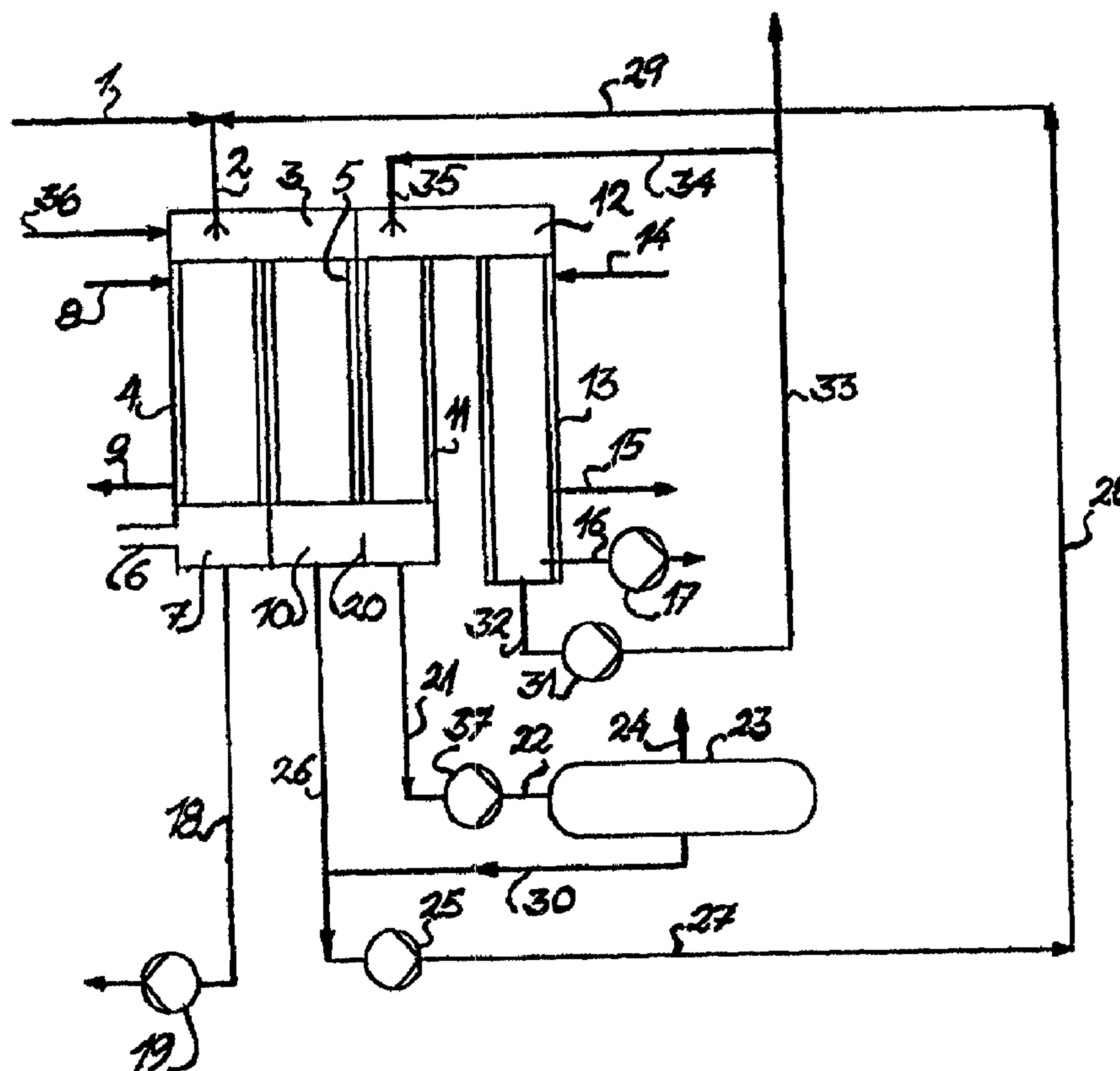




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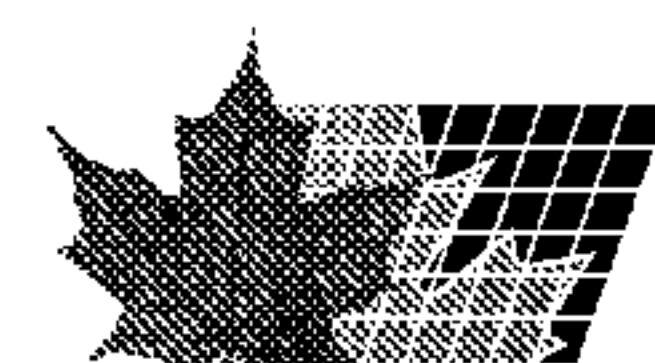
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(54) Titre : PROCEDE ET SYSTEME PERMETTANT DE NETTOYER DES CONDENSES CONTAMINES ET
COMPORTANT UNE COMBINAISON COLONNE DE STRIPPING/CONDENSEUR
(54) Title: METHOD AND ARRANGEMENT FOR CLEANING CONTAMINATED CONDENSATE INCLUDING A
COMBINED STRIPPER/CONDENSER



(57) Abrégé/Abstract:

This invention relates to a method for cleaning unclean condensate, emanated when producing cellulose pulp including evaporation of spent liquor under utilization of a cleaning plant having several condensers, coupled in series, characterized in that process steam from the last evaporation stage and unclean condensate are introduced into a combined stripper/condenser, the



(57) Abrégé(suite)/Abstract(continued):

process steam and the condensate being brought to flow in opposite directions so that direct heat exchange occurs, resulting in that volatile compounds of the condensate are separated and are taken up by the steam under simultaneous indirect cooling, resulting in condensation of the main part of the process steam, that the remaining process steam is gradually flowing further on, the process steam being successively cooled indirectly, resulting in that water and turpentine are first condensed and collected and that methanol is condensed, collected condensate being separated from turpentine, which is removed from the plant and is reintroduced to the stripper/condenser and that methanol is removed from the plant, that principally cleaned condensate is collected at the bottom of the combined stripper/condenser and is removed from the plant or is further purified. The invention also relates to a cleaning plant.

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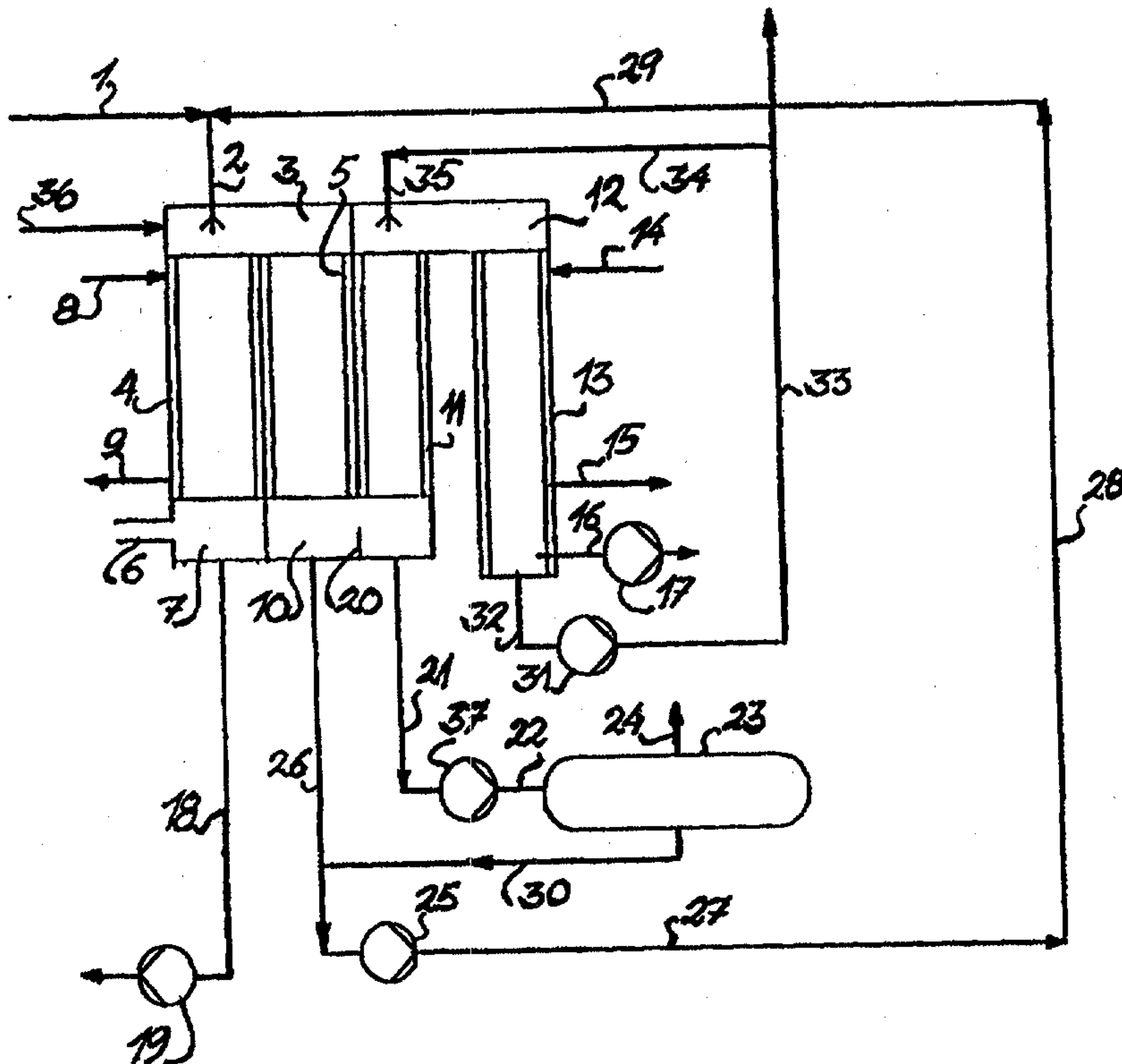
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(54) Title: METHOD AN ARRANGEMENT FOR CLEANING CONTAMINATED CONDENSATE INCLUDING A COMBINED STRIPPER/CONDENSER

