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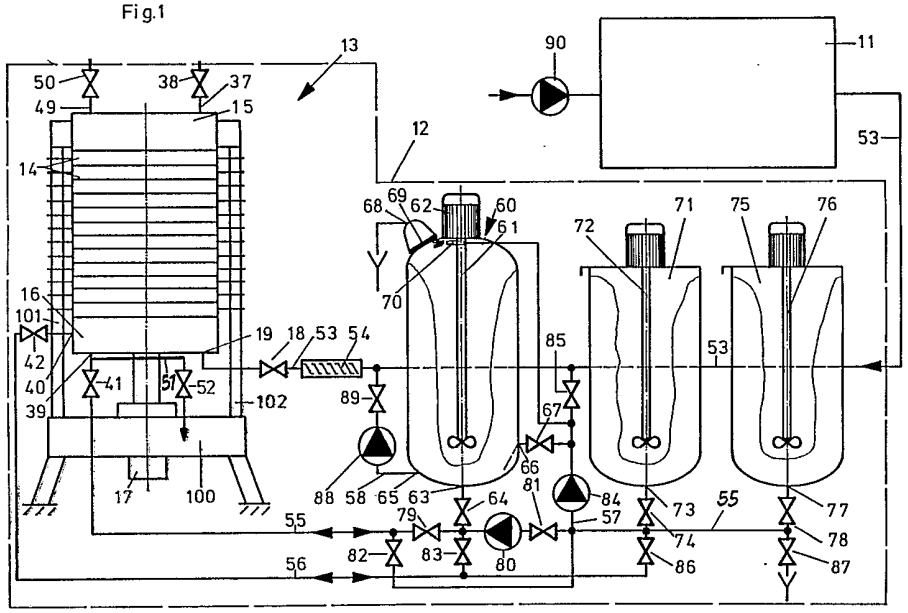
(54) Method and apparatus for clarifying beer

(57) Beer is clarified by first clarifier 11 followed by filtration in a filter press 13, wherein layers of filter aid are formed on each of a stack of filter plates and the beer is filtered therethrough at a flow rate of at least 15 hectolitres per square meter per hour. The filter plates in press 13 are horizontal and arranged for downward flow. Clarifier 11 may be a filter press with vertical plates, also using filter aid, or some other sort of filter. When the filter aid layers in press 13 become clogged, they may be cleaned in situ by delivering soda lye followed by water, then nitric acid and further hot water to sterilise them. After several in situ cleaning steps, the filter aid layers are flushed out of the press and cleaned in container 60 using a similar series of chemicals.

Fig.1



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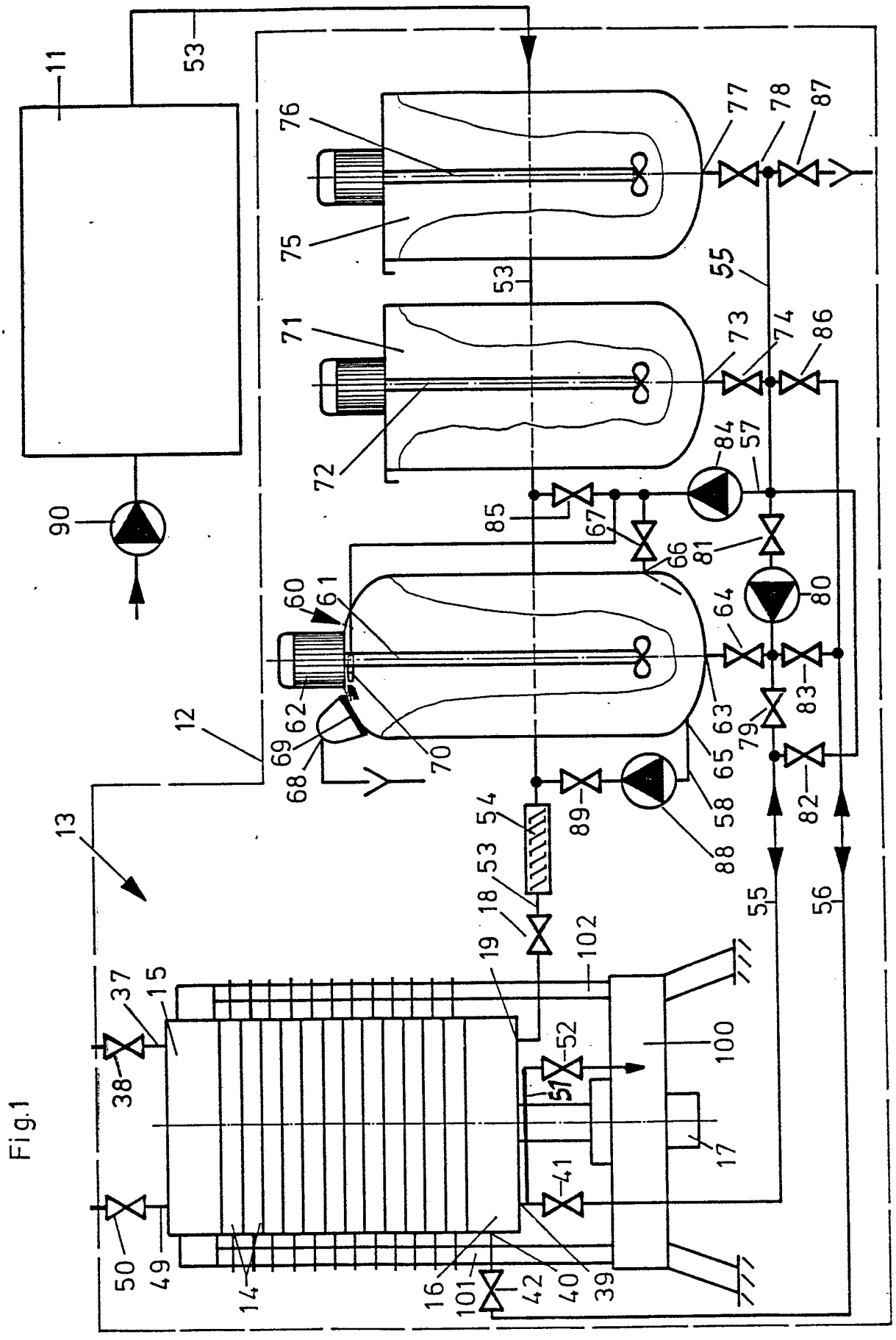
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Fig.1

