment, and this can be effected by means of a pump operating to withdraw the liquid from the separating vessel and deliver it to a tank connected to the centrifuge by the pipe line 4. After some time this tank will contain a liquid freed from solid impurities, and at the same time this liquid will be saturated with desirable gas.

The above described arrangements can also be used for treating liquids which have already been treated in one way or another in order to bring a desirable gas into the liquid. By supplying to the casing the same gas that was used for a previous treatment, the gas absorbed by the liquid is not allowed to escape. Should the previous treatment not have given complete saturation, the liquid can absorb a further amount of gas when passing through the casing as before described.

A treatment of the above described kind is suitable for many purposes. It is, for instance, possible to replace oxygen, absorbed by lubricating oils, transformer oils, or vegetable oils, by inert gases, such as carbonic acid or nitrogen, in order to prevent changes in the composition of the oils. Further, it is possible to treat boiler feed water in the same way in order to replace the oxygen with an inert gas and thus prevent corrosion of the boiler.

In the accompanying claims wherein the term "neutral gas" is used, it is intended to include both inert gases and desirable gases.

Having now fully described my invention, what I claim and desire to protect by Letters Patent is:

1. The combination with a centrifugal purifier and a surrounding casing adapted to receive purified liquid discharged from the purifier, of means including a pipe connection with the purifier to exhaust atmospheric air from the centrifuge and the casing, and means independent of said pipe connection to supply a neutral gas to replace the withdrawn air.

2. The combination with a centrifugal purifier and a surrounding casing adapted to receive purified liquid discharged from the purifier, of a conduit through which the casing may be supplied with a neutral gas, a collecting vessel, an exit pipe connecting the casing and the collecting vessel, and a gas return pipe, independent of said conduit, connecting the collecting vessel and the casing.

3. The combination with a centrifugal purifier and a surrounding casing divided into two compartments adapted to receive respectively a heavy liquid and a light liquid discharged from the purifier, of means to supply both compartments of the casing with a neutral gas, two collecting vessels, closed pipes connecting the respective compartments with the respective vessels, and a pipe for passage of gas connecting the two vessels.

4. The combination with a centrifugal purifier and a surrounding casing adapted to receive purified liquid discharged from the purifier, of means to supply the casing with a neutral gas, a collecting vessel, means to convey both liquid and gas from the casing to the lower part of the collecting vessel, and inclined partitions within the collecting vessel between which the liquid is adapted to flow and along the lower surfaces of which gas bubbles are adapted to escape to above the surface of the liquid in the collecting vessel.

5. In the process of purifying liquids in a centrifuge and discharging them into a separate adjacent receptacle, where the liquid, in finely divided form, tends to react with air to form an objectionable mixture, the process which comprises displacing air in the receptacle with a neutral gas, centrifugally purifying the liquid and discharging it into the body of neutral gas in the receptacle, conveying the liquid mixed with the neutral gas to a different locus and there separating neutral gas from the liquid, and returning the separated neutral gas to the receptacle along a path independent of the paths of flow of the liquid and neutral gas to and from the receptacle.

6. In the process of purifying liquids in a centrifuge and discharging them into a separate adjacent receptacle, where the liquid, in finely divided form, tends to react with air to form an objectionable mixture, the process which comprises first exhausting air from the receptacle and centrifuge, then admitting neutral gas to replace the withdrawn air, and centrifugally purifying the liquid and discharging it into the body of neutral gas in the receptacle.

7. In the process of separating liquids of different specific gravity and discharging them into separate compartments, where the liquid, in finely divided form, tends to re-

act with air to form an objectionable mixture, the process which comprises displacing air in the compartments with a neutral gas, centrifugally separating the liquids and discharging them into the respective compartments, conveying the liquids mixed with the neutral gas to two separate loci and there separating neutral gas from the liquid, and establishing a circulation of said neutral gas between the two loci.

8. In the process of purifying liquids in a centrifuge and discharging them into a separate adjacent receptacle, where the liquid, in finely divided form, tends to react with air to form an objectionable mixture, the process which comprises displacing air in the receptacle with a neutral gas, centrifugally purifying the liquid and discharging it into the body of neutral gas in the receptacle, conveying the purified liquid mixed with the neutral gas to the lower part of a body of such purified liquid, and arresting the vertical movement of gas bubbles in said body of liquid and guiding said arrested gas bubbles upward in a direction inclined to the vertical to above the surface of said body of liquid.

9. In the process of purifying liquids in a centrifuge and discharging them into a separate adjacent receptacle, where the liquid, in finely divided form, tends to react with air to form an objectionable mixture, the process which comprises maintaining an atmosphere of a neutral gas in the receptacle by mixing the liquid to be purified with such neutral gas and then centrifugally purifying the liquid and discharging it into the receptacle along with the neutral gas with which it has been mixed before centrifugation.

In testimony of which invention I have hereunto set my hand at London, England, on this 21 day of December, 1925.

WILLIAM ROY CHADBURN.