(57) Abstract

This invention relates to a method for cleaning unclean condensate, emanated when producing cellulose pulp including evaporation of spent liquor under utilization of a cleaning plant having several condensers, coupled in series, characterized in that process steam from the last evaporation stage and unclean condensate are introduced into a combined stripper/condenser, the process steam and the condensate being brought to flow in opposite directions so that direct heat exchange occurs, resulting in that volatile compounds of the condensate are separated and are taken up by the steam under simultaneous indirect cooling, resulting in condensation of the main part of the process steam, that the remaining process steam is gradually flowing furtheron, the process steam being successively cooled indirectly, resulting in that water and turpentine are first condensed and collected and that methanol is condensed, collected condensate being separated from turpentine, which is removed from the plant and is reintroduced to the stripper/condenser and that methanol is removed from the plant, that principally cleaned condensate is collected at the bottom of the combined stripper/condenser and is removed from the plant or is further purified. The invention also relates to a cleaning plant.



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Method and arrangement for cleaning contaminated condensate including a combined stripper/condenser

5 Technical field

The invention relates to a method and a plant for cleaning of contaminated condensate emanated from pulp production of semichemical and chemical cellulose pulp including at least evaporation of spent liquor.

- 10 When producing chemical cellulose pulps any known lignocellulose material , for instance wood in form of chips, are dissolved under utilisation of an acid or alkaline process. What is happening during the cooking is that the main part of the lignin of for instance the wood, and especially the lignin which mainly forms the middle lamella between the uncountable wood fibres goes in solution in the cooking liquid so that the fibres after the digestion end, for
- 15 example after blowing of the cook according to the batchwise cooking method are separated from each other and form a cellulose pulp. Besides a large part of for instance the lignin content of the wood, a considerable part of the hemicellulose of the wood goes into solution. How much is determined by the pulping degree, which in general is represented as cooking yield in percent. Also a minor part of the wood cellulose content can go into solution.
- 20 Example of an acid cooking process is the sulphite process and an example of the alkaline cooking process is the sulphate process.

Other known alkaline cooking processes are the polysulfide pulping process and processes of soda type (sodium hydroxide) process, where catalysts like some type of quinones compounds can be used. Within the concept sulphate method is for example utilisation of

25 high sulfidity pulping to counter current cooking where white liquor (primarily a mixture of sodium hydroxide and sodium sulphide) is added after a certain time during the cooking phase and utilisation of a chemical treatment of lignocellulose material, prior to the sulphate pulping process.

- The sulphite method or- process can be divided after the base used in the cooking liquor, as
- 30 calcium, magnesium, ammonium and sodium. There are sodium and magnesium cooking liquors, which are usually recovered and therefore are actual in this case.

After pulping the lignocellulose material, the cooking liquor is separated from the fibres.

- The spent cooking liquor mentioned as black liquor or spent liquor is mentioned as thin liquor in connection with recovery, the main part of thin liquor being water. The dry solid content in
- 35 thin liquor (lignin, hemicellulose, cellulose, residual chemicals, etc.) is for instance within the range 15 – 20%. Before combustion of the thin liquor in for instance a recover boiler and transfer the organic compounds to mainly carbon dioxide and water under recovery of energy and let the inorganic compounds form a residual in form of a smelt and recover it for

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production of new cooking liquor must the dry solid content increase to at least 55%. Such black liquor is usually named thick liquor. Thick liquor is created by evaporation of thin liquor in five to seven steps. Each step is named a stage.

- 5 In modern mills for production of chemical cellulose pulp is the ambition to reduce the fresh water consumption as much as possible and even the discharge of waste liquor to the recipient. This will happen by closure of the liquid system in higher or lower degree. This means that spent liquor from the bleaching stages can be reused and mixed with spent cooking liquor. Thin liquor is therefore sometimes; a mixture of spent cooking liquor and
10 spent liquor from different types of bleaching.

Evaporation of thin liquor, condensate is generated. Condensate from some positions has good cleanliness, that condensate can therefore be used at one or several positions in the pulp mill. In other positions contaminated and heavy contaminated condensate is generated. According to the invention it is imperative that such condensate is cleaned. Production of
15 chemical cellulose pulp generates even other type of unclean condensate. Digesting of lignocellulose material is done under pressure giving that after cooking a gas mixture is released from the digester containing steam, organic- and inorganic compounds. At conventional batchwise cooking leaves the spent liquor the digester together with the generated cellulose pulp. Mentioned gas mixture is condensed to a so-called cooking
20 condensate. Such gas mixtures release and are collected even at other places than the real digester or the digesters in the cooking plant and are condensed, by that the name cooking condensate instead of blow steam condensate. Mentioned cooking condensate generates both in batch wise and continuous cooking of lignocellulose material. Such contaminated cooking condensate is mixed with unclean evaporation condensate and that mixture is
25 cleaned according to the invention. It is of course possible to clean the condensate separately but that is not preferred.

There are several semichemical pulping processes. Example of that is neutral sulphite semichemical process, (NSSC). The pulping degree is very low for that type of process; mechanical defibration is therefore necessary for liberation of fibres. In some cases, the pre-
30 treatment liquor or the cooking liquor is recovered. If the recovered liquor is evaporated the invention can be used.

35

Technical standpoint

Cleaning of unclean condensate according to conventional technique, at least one stage called stripping is used. By that means that the unclean condensate through blows with steam, volatile compounds in the contaminated condensate follow the steam flow and hence leave the condensate. According to conventional technique separate or detached stripper plants are used. The steams used in the stripper plants are admission steams generated in the recovery boiler or steam from any evaporator stage in the evaporation plant. Further the stripper plants operate at atmospheric- or over pressure.

In the Swedish letters patent 7704352-9 (423915) a method is described for recovery of sulphur compounds, volatile alcohol's as methanol and by-products as turpentine or similar compounds from contaminated condensate. According to the described method, stripping is performed in two positions, one at the top of a rebuilt evaporation stage resulting in a more expensive evaporation plant and the other is a detached stripper. In the detached stripper steam from the last evaporation stage is used for stripping of contaminated condensate. The use of the steam from the last evaporation stage is process economical an advantage. However the utilisation of the steam is limited to 20 – 25 % of the total amount steam from the last evaporation stage. The surplus steam from the last evaporation stage is condensed in a conventional manner by using condensers, heat exchangers. As coolant, normally fresh water is used, resulting in production of warm water with low value.

Description of the inventionTechnical problem

Present known technique for cleaning of unclean condensate, as described, is uneconomical. The reason for that is that stripping is performed in separate or detached plants and the use of high value steam, mainly admission steam.

