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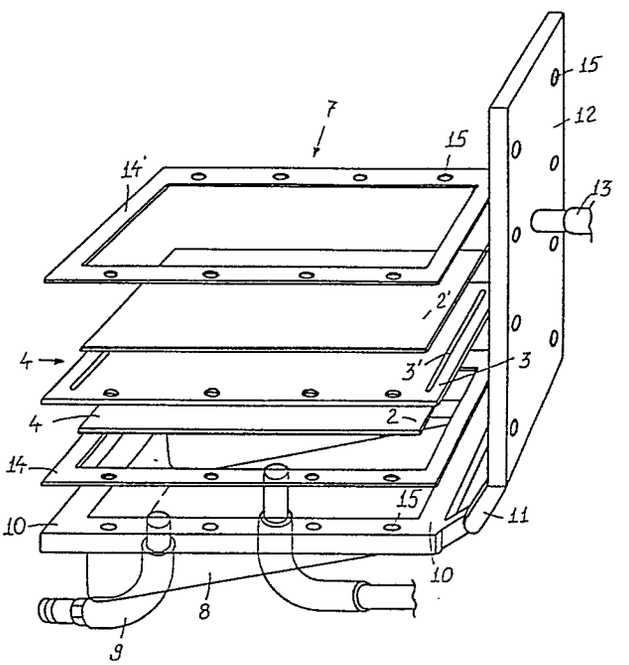
(54) Apparatus for the continuous purification of electrolytes.

(57) Purification apparatus for the continuous electrolytic purification of solutions utilised in electro-deposition treatments and the like includes one or a plurality of cells comprising a bowl (8) containing substantially flat closely spaced anodes (2,2') and at least one cathode (3) having means (3') for determining the inter-electrode separation housed sealingly within a chamber defined by the bowl (8) and a cover (12) and forming a sinuous path for fluid supplied through the cover (12) to pass between the electrodes. The provision of flat closely spaced large-area electrodes allows the current density and electrolytic action to be closely controlled and maximises the available contact area of electrode for the deposition of, for example, unwanted metal ions.



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"Apparatus for the continuous purification of electrolytes"

The present invention relates to apparatus for the continuous electrolytic purification of electrolytes, namely solutions utilised in electro-deposition processes and the like.

Unwanted metallic pollution inevitably occurs in solutions utilised for electro-deposition of metals (galvanic baths) and in solutions forming part of associated treatment cycles, which may for example be baths for degreasing, pickling, activation, passivation and the like. These solutions, in fact, have a tendency over a period of time to become contaminated with extraneous and unwanted metal ions from the workpieces under treatment or at other stages in the treatment cycle, from the superstructure of the installation and also from the accidental introduction of incorrect or impure chemical components.

The contamination of solutions by such unwanted ions is generally detrimental and removal is required, which is generally effected by chemical or electrolytic methods. Among the electrolytic methods currently being used, a distinction is made between those which effect purification directly in the vessel containing the contaminated solution, thereby interrupting production, and those which are performed outside the vessel itself, therefore permitting work to continue even whilst purification is being performed and which, consequently, are referred to as "continuous purification" methods.

Conventional apparatus used to effect continuous purification is comprised of a number of electrolytic cells of a particular form through which the solution to be purified is caused to flow by means of a pump. In such apparatus the purification takes place by electro-deposition at very low current density (normally from 0.1 to 0.5A per square decimetre). The extraneous metals present as contaminants are caused to deposit on the cathode at the lower limit of the range of current density normally employed for electro-deposition, the precise value depending on their position in the electrochemical series of elements and their concentration.

One known type of purification apparatus currently in use is essentially constituted by a cylindrical chamber or cell at the centre of which is positioned an insoluble cylindrical positive electrode (anode). At a certain distance from and concentric with the anode is a negative electrode (cathode). A current rectifier, which may or may not be connected with the said chamber provides the d.c. current necessary for electrolysing the solution to be purified, which latter is caused to flow continuously through the chamber by a pump which withdraws it from and returns it to the working vessel.

