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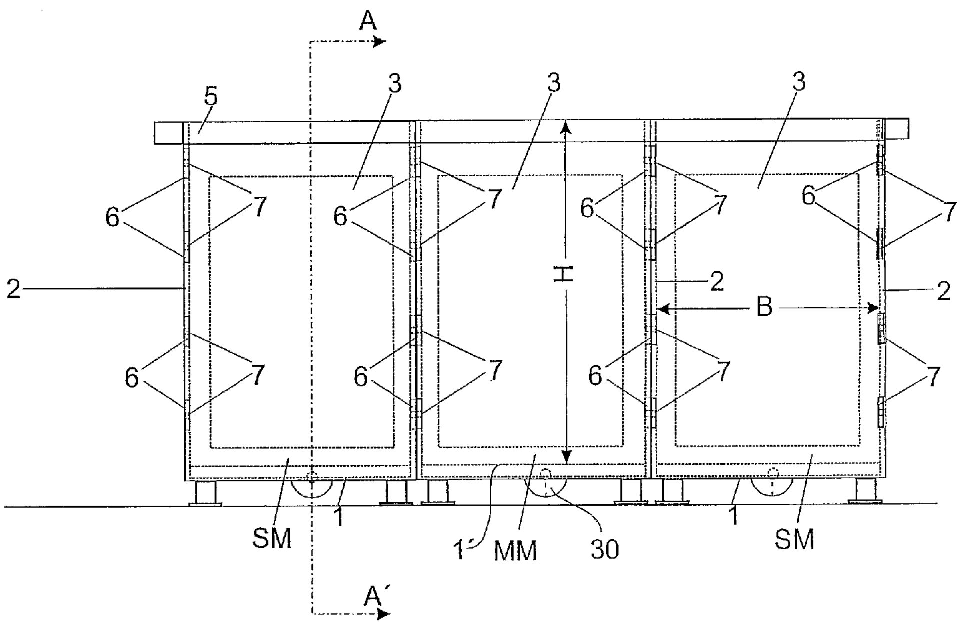
(54) **Title:** TANK FOR A VERTICAL PROCESSING LINE AND METHOD OF MANUFACTURING SAME



(57) **Abstract:** In order to allow for uniform and reproducible processing of printed circuit boards, more specifically of boards having microvias and blind microvias of less than 0.1 mm in diameter, in lines that are advantageous in terms of acquisition cost, a vertical processing line for processing work pieces (3) is proposed, said line being comprised of tanks with an interior space defined by tank walls (2, 10) and by a tank bottom (1, 1'). The tanks are formed from at least two tank modules. The walls and the bottom define respective module interior spaces which have the same heights (H) and which have the same widths (B).

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Tank for a Vertical Processing Line and Method of Manufacturing Same

Specification:

The invention relates to a tank for a wet-processing line and method of manufacturing same, more specifically for processing printed circuit boards and printed circuit foils.

Large scale production of flat work pieces, more specifically of printed circuit boards of the latest generation having microvias and blind microvias of less than 0.1 mm in diameter, places on processing lines such as electroplating lines with low acquisition cost highest requirements with regard to constant quality of the products manufactured therewith. The lines have to be flexibly adjustable to meet most varied requirements without the trade-off of production downtime and changeover costs during the time needed to reset the line to a new process sequence or processing conditions.

In order to make it possible to largely exclude flaws during board production in the lines, the quality of the boards should be, as far as practicable, controlled in-line so as to allow for automatic correction of the production conditions in case of variations. Considerable efforts have been made to achieve this.

In conventional vertical lines the boards are usually fastened to racks or flight bars and immersed into the processing tanks in a vertical orientation. The lines consist of successive tanks filled with baths for the various wet-chemical or electrolytic processing steps. Above the tanks, at least one conveyor carriage travelling on rails conveys the racks or flight bars carrying the boards, in accordance with the processing sequence, to the respective baths into which it immerses the racks or flight bars carrying the boards. Once processing in one processing bath is complete, the conveyor carriage lifts the racks or flight bars with the boards out of the bath and routes them to another processing bath. During the time the boards remain in the bath, a specific monitoring program is run by means of which the readings of sensors mounted in the bath are read out and existing apparatus such as heating, pumping, filtration, dosing and other add-on units are controlled. In order to optimize the capacity of the lines, bath tanks are generally used into which very large racks or flight bars having a lot of boards fastened thereon are immersed. Since a plurality of boards is processed at the same time, the processing conditions of the individual boards vary so that the quality of the individual boards also differs.

The advantage of the vertical processing lines is however that a plurality of different programs and program jumps associated to certain features of the printed circuit boards can be readily realized. These lines are complicated and expensive though. It is further difficult to obtain the same processing results with each printed circuit board.

A horizontal printed circuit board electroplating line through which the printed circuit boards and the printed circuit foils are conveyed and processed in a horizontal orientation on a horizontal conveying path, by contrast, permits to produce said boards and foils on a large scale with constant quality. In this case, each board individually enters the line and is conveyed on reels (wheels, rollers) at a constant rate of feed.

Such type lines however are inflexible. In operation, they raise very strong limitations when one wants to change over to another type of printed circuit board or to correct the quality. If for example one wants to change the line over from one type of printed circuit board to another, the entire line generally has to be emptied in order to be capable of processing the next printed circuit boards with other processing parameters. The processing time can only be changed by changing the transport speed and/or by changing the various processing stations of the line over to other parameter values. If the transport speed is changed for example in order to adjust the conditions, all the processing times change in the line instead of only that of the processing station of concern. Generally, this is not permissible, though. In most cases, the processing times can therefore not be sufficiently adjusted to the changed conditions so that alternative solutions have to be chosen, such as to increase the temperature in specific baths. Such type alternative solutions however generally present notable disadvantages in terms of product quality. As compared to the throughput of the line, the engineering and production cost of horizontal lines is quite low, though.

A plurality of improvements has been proposed to overcome the afore mentioned drawbacks, with said improvements however having only achieved little progress without eliminating the drawbacks.

It is therefore the object of the present invention to avoid the disadvantages mentioned and to more specifically find means permitting a uniform, reproducible treatment of printed circuit boards, more specifically with microvias and blind microvias of less than 0.1 mm in diameter, that also are advantageous in terms of acquisition cost.

The solution to this problem is achieved by the tank as set forth in claim 1 and by the method of manufacturing the tank as set forth in claim 26. Advantageous embodiments of the invention are recited in the subordinate claims.

The tank of the invention is provided for a vertical processing line for processing work pieces, more specifically printed circuit boards. As explained herein after the invention relates, substitutional for any work pieces, to boards, more specifically to electric circuit boards. It is understood that any work pieces rather than boards can be processed in the tank, more specifically formed parts such as three-dimensional injection-moulded parts. The term electric circuit boards is to be construed herein as circuit carriers consisting of a board-shaped laminate that may be built from multiple dielectric and metallic layers and may have vias (through holes, buried vias and blind vias). This term also includes, but is not limited to, board-shaped items serving to electrically connect electrical components that are fastened and electrically contacted on said circuit carriers. These also may be three-dimensional items having circuit trace structures thereon. The term electric circuit board is further to be construed as other circuit carriers such as chip carriers including hybrid systems.

The tank comprises a tank interior space defined by tank walls and a tank bottom. According to the invention, the tank is formed from at least two standardized tank modules. The walls and the bottom of the tank each define module interior spaces which all have the same heights and which all also have the same widths. Inasmuch as same heights and same widths are mentioned herein, standard differences of ±10 % are permitted. The width of the tank refers to the dimension measured along the inner edge of the tank that extends substantially parallel to a side edge of an immersed board. The tank is formed by at least two assembled standardized tank modules.

Since the dimensions provided for the module interior spaces are always the same (same heights on the one hand and same widths on the other hand), the tank, which is made from the modules, also has fixed inner dimensions.

The tank is formed from a row of preferably at least three, for example five tank modules. The modules may be center modules or end modules. In this case, the tank can be formed from a row of modules with one end module at either end of the row and at least one center module between the end modules. Preferably, the end modules are comprised of three side walls so as to be open toward the adjacent module and the center modules are comprised of two opposing side walls that form, together with the bottom, a U-shape. By assembling the modules to form a tank, a plurality of compartments are formed within the tank.

These embodiments permit to assemble the tank from standardized tank modules. In this way, tanks of various sizes can be made from always the same modules: small tanks consisting of two modules that are connected so as to display mirror-image symmetry or larger tanks consisting of at least three modules may be made. In the latter case, the tanks may be made very long by multiplying as required the center modules so that a plurality of boards may be contained side by side in such a tank.

Particular advantages achieved with the standardized tank modules of the invention are obtained if the boards are not processed being suspended from racks but being individually grasped by means of a gripper system and accordingly only electrolytically contacted in the processing bath in the case of electrolytic methods.

By assembling a plurality of laterally open tank modules, the tank formed has no intermediate walls. This may be advantageous if the processing medium in the tank interior space is to circulate as freely as possible in order to prevent different compositions of the processing medium from forming in the tank compartments as a result of differing substance turnover in the various compartments for certain reasons. This embodiment having U-shaped tank modules is preferably used if a common make-up of the electrolyte is provided for. The two existing side walls and the bottom of the module can be laterally bounded by a flange. Said flanges serve to join the individual tank modules together and to enhance the solidity without major material expense. The flange connection may for example consist of a screw connection or of a welding bond. In the case of a screw connection, seals may be interposed between two flange boards of adjacent modules, said seals preventing the electrolyte from leaking through the joints. At either side of such a module tank, side walls may be flanged or welded in the same manner for sealing the tank at the end faces. By flanging a plurality of such modules together, a tank having a plurality of compartments arranged in a side by side relationship may be built, with each compartment receiving preferably one board. The modules may also be joined together by gluing if the adhesive exhibits sufficient chemical stability and durability.