Solution

Present invention solve the problem and relate to a method for cleaning of unclean condensate emanated from pulp production of chemical or semichemical pulp including at least evaporation of spent liquor utilisation of a cleaning plant having several in series coupled condensers, characterised of that the main part of vapour generated at the last evaporation stage, i.e. process steam from the last evaporation stage which has the lowest steam pressure, and unclean condensate feed a combined stripper and condenser, at which process steam and the unclean condensate flow counter current so that heat exchanging take place between process steam and unclean condensate resulting in that volatile

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compounds in the condensate separate from the condensate and follow the flow of process steam at the same time as indirect cooling occur resulting in condensation of the main part of the process steam, that the rest of the process steam flow to another condenser, at which the remaining process steam successively cools indirect leading to that water and turpentine
5 condense and collects together and that methanol thereafter condense, at which the first mentioned collected condensate separates from the main part of the turpentine content which removes from the plant and residual condensate leads back to the combined stripper/condenser and that condensed methanol removes from the plant, and that primary cleaned condensate collects at the bottom of the combined stripper/condenser and removes
10 from the plant or will further be purified. It is highly stressed according to the invention, that all process steam from the evaporation plant last stage i.e. process steam which has the lowest vapour pressure, feed the combined stripper/condenser.

It is optimal if the amount of process steam from the last evaporation stage correspond to the amount steam necessary for purification of the unclean condensate, as described. A surplus
15 of available process steam doesn't mean any problem, as the excess steam can be used for production of warm water according to conventional technique. Shortage of available process steam imply that additional steam must be added i.e. admission steam, for achieving a good cleaning result. In some pulp mills more or less of generated process steam can be used in other places in the mill and therefore not available for purification of unclean condensate as
20 described. If shortages of process steam arise of that reason any kind of additional steam must be added i.e. admission steam. To proceed in that way is not preferred.

It is suitable that the unclean condensate enter in to a space above and in connection with the combined stripper/condenser and that process steam enter in to a space under and in connection with the combined stripper/condenser and that the unclean condensate flow in
25 the direction from the top and downwards through the combined stripper/condenser, while the process steam flow in opposite direction. In the space above and in connection with the combined stripper/condenser de-aeration steam can be introduced from one or more evaporation stages. In such cases there will not be any contribution for cleaning of condensate, but the reason for doing in that way is to condense the unclean process steam
30 and recovery of contaminated chemicals for environmental protection.

According to an absolute preferred description of the invention, the primary cleaned condensate flow downwards through the underlying extension of the combined stripper/condenser and the primary cleaned condensate is heated indirect with steam from de-aeration of one or more evaporation stages. The de-aeration steam entry the under part
35 of the extension, resulting in that the remaining volatile compounds separate from the primary cleaned condensate in form of a gas and flowing upwards and mix with the upwards flowing newly introduced process steam and the highly purified condensate is collected at the

- extensions bottom and thereafter will be removed from the plant. A special case of the invention, the de-aeration steam can be reinforced with admission steam of variable energy content so that the cleanliness of the condensate can be controlled. It is important that the cleanliness of the purified condensate will be as clean as possible. The reason for that is that
- 5 the purified condensate is used in several places in the mill i.e. pulpwashing and to different positions in the bleachplant and the condensate can also be sent to sewer, the recipient. The remaining organic compounds in the purified condensate will have an effect on the environment if the condensate is sent to the recipient. The condensate used in different positions in the mill will have an indirect influence on the environment.
- 10 Conventional methods for cleaning of contaminated condensate have a cleaning efficiency of 90%. Higher cleaning efficiency is desirable and very significant.
- By use of the mentioned admission steam it is possible to further increase the already good cleaning efficiency which will be fulfilled with the previous described embodiment. Cleaning efficiency of 95% and even higher is possible to reach. It is true that adding of admission
- 15 steam is against one of the important principals of the invention, because that only low value steam i.e. cheap steam shall be used for cleaning of unclean condensate but the improvement that can be reached by means of such acting can be very favourable in comparison with other cleaning alternatives and also an advantage from economical point of view.
- 20 The remaining part of de-aeration steam, for indirect heating, leaves the extension part at the upper end. The surplus de-aeration steam entry the space at the top of the cleaning plant, the combined stripper/condenser. The reason for that has been described earlier.
- According to another absolute preferred description of the invention there is a device for evacuation of the cleaning plant connected to the discharge unit, which result in that inert
- 25 gases and evil smelling sulphur containing gases will be removed from the plant. The meaning of inert gases in this case is that the gases will not condense at present conditions, thus there is no relation with chemical inert. Those gases are sent to an incineration plant for destruction of evil smelling gases, according to known technique. As low pressure is created in the device for cleaning of unclean condensate, process steam with temperatures below
- 30 100 °C can be used. The temperature of the process steam can for example be 50 – 65 °C. Cleaning of contaminated unclean condensate is performed, as described earlier, in several steps and suitable number of steps is four. The condensed methanol is collected in the bottom of the last condenser in series, a part of the condensed methanol entry a space above or in close connection with the last condenser in series and the rest of the
- 35 methanol is removed from the plant. The process steam removes impurities in the unclean condensate; the impurities are then recovered by condensation of the further contaminated condensate. To achieve condensation coolant has to be introduced in to each step and

heated coolant has to be removed in several positions. According to the first condenser i.e. the combined stripper/condenser, the coolant is introduced at the condensers upper end and is removed at increased temperature from the bottom end, alternatively at its middle section. Any coolant can be used, but cold water is preferable.

5

The invention also relates to a plant for cleaning of contaminated condensate emanated at production of semichemical or chemical pulp including at least evaporation of spent liquor, comprises several in series coupled condensers, characterised of, a first unit in form of a combined stripper/condenser having several insertions through which process steam and
10 unclean, contaminated, condensate flowing counter current and with direct contact between the process steam and the unclean condensate. The insertions are surrounded with a closed space for cooling agent and a space above and under the unit. The space under the unit serve as bottom, means for supply of unclean condensate to the space at the units upper end, means for supply of process steam to the space at the units bottom end, means for
15 supply of cooling agent at one end of the unit and means for removal of heated cooling agent at the opposite end of the unit, means for removal of primary purified condensate and further condensers for residual steam from the first condenser, not condensed process steam, having several insertions through which only process steam and steam generated from condensate flows, which insertions are surrounded with a closed space for cooling agent
20 resulting in condensation in series of contaminated water and turpentine in a mixture and methanol and to respective condenser on theirs top end and bottom end connected space, means for supply of cooling agent at one side of the condenser and means for removal of above mentioned condensate mixture from the space on the condensers bottom end and for separation of the main part of the condensate mixtures turpentine content and for removal of
25 turpentine from the plant and for transport of remaining condensate back to the space in the first unit there the unclean condensate is put in to, means for removal of condensed methanol from the bottom side space of the subsequent condenser from the plant.

Mentioned insertions can be either tubes or lamella. The plant can also consist of means for
30 supply of de-aeration steam from one or more evaporation stages to the space in the first unit where unclean condensate is introduced. According to a preferred description of the plant and according to the invention is the first unit in form of a combined stripper/condenser completed with a downward extension having insertions through which the primary cleaned condensate flows, which insertions are surrounded with a space for through flowing of in the
35 first case de-aeration steam from one or more evaporation stages counter current with the primary cleaned condensate, the extension is completed with a bottom, from which

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High-grade cleaned condensate is removed according to previous mentioned means and further means for supply of steam and removal of residual of the indirect heating steam. Just mentioned insertions can preferably be tubes.