In this conventional type of apparatus the solution to be purified is free, within the cell, to move in all directions in a non-ordered manner, allowing preferential flow paths to develop which, in general, do not pass uniformly over all regions of the surface of the electrodes. Moreover, in this known apparatus the inter-electrode distances are rather large and, in any case, greater than 20 millimetres, whilst the surface areas of the two electrodes are different from one another and, largely, in the ratio of 2 to 1 (cathod to anode). Consequently, the purification of the solutions is not performed as well as it could be in that a large part of the solution can flow through the cell at a distance

from the electrodes too great to allow a satisfacvtory electroysis in the dwell time available.

Moreover, the different dimensions of the electrodes themselves does not permit a uniform distribution of the current in the solution and, therefore, does not allow a sufficient selectivity of the purification operation.

The object of the present invention is that of eliminating the disadvantages outlined above, by providing apparatus for the electrolytic purification of solutions utilised in electro--deposition treatments and the like, which forces the solution to flow through narrow passages in such a way as to subject it uniformly to the purification treatment.

According to the present invention, there is provided apparatus for the continuous electrolytic purification of solutions utilised in electro-deposition treatments and the like, characterised in that it includes positive and negative electrodes (2,2',3) having substantially the same surface area and positioned parallel to and facing one another in such a way as to define narrow passages through which the solution to be purified is forced to pass.

A particular advantage of the apparatus of the present invention is that it can perform electrolytic purification with a uniform distribution of current within the solution to be treated so as to ensure that all parts of the solution experience substantially the same conditions.

Another advantage of the present invention is that it provides electrolytic purification apparatus which is structually simple and of great reliability.

One embodiment of the present invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a side view of the embodiment; and

Figure 2 is an exploded view of a single electrode structure used in the embodiment of Figure 1.

With reference to the drawings, the elecrolytic purification apparatus forming the subject of the invention is constituted essentially by a chamber 1 resistant to acids, in which are housed assemblies of positive electrodes 2 and negative electrodes 3.

More precisely, these negative and positive electrode assemblies have an identical surface area and are counterposed and parallel to one another in such a way as to create narrow interspaces 4, at a distance from one another of between 1 and 20 millimetres, preferably between 1 and 5 millimetres, through which the solution to be purified is forced to pass by the action of a pump 5. The apparatus may be provided with its own pump or may be connected by a bypass to another pump such as the same pump already provided in the treatment apparatus for filtering the solution. The apparatus illustrated is provided with its own current rectifier 6, although it will be appreciated that this is not critical and other embodiments may draw d.c. current from another source.

In the embodiment illustrated, as shown in Figure 2, each individual purification cell, generally indicated with the reference numeral 7, is constituted by a lower bowl 8 of rectangular plan form, having an inclined floor and communicating with the outside through an elbow bend connector 9. On one of the shorter sides of this bowl, which is provided with appropriately projecting edges 10, there is coupled, by means of a double hinge

11 a cover 12 of the same outline to which is joined a duct 13 for delivering solution to be purified, which is supplied by the said pump 5. Between the edges of this bowl 8 and the cover are arranged, in series from the bottom upwardly, a first gasket 14, a first anode 2, a cathode 3 provided with transverse projections 3', interchangeable in dependence on the distance which it is desired to create between the cathode and the anodes, a second anode 2', and a second gasket 14'. The edges of these superimposed elements, are provided with corresponding through holes 15 in which are inserted a corresponding number of bolts 16 operable to join them all together; however opposite edges of the anode 2, the cathode 3 and the annode 2' are spaced from the edges of the cell to define a sinuous path through the cell.

The anodes 2,2' are preferably of insoluble type (graphite, platinised titanium, etc), although the use, in particular applications, of soluble anodes can be arranged if desired. The cathodes 3, on the other hand, are constituted by simple sheet metal pieces of steel or, of other suitable material; these are regenerable or replaceable by way of interchangeable cartridges, after a certain number of hours in service or when a certain quantity of "contaminated" deposit has accumulated thereon.

In practice, the structure, thus obtained, has close electrodes of large area between which the solution to be purified passes substantially in laminar layers, and this permits electrolysis to take place at a predeterminable and almost constant current density over all points of the surface of the cathode. Consequently, the electrolytic purification apparatus forming the subject of the invention is capable of a greater selectivity in that it makes it possible to choose the most convenient working conditions and, therefore, to establish the flow rate and accuracy of performance as a function of the type of contamination present in the solution

and to be eliminated, thereby avoiding the contemporaneous and unwanted deposition of the useful metal, that is to say of the metal of which the solution is rich by its proper formulation.