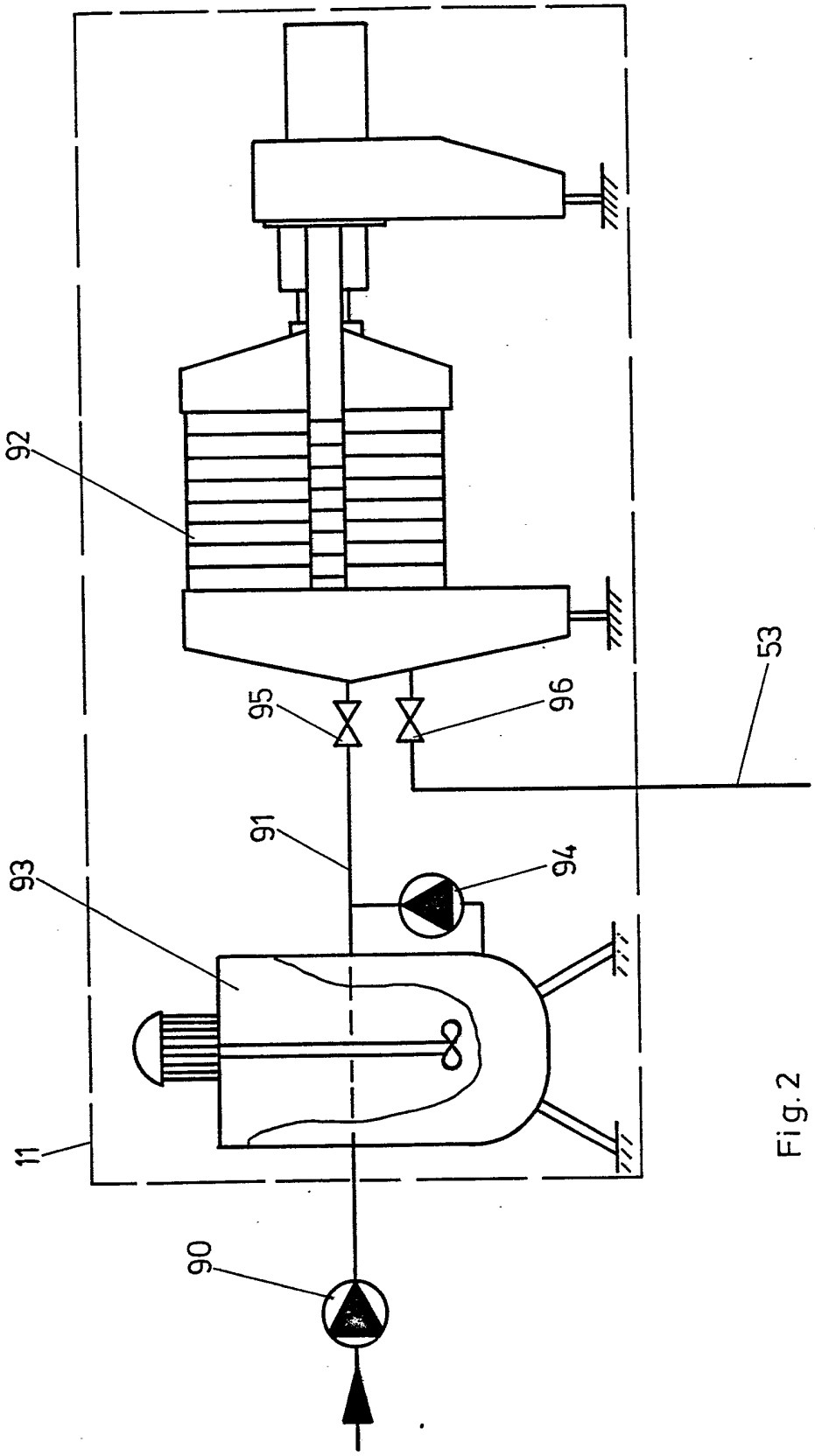

Fig.2

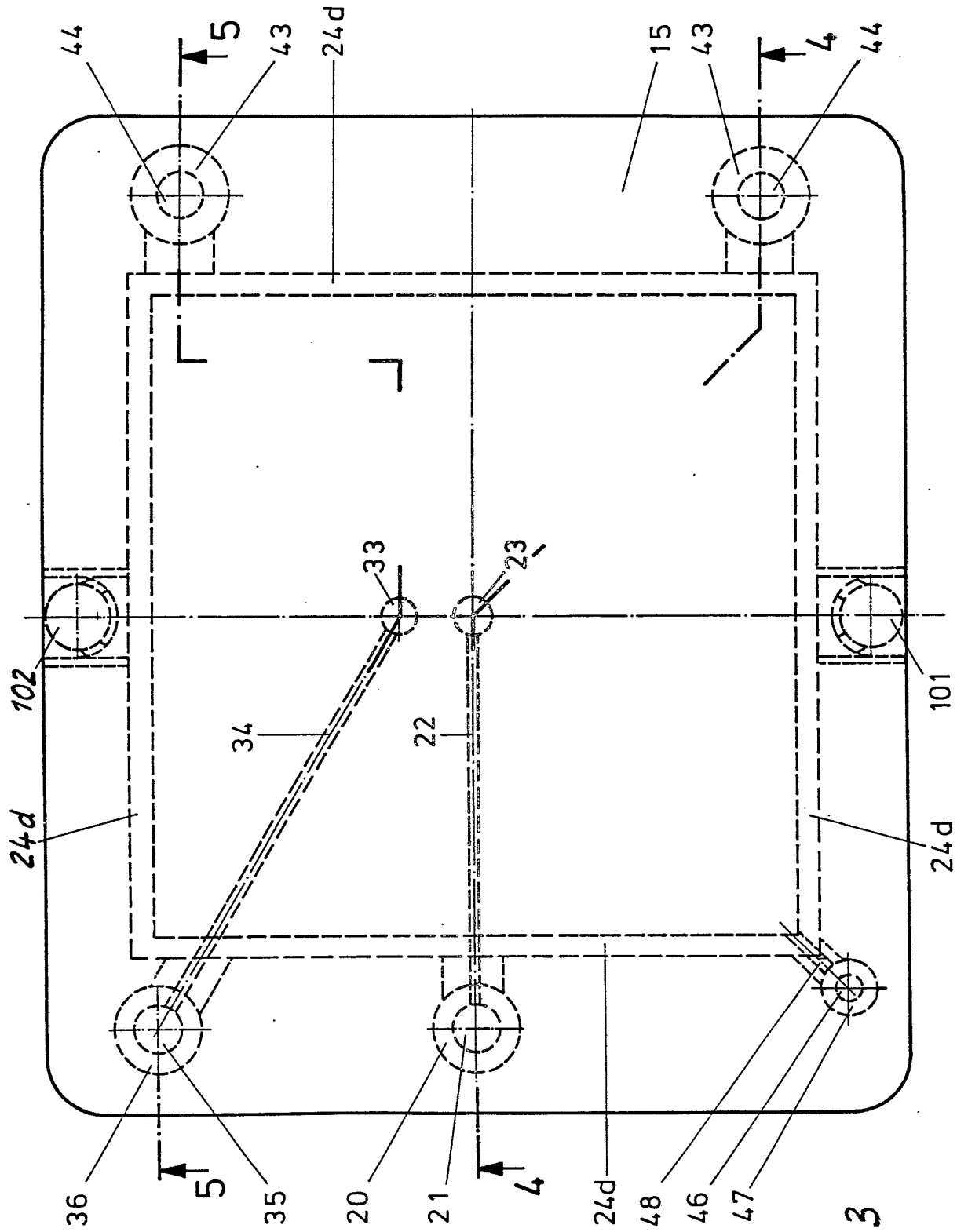
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Fig. 3

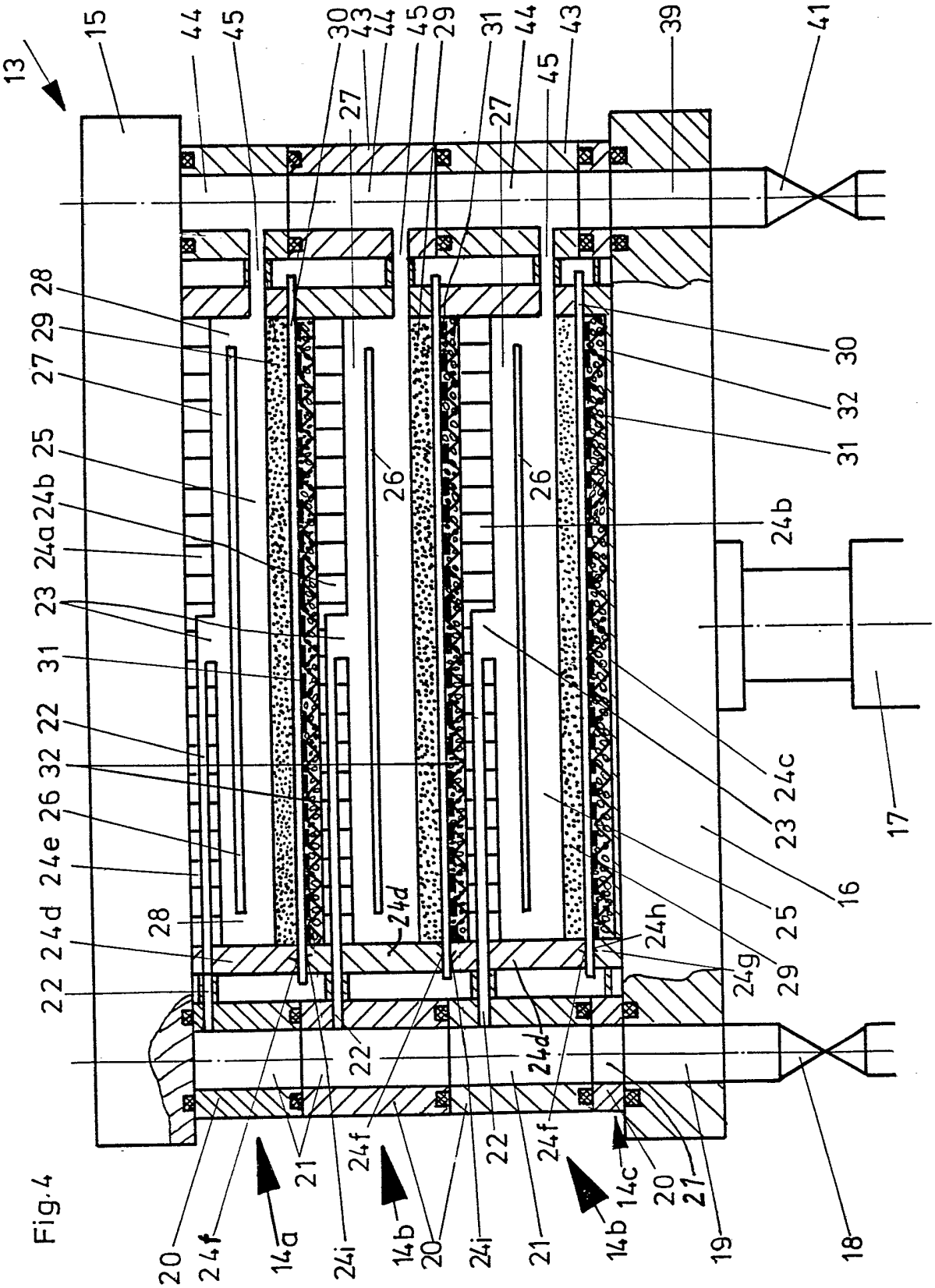
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Fig.4