Alternatively, intermediate walls for spatially separating the individual processing compartments may additionally be provided between the modules. The partition walls in the entire line are preferably identically designed as well and also have the same dimensions. It may be advantageous to insert intermediate walls if the flow of processing medium is to be directed selectively in a certain direction and if mutual influence between the compartments / boards is to be prevented from occurring. It may also be necessary to separate the individual compartments if the electrical field lines of two adjacent compartments are to be prevented from influencing each other. The compartments must also be separated if, for a specific workpiece, the chemical composition is selectively changed in certain compartments.

The same configuration of the individual tank modules also ideally permits to readily manufacture the tanks at a low cost. For this purpose, a standard mould for forming the standardized tank modules may be provided in particular. In this case, the modules are made by deep-drawing, sintering, injection-moulding or blow-moulding plastic material into the standard mould and by subsequently removing from the standard mould the module produced. As all of the tanks have the same shape and dimensions, the cost for each tank involved by injection-moulding moulds, deep-drawing moulds and the like is very low.

The tank is then assembled from at least two standardized tank modules, at need also from three tank modules so that the walls and the bottom of the tank define, in accordance with the invention, respective module interior spaces or compartments which have the same heights and which also have the same widths.

The invention permits for the first time to concurrently realize the advantages of the vertical processing lines and those of the horizontal printed circuit board lines:

A vertical processing line can be assembled from the tanks of the invention. This permits to flexibly adapt to various requirements when processing the boards with the boards being immersed one after the other into the various tanks. Different processing conditions can be set in individual processing tanks / compartments independent of the conditions in other tanks / compartments of a processing sequence. Further, the advantages of low investment costs of the horizontal lines can be ideally realized with the modular concept of the present invention. This applies in particular if the containers have, as far as practicable, a space-saving configuration so that a plurality of tanks may be placed on a small floor space.

The standardized manufacturing technique having but a few standardized components for constructing the tanks permits to efficiently save costs in much the same way as with the horizontal processing lines. Besides the technical advantages of the modular tanks, the engineering and production cost is considerably lower than in conventional vertical processing lines. Since all the tank cells have the same size, development and construction of the tanks involve much lower costs. It further makes production methods for the individual modules possible that are impossible in the current state of the art for economical reasons. These methods include all the methods that require a certain blow moulding mould, casting mould or injection-moulding mould or special tools for economically manufacturing the modules. Accordingly, the overall production costs are similarly low as compared to the horizontal lines.

By keeping certain internal dimensions of the tank modules and, as a result thereof, of the tanks, processing compartments for holding one board each during processing are formed. The width and height of the modules may for example be approximately the size of one single board so that each module corresponds to a processing compartment prior to assembly. Two processing compartments may for example be formed by joining together two tank modules. It is understood that, in an alternative, the modules may also receive side by side a plurality of such type processing compartments, for example two, three or four, so that, upon assembling the corresponding modules, one obtains a tank comprising a corresponding number of processing compartments.

The internal dimensions of the tank modules are preferably orientated to a standard board size. The height and width of the module interior spaces are chosen to allow boards of a certain size to be accommodated in such type tanks while keeping them at required safety distances. The width and the height of the module interior spaces should be slightly larger than the edge lengths of the boards. The slightly larger internal dimensions of the module interior spaces over the dimensions of the boards permit to keep the boards at a small distance from the tank walls and the bottom as well as from each other when arranged side by side during processing. This distance should be minimal so that the tank occupies as little space as possible and so that the volume of the processing medium in the tank can be the smallest possible. A minimum distance between side by side boards is to be kept, though. The minimum distance is dictated by the fact that the boards are to be prevented from contacting each other during processing or that metal deposition on adjacent boards is to be prevented from influencing each other. It is thereby to be taken into consideration that the boards cannot be placed with accuracy when they are supplied automatically. The boards have further to be prevented from touching the walls of the tank when they are immersed into the tank, processed and lifted out of the tank. Additional add-on units such as current supply devices and moving devices as well as guides for the work pieces, nozzles, more specifically jet nozzles, spray nozzles and flow nozzles, air supply devices, pumps, heating elements, cooling elements, filters, sensors, dosing devices and chemical processing devices that may be disposed in a space located in the tank beneath or on the side of the boards may contribute to determine the height of the modules.

It is understood that the lateral depth of the tank or of the modules may also be minimized in order to minimize the space occupied by the tank and by the volume of the processing fluid within the tank. The lateral depth is a tank internal dimension along one edge of the tank that extends substantially at right angles to the tank edges determining the width and the depth of the tank. A minimum lateral depth is dictated by the direct processing area of the boards. Said processing area is possibly determined by the back/forth movement of the boards during processing, by the spatial extension of possible holding elements for holding the boards as well as by a minimum distance between the board and the side walls of the tank or for example laterally disposed anodes. Additional built-in devices that may be mounted in spaces adjacent the area for processing the boards may however also contribute to determine the lateral depth and height of the tank.

Under the afore mentioned conditions, the boards can be processed under precisely defined conditions. As contrasted to processing performed in conventional vertical processing lines, this results in a substantially improved processing reproducibility so that processing is more uniform as compared to processing using conventional lines. Major progress is thus achieved in processing printed circuit boards since extremely high requirements are placed on processing uniformity in particular in the manufacturing of boards having finest lines and vias.

It has for example been found out that undefined flow conditions in an immersion bath result in unpredictable properties of deposited metal layers. This applies in particular in electroless metal plating. This disadvantage is avoided by selectively adapting, according to the manufacturer's wishes, the size of the processing compartments in the tanks and, as a result thereof, of the tanks to the size of the printed circuit boards.

Moreover, actions taken to correct the baths in the tanks become effective much sooner in the individual compartments because of the small bath volume than in tanks having a large bath volume. This applies both to chemical make-up and to required temperature variations during the manufacturing process. Above all, changes can be made separately in every compartment if the compartments are separated by intermediate walls so that concentration and temperature may differ to a much smaller extent from the target values in the baths.

Further, in a conventional processing line, printed circuit boards that are processed simultaneously may influence each other during processing. This also makes it impossible to achieve a predictable and more specifically reproducible treatment. This is for example due to the fact that, if for example ten printed circuit boards are suspended side by side and possibly also beneath each other from a long rack or flight bar and are electroplated in a bath with one rectifier on either side of the board, the individual boards are not electroplated at the same field line density, *i.a.,* because of the electric resistance in the current supply rail. As a result, the boards are electrolytically metal-plated at different current densities so that the boards have layers of deposited metal of different thickness. In the case of electrolytic metal plating, anodes being suspended in the bath so as to be parallel to the printed circuit boards may also show differences. As the relative movement possible between the boards and the anode is quite small, voids at the anodes (such as gaps in the anode basket) directly result in voids in the boards. The processing parameters for individual boards on the rack or flight bar cannot be measured or only to a limited extent and they more specifically cannot be adapted to individual work pieces.

The tank modules may be readily emptied if the bottoms of the various modules are disposed at an incline. In this case, drain connectors are preferably provided at the lowermost portion of the bottom, said drain connectors merging into a drain piping. Each module is provided with its own inclined bottom because the seams forming between two connected modules prevent liquid from passing unhindered from one module into the next. Since, as far as practicable, the drain connectors are not to be disposed on the underside of the modules for ease of mounting, they should be provided on the side walls that are not abutting on an adjacent module. Accordingly, the drain connectors can be connected to the drain piping after the modules have been connected to form a tank. For this reason, the bottoms of the individual modules are inclined along the lateral depth of the modules. Once the drain piping of every single tank has been made, the tanks may be assembled and the drain pipes connected together.

Another way to achieve a low cost of manufacturing for the tanks is to use standardized bonding techniques for bonding the tank modules to form a tank. For this purpose, the discrete modules can be manufactured with standardized connecting elements for joining the modules together. The connecting elements preferably are flange plates or stiffening flanges. It is preferred that the flange plates be always provided at the same places on the modules. These plates may be formed as a part of the modules during production thereof, for example by forming metal plates as integral parts of the plastic walls when the tanks are made by deep-drawing, sintering, by injection-moulding or blow-moulding of the plastic material into the standard mould. The stiffening flanges are preferably U-shaped and embrace the tank on three faces. Such type stiffening flanges may also be integrally formed as a part of the tank during the construction thereof.

Through the connecting elements, the modules may then be joined together by means of screws and/or rivets and be sealed against each other at junctures, more specifically at connecting surfaces, between the modules by means of a preferably elastic sealing material so as to prevent processing fluid from leaking there through. Alternatively, the modules may be joined together through the connecting elements by fusion welding or gluing to form a liquid-tight bond; the adhesive material must thereby be capable of resisting the processing medium utilized. For fusion welding, it is preferred to use a thermoplastic material.

The standardized bonding techniques permit the continuous production of machine-made tanks, which can bring a significant cost saving.

Another way to simplify the process and to save costs as a result thereof is to manufacture a light construction tank. This is made possible by a low cost forming process. The required solidity and stiffness of the tank walls is achieved by forming rather than by increasing the material thickness. This means that the material thickness of the side walls and of the tank bottom is chosen to be lower than in conventional tanks. Depending on the material used (plastic material such as polypropylene or glass fiber reinforced plastic material such as polyester), the wall thickness of large tanks may for example be 20 – 40 mm and in the case of a modular technique, 4 – 15 mm. Another way to make sure the tank has the required solidity is to place the tank into a stiffening frame that also has a modular structure. This stiffening frame may for example be a frame made from a U-profile or a rectangular tube that supports the tank on the sides thereof and at the bottom. A plurality of such profiles may be used, a plurality of these profiles being additionally joined together by a cross-tie member so that they are additionally stiffened against each other. The stiffening frames, which are of the same type for all of the tanks, may for example snap-fit into the side walls and into the bottom of the tank. This solution brings a significant material and labour saving.

