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(54) **Process and apparatus for the preparation of materials to be subjected to finishing treatments**

(57) Process for the treatment of materials to be subjected to finishing processes, in particular for the pre-treatment of metallic and non metallic materials which comprises the treatment of said materials with appropriate substances, normally fluids, in suitable con-

tainment baths equipped with devices able to confer kinetic energy to said fluids, said baths being equipped with appropriate two-way sections formed within their interior and thus allowing the complete recycling of the fluids involved, their mixing, possible filtering, and passage at high speed on the materials to be treated.

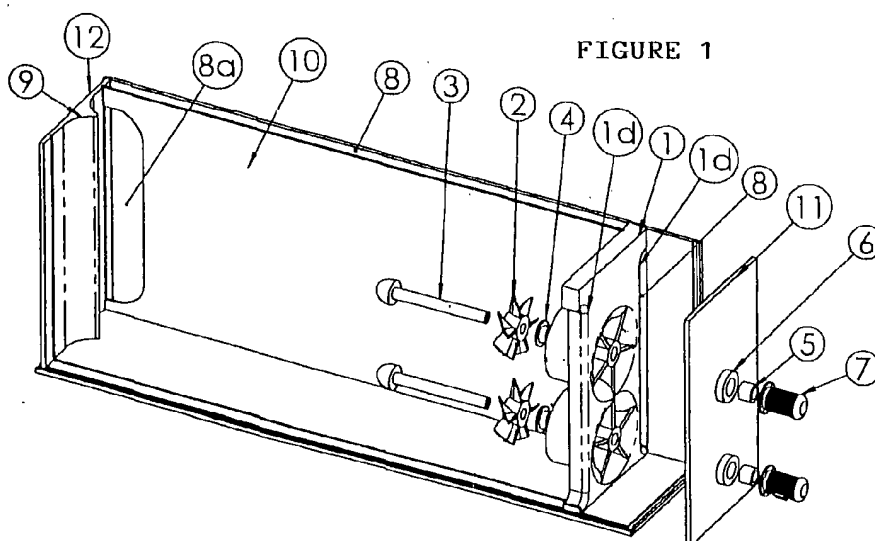


FIGURE 1

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Description

[0001] The finishing treatments for materials, in particular metallic materials, generally require that the material to be treated be subjected to one or more preliminary processing stages, commonly known as pre-treatment stages, which are addressed at "cleaning" the material and removing every layer of compound believed to be "polluting" from its surface for the subsequent operations (see for example oils, oxides, residues from previous processes etc.).

[0002] Indeed, in the case of metallic materials, such as for example steel, the crude material emerges from the steelworks with greasy residues due to the processes undergone, for example residues due to fluids used during lamination, and in addition is subjected to surface oxidation processes caused by the exposure to atmospheric agents in the storage and transportation stages. Hence, prior to undergoing the finishing treatment, it must be subjected to a series of so-called pre-treatment stages which may be outlined as follows:

- a) de-greasing
- b) pickling (removal of the oxidised layers)
- c) washing
- d) flushing

At the end of the main finishing treatment, there may also be envisaged a subsequent stage known as

- e) cooling.

[0003] As outlined above, each surface nobling operation cycle begins with the operations of degreasing and pickling, performed according to several methods, and interspaced with washing and/or other specific treatment operations according to the type of processing in question. However, all the pre-treatments tend to essentially have a single aim: the superficial cleaning of the material to be treated. By means of example, some surface nobling treatments which require the above pre-treatments are cited : hot (dip) zinc coating, galvanic zinc coating, chrome-plating, silver-plating, gold-plating, varnishing, anodisation, metalisation, phosphatisation and the like, to be applied to certain semi finished and/or finished metallic and non metallic alloy products. The state of the art, for carrying out said pre-treatments, may be sub-divided into two technologies: cleaning through a mechanical-type of action (for example sand-blasting or shot blasting) or through a chemical-type of action, *i.e.* using substances (for example hydrochloric acid, sulphuric acid, caustic soda etc.) capable of removing any "soiled" surface layers which may possibly be present on the surface of the material to be treated. For various reasons, the preparation of the materials through the use of chemical-type substances, is the most important, due to its flexibility, the lower costs of operation, plant and maintenance with respect to the treatment of the material by mechanical action. For example, a typical plant according to the known art for the