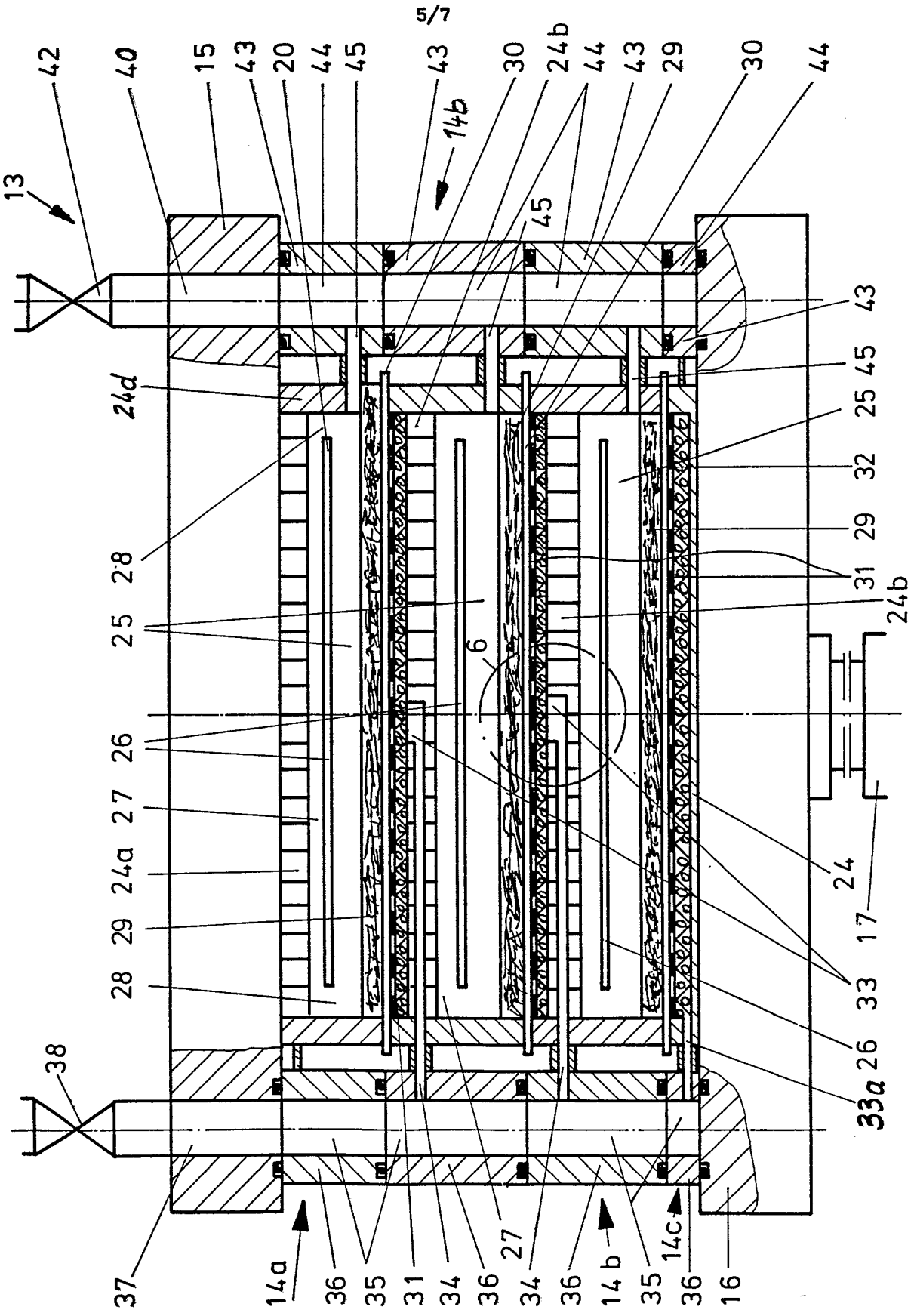
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Fig. 5