Further, the tanks of the invention may additionally be provided with pre-defined fastening elements for built-in devices. The built-in devices may more specifically be contacting frames, contacting clamps, current supply devices and moving devices as well as guides for the work pieces, nozzles, more specifically jet nozzles, spray nozzles and flow nozzles, air supply devices, pumps, heating elements, cooling elements, filters, sensors, dosing devices and chemical processing devices. It is preferred that the respective built-in devices be built according to the same design principle. They are provided as a function of the bath-specific requirements placed on a certain type of bath contained in a tank (for example chemical or electrolytic processing). Accordingly, a nozzle system for spraying the printed circuit boards may for example be provided in a compartment for chemical cleaning and a heating system for heating the electrolyte contained in the tank may be provided in the same compartment in proximity to the bottom. On the side of the tank, pumps needed for circulating the bath may be accommodated for example. A rinsing bath mounted downstream thereof may be built in just the same manner. In this case, the heating may be eliminated as it is not necessary for rinsing.

The fastening elements may more specifically be threaded bolts or nuts inserted by pressing or casting. Further, the fastening elements are preferably built according to the same principle and are provided at the same place in all the modules. The fastening elements for the built-in devices may for example be integrally formed as a part of the tanks during the deep-drawing, sintering, injection-moulding or blow-moulding of the plastic material into the standard mould.

The standardized fastening elements aid in reducing the design and production costs of the tanks. This is achieved in that such type low cost fastening elements are provided irrespective of the devices one actually wants to insert. As a result, the tank may be constructed without having to already determine which devices will have to be incorporated in the tank compartment of concern. Accordingly, most of the tank modules and tanks may also be manufactured independent of the type of bath they will have to accommodate. As a result, a plurality of tanks may be built according to the same design principle. Further, the fastening elements may be integrally formed as a part of the module walls and/or bottom during the manufacturing of the tank modules for ease of manufacture. This makes it also possible to store the modules since their final use will only be determined at a later stage.

The built-in devices may further be supported on carrier frames. The carrier frames are preferably configured in such a manner that the built-in devices may be lifted out of the tank and lowered into the tank. This allows for very simple maintenance and easy replacement of the various add-on units since the carrier frames and the add-on units fastened thereon may be lifted out of the tanks without problem by means of suited hoists. In a preferred embodiment, all the built-in devices needed in a tank compartment are fastened to a carrier frame for improved maintenance. The carrier frame may be lifted out of the cells as one unit for purposes of maintenance, changeover, restructuring and the like. For this purpose, the carrier frame has holding devices by means of which the conveyor carriage or a special maintenance carriage may lift the carrier frame out of a tank compartment and lower it back into the same after maintenance has completed.

For each board, *i.e.*, in every tank compartment (provided one compartment accommodates but one board), all the built-in devices that are to be inserted (except for the apparatus for make-up of the electrolyte, if this make-up is performed separately) can be fastened on the preferably modular carrier frame. The built-in equipment also includes sensors for measuring important processing parameters for every single board. The modular structure permits to realize low cost production at very low construction costs. Immersion pumps for supplying processing fluid to the boards and corresponding filters may also be provided on the carrier frame. If maintenance is required, the apparatus are simply lifted out of the tank and brought to an easily accessible maintenance station. In this station, the apparatus are cleaned, repaired, the filters are replaced and the like. Since such a maintenance station is equipped with all the necessary tools, the time needed for such operations is considerably reduced over conventional methods.

The carrier frame with the built-in devices also permits to provide replacement devices. If a failure occurs, the failing device can be replaced within a few minutes by a new replacement device, which has already been adjusted beforehand to the values of the respective compartment, so that the downtime is very short. The device, which can be lifted out of the tank, may for example be adjusted beforehand in a small pilot line that has one compartment for each method step and that also serves to test new products and methods.

If connections to stationary devices are required, this may be realized through plug-type connectors. In order to supply electric current to the built-in devices fastened to the carrier frames, releasable plug-type or screw-type connectors may be provided for electrical connection between the tank and built-in devices mounted to carrier frames that may be lifted out of, and lowered into, said tank. These components may also be standardized. The same also applies to other connections such as pipe fittings for supply or discharge of liquid or gas such as water, processing fluid or air.

The pipe connections are preferably implemented as simple plug-in connections without securing members, seals such as O-rings, for example toroidal sealing rings or retaining rings, being used for sealing against leaking medium. For this purpose, the one pipe portion may be inserted into the mating part tapering in the shape of a flaring horn. The dead weight of the carrier frame and of the built-in devices thereby suffices to secure the pipe connections. In order to prevent the pipe portions from drifting apart, separate connection securing members such as screw members, bayonet members or other securing members need only be provided if the weight does not suffice and/or if the pressure in the pipelines is too high. A pipe connection without separate securing members is advantageous because the necessary pipe connections are established by the mere action of placing the carrier frame with the built-in devices without the need for separate installation works. This is particularly desirable when the discrete tank modules are formed in matrix arrangement because in this case the places of installations are not readily accessible if at all.

For ease of manufacture of the tank with these standardized fittings, connection elements or couplings for fitting or connecting pipelines may be formed as an integral part of the tank during the forming thereof by deep-drawing, sintering, injection-moulding or blow-moulding the plastic material into the standard mould.

Together, the tanks form a processing line. For this purpose, the tanks are usually arranged in a tank sequence determining the processing sequence of the boards. The number of tanks that are to be disposed one behind the other is determined as a function of the processing sequence to be run. The individual tanks contain the baths for performing the treatment according to the discrete steps of the process. For processing, the boards may then simply be immersed one after the other in the direction of transport of the boards into the individual baths contained in the tanks. Across the direction of transport of the boards in the line, a plurality of processing compartments in one tank form a common processing station into which a plurality of boards, which are for example suspended side by side from a carrier device, are immersed together. After processing has completed, the flight bar is lifted out of the compartment combination and conveyed to the next processing station.

If, for certain boards, the processing sequence has to be changed, the drive program of the conveyor carriage and possibly the program for controlling and monitoring the devices inserted in the bath have to be modified by specialists of the manufacturing firm. If the tanks and built-in devices are completely built in a modular structure, this changeover may be achieved by replacing the carrier frames with the additional units required without having to change the drive program of the conveyor carriage. Such a simple mechanical operation may be readily performed by skilled employees of the line's operator. If each carrier frame is equipped with a computer-readable identification code through which the mating new control and monitoring program may be automatically loaded in the control unit, most of the changeovers may be performed by the operator of the line himself, which also contributes to further reduce the operating costs.

In order to allow for simultaneous processing of a plurality of boards, it is preferred to dispose side by side, depending on the throughput, wide tanks with or without intermediate walls between the discrete tank compartments. The discrete tank compartments are disposed side by side in rows. A plurality of tanks or a plurality of rows of tank compartments are in turn disposed one behind the other in a sequence in the tank. A processing compartment matrix having a plurality of compartments disposed side by side in a row and a plurality of compartments disposed one behind the other in a sequence is thus formed. In order to even further increase the throughput through such a line, a stack of a plurality of boards may also be immersed simultaneously into one compartment of the tank. For this purpose, the tank compartments have a larger lateral depth so that they are capable of simultaneously receiving a plurality of boards.

In addition to the afore mentioned tanks, separate additional cells communicating with the tank interior spaces via pipelines may be provided to receive processing fluid. These additional cells may be either part of a tank, if a region of the tank interior space is reserved for such an additional compartment by suitably separating this region from the remainder of the interior space, or additional tanks are placed beside the tank sequences.

Additional cells may be used if temperature and bath composition are not subjected to strong limitation because of the chemicals used. In these cases, the processing fluid may be processed and stored in these special processing compartments or tanks. The entire processing solution for all the processing compartments of a tank may be made up in one additional cell. In this case, the additional cell is equipped with all the apparatus necessary for making up the processing fluid. These are for example a heating system, a cooling system, dosing devices, filter devices and measurement systems for the processing fluid, such as a bath electrolyte. Pumps deliver and distribute the processing fluid to the various processing compartments and from there back to the additional cell. If the liquid level in the additional cells is lower than in the processing compartments, the processing fluid may also be drained by gravity from the processing compartments to the additional cells.

As mentioned herein above, built-in devices may also be provided in the additional cells such as nozzles, air supply devices, pumps, heating elements, cooling elements, filters, sensors, dosing devices and chemical processing devices.

Further, a modular station software program by means of which the data measured by measurement devices or sensors located in each processing compartment are recorded and transmitted to a host computer may be allocated to each processing compartment. The control of the built-in devices in the compartments may also be modular with the hard- and software components always remaining the same. The same applies to the electrical switchgears. The sensors may register for example the spray pressure of flow nozzles, the movement of the nozzles, the switching on and off of the circulating pumps, the control of moving devices for moving the boards in the processing baths and of the electroplating current for every single board and the associated built-in devices may be controlled after the registered data have been processed in a host computer. The moving devices and the power sources may for example be switched on and off at fixed times or on the occasion of certain events. The same applies to electrolytic processing.

In a preferred embodiment, current is supplied to the boards by means of a contacting frame. Said contacting frames are disposed in the processing compartments and serve to receive the boards for processing and to supply electric current. Each contacting frame serves to receive one printed circuit board.

The contacting frames preferably consist of contacting bars that are combined to form one half of the frame. The contacting bars of this frame half are pressed onto the borders of the board. Two such type frame halves may be provided; they are pressed onto the two faces of the board and form together the contacting frame. It is preferred that the frame halves be approximately of the same size as the boards. Since the contacting bars serve to supply current, the board can be electrically contacted through the borders. The contacting bars may be implemented so as to hold the board when the board is wedged between two halves of the contacting frame. Once the board is wedged, the contacting bars of the frame are substantially parallel to the side borders of the board. The frame halves are preferably pivoted together so that a board that has been inserted between the two frame halves may be grasped by them. For this purpose, a hinge may be provided on a respective one of the long sides of the frame halves. The frame may be opened and closed again by means of suited actuators.