- According to one more preferred design of the plant according to the invention is an
- 5 arrangement connected to the last in series condenser bottom end for creating of a negative pressure in the insertions of the condenser and connected spaces and for removal of mainly inert gases and eventually evil smelling sulphur containing gases. The number of condensers connected in series is not critical, but it has been shown that an appropriate number is four, with the first as a combined stripper and condenser. The meaning of that the condensers are
- 10 connected in series mean that the condensers are connected with each other. For example, the first and the second condenser can be connected with a space at the top and above the condensers and the second and the third are connected with a space at the bottom end below the condensers and the third and the fourth condensers are connected with a space above the condensers. The fourth or commonly the last condenser in series can either be
- 15 placed in close connection with the last condenser or it can be placed separately away from the last condenser. In the first case a common cooling agent system can be used for all condensers, for example four condensers, while in the second case a special cooling agent system will be used, where methanol is collected and removed. This make it possible to use a powerful cooling agent system, which imply that a number of sulphur
- 20 containing gases condense and will mix with the condensed methanol. In that way, the volume of the residual or inert gases will be reduced, which have to be collected at the end part of the plant, at the same time the volume of condensed liquor will increase in that position. As the recovered methanol normally will be sent to some equipment for incineration it is favourable to get rid of sulphur containing agent, which else appears as very voluminous
- 25 gases.
- It is preferable to build in all condensers, for example four, in a common surrounded space. However, the last condenser can be placed separately of mentioned reasons. According to the design, the invention comprise of means for take out of a part of the removed methanol for reflux to the space above the last condenser in series.
- 30 To increase the stripping efficiency in the first unit the combined stripper and condenser, it is suitable to apply means for increasing the surface contact inside the tubes i.e. the contact between the condensate and the stripper steam, process steam. The means can be two joint plates inside the tube creating any type of pattern, for example a cross. For further increasing the efficiency the means can be twisted along the longitudinal axes creating a spiral form.
- 35 The means can also be corrugated plates. The mean can be in contact with the tubes inside wall or it can be placed a distance from the inside wall. It is of course possible to join more than two plates, for example three or four, creating different types of pattern.
- The means can consist of two joined elongated elements which form a folded sheet iron creating a wave pattern.

Advantages

According to present invention it is preferred that the total amount of steam necessary for cleaning the unclean condensate constitute of low value, cheap steam, which is available as residual product at evaporation of spent liquor. That contributes to low operating cost for the cleaning process. The fixed cost i.e. the investment cost for the cleaning plant will be reduced to a great extend depending on the design of the combined stripper and condenser. Further, according to the invention, it is possible to reduce the main part of the cleaning plant to one unit i.e. all condensers are enclosed for example in a cylindrical building or if so a cylindrical tower. That implies on one hand that the cost of material will be reduced on the other that necessary place for the plant also will decrease. For pulp mills, which has shortage of space, this fact is of big importance. Further, according to the invention, it will be possible to increase the cleaning efficiency to 95 % and even higher which give big environmental advantages. In some cases it can be necessary to use admission steam for reaching a high degree of cleaning, but for special cases it can be worth it in comparison with other measures.

Description of figures

In figure 1 is shown schematically an embodiment of a cleaning plant according to the invention. In figure 2 is shown schematically a preferred embodiment of a cleaning plant according to the invention. In figures 3,4,5 and 6, are shown in more detail the central parts of another preferred embodiment of the cleaning plant according to the invention.

The best performance

In the following, represents the invention as for proceedings and as a plant with reference to the mentioned figures and further some circumstances and conditions will be explained.

In figure 1 shows schematic a cleaning plant according to the invention, which can be used for cleaning the unclean condensate considerable i.e. to primary cleaned condensate but not maximum cleaned condensate, high-grade cleaned condensate.

Unclean condensate, for example a mixture of digester condensate and evaporation condensate, feed the space 3 through the pipes 1 and 2 which is placed above the combined stripper/condenser 4. The space 3 connects the combined stripper/condenser 4 with the subsequent condenser 5. Through the pipe socket 6 process steam is supplied to the space 7. Inside the stripper/condenser there is a lot of insertions in form of tubes or lamella (not shown in the figure). Those insertions are surrounded of a space for coolant, for example cold water. Supply of coolant is done via the pipe 8 and the heated coolant is discharged via

the pipe 9. It has been mentioned several times that the space for coolant is closed the meaning of that is that the coolant which surrounds the tubes is not in direct contact with inside of the tubes, i.e. the cooling is indirect. That coolant is supplied in a pipe 8 and is discharged in a pipe 9 includes the concept closed as described.

- 5 If the insertions in unit 4 consist of tubes, the following is true. The length of the tubes are the same as unit 4 one of the open end is towards the space 7 and the other open end is towards the space 3. Mentioned open ends are surrounded of a joint unit for example a sheet iron.

- 10 The unclean condensate is distributed by a pipe 2 over the unit 4 cross section and the condensate flows downwards through the tubes by action of the force of gravitation. The process steam which supply to the space 7, i.e. the opposite end of unit 4, flows upwards through the tubes and meet the down flowing unclean condensate. When process steam and unclean condensate is flowing counter current, stripping of the condensate occur, i.e. the main part of the volatile components in the unclean condensate leave the condensate in gas
- 15 state and follow with the remaining uncondensed process steam upwards and from unit 4 to the space 3. The condensate get cleaner and cleaner when the condensate flows downwards in the unit 4 tubes. At the same time as cleaning of the condensate occurs the indirect cooling of the tube give that the process steam will condense inside the tubes. The degree of condensation is depending on several reasons, but the condensation degree can for
- 20 example be 70 – 75%. That means, that only 25 – 30% of the supplied process steam reach the space 3. The condensate from the condensed process steam flowing down wards with the cleaned condensate, the condensate mixture is collected in the space 7. The remaining process steam flows via space 3 further down through the tubes, for example, which are in condenser 5 (not shown in the figure). In the tubes of condenser 5 only process steam is
- 25 flowing. However the tubes are surrounded with coolant, which imply further condensation of water. At the same time and even before turpentine will condense, turpentine and water is flowing downwards on the tube walls to the space 10, those agent give a mixture, with turpentine as a top layer on the water. The remaining process steam flowing via the space 10 in to the third condenser 11 in series. The steam is flowing upwards through the tubes, for
- 30 example, in condenser 11 (not shown in the figure) and reach space 12. Condensation of turpentine and water will condense all the time. The remaining steam flowing through space 12 and downwards through condenser 13 and those tubes for example, (not shown in the figure). In condenser 13 mainly methanol will condense, which will be collected at the bottom side. If the condensate has it's origin from sulphate pulping and the temperature of the
- 35 coolant which is supplied via the pipe 14 and removed heated via the pipe 15, is mainly the same temperature as the temperature of the coolant mentioned earlier, sulphur compounds

will condense as for example dimethylsulphide. The remaining not condensed agents are removed from the plant in gas state via the pipe 16 and arrangement 17.

The temperature of the process steam, which is supplied to the plant via the pipe socket 6, is depending on the type of evaporation plant for spent liquor. There are evaporation plants, which are working at overpressure; the process steam has then a temperature higher than 100°C, which will be used according to the invention. In such cases, the arrangement 17 can be a simple valve or a fan. Normally the evaporation plants operate so that the process steam has a temperature less than 100°C and for example 60 – 65 °C. That imply that the process steam has it's origin from parts which has a negative pressure. In those cases is it necessary, that arrangement 17 consist of device, which create negative pressure, for example a vacuum pump or an ejector. Appropriate pressure is in both cases, about 10 – 20 kPa (0,1 – 0,2 bars). The temperature of the coolant, for example water, which is used, can vary. 10°C is an example of a suitable temperature. Such a temperature is natural in the Nordic countries at least during the winter season, for example Sweden. During the summer season and in other cases the water can be cold down to about 10°C with a refrigerating machine. When the process steam has a temperature of 60°C the heated coolant will have a temperature of about 50 °C, when the coolant is water. The primary cleaned condensate is removed via the pipe 18 by use of a pump 19.

Approximately in the middle of space 10 there is an overflow 20, the upper edge is for example clogged. As the condensed mixture of water and turpentine, in condenser 5, is collected in space 10 the turpentine form a layer on the water and overflow to the right section of space 10. The turpentine-enriched condensate is pumped with pump 37 via the pipes 21 and 22 to the container 23, in which there often is an overpressure, which is created, by the pump. Separation of turpentine and water continue in the container. The turpentine, which is purified in two steps, is removed from the system via the pipe 24. The contaminated water, which are in the left side of space 10, is transported by the pump 25 via the pipes 26,27,28 and 29 back to the system and mixed with new influx of unclean condensate which entry to the space 3 above the combined stripper/condenser 4 via the pipe 2. The water phase in the container 23 feed the pipe 26 via the pipe 30.

It's not necessary to use the over flow 20 with the aim to make a first coarse decanting of the water/turpentine mixture, it's of course possible to transport the mixture from space 10 to a separate unit (not shown in the figure) where an optimal separation of turpentine can be done. Those two liquid streams are handled in the same way as earlier described. In the bottom of condenser 13, a condensate of mainly methanol is collected. With the pump 31 methanol is pumped from the system via the pipes 32 and 33. Normally the methanol is

transported to some arrangement for incineration. In order to optimise the cleaning process it is preferably that a fraction of the methanol which is transported via pipe 33 re-circulate via the pipes 34 and 35 to the left side of the space 12 i.e. above the condenser 11.