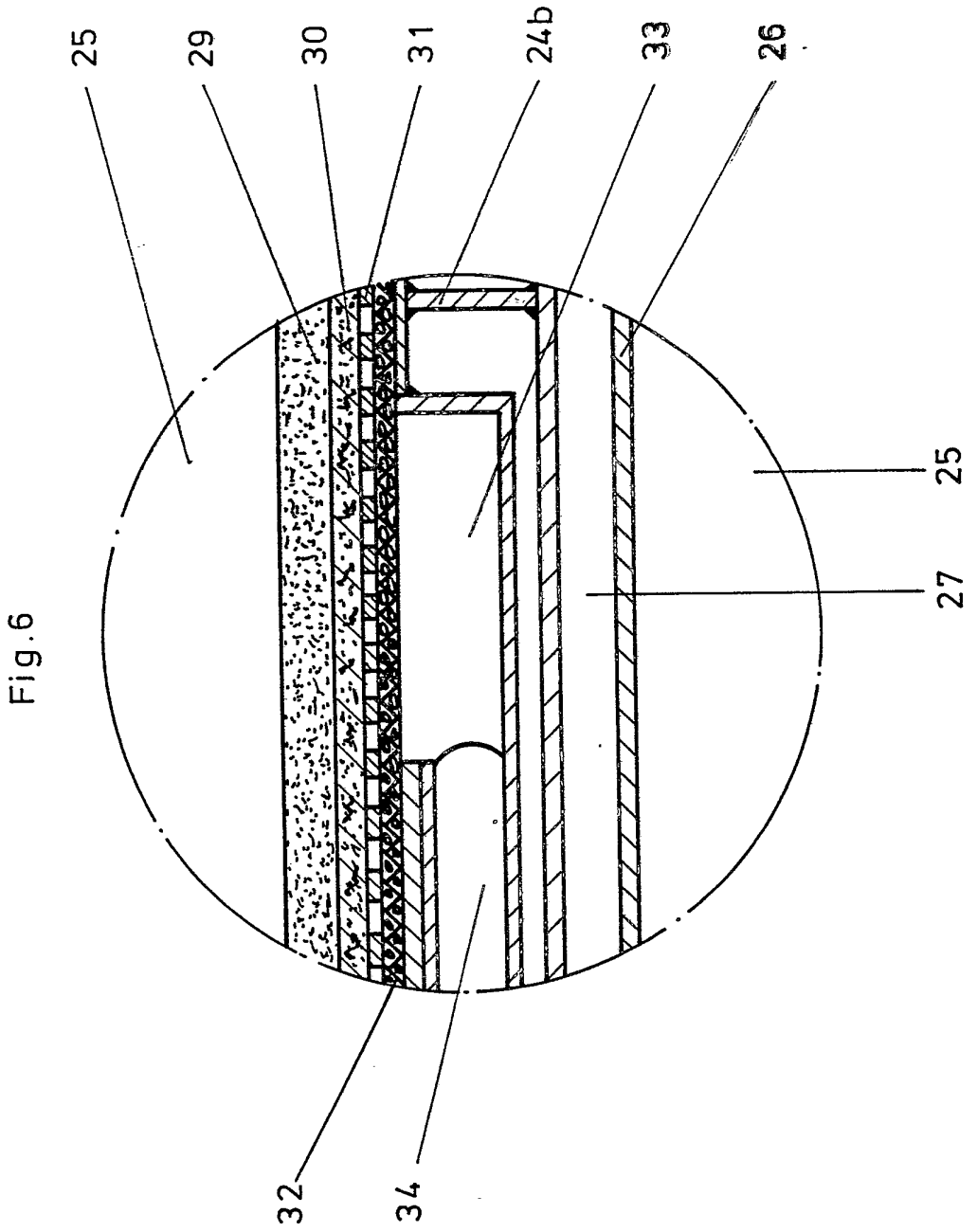
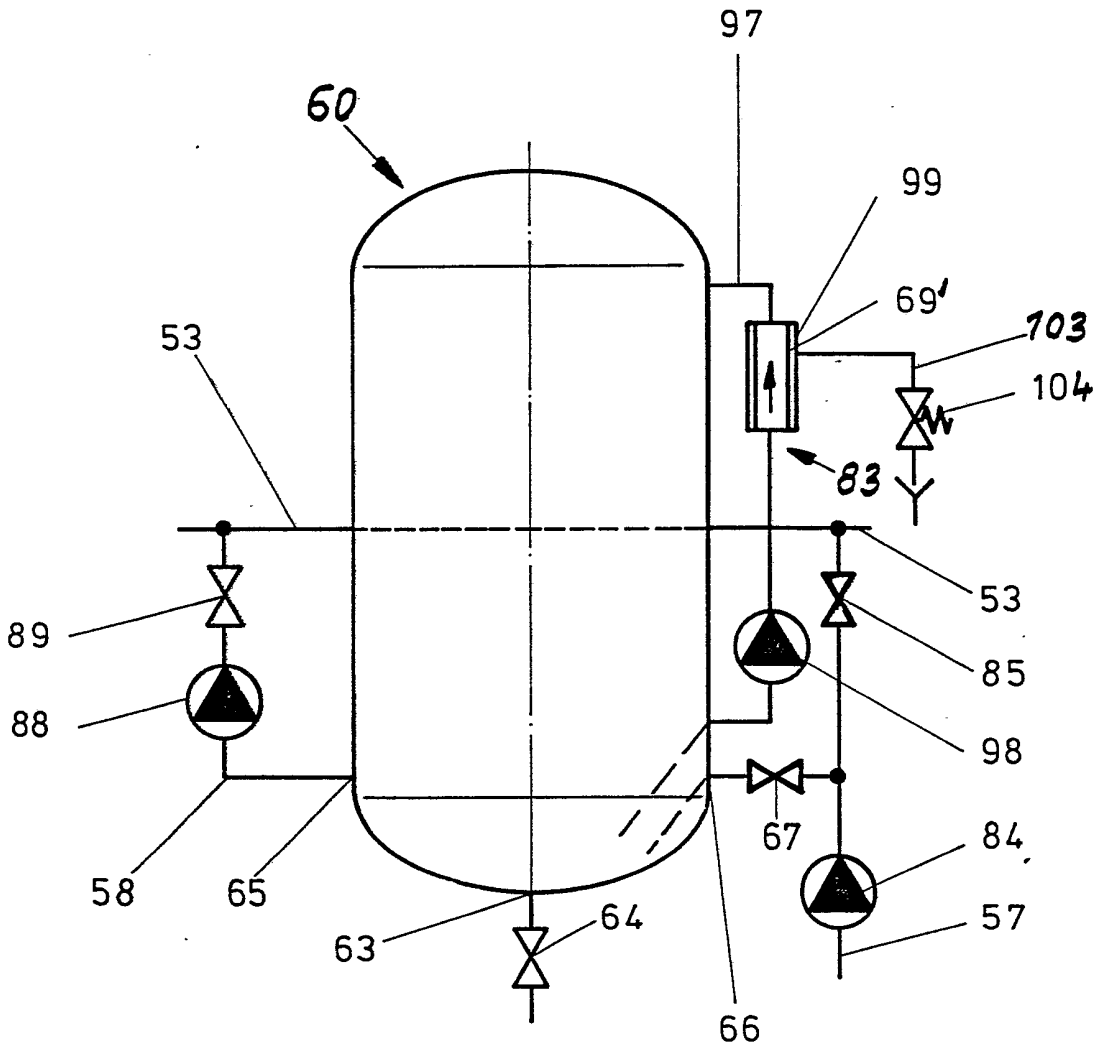


Fig.6

Fig. 7



SPECIFICATION

Method of and apparatus for removing impurities from a liquid

The present invention relates to a method of and apparatus for removing impurities from liquids, such as still liquids or liquids containing carbon dioxide, in particular beverages.

In known multi-stage methods for the removal of impurities from still liquids or liquids containing carbon dioxide, in particular beverages, the filters used in a last process stage for the removal of residual impurities, in particular microbiological impurities, act as sterilisation filters, although filters of that kind have substantially lower flow speed and thereby appreciably reduce throughput performance by comparison with the filters used for preliminary clarification in preceding process stages. In order to make a continuous process possible, considerably larger filtration devices would have to be used in the process stage compared with a process stage which serves for the preliminary clarification of the liquid. However, this would require appreciable investment, and increased costs for the performance of the process, in respect of filter material, process monitoring, maintenance and so forth. Moreover, large-size filtration devices would require space which is often not available.

There is thus a need for a method and apparatus which may be able to carry out a filtration for the removal of residual impurities, in particular microbiological impurities, at high flow speed and correspondingly high throughout performance with the least possible consumption of filter material and with use of compact equipment.

According to a first aspect of the present invention there is provided a method of removing impurities from a liquid, the method comprising the steps of carrying out a preliminary clarification of the liquid, forming at least one regenerable alluvial filtration layer of predetermined thickness in a filter press by supplying filter material in flowable form to the press under damped turbulence and at a flow rate of at least 15 hectolitres per square metre per hour, and filtering the clarified liquid by passing it through the formed layer or layers in the press.

It is known that alluvial filtration processes, with use of appropriate filter materials or mixtures and with maintenance of limited flow speed of the liquid to be filtered through an alluviated layer, can be provided with sterilisation properties. It is also known that constant additive metering, conventional in alluvial filtration processes, of filter materials to the liquid to be filtered can be omitted if the liquid does not contain impurities clogging the surface region of the alluviated layer. It is, however, surprising that an alluvial filtration process exclusively for the removal of residual impurities, in particular microbiological impurities, from preliminarily clarified liquid can be so structured that sterilising filtration, even at high flow speed of the liquid through the alluviated layer and with least possible use of filter material, can be performed by building up an alluvial layer to a predetermined thickness while maintaining the stated flow rate and that this alluviated layer retains its original thickness during the filtration process. It is also surprising that such an alluvial layer can be regenerated in its properties for the removal of residual impurities and that also regeneration and renewed alluviation of the filter material utilised in such an alluvial layer can be carried out, for example after removal of the filter cake.