The contacting frame can be disposed in a tank compartment, more specifically so as to be stationary. For this purpose, the frame is supported on supporting points by supporting elements. The supporting elements are configured so as to be movable in order to adjust the position of the contacting frame relative to the supporting points in the tank compartment. For this purpose as well, suited actuators are provided for a precise positioning of the contacting frame holding the board. This may for example be necessary if during electrolytic metallization the distance between the two board sides and the anodes is not the same and must be adjusted.

Since every single printed circuit board is supplied with current through a contacting frame and an associated rectifier, precise measurement of the resistance, the voltage and the current may be made to ensure a constant quality level during electroplating. If the measured data differ from the target parameters, a special program that has been established in advance for such differences can be started for processing the defective board. The special program can enable changes to occur within said compartment, such as changes in temperature, current density, bath circulation and the like or to initiate a transport to another bath in the line. The frame may also be provided only for holding a board in a tank compartment, for example in a tank compartment in which the board is not electrolytically processed, without current being transferred.

As described herein above, the contacting frame may also be fastened to a carrier frame and be transported for maintenance purposes.

To transport the boards from one processing compartment to the next, conveyor carriages are used. The usually used conveyor carriages are capable of simultaneously transporting all the boards that are contained in one tank to another tank of the sequence of tanks (next processing station). For transport, the boards are lifted out of the tank by the conveyor carriage (this includes that the remainder liquid is allowed to drip off) and conveyed to the next processing tank in the sequence of processing tanks into which it is immersed. If, during the processing of a board, a failure occurs in one compartment in a processing tank so that this board requires special processing in a special bath, it is possible to only remove this one board from the defective compartment and to convey it to a special processing tank. For this purpose, the conveyor carriage may, in a special embodiment, be fitted with a gripper system for each board and with its own hoist for one single board.

The invention will be explained in closer detail herein after with reference to the drawings.

Fig. 1 shows a conventional prior art electroplating tank illustrated in a partial section front view;

Fig. 2 illustrates a section through a processing tank of the invention taken along the section line A – A' in Fig. 3;

Fig. 3 shows the side view of the tank of Fig. 2;

Fig. 4 illustrates a section through an improved processing tank of the invention taken along the section line B – B' in Fig. 5;

Fig. 5 shows the side view of the tank of Fig. 4;

Fig. 6 shows a section view of a sequence of a plurality of processing tanks disposed one behind the other;

Fig. 7 shows a top view of a matrix arrangement of the processing tanks of the invention illustrated in Fig. 6;

Fig. 8 shows a section view of a processing tank taken along the section line C – C' in Fig. 9, said processing tank having a carrier frame for carrying built-in devices that is adapted to be lifted out of said tank;

Fig. 9 shows the side view of the tank in Fig. 8;

Fig. 10 shows a first embodiment of a connection of processing medium carrying pipes, said connection being formed at interfaces between a tank module and a carrier frame for built-in devices;

Fig. 11 shows a second embodiment of a connection of processing medium carrying pipes, said connection being formed at interfaces between a tank module and a carrier frame for built-in devices;

Fig. 12 shows the screw collar ring of Fig. 11 as viewed from the bottom;

Fig. 13 shows the washer of Fig. 11.

As far as numerals and other reference signs are used herein after, the same numerals and other signs will be used to identify identical elements in the various figures.

Fig. 1 shows a conventional processing tank for the wet-chemical or electrolytic processing of work pieces 3 such as printed circuit boards. The tank comprises a tank bottom 1 and side walls 2. Further, the tank stands on supports 4. At its upper border, the tank comprises a stiffening member 5. In the case of large tanks, further stiffening members may be welded to the side walls and to the bottom or they may be integrally formed in the shape of (what are termed) crimps.

The front side wall 2 of the tank is partially cut away to illustrate the printed circuit boards 3 being suspended in the tank. Here, the printed circuit boards 3 are fastened to a rack 21. The rack 21 in turn is held by a flight bar 20 that rests on the upper stiffened border 5 of the tank. The stiffened border 5 concurrently serves to fasten the routing guides (not shown) for the flight bar 20 and the required additional devices.

The boards 3 are fastened to the flight bars 20 via the racks 21 and are hung in one to three rows one behind the other. If the boards in the tank are electrolytically processed, the flight bar 20 and the rack 21 also serve to supply current and are accordingly implemented to exhibit good electrical conducting properties.

The size of the tank is adapted, in accordance with the invention, to the size of the board, *i.e.*, to the size of the workpiece, taking into consideration the built-in devices. For this purpose, it must be constructed so as to be adapted to each method step, the kind of chemicals used having to be taken into consideration. This includes the appropriate choice of chemical-resistant materials, computation of the solidity according to the loads that are to be carried (filling quantity and built-in devices as well as the work pieces) as well as the making of drawings and lists of parts for the tank and the built-in devices. These provisions already constitute about 20 – 25 % of the tank manufacturing costs.

In order to completely avoid these provisions, or to at least drastically reduce them, it is suggested to design the construction of the tanks, and preferably also the built-in devices and their fastening elements, in such a manner that always the same tanks and built-in devices may be used, irrespective of the capacity of the line. This applies in particular if the boards always have the same or at least very similar dimensions in width and length, *i.e.*, that the dimensions obtained for the tank are many times the dimensions of the boards 3.

To better illustrate the tank of the invention, the tank is shown in a sectional view in Fig. 2 and in a side view horizontally rotated 90 degrees in Fig. 3. The representation in Fig. 2 is a section of the tank taken along the section line A – A' in Fig. 3. As is evident from Fig. 3, the tank is formed from a left tank module SM (end module), from a central tank module MM (center module) and from a right tank module SM (end module). The tank is again comprised of a tank bottom 1 and of side walls 2. Further, each tank module rests on supports 4. At its upper border, the container comprises a stiffening member 5. To facilitate the understanding, the parameters height H, width B and lateral depth T are shown.

The tank bottom 1 is at an incline so that the tank module may be readily emptied. This incline is also outlined in Fig. 3 by the dashed line shown above the bottom level labelled at 1 and denoting the tank level 1' lying beyond the viewing plane.

Fig. 2 further shows a drain connector 29 that is mounted in the side wall 2 of the tank module in the lowermost portion of the inclined bottom 1. This permits to ensure that the tank module may be completely emptied by draining. Such type drain connectors 29 are provided in all the tank modules so that these may be emptied separately. Flanges 30 are further provided to connect the drain connectors 29 to the piping. Such type flanges 30 are also shown in Fig. 3.

The end modules SM at the ends of the row of tank compartments consist of confronting module side walls 2, a module end wall 2 and a module bottom 1. The center module MM is formed into a U-shape and consists of two confronting side walls 2 joined together by a module bottom 1. By assembling the modules SM, MM, a tank is formed that has a unitary interior space and no intermediate walls. At the contacting surfaces of the modules SM, MM flange plates 6 are provided for connection. Here, the flange plates 6 of the tank modules MM, SM are joined together through the connecting holes 7 by means of screws and nuts. To seal the tank, elastic sealing material is inserted into the seams at the juncture between the modules SM, MM. The stiffness of the tanks is increased by the shape of the flange plates and by the screw connection thereof to said tanks. As a matter of course, it is understood that other connection techniques such as by welding or gluing are also possible.

Each tank module SM, MM of the tank forms an inherently tight, completely portable tank compartment for one board 3 or for a rack. The boards may for example be placed into contacting frames provided in the compartments and be retained therein during processing (not shown). Since all the modules always have the same dimensions, lower cost production methods may be utilized. An attractive benefit is for example obtained if a mould is made and the tanks injection-moulded from glass fiber reinforced plastic material or if the tanks are produced in the mould by blow-moulding or deep-drawing. Surprisingly, cost calculation has shown that in spite of the higher amount of material utilized the overall production costs are lower than the production costs for conventional tanks.

The conveyor system needed for conveying the work pieces 3 is not illustrated in Figs. 2, 3. It is located above the line and moves the work pieces 3 up and down and back and forth in accordance with the process sequence and the setting of the line. The direction of travel of the conveyor system is indicated by the double-headed arrow 18 in Fig. 2 and in Figs. 6, 8 though.

When viewed in the direction of travel, all the tanks have the same lateral depth T that may be utilized by the work pieces 3. The three modules shown in Fig. 3 form three tank compartments. For each tank of the line, these modules have exactly the same dimensions which in turn correspond to the dimensions of the workpiece 3 taking into account the greatest possible number of built-in devices that may be incorporated in a tank (such as current supply devices and moving devices as well as guides for the work pieces, nozzles, more specifically jet nozzles, spray nozzles and flow nozzles, air supply devices, pumps 13, heating elements 19, cooling elements, filters, sensors, dosing devices and chemical processing devices). All the built-in devices are always at the same place irrespective of the method step so that holes for fastening elements for fastening the built-in devices, for brackets and the like are always provided at the same place.

Fig. 4 shows the tank in a section view taken along the section line B – B' in Fig. 5. Fig. 5 is a side view that is horizontally rotated 90 degrees from that in Fig. 4. The tank shown in these Figs. is a preferred embodiment of the tank module according to Figs. 2, 3.

The tank consists of two end modules SM and of one center module MM. Accordingly, the smallest possible tank is formed from one center module. It comprises side walls 2, end walls 10, each of which having an integrally formed upper border 5, and a tank bottom 1. The tank again stands on supports 4. Up to nine further center modules MM may be inserted for increased throughput. In this case also, the tank bottom 1 of every single tank module is inclined. As already shown in Fig. 3, the higher bottom level of the inclined bottom, which is labelled at 1', is shown in a dashed line in Fig. 5 as well. Fig. 4 also shows a drain connector 29 with a flange 30. In Fig. 5, all the tank modules are provided with such type flanges 30.