pre-treatment of material to be subjected to subsequent surface finishing, is constituted by a series of containers (tanks) (baths) in which the suitable chemical compound is to be found and into which the material to be treated is immersed, to be placed in direct contact with said chemical compound. Normally such containers (tanks) (baths) have a static mode of operation *i.e.* the surfaces of the immersed material, come into contact with the chemical substance in a motionless state, with the consequent formation, in the layer of contact between the material and the substance, of a saturated solution of salts and/or any other possible compounds deriving from the reaction between the components for elimination present on the surface of the material to be treated and the chemical compound in which said material is immersed. Said salts and/ or derived compounds, create a concentration difference around the material to be treated with respect to the mean concentration present in each container, thus inducing a notable slowing down of the treatment times in as much as there is a lack, in substance, of the continuous flow of reasonably "fresh" chemical compound. In some cases, in order to resolve this problem, methods attempting to normalise the mean overall concentration of the tank have been applied, obtaining a insignificant reduction in treatment times. Some of these methods correspond, for example, to the periodic agitation of the material immersed to be treated, to the flushing of the tank with jets of compressed air, to molecular agitation through the use of microwaves or ultrasound.

[0004] In addition, it should be considered that, in general , in surface nobling plants, it is exactly the pre-treatment plants which represent the "bottleneck" with regard to manufacturing times and, as a consequence, the costs (for example, in order to service a hot zinc deposition furnace according to the known art, also dozens of degreasing, pickling and washing tanks are installed). Indeed, depending on the degree of "dirt" to be removed from the surface of the material to be treated, the pre-treatment according to the known art may last from a few hours to even entire days and beyond, for example in the case of the treatments which envisage molecular agitation by microwaves or ultrasound, high energy expenditure and consequent raised operating costs, make them unsuited to large scale application.

AIMS OF THE INVENTION

[0005] The aim of the present invention is that of providing a process for the treatment of materials to be subjected to finishing processes (pre-treatment) which is rapid and which allows the attainment of the complete cleaning of the surface of the material in short times, independently of the conditions of the surface itself.

[0006] Another aim of the present invention is that of providing a process for the treatment of materials to be subjected to finishing processes (pre-treatment) which ensures the more or less complete mixing of the fluid

used in the pre-treatment stage with the attainment of the homogeneous mean concentration and temperature of the tank.

[0007] Another aim of the present finding is that of providing a process for the treatment of materials to be subjected to finishing processes (pre-treatment) which allows the inversion, or in any case the variation of the direction of movement of the fluid inside the tank in such a manner as to allow all the surfaces of the materials to be treated efficiently.

[0008] Another aim of the present invention is that of providing a process for the treatment of materials to be subjected to finishing processes (pre-treatment) which is adapted to all the stages of the so-called pre-treatment of the material, and may also possibly be used in any possible cooling stages, subsequent to the main finishing treatment, if envisaged.

[0009] Still the aim of the finding is that of providing a process for the treatment of materials to be subjected to finishing processes (pre-treatment) which allows the elimination of at least one of the obligatory steps according to the known art.

[0010] Another aim of the present invention is that of providing an apparatus for the pre-treatment of materials to be subjected to finishing processes (pre-treatment) which perform a rapid and effective "cleaning" action on said material.

DESCRIPTION OF THE INVENTION

[0011] These and still other aims and the relative advantages which will be better clarified from the following descriptions, are achieved by a process for the treatment of materials to be subjected to finishing processes (pre-treatment) which envisages placing said material in contact with at least one fluid in at least one container or treatment tank, said container being equipped with at least one body for the provision of reversible kinetic energy with equal output in both directions. According to the present invention, said container or tank is equipped, in its inner chamber, with at least one separating membrane, but preferably at least two, which extends for at least 50% of the length of the container itself, for example, it extends for approx. 70% of the length of the container or tank. In particular, said kinetic energy conferring body is a pump, for example with a screw propeller form type with the capacity to confer an axial and/or radial movement to the fluid.

[0012] According to one variant of the process, still according to the present invention, the containers or tanks into which the material to be treated are immersed and which contain the substance or mixture of substances through which this pre-treatment stage is carried out, are equipped with at least two pumps, each positioned on opposite sides of the container. In this case, the container will be equipped with at least two separation membranes, but preferably at least four, each of which extends for a length of less than 50% with respect to the

length of the container. In particular, each membrane extends for approx. 40% of the length of the container or tank.

[0013] The process according to the present invention, therefore allows the creation of a pre-treatment bath for materials to be subjected to subsequent finishing processes, endowed with an extremely efficient motion of the fluid contained within it and able to significantly accelerate the treatment times of the materials. Furthermore, thanks to the action of said pumps and to the simultaneous presence of said separation membranes positioned inside each container or pre-treatment tank, the agitation of the fluid is such that the treatment times no longer depend on the degree of "dirt" to be eliminated present on the surface of the piece to be treated. That means that, besides allowing a remarkable reduction in treatment times with respect to the systems according to the known art, the process according to the invention allows the treatment of pieces with differing degrees of "surface dirt" for the same amount of time, perceptibly improving the efficiency of the entire process. Indeed, according to the known art, a piece of material having surface "dirtiness" equal to 20% with respect to the standard could require shorter "cleaning" times, even by several hours, with respect to an analogous material having a surface "dirtiness" equal to 80% with respect to the same standard. With the process according to the invention, both materials would have the same treatment time, regardless of the degree of surface "dirtiness". The process according to the invention may be advantageously used for all the so-called pre-treatment stages, and also for the possible cooling stages subsequent to some finishing stages. Furthermore, being thus efficient, the process according to the finding allows avoiding, in some cases, the degreasing stage and passing directly from the crude material, to the pickling stage, with a substantial saving in terms of the time and costs of the process, besides allowing improved compactness of the plant necessary for carrying out the pre-treatments.