It has proved that kieselgur is particularly advantageous for use in formation of the layer, as also are fibrous substances. If the filter material contains synthetic material fibres, then alluviation of the layer or layers can be achieved by way of a dispersion consisting of cold or warm water with an addition quantity of filter material in the region of 10% of parts by mass of synthetic material fibres. Alluviation then preferably takes place with maintenance of an alluvial flow of between 50 and 100 hectolitres per square meter per hour, preferably 70 hectolitres per square metre per hour. The thickness of the layer or layers should preferably be as uniform as possible, such as 5 and 15 millimeters, preferably 8 millimetres. It has also proved to be advantageous to dispose the layer or layers in a substantially horizontal position.

The method may comprise the steps of monitoring pressure drop of the liquid across the layer or layers under a constant rate of flow of the liquid thereto and regenerating the layer or layers in the press on increase of the pressure drop above a given limit value. Alternatively, the method may comprise the steps of monitoring a parameter of throughput of the liquid through the press, removing the layer or layers from the press if and when the parameter falls below a given limit and forming a new layer or new layers in the press by supplying alluvial filter material in flowable form to the press. The parameter may be the pressure drop of the liquid across the layer under a constant rate of flow of the liquid thereto.

According to a second aspect of the present invention there is provided apparatus for carrying out the first aspect of the invention, the apparatus comprising clarifying equipment for preliminary clarification of such liquid, filtering equipment for filtering the clarified liquid, the filtering equipment comprising a filter press with support means for at least one regenerable alluvial filtration layer and with duct means for conducting filter material to form the or each such layer, for conducting clarified liquid to and filtered liquid from the or each such layer and for conducting rinsing agent to rinse the filter material, and supply equipment for supplying a metered quantity of such filter material to the filter press.

Preferably the apparatus comprises, as well as the equipment required for maintenance of the filtration operation of the filter press and for preparation and finishing treatment of the filtration process, also equipment for regeneration of the layer or layers.

Preferably the press comprises at least one frame which is arranged in the press horizontally between two relatively movable clamping members and which comprises a distributor chamber communicating with liquid inlet means and a filtration chamber disposed below the distributor chamber and liquid inlet means laterally communicating with rinsing agent inlet means, a respective liquid-permeable carried element

being provided to carry a layer of filter material for filtration of liquid in the or each filtration chamber and respective outlet means being disposed below the carrier element to conduct away liquid filtered by the layer.

In one embodiment the press comprises a single such frame and further comprises an outlet plate which is arranged below the frame and includes an upwardly extending circumferential wall provided with the outlet means, the carrier element being sealingly clamped between the lower end face of the frame and the upper end face of said circumferential wall.

In another embodiment the press comprises a stack of such frames and further comprises an outlet plate which is arranged below the lowermost one of the frames and which has an upwardly extending circumferential wall provided with the outlet means for the filtration chamber of said lowermost one of the frames, a respective such carrier element being sealingly clamped between the lower end face of said lowermost one of the frames and the upper end face of said circumferential wall and also between adjacent upper and lower end faces of the or each two adjacent frames in the stack.

An example of the method and embodiment of the apparatus of the invention will now be more particularly described by way of example with reference to the accompanying drawings. in which:

Fig. 1 is general view of apparatus embodying the invention;

Fig. 2 is a schematic view of preliminary clarification equipment of the apparatus;

Fig. 3 is a schematic plan view of a filter press of the apparatus;

Fig. 4 is a vertical section of the press along the line 4-4 of Fig. 3;

Fig. 5 is a vertical section of the press along the line 5-5 of Fig. 3;

Fig. 6 is detail 6 of Fig. 5 to an enlarged scale; and

Fig. 7 is a schematic view of a modified alluviating ahd regenerating container of the apparatus.

Referring now to the drawings, there is shown in Fig. 1 apparatus for the removal, in two or more stages, of impurities from still liquids or liquids containing carbon dioxide, for example beer. The apparatus includes equipment 11 for preliminary clarification of the beer and adjoining filtering equipment 12 for the removal of residual impurities, in particular microbiological impurities, such as yeasts, bacteria and so forth, from the preliminarily clarified beer. The equipment 12 contains a filter press 13, constructed for alluvial filtration, with horizontally arranged dross frames 14, which are retained between a fixed upper cover 15 and a vertically movable lower cover 16. A hydraulic pressure device 17, which acts from below, is provided for pressing of the dross frames between the two covers 15 and 16, wherein the upper cover 15 and a frame 100, which is supported on the ground and receives the device 17, are connected together by means of two parallel struts 101 and 102.

As Figs. 4 and 5 show, the division of the frames 14 of the press 13 is as follows:

Arranged below the upper cover 15 is an upper frame 14a, the ceiling 24a of which rests against the underside of the cover 15. An inlet 23 for the beer is provided in the ceiling 24a. Extending downwardly from the ceiling 24a is a circumferential wall 24d, which surrounds a horizontally disposed filtration or dross space 25 and a horizontally arranged distributor chamber 27 as well as a similarly horizontally arranged metal guide plate 26 inserted between the chamber 27 and the space 25. An annular gap 28 is formed between the circumferential wall 24d and the circumferential rim of the plate 26. The wall 24d has a lower annular end face 24f.

An outlet plate 14c, which includes a bottom wall 24c and a heightened circumferential frame 24g, is disposed on the upper side of the lower cover 16. This frame 24g contains collecting and outlet equipments for the filtrate and has an upper end face 24h.

Also provided, as shown in Figs. 4 and 5, are insert filtration or dross frames 14b, which are to be inserted according to choice and in desired number between the upper frame 14a and the outlet plate 14c. These insert frames 14b differ from the upper frame 14a in that they have a slightly higher circumferential wall 24d and are provided, in place of the ceiling wall 24a in the upper part, with an intermediate bottom wall 24b, which is recessed relative to the upper end face 24i and contains the collecting and outlet equipment for the filtrate. An inlet 23 for the beer and a filtrate outlet 33 displaced laterally therefrom are also provided in the wall 24b.

If operation is to be with only a single frame 14, then the upper frame 14a and outlet plate 14c alone are inserted into the press 13 in such a manner that the upper end face 24h of the frame 24g and the lower end face 24f at the circumferential wall 24d of the upper frame 14a are disposed opposite each other. If a greater effective filter area is desired, then a selected number of insert frames 14b can be mounted one above the other between the upper frame 14a and the outlet plate 14c, as is shown in Figs. 4 and 5 by the example of two such insert frames 14b.

The conduction of the preliminarily clarified beer and the finished filtrate in the press 13 is as follows:

As Fig. 4 shows, the inlet 19 at the lower cover 16 leads to an inlet channel 21, which is formed in eyelets 20 of the outlet plate 14c and the frames 14a and 14b, for the preliminarily clarified beer. Formed in the ceiling 24a of the upper frame 14a and in the intermediate wall 24b of the insert frames 14b are inlet channels 22, which lead from the feed channel 21 led through the eyelets 20 to the downwardly directed inlet 23 formed centrally above the distributor chamber 27. The preliminarily clarified beer passes from this inlet 23 into the distributor chamber 27 of the upper frame 14a and the insert frames 14b and then through the passage slot 28 with damped turbulence into the dross space 25. At the bottom of each space 25, an alluviated layer 29 is formed on a carrier element 30, which can be, for example, a prefabricated plate-shaped filter layer, a filter cloth or the like. The respective carrier element 30 is tightly clamped by its circumferential rim region. Thus the carrier element 30 arranged between the outlet plate 14c and the insert frame 14b is clamped between the lower end face 24f and the upper end face 24h. The carrier element arranged between the upper frame 14a and

the insert frame 14b arranged thereunder is clamped between the lower end face 24f and the upper end face 24i. The carrier element 30 arranged between the two insert frames 14b is clamped between the lower end face 24f and the upper end face 24i of these two frames. These annular end faces 24f, 24h and 24i are accordingly formed as clamping or pressing surfaces. Each carrier element 30 at the same time forms a rim seal at the bottom circumference of the respective space 25.