The solidity of the tank modules is calculated in such a manner that the same materials and material thickness may be chosen for the modules of the line irrespective of the number of modules. It can be seen from Fig. 4 that each center module MM is comprised of a stiffening flange 8 that extends in a U-shape about three sides of the module for increased solidity. Said flange 8 may be integrally formed as a part of the modules during the manufacturing thereof and may for example be made from plastic-covered flat metal. The flange 8 is disposed in a U-shape around the side walls 2 and the tank bottom 1 in the region of the seams at the juncture between the modules SM, MM and at the end sides of the tank. At these flanges 8, the modules SM, MM are assembled and/or screwed together by appropriate liquid-tight bonding techniques. The holes 7 in the flanges 8 serve this purpose. A wedged soft seal serves to seal it against leaking liquid. If glass fiber reinforced polyester plastic is used, it is well suited to bond the modules together at the flanges 8. In this case, the flanges 8 may also be covered with glass fiber reinforced plastic material. Solid and tight bonds may also be achieved by fusion welding the flange surfaces made of thermoplastic material, heating them on either side and pressing them together using therefore suited jointing devices. In this case, the connecting holes 7 can be eliminated.

The space 9 provided for built-in devices is shown in dash-dot lines (place holder) in Figs. 4, 5. The boards 3 are located between the reserved regions 9 for the built-in devices. In Fig. 4, the flight bar is not shown and in Fig. 5 both the suspension devices for the boards 3 and the flight bar have not been illustrated.

Figs. 6, 7 show a line made up from a plurality of tanks of the invention, which in turn consist of discrete modules. The modules are formed in matrix arrangement in rows and sequences. Fig. 6 shows a sequence of a plurality of tanks 11', 11", 11"', 11"", 11""' disposed side by side. In each tank, a definite treatment takes place.

The tanks again comprise side walls 2, end walls 10 and a tank bottom 1. An upper stiffened border 5 is provided on the tanks for additional stability. The tanks stand on supports 4. The tank modules are joined together at the seams thereof via stiffening flanges 8. Further, each tank module comprises supports and a drain connector 29 for completely emptying the tanks for cleaning purposes. The respective drain connectors 29 are connected to a drain piping 31 via flanges 30. The tank bottoms 1 are slightly inclined so that the tank may readily be emptied. The drain connector 29 is provided approximately at the lowermost portion thereof.

As best shown in Fig. 7, which represents a top view of the tank matrix, maintenance works at the inner modules MM are difficult to perform as they are accessible from the top only. This problem is solved by the carrier frames shown in Figs. 8, 9:

Figs. 8, 9 show another embodiment of the present invention, with the view in Fig. 8 showing a tank of the invention taken along the section line C – C' in Fig. 9. In this case, there is provided a carrier frame 14 that is firmly retained in the right position on the tank by means of centering prism members 17 and corresponding mating parts. To secure the carrier frame, *e.g.*, against the liquid pressure exerted onto the pipe connectors, the carrier frames 14 may comprise on the centering prism members or on the border of the tank holding devices that have not been illustrated herein and that are tightened once the carrier frame has been placed thereon, thus wedging the entire carrier frame with the devices fastened thereon.

In the exemplary embodiment of Figs. 8, 9, the frame 14 comprises a transverse cross member that extends over the entire tank and accordingly is able to get to all the compartments in the tank. As a result, all the built-in devices in this tank may be served concurrently. The carrier frame 14 has suspension devices 15 for transport through which a conveyor system that has not been illustrated herein is capable of lifting out of the tank via carrier arms 16 the carrier frame 14 with all built-in devices such as immersion pumps 13 or electrical rod heaters 19 fastened thereon and of conveying it to a maintenance location (not shown) at the end of the line.

Connections with stationary supply devices for electric current, compressed air or other media that have not been illustrated in the Figs. are preferably established on either side of the frame 14 such as through plug-type connectors.

The frame 14 may consist of discrete modules just like the tanks (for example two side modules with suspension devices 15 for the conveyor system and N – 2 center modules for fastening the built-in devices, wherein N is the number of compartments in the tank). The center modules of the carrier frame 14 correspond to the width of the center modules MM of the tank. This embodiment is however only shown in a dashed line in Figs. 8, 9.

Figs. 10, 11, 12 and 13 show two different embodiments for inventive plug-type connections for pipes carrying processing medium such as processing liquid. These connections are provided at the interfaces between a tank module and a carrier frame for built-in devices for this module so that the carrier frame can be inserted into the module without problem while concurrently establishing the connections for the required media.

The plug-type connection according to Fig. 10 consists of a pipe 23 that is provided on a tank module and that has on its front edge a conical shape 26 for insertion into the bushing of the mating part 22 provided on the carrier frame. It is understood that the pipe 23 could also be provided on the carrier frame and the mating part 22 on the tank module. The bushing mating part 22 has a front portion 25 tapering in the shape of a flaring horn so that the pipe portions may glide into each other at the connection even if the bushing mating part is not positioned accurately (= carrier frame position). An O-ring 24 for sealing the connection is inserted into an annular groove. The connection is not secured separately. The connection is maintained so as to even withstand the medium pressure within the pipe by the mere high dead weight of the carrier frame 14 without any other provisions being taken. This is particularly advantageous because of the poor accessibility of the center modules as this type of connection dispenses with the need for particular installation works for inserting the carrier frame into the module and for connecting the built-in devices.

If the carrier frames are also modular, *i.e.*, if each tank module is provided with its own carrier frame 14 (shown in a dashed line above the tank modules in Fig. 9), the dead weight of the carrier frame with the built-in devices may no longer suffice if the pressure is very high and if a plurality of large pipe connections are provided. In this case, the pipe connections according to Figs. 11, 12 and 13 may be used:

In this case, a securing member is chosen for the pipe connection. The pipe portion 23 has a washer 28 solidly connected to the pipe for locking the connection. The pipe mating part 22 has a screw collar ring 27 that is laterally countersunk in the lower portion, as shown in Fig. 12. In the assembled state, the conical surface 26, which is not countersunk, rests against the also conical surface of the bushing 22. Upon insertion of the carrier frame 14 into the module tank arrangement, the screw collar ring 27 is rotated in the open position. In this state, the bushing 22 can be moved downward over the washer 28 by means of the screw collar ring 27. By rotating thereafter the screw collar ring 27 approximately 90 degrees, said screw collar ring is pushed beneath the washer 28. The lower noses of the screw collar ring 27 are thereby snap-fitted behind the washer 28 (see Fig. 11) so that the coupling is secured from being pushed apart.

The various embodiments of the modules described may vary from one tank to the other within one line.

It is understood that the examples and embodiments described herein are for illustrative purpose only and that various modifications and changes in light thereof as well as combinations of features described in this application will be suggested to persons skilled in the art and are to be included within the spirit and purview of the described invention and within the scope of the appended claims.

List of reference symbols

1,1'	tank bottom
2	side wall
3	workpiece, board
4	support
5	stiffening border
6	flange plate
7	connecting hole
8	stiffening flange
9	free space for inserts
10	end wall
11', 11", 11"', 11"", 11""'	tank
13	immersion pump (built-in device)
14	carrier frame
15	suspension device on the conveyor
16	carrier arm of the conveyor carriage
17	centering prism member
18	direction of travel of the conveyor system
19	rod heater (built-in device)
20	flight bar
21	rack
22	bushing mating part
23	pipe
24	O-ring
25	portion tapering in the shape of a flaring horn
26	conical shape
27	screw collar ring
28	washer
29	drain connector
30	flange of the drain connector 29

31	drain piping
MM	center module
SM	side module

Patent Claims:

1. A tank for a vertical processing line for processing work pieces (3) comprising a tank interior space defined by tank walls (2, 10) and a tank bottom (1, 1'), characterized in that the tank is formed from at least two tank modules and that the walls and the bottom define respective module interior spaces which have the same heights (H) and which have the same widths (B).

2. The tank according to claim 1, characterized in that the tank is formed from at least three tank modules and that the modules are center modules (MM) and end modules (SM).

3. The tank according to claim 2, characterized in that the tank is formed from a row of modules, each row having one end module (SM) at either end of the row and at least one center module (MM) between said end modules.

4. The tank according to any one of claims 2 and 3, characterized in that the end modules (SM) comprise three side walls (2, 10) so as to be open toward the adjacent module.

5. The tank according to any one of claims 2 and 3, characterized in that the center modules (MM) comprise two side walls (2, 10) that form, together with the bottom (1, 1'), a U-shape.

6. The tank according to any one of the preceding claims, characterized in that intermediate walls are provided between the modules.

7. The tank according to any one of the preceding claims, characterized in that each module comprises four side walls (2, 10).

8. The tank according to any one of the preceding claims, characterized in that each module forms processing compartments in each of which only one workpiece (3) is processed.

9. The tank according to claim 8, characterized in that the work pieces are boards (3) and that the height (H) and the width (B) of the tank modules is approximately the size of the edge length of the boards.

10. The tank according to any one of the preceding claims, characterized in that the modules comprise connecting elements (6, 8) for connecting the modules together.

11. The tank according to claim 10, characterized in that the connecting elements are flange plates (6) or stiffening flanges (8).

12. The tank according to claim 11, characterized in that the stiffening flanges (8) embrace the tank on three sides.

13. The tank according to any one of claims 10 – 12, characterized in that the modules are connected together via the connecting elements (6, 8) by means of screws and/or rivets and are sealed against each other at junctures between the modules by means of an elastic sealing material so as to prevent processing fluid from leaking there through.

14. The tank according to any one of claims 10 – 12, characterized in that the modules are connected together via the connecting elements (6, 8) by means of fusion welding or gluing to form a liquid-tight bond.

15. The tank according to any one of the preceding claims, characterized in that additional fastening elements for built-in parts (13, 19) are provided.

16. The tank according to claim 15, characterized in that the fastening elements are threaded bolts or nuts inserted by pressing or casting.

17. The tank according to any one of claims 15 and 16, characterized in that the fastening elements in all the modules are identically built and provided at the same place.