Since the condenser 13 is separate in comparison with the other three condensers 4,5 and 11 and have a separate system for coolant which make it possible to increase the condensation efficiency further i.e. so that more sulphur containing gases will condense, for example when unclean condensate from sulphate pulping will be purified according to the invention. By means of a refrigeration machine the coolant temperature, for example water, can be reduced to about 0°C.

10 Via the pipe 36, de-aeration steam from the evaporation plant, can be supplied to the cleaning plant where the aim is to clean the steam i.e. the main part of the steams impurities will condense and be recovered.

15 In figure 2 is shown a schematically preferred embodiment of the cleaning plant according to the invention. Both cleaning plants are almost the same and of that reason same figures are used for figure 2 as in figure 1 for objects which are in conformity. The difference between the two cleaning plants is, that the preferred cleaning plant according to figure 2 have a completion extension downwards 38 to the combined stripper/condenser 4. The extension also has insertions as tubes or lamella (not shown in the figure). Those insertions are
20 surrounded with a closed space aimed for heating steam. The heating steam is in the first-hand de-aeration steam from one or more evaporation stages in the evaporation plant, which is supplied via the pipe 39 to the pipe socket 40. In the case where the insertions are tubes the heating steam flows along the tubes, which has a temperature of 70 – 80 °C or slightly higher, remaining steam not condensed leave the unit 38 via the pipe socket 41 and the
25 pipes 42 and 43. Last-mentioned pipe is connected to pipe 36 and remaining de-aeration steam is supplied to space 3 for cleaning according to earlier description.

The primary cleaned condensate, which leave the combined stripper/condenser 4 flows via space 7 downwards to extension 38 and through the tubes, for instance, which are in the whole length of the extension and ends in the extensions bottom 44. In the opposite direction
30 of the primary cleaned condensate, in-side the tubes, indirect heated steam is flowing outside the tubes. As the condensate in question has a temperature of, for example, 60 – 65 °C and the heating steam a temperature of, for example, 70 – 80 °C the condensate will be heated somewhat as the condensate flows downwards through the tubes. That imply that a fraction of the impurities which is still in the condensate, leave the condensate in gas state,
35 the gas flows upwards through the tubes and reach space 7 where the gas mixes with new

influx of process steam which as earlier mentioned supplies via the pipe socket 6 and that gas-mixture flows upwards through the combined stripper/condenser as earlier described. The description above means that the primary cleaned condensate cleans further and transform to highly cleaned condensate which collects at the bottom 44.

- 5 Via the pipe 18 and by means of the pump 19 the highly cleaned condensate is removed from the cleaning plant.

The amount of de-aeration steam from the evaporation plant is limited, and the amount of condensate, which flows downwards the extension 38, is large. Despite that the temperature between the two media can be large, the temperature increase of the condensate will
10 increase slightly depending on large amount of condensate in comparison with the amount of steam. The temperature increase of the condensate is enough for further cleaning the condensate.

A fraction of de-aeration steam will condense when it flows upwards the unit 38; the condensate collects in the bottom of earlier mentioned closed space including pipe socket
15 40. The condensate in question goes via pipe 45 to pipe 26 and mixes with contaminated water, which will be re-circulated in the plant as earlier described. The remaining steam in space 3 and forwards will be handled in accordance with what earlier has been mentioned and shown in figure 1.

20 In figures 3 and 4 shows the over part of central section of a preferred embodiment of a cleaning plant according to the invention. Those central parts constitute of four condensers enclosed in a longitudinal cylindrical tower, with the first unit as a combined stripper/condenser. In figures 3,4,5 and 6 shows not the unit 38 according to figure 2 or other supplementary equipment's in the cleaning plant according to the invention, which can be
25 clear from figure 2 and figure 1. The over section of tower 46 shows from the side in figure 3 and cross sectional in figure 4. Through the pipe socket 47, unclean condensate and condensate from the bottom of the second condenser in series, is supplied. Through the pipe socket 48, a part of condensed methanol is re-circulated, which is collected at the bottom of the fourth condenser in series. Through the pipe socket 49 coolant is supplied, for example
30 cold water. The tower 46 contains a large number of tubes 50. Those tubes are surrounded of a joint mean 59, for example a sheet-iron.

The left part 51 of the tower, which clearly can be seen in the cross section in figure 4, is a combined stripper and condenser. To the right is the second condenser 52 in series. There is a wall 72 that separate the combined stripper condenser 51 from condenser 52. The wall 72
35 don't reach up to the towers 46 top, but the process steam flows up through the tubes 50 in unit 51, over the wall 72 and downwards through the tubes 50 in unit 52. Unit 52 is

connected with the third condenser 53 in series at the bottom of unit 52. Unit 53 is connected with the fourth condenser 54 at the top of the tower 46.

The wall 55 that separate the condensers 53 and 54 is up to the top of the tower 46. The wall 56 that separate condenser 53 from condenser 54 doesn't reach the top of the tower 46.

5 The number of tubes 50 that is shown in the combined stripper condenser 51 is twelve.

Corresponding number of tubes 50 in condenser 52 are four, while the number of tubes in the third condenser 53 is two and in the last condenser one. This is a result of that more and more steam will condense and therefore the necessary cooling capacity is decreased.

10 The plant is thus designed so that $\frac{2}{3}$ of the of the supplied process steam has condensed inside the tubes 50 when the steam has reached the upper end 57 in the combined stripper and condenser. Coolant is supplied as earlier described to a closed space. The space is restricted upwards by a mean, for example a sheet-iron. Prior mentioned mean 59, for example a sheet-iron, is not close connected to the tubes 50. On for example four point of the tubes periphery will be connected with the mean. Those points can be on the top of a half
15 circle shaped pattern, which will put the tube into an exact position. Between the points there is a space between the mean and the tube, which will help the supplied coolant to flow along the tubes 50 outside down through the tower 46. Such means 59 are applied to the tubes, with for example a distance of two meters, down through the tower. The means have two purposes. The tubes will be efficient cooled, as cold water flowing along the outside of the
20 tubes, the tubes will also be reinforced efficiently by the mean.

In figures 5 and 6 shows the lower section of the tower 46.

25 In figure 5 shows a cross section of the tower 46, seen from the bottom side. Process steam is supplied through pipe socket 60 to the combined stripper and condenser 51. The wall 61 separates the stripper and condenser from the condensers 52 and 53. Condenser 52 and 53 are connected with each other at the bottom side imply that process steam can flow from condenser 52 up through condenser 53. From there process steam flows, which volume reduces after each condenser, downwards through condenser 54. That is separated from
30 condenser 52 by the wall 62 and from condenser 53 by the wall 63. Via pipe socket 64 inert gases are removed including eventually evil smelling sulphur containing gases and according to preferred embodiment of the invention the pipe socket 64 is connected to an arrangement for creating of negative pressure (not shown in the figure).

35 In figure 6 shows the pipe socket 65, through which heated coolant is removed. The closed space for coolant is restricted downwards by a means 66, for example a sheet-iron. In the bottom of the space 67 clean condensate is collected and is removed from the plant via the

pipe socket 68. In the bottom of space 69 below condenser 54 is condensed methanol collected and removed via the pipe socket 70. In the bottom of space 71 is turpentine and contaminated water in a mixture; the mixture is removed via pipe socket (not shown in the figure) for separation of turpentine and re-circulation of remaining condensate according to earlier descriptions.

That is shown in figures 3,4,5 and 6 doesn't differ from the condensers 4,5,11 and 13 with corresponding spaces 7,3,10 and 12, and connected pipes including pipe sockets according to the figures 1 and 2, principally but shows a similar cleaning plant which is extremely compact and therefore need minimum of space.