In the region of the bottom surface of the associated space 25 the carrier element 30 rests on a support element 31, for example a perforated metal plate, which is in turn for liquid removal underlaid by a porous underlay 32, for example a wire mesh. This underlay 32 lies on the upper side of the bottom wall 24c of the outlet plate 14c or on the upper side of the intermediate wall 24b of each insert frame 14b. The intermediate wall 24b of each frame 14b is provided in the middle region, but displaced laterally from the inlet 23, with a filtrate outlet 33, which by way of a filtrate outlet channel 34 opens into a filtrate removal channel 35 formed in lateral eyelets 36 of the frames 14a and 14b and outlet plate 14c (cf. Figs. 3 and 5). A filtrate outlet 37 in the cover 15 leads from the channel 35 by way of a blockable valve 38 to a filtrate removal pipe (not shown).

The filtrate outlet 33a associated laterally with the outlet plate 14c also opens into the channel 35. This can, however, also be formed in the respective insert frame 14b in place of the filtrate outlet 33 and the filtrate outlet channel 34. Equally, it is possible to associate the outlet plate 14c with the filtrate outlet 33 and the filtrate outlet channel 34 when the bottom wall 24c is structured in correspondence wih the intermediate wall 24b.

The press 13 is furthermore equipped with rinsing equipment for the removal of the filter cake or the alluviated layers 29. For this purpose a rinsing agent inlet 39 and a rinsing outlet 40 are provided in the cover 16, wherein the rinsing agent outlet can, as shown in Fig. 5, also be provided in the cover 15. The inlet 39 and outlet 40 are associated outside the press 13 with shut-off valves 41 and 42 and within the press with rinsing channels 44 formed in eyelets 43 of the frames 14a and 14b and the outlet plate 14c. In the circumferential wall 24d of each of the frames 14a and 14b, a rinsing bore 45 extends from each rinsing channel 44 into the bottom region of each space 25 at a spacing above the respective carrier element 30 which corresponds substantially to the maximum thickness of a layer 29 to be alluviated. In addition, the press 13 is provided with ventialtion means (Fig. 3) which comprises a vertical ventilating channel 46 extending through lateral eyelets 47 at the frames 14a and 14b and outlet plate 14c. The channel 46 is connected in each frame 14a and 14b through a ventilating bore 48 to the upper part of the distributor chamber 27 and leads to a ventilation outlet 49 in the upper cover 15 with ventilating valve 50.

Finally, an emptying outlet 51, which is connected to the rinsing agent channel 39 and to which also the filtrate removal channel 35 is connectible, with shut-off valve 52 is provided in the region of the lower movable cover 16 of the press 13.

As Fig. 1 shows, the filtering equipment 12 for removal of residual impurities from the preliminarily clarified beer is connected to a duct 53 leading from the preliminary clarifying equimpment 11 to the inlet shut-off valve 18 of the filter press 13. Arranged in the duct 53 is a static mixer 54 which — as explained below — becomes effective during the alluviation of the layer or layers 29 in the press 13.

The equipment 12 also includes an alluviating and regenerating container 60, in which a stirring mechanism 61 driven by a motor 62 is mounted. The container 60 has a bottom connection 63 with a shut-off valve 64, as well as an outlet arranged in the bottom region and also a second connection 66 with shut-off valve 67 arranged in the lower container part. Finally, as illustrated in Fig. 1, the container 60 can be provided at its upper part with an overflow device 68 with a retaining web or filter screen 69 holding back filter material. Spray cleaning means, in the from of a nozzle 70 chargeable with alluviating liquid, is disposed opposite the web 69 in the interior of the container for the removal of filter material adhering to the web.

The equipment 12 also includes a liquor container 71 with a motor driven stirring mechanism 72. The container 71 has a bottom connection 73 with shut-off valve 74. Finally, an acid container 75 with a motor-driven stirring mechanism 76 is provided in the equipment 12 and it, too, has a bottom connection 77 with a shut-off valve 78.

Provided for the operation of the rinsing equipment of the press 13 are two rinsing agent ducts 55 and 56, of which the duct 55 is led from the valve 78 of the container 75, the valve 74 of the container 71 and the valve 64 of the container 60 by way of the valve 41 to the rinsing agent connection 39 of the press 13. An additional shut-off valve 79 is arranged between the valves 64 and 41, while an emptying pump 80 and a further shut-off valve 81 are connected between the valve 64 and the valves 74 and 78, wherein the valves 79 and 81 and the emptying pump 80 can be bridged over by a bypass closable by a shut-off valve 82. A regenerating agent duct 57, in which a regenerating agent pump 84 is arranged, is also connected to the duct 55. The outlet of the pump 84 leads to the valve 67 of the second connection 66 at the bottom region of the container 60, and also to the spray nozzle 70 and by way of a shut-off valve 85 to the duct 53. The second rinsing agent duct 56 leads from the valve 42 of the press 13 by way of a shut-off valve 83 to the connecting region, between the valve 79 and the pump 80, of the valve 64 of the first duct 55 and by way of a further shut-off valve 86 to that part of the duct 55 at which the valves 74 and 78 are connected. A shut-off valve 87 leading to a liquid outlet is also provided at the rinsing agent duct 55. Provided as significant part finally in the filtering equipment 12 is an alluviating duct 58, which leads from the bottom connection 65 of the container 60 by way of the pump 88 and a shut-off valve 89 to the duct 53 and in such a manner that the static mixer 54 lies between the connection of the duct 58 and the inlet valve 18 of the press 13 in the duct 53.

A main conveying pump 90, which drives the entire liquid flow through the preliminary clarifying equipment 11 as well as through the filtering equipment 12, is mounted in front of the inlet of the equipment 11.

The preliminary clarification equipment 11 can be of several kinds. For example, a layer filter can be provided with layers for preliminary clarification. Vat filters such as centrifugal cleaning filters, cartridge filters, plate-type filters and so forth can also be used. The equipment 11 can also have one or more centrifuges. Finally, a filter press, similar to or like the filter press 13, can be used and can provide alluvial filtration with a hortizontal layer arrangement, of a kieselgur alluviating filter 92 with a vertical layer arrangement can be provided. This latter possibility is indicated as example in Fig. 2. A main conveying duct 91 extends from the pump 90 to the inlet of the filter 92. A kieselgur metering device 93 of known kind with metering pumps 94 is connected to the duct 91. The duct 53 extends from the filter 92 to the equipment 12. In conventional manner, respective shut-off valves 95 and 96 are mounted at the inlet and the outlet of the filter 92.

The preliminary clarifying equipment 11 can naturally also be constructed in two or more stages.

A multistage method for removal of impurities from beer can be carried out by the above-described apparatus in the following manner:

For the preparaion of the apparatus, the layer 29 is or layers are initially built up in the filter 92 (assuming such is used for preliminary clarification) and in the filter press 13. In the filter press 13, the build-up of the layer or layers takes place in such a manner that a dispersion is formed in the container 60 from water or preliminarily clarified beer and metered quantity of filter material and conducted by way of the pump 88, the duct 53 and the static mixer 54 arranged therein (with closed valves 41, 42, 50, 52, 64, 67, 85, 96) into the feeding and distributing devices 18 to 28 of the press 13. The pump 88 is in that case so controlled that a flow quantity of at least 15 hectolitres per square metre per hour is maintained. If the filter material (which can be a mixture of substances) contains synthetic material fibres, then the flow rate is preferably to be held at a value between 50 and 100 hectolitres per square metre per hour, for preference 70 hectolitres per square metre per hour. The liquid flowing away during alluviating of the layer or layers is conducted away by way of the collecting and outlet devices 32, to 41, utilised also during the filtering operation for the filtrate, and can be collected at the filtrate outlet 37 of the filter press 13. This liquid can, if desired, be retained for re-use as rinsing agent or for renewed alluviation and at the conclusion of the alluviating process be returned to the container 60.

After the alluviating process has taken place, i.e. when the layer or layers 29 each have attained a substantially uniform thickness between 5 and 15 millimetres, preferably substantially 8 millimetres, the layers 29 are rinsed through in conventional manner with warm or cold water and subsequently sterilised in flow direction at about 85°C for 20 minutes. After sterilising of the layer or layers, the filtering process is undertaken, in which the liquid, for example beer, preliminarily clarified in the kieselgur alluviating filter 92, is pumped by means of the pump 90 continuously by way of the duct 53 and the inlet 19 into the press 13. During filtering, it is recommended to monitor the pressure drop across the alluviated layer 29 while maintaining constant flow. On rise of the pressure drop above a fixed limit value, the filtering operation is interrupted and a regeneration treatment is undertaken.