Moreover, given that the whole of the solution which is pumped into the chamber 1 is constrained to flow through the narrow spaces between the anodes 2,2'and the cathodes 3, and given that the possibility is provided of bringing the electrodes closer at will thereby obtaining a very thin laminar flow, than for a given volume of solution flowing in a given unit of time the ratio between the amount of solution present in an inter-electrode space and the layer thereof which is located facing the cathode is the lowest possible. Consequently, at any instant the quantity of depositable extraneous metallic ions as a ratio to the quantity of solution under electrolysis is the greatest possible.

The closeness of the electrodes ensures that, for the same rate of flow there is a very rapid exchange of solution in the inter-electrode spaces and a high speed of flow over the cathode. This increases the yield of deposit and, in the presence of low concentrations of contaminating ions, permits these to be subtracted with the minimum possible removal of useful metal. Moreover, the energy cost to effect the desired purification treatment is reduced to the minimum. In substance, the electrolytic purification apparatus forming the subject can be utilised both for prophylactic purification (to remove the small and continuous contaminations gradually as they form) and for exceptional interventions, for example in a case in which a massive and unexpected contamination of the bath should occur. The apparatus can also function as a discontinuous purifier and is able to ensure the maximum purification with the smallest possible number of "passes".

Obviously, this apparatus, thanks to its high selectivity, is advantageously usable also for removing metallic contaminations from solutions for degreasing, pickling, activation, passivation etc used in the galvanic industry. The same apparatus, whenutilised for baths which deposit alloys composed of two or more metals, permits two objectives to be achieved: first, removing a contamination caused by extraneous metal ions from those of the alloy, without compromising the concentration and the ratio of those provided for the deposition of the alloy itself; and second, re-establishing the ratio between the different ions provided for the deposition of the alloy by selectively depositing, those which are in excess. This is obtained thanks to the possibility of operating with a predetermined and very narrow range of current density, which permits the deposition predominantly of one species of metallic ions present in solution to be effected.

The present apparatus further allows the recovery of metals, particularly precious metals from exhausted solutions or from washing water; in such cases it functions, in practice, as an effluent purifier.

Claims:

1. Apparatus for the continuous electrolytic purification of solutions utilised in electro-deposition treatments and the like, characterised in that it includes positive and negative electrodes (2,2',3) having substantially the same surface area and positioned parallel to and facing one another in such a way as to define narrow passages through which the solution to be purified is forced to pass.

2. Purification apparatus according to Claim 1, characterised in that it includes a chamber (1) resistant to acids, in which the said positive and negative electrodes (2,2'3) are housed and in that the anodes (2,2') are of insoluble type such as graphite or platinised titanium, and the cathodes (3) are constituted by elements of steel sheet or other appropriate materials and are regenerable or interchangeable.

3. Purification apparatus according to Claim 1 or Claim 2, characterised in that it comprises one or more purification cells (7) constitutyed by a lower bowl (8) of rectangular plan form having an inclined floor and communicating with the outside through an elbow connector (9) the bowl (8) having flanged edges one of which (10) is coupled, by means of a double hinge (11) to a coer (12) having the same outline as the bowl (8), and to which cover (12) is connected a duct (13) for delivering the solution to be purified.

4. Purification apparatus according to any of Claims 1 to 3, characterised in that between the edges of the said bowl (8) and the cover (12) there are arranged, in series, from the bottom upwardly, a first seal (14) a first anode (2), a cathode (3) provided with transverse projections (3') interchangeable in

dependence on the distance which it is desired to set between the cathode(3) and the anodes (2,2'), a second anode (2') and a second seal (14') at least one of the edges of each of the superimposed electrodes being offset to allow fluid flow from one side to the other thereof.

5. Purification apparatus according to any preceding Claim, characterised in that the apparatus is provided with its own pump (5) and/or its own current rectifier (6).

6. Purification apparatus according to any preceding Claims, characterised in that it includes means for adjusting the current density whereby to obtain a uniform distribution thereof over the whole surface of the cathodes, and in that, there are means for controlling the rate of flow of the solution to be purified through the inter-electrode spaces.