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CLAIMS

1, Method for purification of unclean condensate resulting from production of semi chemical or chemical cellulose pulp and from evaporation of spent liquor by means of a cleaning plant having in series several coupled condensers comprising the steps of;

(a) feeding vapor generated during a last evaporation stage, which is process steam from such last evaporation stage, together with unclean condensate into a combined stripper and condenser, the process steam and the unclean condensate being forced to flow in opposite directions so that direct heat exchange takes place and heat is transferred from the process steam to the unclean condensate resulting in separation of turpentine, methanol and other volatile compounds in the unclean condensate which turpentine, methanol and other volatile compounds are taken up by the flow of process steam at the same time as indirect cooling occurs, resulting in condensation of a main part of the process steam to form a primary cleaned condensate;

(b) causing a remainder of the process steam with the turpentine, methanol and other volatile compounds to flow to another condenser, the remainder of the process steam with the turpentine, methanol and other volatile compounds to be cooled indirectly such that contaminated water and turpentine are condensed and collected together and, the methanol thereafter will be condensed;

(c) separating the contaminated water from the main part of the turpentine content which is removed from the plant;

(d) circulating the contaminated water back to the combined stripper and condenser;

(e) condensing the methanol and removing the condensed methanol from the plant;

(f) collecting the primary cleaned condensate at a bottom of the combined stripper and condenser, and

(g) removing the primary cleaned condensate from the plant.

2. Method according to claim 1, wherein all of the process steam from the last stage of evaporation of the spent liquor is introduced into the combined stripper and condenser.

3. Method according to claim 1, wherein, during the feeding step, the unclean condensate is introduced into a space above and in connection with the combined stripper and condenser, and the process steam is introduced into a space under and in connection with the combined stripper and condenser, and the unclean condensate flows in a direction downward through the combined stripper and condenser, while the process steam flows in an opposite direction.

4. Method according to claim 3, wherein the de-aeration steam from at least one evaporation stage is introduced into a space in connection with the combined stripper and condenser.

5. Method according to claim 3, wherein, during the primary cleaned condensate removing step, the primary cleaned condensate is forced to flow downward through an underlying extension of the combined stripper and condenser and is heated indirectly by de-aeration steam of at least one evaporation stage, which de-aeration steam is introduced at an under part of the extension, resulting in remaining turpentine, methanol and other volatile compounds in the primary cleaned condensate being separated from the primary cleaned condensate in a gaseous state and flowing upward and being mixed with the upward flowing, newly introduced de-aeration steam such that a highly purified condensate is collected at the bottom of the extension and removed from the plant.

6. Method according to claim 5, wherein the de-aeration steam is mixed with admission steam of variable energy content so that cleanliness of highly purified condensate can be closely controlled.

7. Method according to claim 5, wherein any uncondensed de-aeration steam is discharged at the upper part of the extension, and is introduced into a space in connection with the combined stripper and condenser.

8. Method according to claim 1, further comprising the step of removing inert gases and sulphur containing gases by means of an arrangement for creating negative pressure which is connected to a discharge end of the plant.

9. Method according to claim 1, wherein during the methanol condensing step, methanol is collected at the bottom of a last condenser in series, and a portion of the methanol is removed from the plant, and a portion of the removed methanol is recirculated to the top of the next to last condenser in series.

10. Method according to claim 1, further comprising the steps of supplying at least one coolant to an upper section of the combined stripper and condenser and removing the coolant at an increased temperature from a point below the upper section of the combined stripper and condenser.

11. A plant for cleaning of unclean condensate from production of chemical or semi chemical cellulose pulp including evaporation of spent liquor, comprising;

(a) a combined stripper and condenser, having several insertions through which process steam and unclean condensate flow counter current and in direct contact with each other, which insertions are surrounded by a space intended for through flow by a coolant and spaces connected on a topside and an underside of the combined stripper and condenser, the space on the underside serves as a bottom of the combined stripper and condenser;

(b) means for supplying unclean condensate to the space at the topside of the combined stripper and condenser;

(c) means for supplying process steam to the space at the underside of the combined stripper and condenser;

(d) further condensers connected in series with the combined stripper and condenser, the further condensers having several insertions through which residual, uncondensed process steam and turpentine, methanol and other volatile compounds generated from the unclean condensate flow, which insertions are surrounded by a space intended for through flow by coolant, resulting in condensation in series of contaminated water and turpentine in a mixture and methanol in spaces connected to the respective condensers;

(e) means for supplying coolant to the spaces surrounding the insertions of the combined stripper and condenser and the further condensers;

(f) means for removing heated coolant from the spaces surrounding the insertions of the combined stripper and condenser and the further condensers;

(g) means for removing primary cleaned condensate from the bottom of the combined stripper and condenser;

(h) means for separating a main part of the turpentine from the contaminated water and turpentine mixture;

(i) means for removing a main part of the turpentine from the plant;

(j) means for transporting the contaminated water back to the space in the combined stripper and condenser where the unclean condensate is introduced; and

(k) means for removing the condensed methanol out of the plant from the space in which the condensed methanol is condensed.

12. Plant according to claim 11, wherein said insertions are tubes.

13. Plant according to claim 12, further including means for increasing contact surface between the unclean condensate and the process steam inserted inside the tubes.

14. Plant according to claim 13, wherein said means for increasing contact are chosen from the group consisting of two joined elongated elements which in cross section form a cross, a folded sheet iron creating a wave pattern and elongated elements twisted along their longitudinal axis giving a spiral pattern.

15. Plant according to claim 11, wherein said insertions are lamellae.

16. Plant according to claim 11, further comprising means for supplying de-aeration steam from at least one evaporation stage to the combined stripper and condenser.

17. Plant according to claim 11, further comprising a downward extension connected to the combined stripper and condenser, the downward extension having insertions through which primary cleaned condensate from the combined stripper and condenser flows in one direction and primary de-aeration steam, from at least one evaporation stage flows counter current with the primary cleaned condensate, the extension has a bottom from which highly purified condensate is removed.

18. Plant according to claim 17, wherein insertions of the downward extension are tubes.

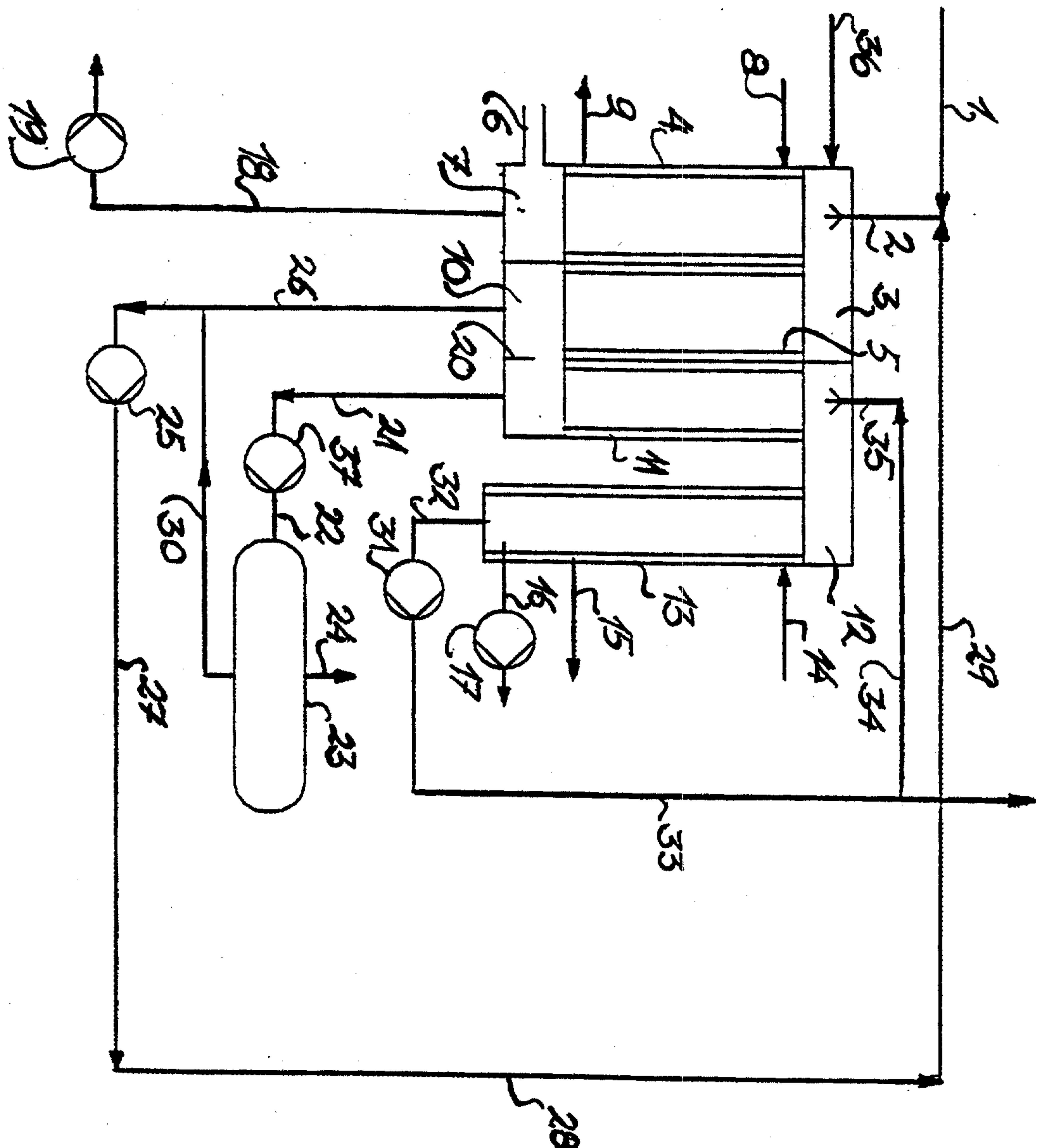
19. Plant according to claim 11, wherein a lower part of the last of the further condensers in series includes devices arranged for creating a negative pressure inside of the insertions of the further condensers and their connecting spaces and for removal of mainly inert gases and foul smelling sulphur containing gases.