A regeneration treatment of the layer or layers in situ in the filter press 13 is recommended initially. For this purpose, 50% concentration, 3% soda lye is utilised, which is contained in the liquor containter 71 and which has been warmed up previously to 60°C by means of heating devices (not shown) in the container 71. This soda lye is introduced, with closed shut-off valves 67, 81, 86, 87, 78 and 89, by way of the opened valve 74 to the pump 84 and from this with opened valve 85 and closed valve 96 into the duct 53. Within the press 13, the lye is conducted by way of the feeding and distributing devices 18 to 28, which are provided for the preliminarily clarified liquid during the filtering operation, to the layer or layers 29 and, with appropriate setting of the pump 84, conducted at a flow speed of 16 hectolitres per square metre per hour for at least 10 minutes, preferably 30 to 45 minutes, through the layer or layers. The removal of the lye takes place by way of the collecting and outlet devices 32 to 41 provided for the filtrate during the filtration process, The lye is collected at the outlet 37 of the press 13 and conducted back in closed circuit to the container 71 by way of a duct (not shown). After this regenerating process has been completed, rinsing is undertaken with water, preferably warm water at about 60°C, which can, for example, be present as alluviating agent in the container 60. This rinsing operation is preferably undertaken by way of the pump 88 and the feeding and distributing devices 18 to 28 and the collecting and outlet devices 32 to 34 of the filter press 13, wherein the water is again conducted in closed circuit from the filtrate outlet 37 of the press 13 back to the container 60. Finally, neutralisation of the layer or layers 29 can be undertaken by, for preference, strongly diluted nitric acid (0.1% to 0.3% nitric acid) at about 10°C for 15 minutes. This nitric acid is conducted in closed circuit out of the container 75 by way of valve 78, the pump 84 and the valve 85 to the duct 53 and likewise by way of the feeding and distributing devices 18 to 28 and the collecting and removal devices 32 to 41 of the press 13. At the conclusion of this regenerating operation, a renewed sterilisation of the layer or layers and the entire press 13 is undertaken, as already explained. The regenerating process can be repeated several times at previously fixed time intervals or by the monitoring of the pressure drop discussed above. After several repetitions of this regenerating process of the layer or layers in situ or when a very rapid and strong pressure drop across the layer or layers is ascertained on monitoring the pressure drop during the filtering process, it is recommended to remove the layer or layers with entrained impurities, thus the filter cake consisting of the layer or layers, from the press 13. For this purpose, the filter cake is rinsed out of the press 13 by way of the ducts 55 and 56 and the rinsing devices 39 and 45 in the press and transferred into the container 60 together with the rinsing liquid, for example water. The rinsing of the filter cake out of the press 13 can also be undertaken by means of the 40% concentration, 0.3% soda lye stored in the container 71. Regeneration then takes place in the container 60

under intensive stirring and intermediate washing-out with cold or warm water as well as neutralisation with 0.1% to 0.3% nitric acid at about 10°C for about 15 minutes. The regeneration time can amount to 16 hours. After regeneration has taken place, the dispersion in the container 60 is metered and prepared for the alluviating process, optionally through replenishment with fresh filter material. The renewed alluviating process then takes place in like manner as explained above.

At the beginning of the each filtration or alluviation process, but also during emptying of the press 13, the ventilating valve 50 is opened for sufficiently long that the filtration or alluviating process takes place with completely filled respective dross space 28 or distributor chamber 27 and the press 13 is emptied completely during the emptying process.

As Fig. 7 shows, the container 60 can include a circulating pump device 83 in place of the motor-driven stirring mechanism 61 and the overflow device 68 with retaining web 69 and spray nozzle 70. This circulating pump device 83 includes a circulating duct 97, which extends from the bottom region of the container 60 to the upper part thereof and into which a pump 98 and — in flow direction above the pump 98 — an overflow vessel 99 are inserted. Leading from this to the outflow is an overflow duct 103 with interposed overflow valve 104. Provided within the overflow vessel 99 is a retaining web 69, which keeps free the opening at the vessel side of the overflow duct 103 and which is kept free of the dispersion, the dispersion having the form of a suspension flowing within the duct 97 and inducted by means of the pump 98 out of the lower part of the container 60. Thus, when the overflow valve 104 is open, excess regenerating agent can enter unhindered by way of the opening at the vessel side into the overflow duct 103 and, after the passing therethrough, get into the outflow.

The filter material can be kieselgur, perlite, cellulose and/or synthetic material fibres, as are usual in alluvial filtration and from which mixtures can be formed. The filter material should have such properties that the layer or layars 29 formed therefrom hold back the beverage-damaging substances, such as yeast, bacteria, fungi, spores and so forth with high filtration performance, and is or are regenerable.

The method exemplifying and apparatus embodying the invention as hereinbefore described may offer the advantages of providing a high specific areal performance of the alluviated layer or layers with full assurance of the filtration task, whereby the filtration stage for removal of residual impurities can be matched to the preliminary clarification stage. Due to this high specific areal performance, compact dimensions of the filter press constructed are possible, whereby the investment costs can be kept small. Moreover, due to the possibility of regeneration, an extended life of the filter material can result. The filtration costs themselves can be kept small. For example, filtration costs for removal of microbiological impurities can be only about 10% of those for known sterilising filtration processes. The regenerating of the alluviated layer as well as of the filter material outside the filter press can be carried out particularly simply and the process as a whole may be distinguished by relatively low consumption of water and energy. Removal of the consumed filter material from the apparatus is simple and automation is possible, with a low requirement for operating and maintenance personnel. The reduced consumption of filter material results in reduction of environmental pollution. The apparatus can embody a system which is safe against short-circuit and need contain relatively few movable parts, so that wear may be low. The apparatus is also amenable to maintenance, which in any case is small and simple to carry out. The filter press can be operated in simple manner, in particular on shift change, since the few elements automatically separate on opening of the filter press and accordingly can be taken out individually. In the case of horizontal arrangement of the layer or layerss, there is low sensitivity to pressure shocks during operation of the filtration process.

CLAIMS

1. A method of removing impurities from a liquid, the method comprising the steps of carrying out a preliminary clarification of the liquid, forming at least one regenerable alluvial filtration layer of predetermined thickness in a filter press by supplying filter material in flowable form to the press under damped turbulence and at a flow rate of at least 15 hectolitres per square metre per hour, and filtering the clarified liquid by passing it through the formed layer or layers in the press.

2. A method as claimed in claim 1, wherein the filter material comprises synthetic material fibres and is supplied to the press as an aqueous dispersion containing 10% of the filter material by mass and at a flow rate of 50 to 100 hectolitres per square metre per hour.

3. A method as claimed in claim 2, wherein the flow rate is substantially 70 hectolitres per square metre per hour.

4. A method as claimed in any one of the preceding claims, wherein said predetermined thickness is 5 to 10 millimetres.

5. A method as claimed in claim 4, wherein said predetermined thickness is substantially 8 millimetres.

6. A method as claimed in any one of the preceding claims, wherein the or each layer is disposed in a substantially horizontal plane.

7. A method as claimed in any one of the preceding claims, comprising the steps of monitoring pressure drop of the liquid across the layer or layers under a constant rate of flow of the liquid thereto and regenerating the layer or layers under a constant rate of flow of the liquid thereto and regenerating the layer or layers in the press on increase of the pressure drop above a given limit value.

8. A method as claimed in claim 7, wherein the step of regenerating comprises treating the layer or layers with soda lye and rinsing the treated layer or layers with water.

9. A method as claimed in claim 8, wherein the soda lye is 50% concentration, 0.3% soda lye and the treating is carried out for 30 to 40 minutes at a temperature of substantially 60°C.