18. The tank according to any one of claims 15 – 17, characterized in that the built-in devices are selected from the group comprising contacting frames, contacting clamps, current supply devices and moving devices as well as guides for the work pieces, nozzles, more specifically jet nozzles, spray nozzles and flow nozzles, air supply devices, pumps (13), heating elements (19), cooling elements, filters, sensors, dosing devices and chemical processing devices.

19. The tank according to any one of claims 15 – 18, characterized in that the built-in devices (13, 19) are held by carrier frames (14).

20. The tank according to claim 19, characterized in that the carrier frames (14) with the built-in devices (13, 19) can be lifted out of the tank and lowered into said tank.

21. The tank according to any one of the preceding claims, characterized in that there is provided at least one separate additional cell for receiving processing

fluid, said additional cell communicating with the tank interior space via pipelines.

22. The tank according to claim 21, characterized in that the additional cell accommodates built-in devices selected from the group comprising nozzles, air supply devices, pumps (13), heating elements (19), cooling elements, filters, sensors, dosing devices and chemical processing devices.

23. The tank according to any one of the preceding claims, characterized in that it is a light construction tank and in that it is placed in a stiffening frame for providing the required solidity.

24. The tank according to any one of the preceding claims, characterized in that releasable plug-type or screw-type connectors may be provided for electrical connection between the tank and built-in devices (13, 19) mounted to carrier frames (14) that may be lifted out of, and lowered into, said tank.

25. The tank according to any one of the preceding claims, characterized in that releasable plug-type or screw-type connectors are provided for connecting processing medium carrying pipelines between the tank and built-in devices (13, 19) mounted to carrier frames (14) that may be lifted out of, and lowered into, said tank.

26. A method of manufacturing a tank module for a tank for a vertical processing line comprising a tank interior space defined by tank walls (2, 10) and a tank bottom (1, 1'), characterized in that the method comprises the following method steps:

a) providing a standard mould for forming standardized tank modules,
b) deep-drawing, sintering, injection-moulding or blow-moulding plastic material into the standard mould and removing the formed modules from the standard mould,

c) forming the tank from at least two standardized tank modules so that the walls (2, 10) and the bottom (19) of the tank define respective module interior spaces which have the same heights (H) and which have the same widths (B).

27. The method according to claim 26, characterized in that fastening elements for fastening built-in devices (13, 19) in the tanks are integrally formed as a part of said tank during the deep-drawing, sintering, injection-moulding or blow-moulding of the plastic material into the standard mould.

28. The method according to any one of claims 26 and 27, characterized in that connecting elements for the fitting or the connection of pipelines are integrally formed as a part of the tank during the deep-drawing, sintering, injection-moulding or blow-moulding of the plastic material into the standard mould.

29. The method according to any one of claims 26 - 28, characterized in that flanges (6, 8) for connecting the modules together are integrally formed as a part of the tank during the deep-drawing, sintering, injection-moulding or blow-moulding of the plastic material into the standard mould.

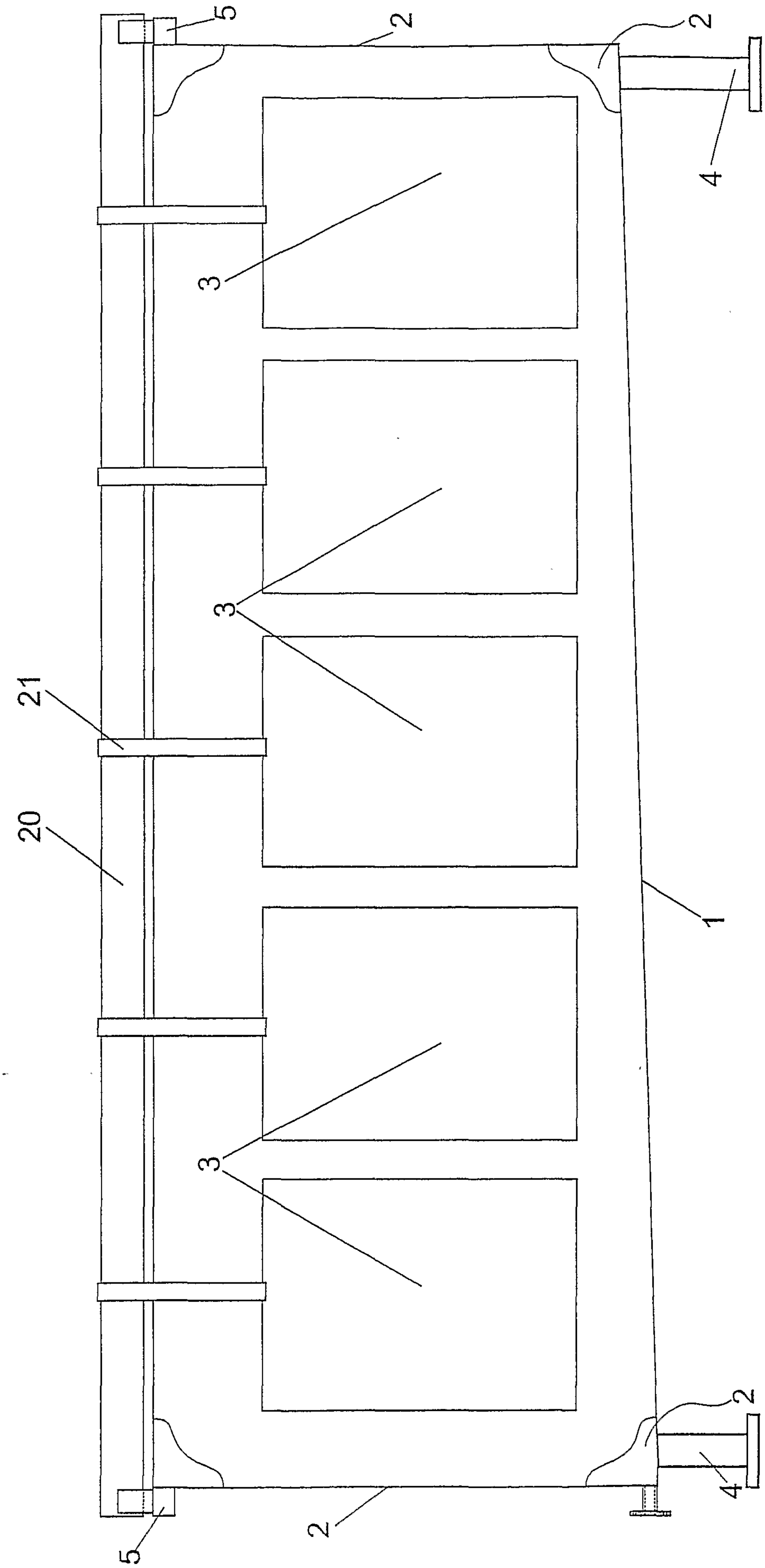


Fig. 1

"Prior Art"