20. Plant according to claim 11, wherein the further condensers are three condensers.

21. Plant according to claim 11, wherein said means removing the condensed methanol from the plant includes means for recirculation of at least some of such methanol to a space above the next to the last condensers of the further condensers in series.

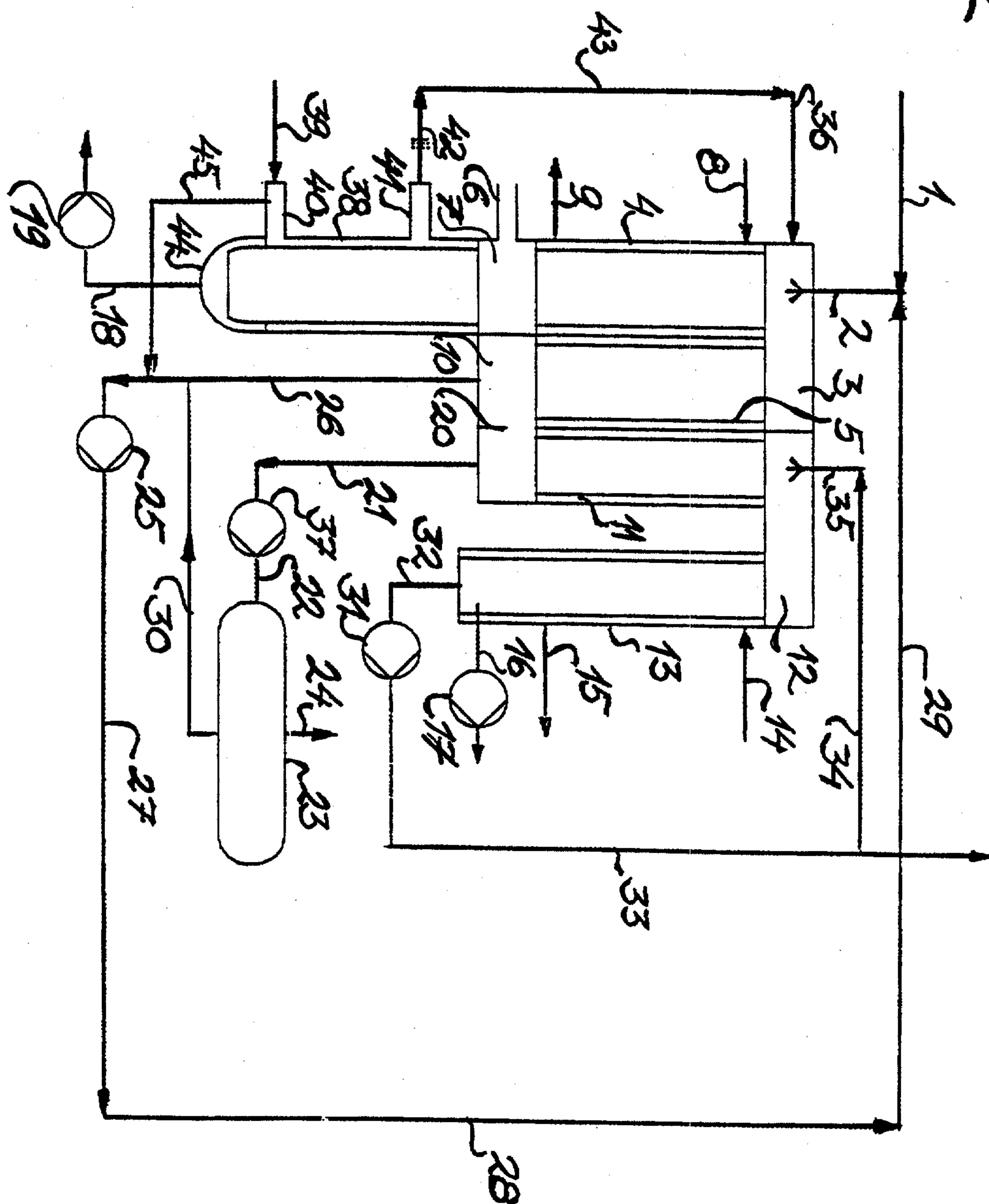
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Fig. 1