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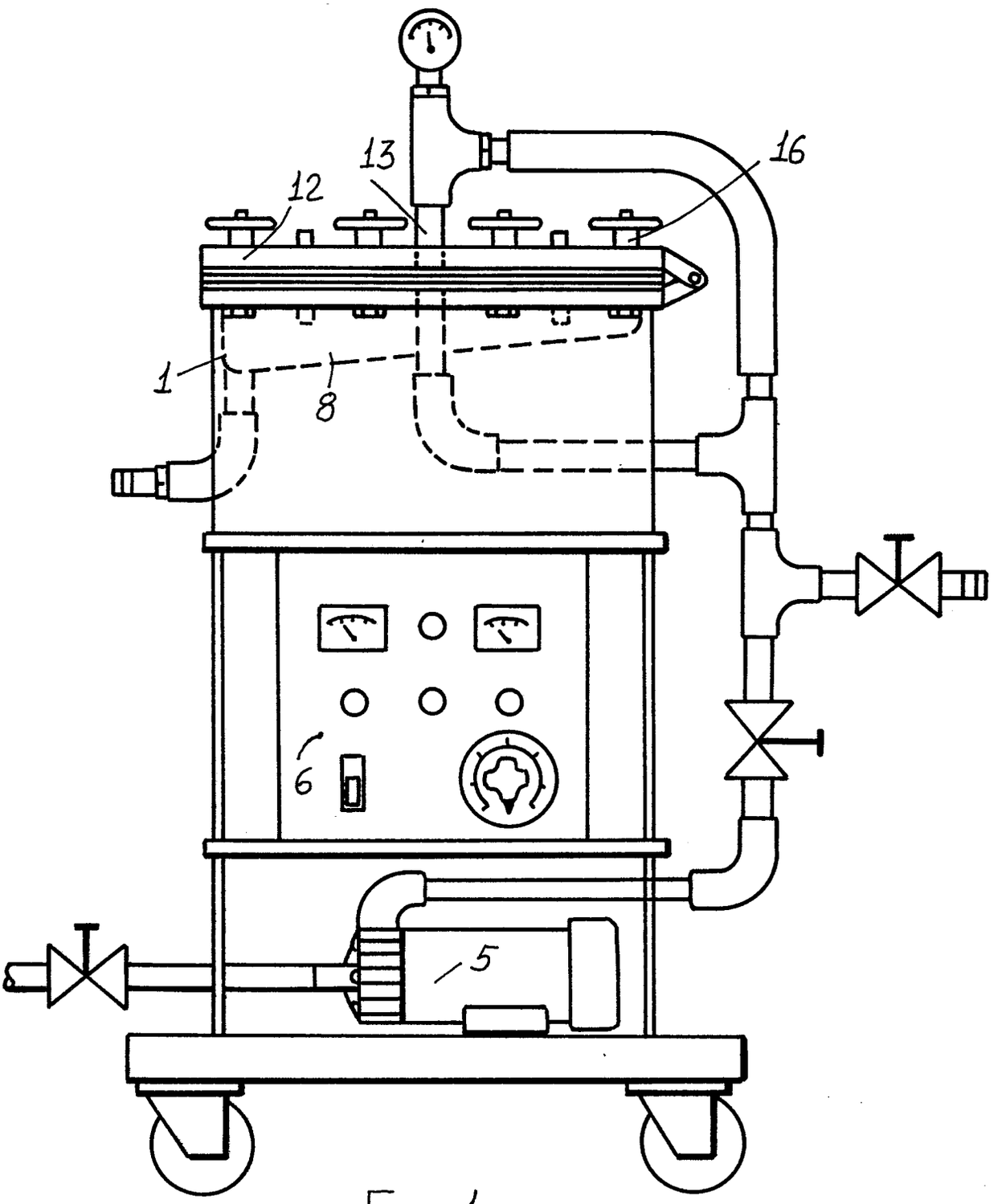