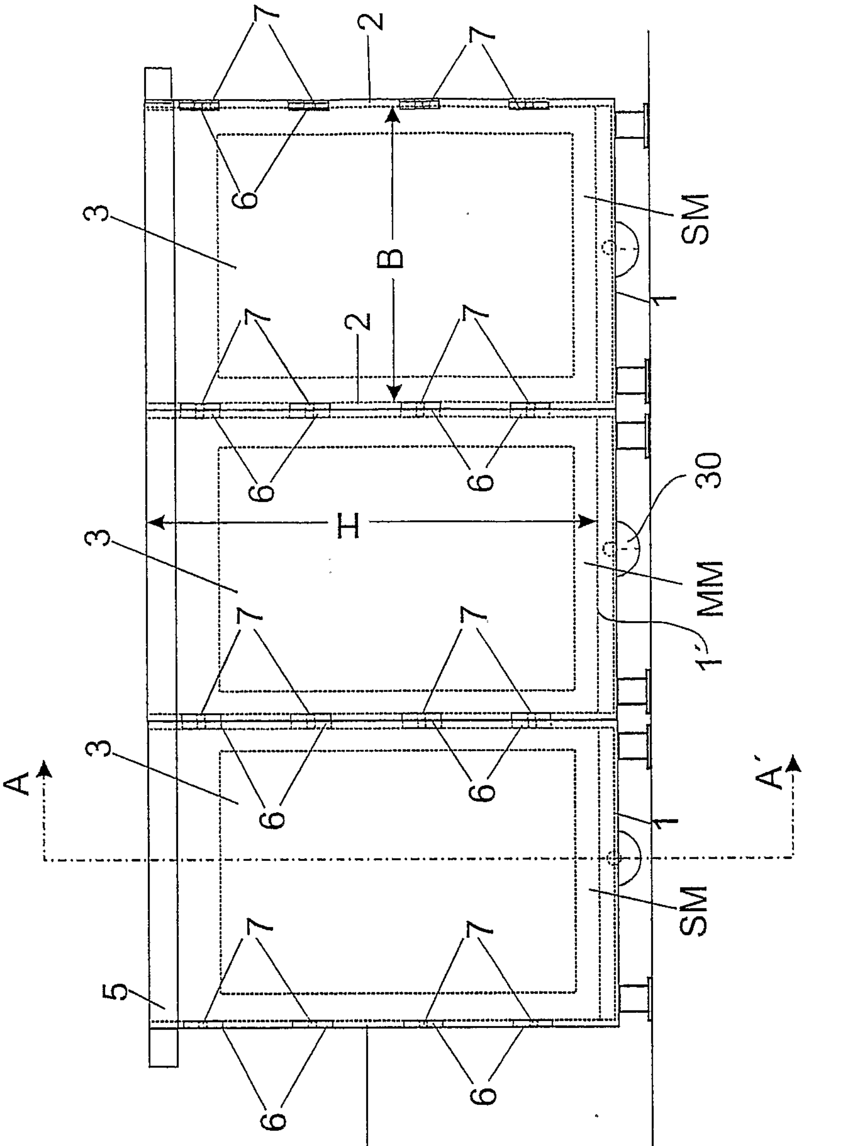


Fig. 3

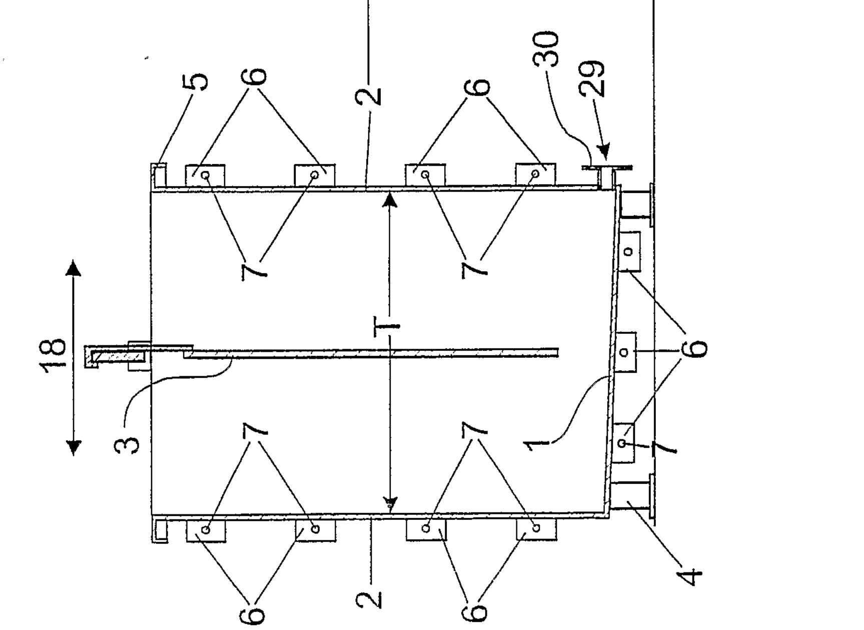
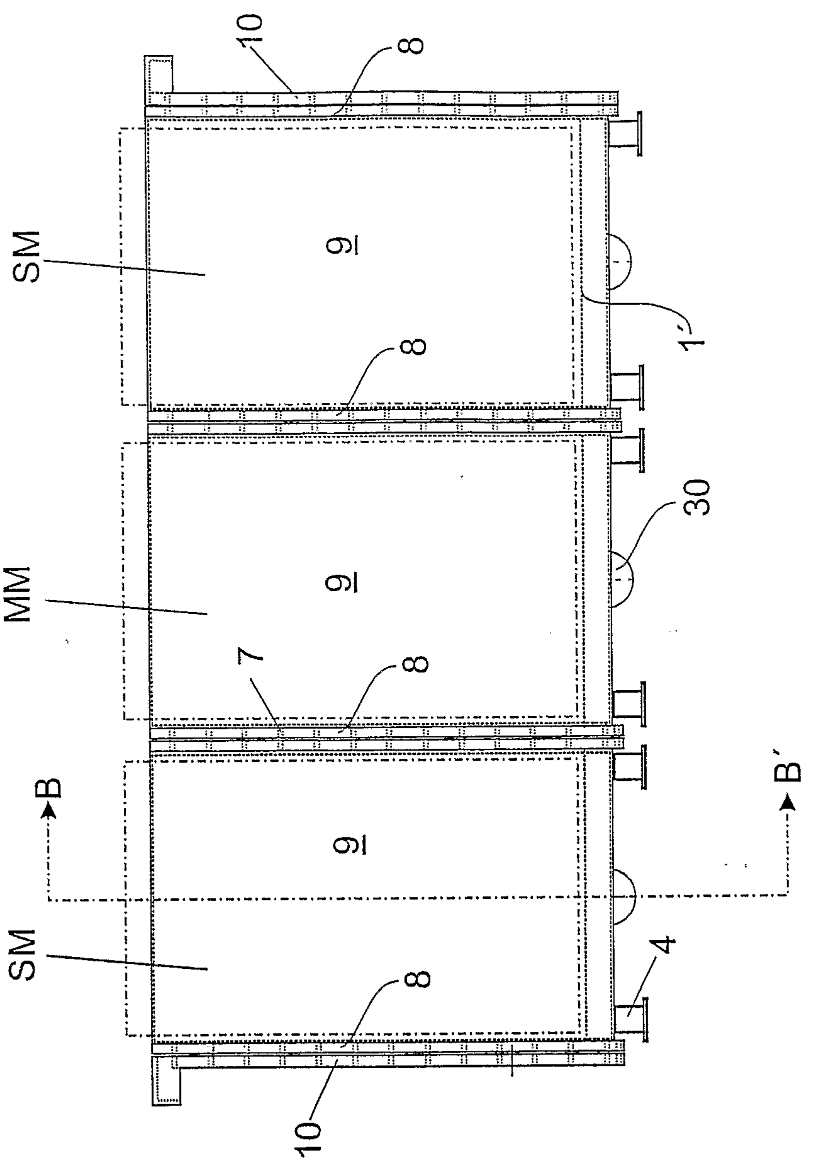


Fig. 2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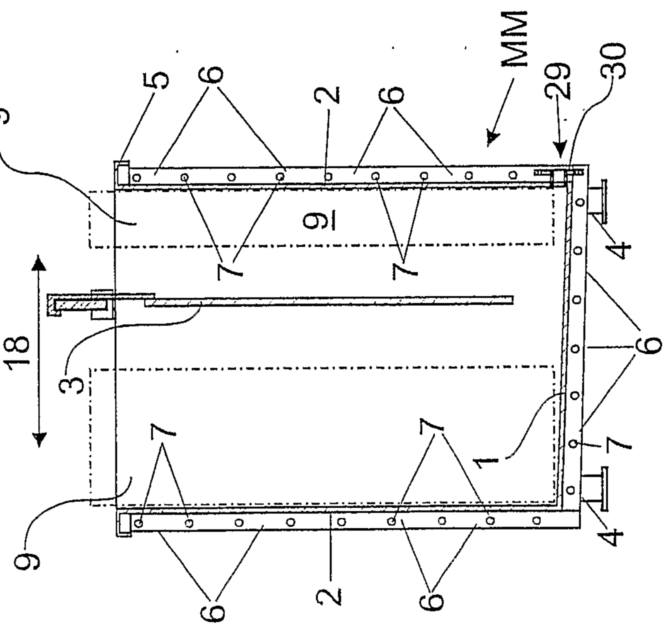
8
SM
9
1'
8
MM
9
30
7
8
B
9
B'
SM
4
8
10

Fig. 5


9
5
6
2
6
MM
29
30
9
7
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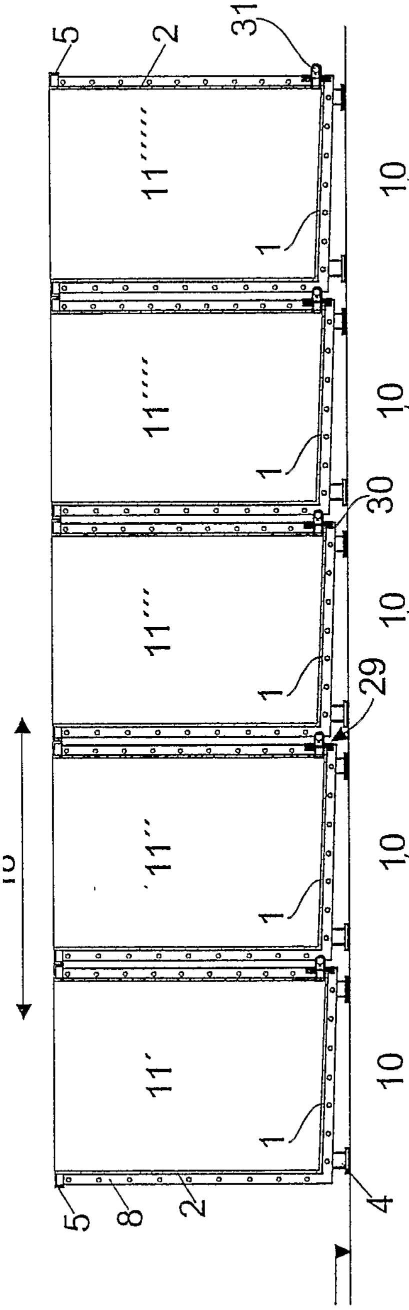
4
18
3
6
7
7
7
1
4
9
6
2
6

Fig. 4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31
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11''
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11'
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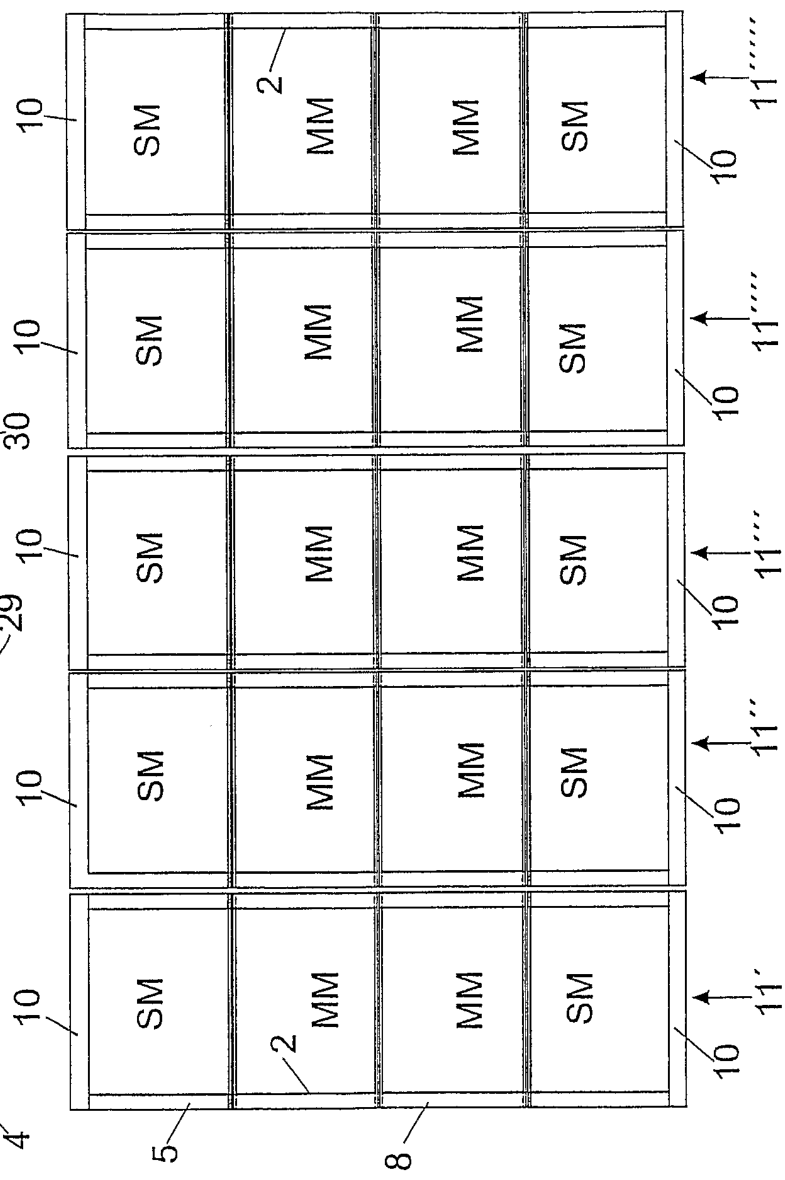
2
4