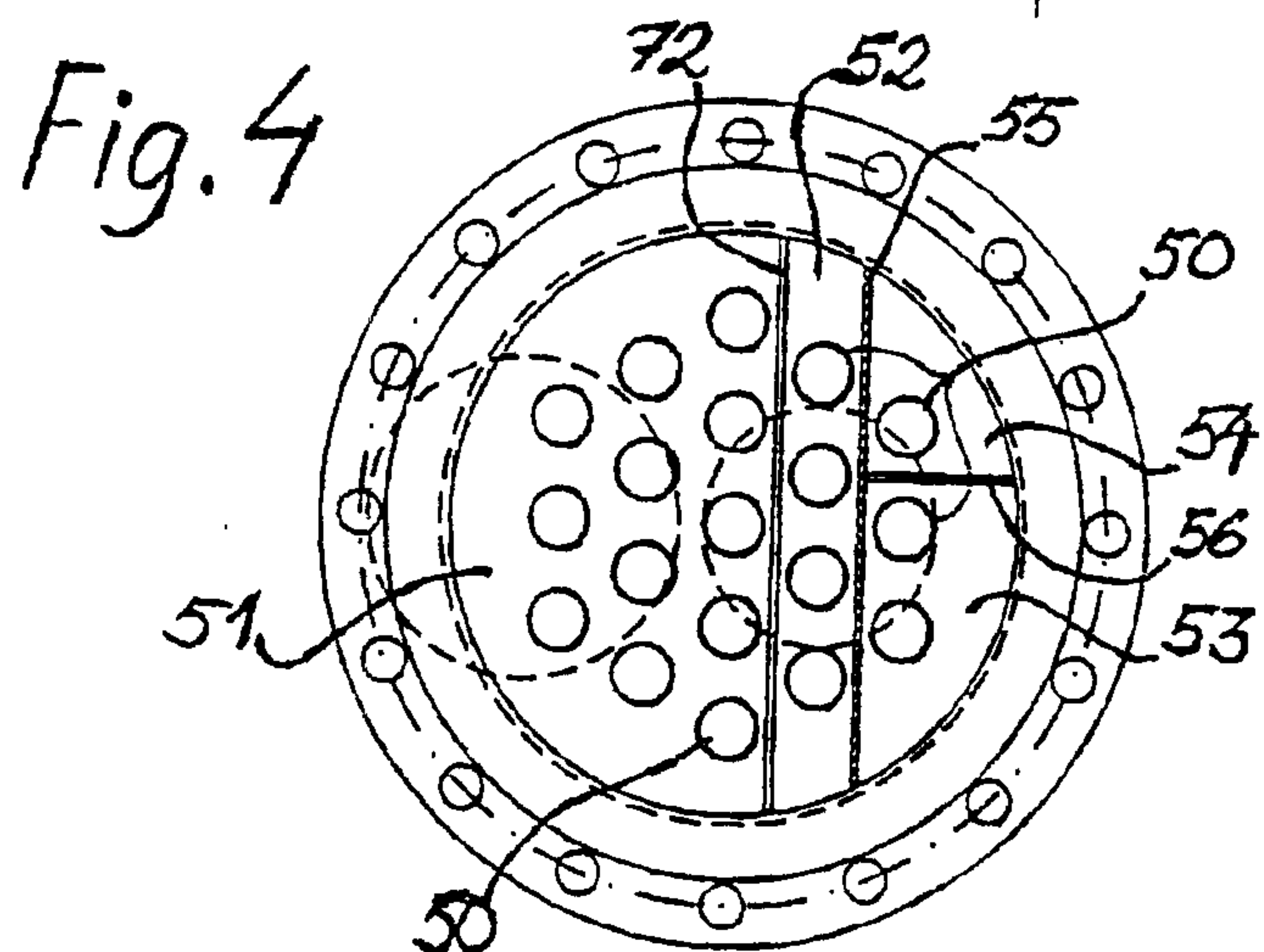
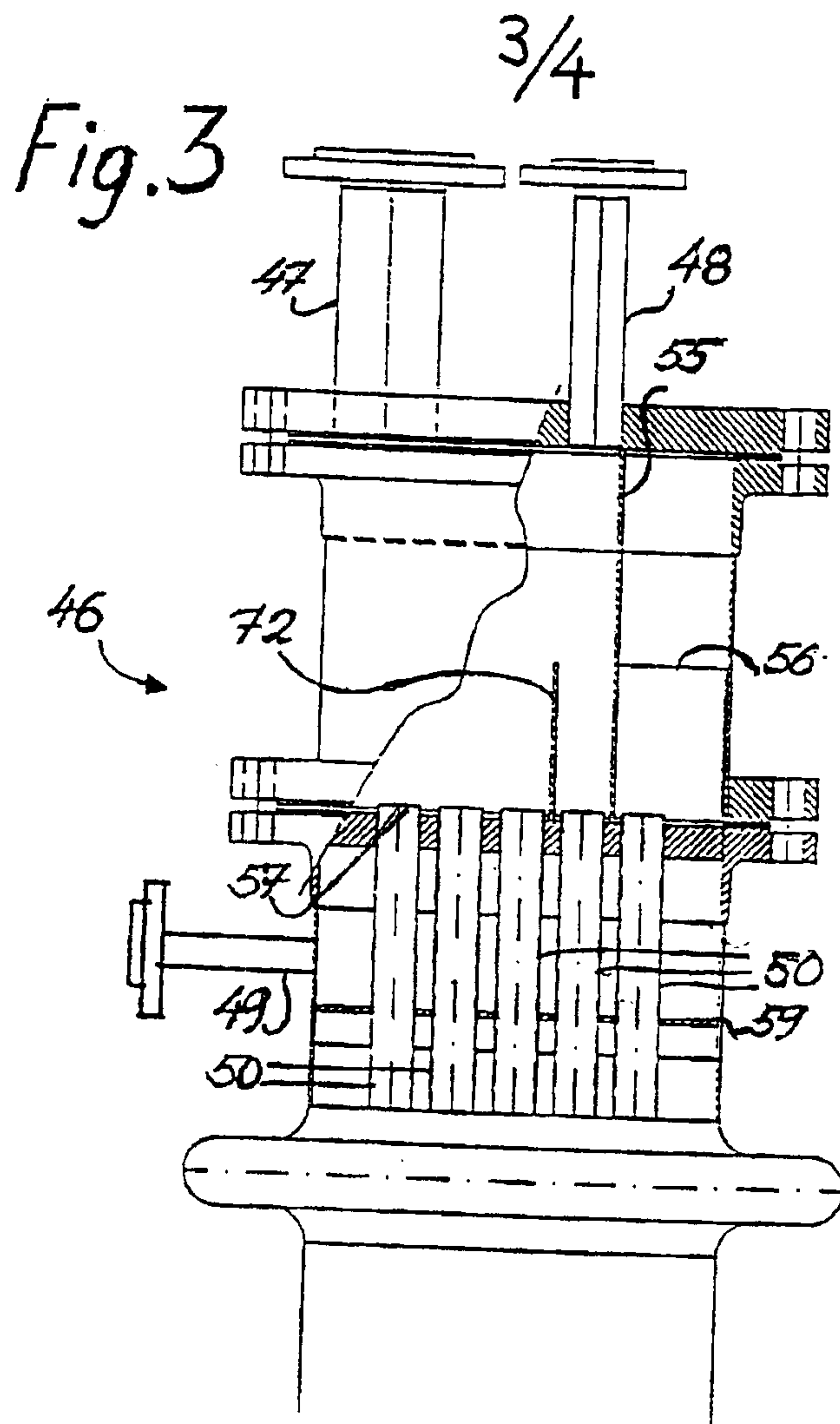
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Fig. 2



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Fig. 5

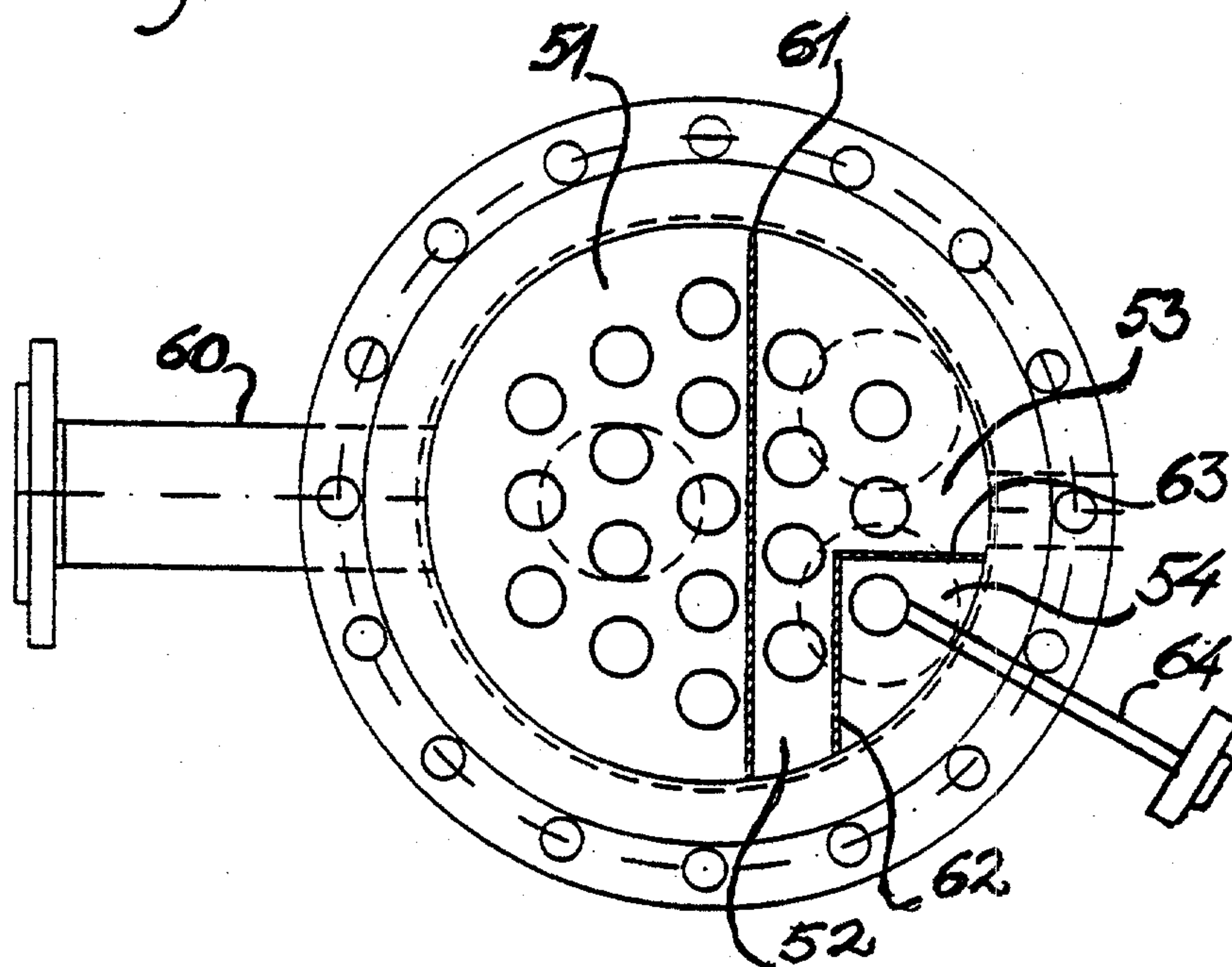


Fig. 6