FIG. 1

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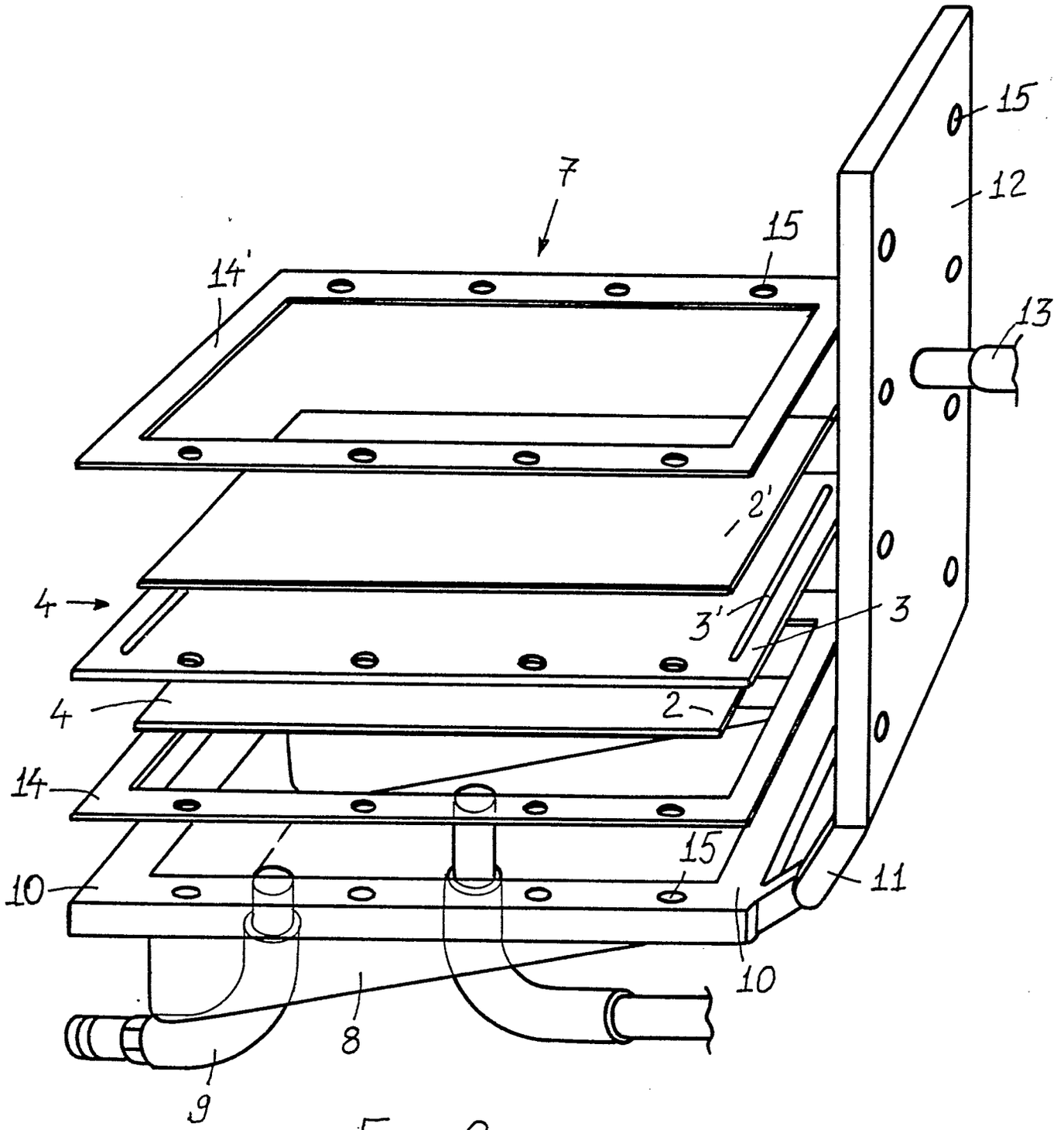

FIG. 2

European Patent Office

EUROPEAN SEARCH REPORT

0242337
Application number

EP 87 83 0101

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	GB-A-1 066 213 (SIMON-CARVES) * Page 1, lines 28-41,72; page 2, lines 12-22 *	1,2,5, 6	C 25 D 21/18
A	US-A-3 926 754 (LEE)		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

C 25 D
C 25 F
C 02 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27-05-1987	NGUYEN THE NGHIEP

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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