10. A method as claimed in either claim 8 or claim 9, wherein the rinsing is carried out for substantially

15 minutes at a temperature of substantially 60°C.

11. A method as claimed in any one of claims 8 to 10, wherein the step of generating comprises finally treating the layer or layers with an acid wash.

12. A method as claimed in claim 11, wherein the acid wash comprises 0.1 to 0.3% nitric acid.

13. A method as claimed in any one of claims 1 to 6, comprising the step of monitoring a parameter of throughput of the liquid through the press, removing the layer or layers from the press if and when the parameter falls below a given limit and forming a new layer or new layers in the press by supplying alluvial filter material in flowable form to the press.

14. A method as claimed in claim 13, wherein the parameter is the pressure drop of the liquid across the layer under a constant rate of flow of the liquid thereto.

15. A method as claimed in claim 13, wherein the parameter is the period of time before a pressure drop of the liquid across the layer or layers occurs.

16. A method as claimed in any one of claims 13 to 15, comprising the step of regenerating the filtering material of the removed layer or layers and returning the regenerated filter material to the press for formation of the new layer or layers.

17. A method as claimed in claim 16, wherein the regenerated filter material is supplied to the press together with fresh filter material.

18. A method as claimed in either claim 16 or 17, wherein the step of regenerating comprises dispersing the filter material of the removed layer or layers in soda lye under stirring, washing the stirred dispersion with water to remove the lye and neutralising the residual filter material with an acid wash.

19. A method as claimed in claim 1, wherein the steps of dispersing and washing are repeated at least once before the step of neutralising is carried out.

20. A method as claimed in either claim 18 or claim 19, wherein the soda lye is 50% concentration, 0.3% soda lye.

21. A method as claimed in any one of claims 18 to 20, wherein the acid wash comprises 0.1 to 0.3% nitric acid and the step of neutralising is carried out for substantially 15 minutes at a temperature of substantially 10°C.

22. A method as claimed in any one of the preceding claims, wherein the step of preliminary clarification comprises passing the liquid through at least one layer of alluvial filter material in a closed system in which filtering material is constantly added to the liquid.

23. A method as claimed in any one of claims 1 to 21, wherein the step of preliminary clarification comprises centrifuging the liquid.

24. A method as claimed in any one of claims 1 to 21, wherein the step of preliminary clarification comprises passing the liquid through at least one prefrabricated filter layer or filter cartridge.

25. A method as claimed in any one of the preceding claims, wherein the liquid is a beverage.

26. A method as claimed in claim 1 and substantially as hereinbefore described with reference to the accompanying drawings.

27. Apparatus for carrying out the method claimed in claim 1, comprising clarifying equipment for preliminary clarification of such liquid, filtering equipment for filtering the clarified liquid, the filtering equipment comprising a filter press with support means for at least one regenerable alluvial filtration layer and with duct means for conducting filter material to form the or each such layer, for conducting clarified liquid to and filtered liquid from the or each such layer and for conducting rinsing agent to rinse the filter material, and supply equipment for supplying a metered quantity of such filter material to the filter press.

28. Apparatus as claimed in claim 27, the filtering means comprising duct means for removal of the such filter material from the filter press.

29. Apparatus as claimed in either claim 27 or claim 28, comprising regenerating equipment for effecting regeneration of such filter material intrernally or externally of the filter press.

30. Apparatus as claimed in any one of claims 27 to 29, wherein the press comprises at least one frame which is arranged in the press horizontally between two relatively moveable clamping members and which comprises a distributor chamber communicating with liquid inlet means and a filtration chamber disposed below the distributor chamber and liquid inlet means laterally communicating with rinsing agent inlet means, a respective liquid-permeable carrier element being provided to carry a layer of filter material for filtration of liquid in the or each filtration chamber and respective outlet means being disposed below the carrier element to conduct away liquid filtered by the layer.

31. Apparatus as claimed in claim 30, wherein the or each frame comprises a separating plate separating the distributor chamber from the filtration chamber, the chambers being disposed in communication with each other by way of passage means at the circumference of the plate and the distributor chamber communicating with the liquid inlet means centrally of its uppermost side.

32. Apparatus as claimed in either claim 30 or claim 31, wherein the or each carrier element is supported by a liquid-permeable support element at the base of the associated filtration chamber.

33. Apparatus as claimed in claim 32, wherein the support element is a perforated plate.

34. Apparatus as claimed in any one of claims 30 to 33, wherein the or each carrier element comprises a prefabricated plate-shaped filter body which additionally provides a seal at the lowermost circumferential edge of the associated filtration chamber.

35. Apparatus as claimed in any one of claims 30 to 34, comprising a porous underlay arranged under the or each carrier element, the associated outlet means being disposed under the carrier element.

36. Apparatus as claimed in any one of claims 30 to 35, the rinsing agent inlet means of the or each frame comprising two substantially vertical passages disposed in an edge region of the frame and a respective bore communicating with each of said passages and with the filtration chamber at a location above a given maximum depth of a layer or filter material carried by the associated carrier element.

37. Apparatus as claimed in any one of claims 30 to 36, wherein the press comprises a single such frame and further comprises an outlet plate which is

arranged below the frame and includes an upwardly extending circumferential wall provided with the outlet means, the carrier element being sealingly clamped between the lower end face of the frame and the upper end face of said circumferential wall.

38. Apparatus as claimed in any one of claims 30 to 36, wherein the press comprises a stack of such frames and further comprises an outlet plate which is arranged below the lowermost one of the frames and which has an upwardly extending circumferential wall provided with the outlet means for the filtration chamber of said lowermost one of the frames, a respective such carrier element being sealingly clamped between the lower end face of said lowermost one of the frames and the upper end face of said circumferential wall and also between adjacent upper and lower end faces of the or each two adjacent frames in the stack.

39. Apparatus as claimed in any one of claims 30 to 38, wherein the clamping members comprise an upper clamping member disposed in a fixed position and a lower clamping member connected to displacing means and vertically displaceable relative to the upper clamping member by the displacing means, the duct means being provided in part by ducts in at least the upper one of the clamping members.

40. Apparatus as claimed in claim 29 or any one of claims 30 to 39 when appended to claim 29, wherein the supply equipment and regenerating equipment are integrated one with the other and comprise a filter material mixing and regenerating container, a liquor container, an acid container, pumping means for pumping out the contents of the containers, and valve means operable to produce predetermined connections of the containers with each other and with the filter press, metering means being provided for metering pumped flow to the press.

41. Apparatus as claimed in claim 40, wherein the mixing and regenerating container is provided with an overflow opening covered by a filter screen resisting outflow of filter material and with spray cleaning means for cleaning filter material from the screen.

42. Apparatus as claimed in either claim 40 or claim 41, wherein the mixing and regenerating container is constructed as a metering vessel for metered supply of filter material and carrier liquid, the metering means being provided by the metering vessel.

43. Apparatus as claimed in either claim 40 or claim 41, wherein the pumping means and the valve means comprising a pump for pumping filtering material out of the mixing and regenerating container and an associated valve for connecting the pump outlet to feed means for feeding clarified liquid from the clarifying equipment to the filtering equipment, the metering means being provided by the pump and associated valve.

44. Apparatus as claimed in any one of claims 27 to 43, comprising mixing means arranged in feed means to the filtering equipment to mix filter material from the supply equipment with clarified liquid from the calrifying means.

45. Apparatus as claimed in any one of claims 27 to 44, wherein said duct means for conducting clarified liquid to the or each layer in the filter press is connected to outlet means of the clarifying equipment and the apparatus comprises a main conveying pump arranged upstream of the clarifying equipment and operable to pump liquid through the clarifying equipment to said duct means.

46. Apparatus as claimed in any one of claims 27 to 45, wherein the clarifying equipment comprises a respective filter press provided with at least one substantially horizontal filter frame or plate.

47. Apparatus for carrying out the method claimed in claim 1 and substantially as hereinbefore described with reference to Figs. 1 to 6 of the accompanying drawings.

48. Apparatus as claimed in claim 46 and modified substantially as hereinbefore described with reference to Fig. 7 of the accompanying drawings.

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