Fig. 6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8

Fig. 7

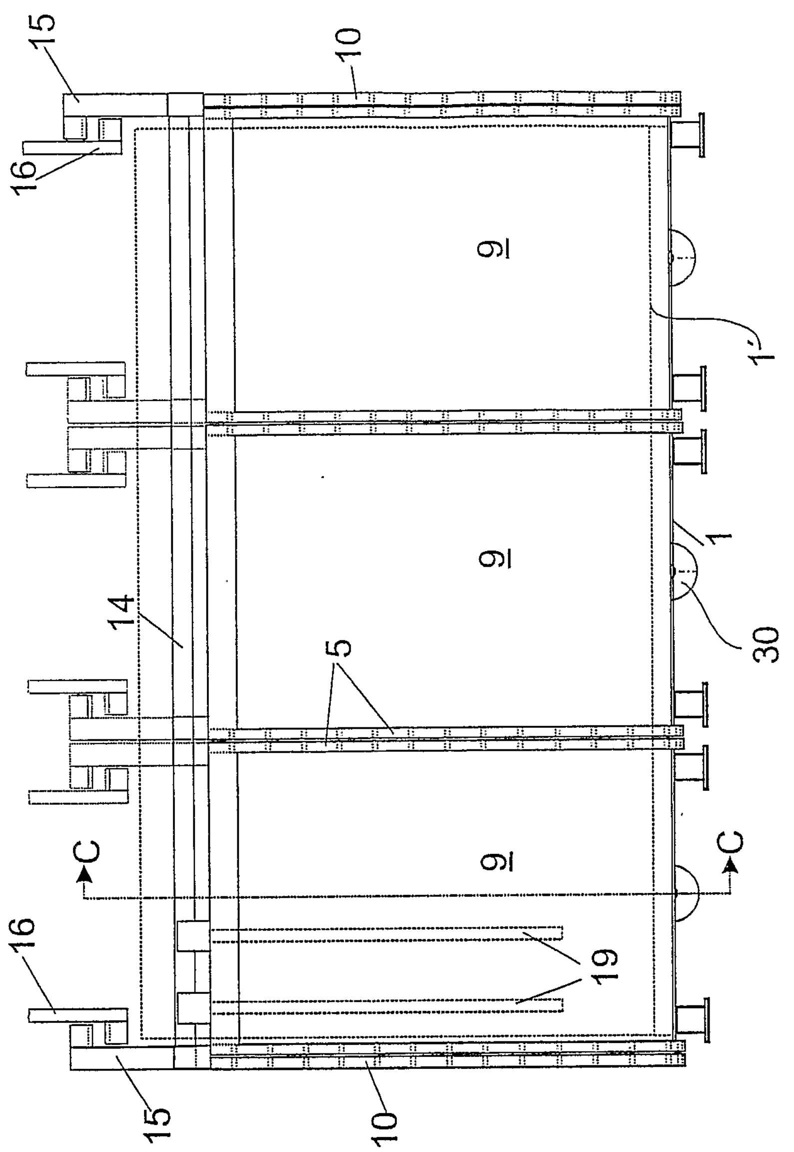

Fig. 9

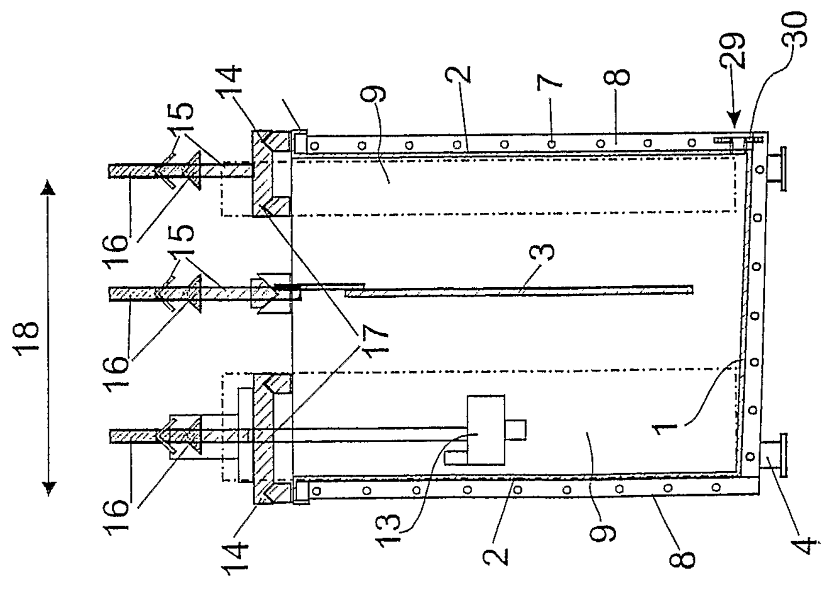

Fig. 8

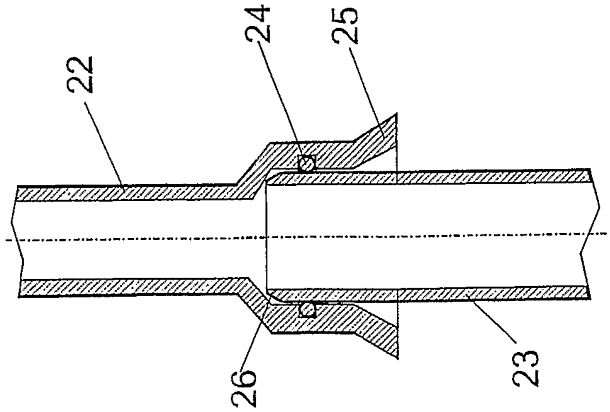

Fig. 10

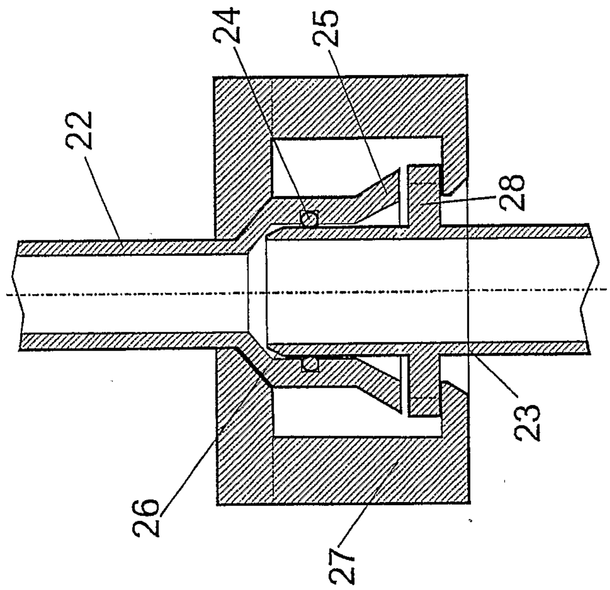

Fig. 11

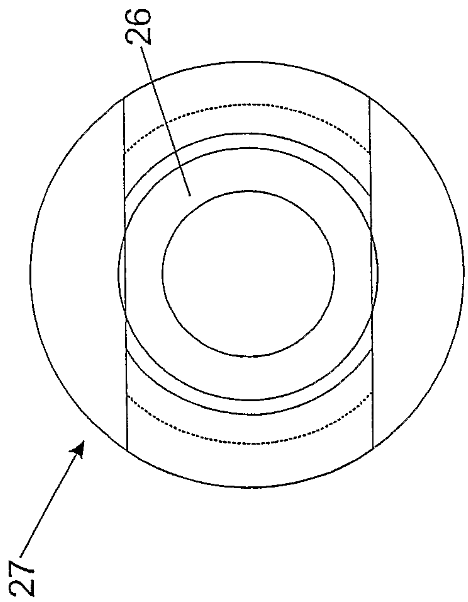

Fig. 12

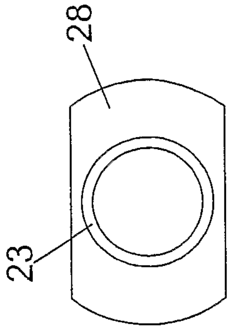

Fig. 13

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/008769

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H05K3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H05K C25D B65G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 99/24337 A (HOLMSTRANDS AUTOMATION AB; LARSSON, STIG; NILSSON, ROLF) 20 May 1999 (1999-05-20) page 5, line 8 - page 6, line 30; figures 1-4	1-25
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 November 2005	21/11/2005

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Batev, P

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/008769

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 4 933 061 A (KULKARNI ET AL) 12 June 1990 (1990-06-12) column 3, lines 35-45; figure 1	1-29
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International Application No
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