[0014] As already mentioned, the process according to the invention allows, a high performance recirculation in such a manner as to obtain, through the specific kinetic energy conferring bodies, coupled directly with the fluid (chemical compound) used, and by specific two way sections defined above as separation membranes, both the dispersion of areas of high concentrations of salts and/or derived compounds possibly present in the fluid-material to be treated area, and the complete mixing of the fluid used, in such a manner as to obtain a mean concentration and bath temperature as homogeneous and comprehensive as possible. In this manner, the material subjected to treatment will be continuously bathed, for example, by the chemical compound used, as reasonably "fresh" fluid, and as a consequence the actions on the surface of the material to be treated ascribed to the latter will be accelerated, with the substantial saving both in the treatment times, and in the number

of tanks installed, and as a consequence, on the management costs of the process. The speed of the fluid (chemical compound) will be differentiated within the two-way sections in such a manner as to obtain the correct values, which will be correlated, on the one hand with the dispersion of the saturated layer of salts and/or derived compounds in the fluid - surface contact area of the material, and on the other with the correct mixing or rather they will be aimed at obtaining as homogeneous and comprehensive concentration as possible. During the cycle stage, the velocity vectors may be inverted and/or directed, in such a manner as to allow bathing all the surface parts of the material to be treated with the fluid (chemical compound). During the cycle, the values for the velocity may assume, for any given time, equal to 0, depending on the chemical reaction time of the various typical compounds used for the treatment in question. In general by assuming with ρ the density or volumetric mass (kg/m^3) of the fluid (chemical compound), V the velocity (m/s) of the fluid (chemical compound), D a characteristic length (m) of the sections of fluid (chemical compound) flow and η the viscosity (kg/ms) of the fluid (chemical compound), the Reynolds number Re must be (except during the possible motionless states) equal to:

$$Re = \frac{\rho \cdot V \cdot D}{\eta}$$

and comprised between a value (dimensionless) of 1000 and 7000. Still according to the present invention, it is possible to reduce, given the increased efficiency of the system, the values of the concentrations of the chemical compounds present within the tank (bath), as well as the number of plants installed and as a consequence the surface of evaporation, in such a manner as to limit by as much as possible the danger, costs, environmental impact, during the transfer stages for the regeneration, the costs and the problems correlated with safety at work. Regarding the latter, the high performance recirculation will allow a reduction in the quantities used and the more efficient action of the chemical foaming agent additives normally used and suited to preventing the evaporation of the toxic substances present within the chemical compounds dissolved in the tank (bath). Another advantage of the process according to the invention is that of limiting the power installed suitable for controlling the kinetic energy conferring bodies or pumps.

[0015] Some graphical representations, given for non-limiting indication of the present invention are illustrated in the following.

[0016] Figures 1-2-3-4-5-6-7-8-9-10-11-12-13-14, represent, in various longitudinal sections, exploded and assembled views, plans and cross sections, a non-limiting embodiment of a container (tank) (bath) equipped with the high performance recirculating system. In figures 1-2-3-4- such a tank is represented with-

out one of the side walls and devoid of separating membrane or left duct. In figures 5-6-7-8- is represented in detail the mechanical motion conferring unit, whilst in figures 9-10-11-12-13-14 the representations comprise all the elements of the entire system. In particular it is composed (see enclosed figures 1-2-3-4-5-6-7-8-9-10-11-12-13-14) of a transversal "membrane"-1- of housing and forward support for the kinetic energy conferring body -2- for the fluid (chemical compound) contained within the tank itself and realised by a propeller with a suitable blade profile suited to imparting an axial and/or radial motion to the fluid itself. The membrane -1- carries to the fore and to the rear, special fluid inlet and outlet ducts-1 a- and -1b- concentrically to which is formed the support and rotation seat -1 c- for the transmission shaft -3- rigidly fixed to the rotor -2- and to the motor body -7-. This shaft is supported and rotates, anteriorly, on a special axle box and/or bearing -4-, and posteriorly on another special axle box -5- to which is also ascribed the role of sealing the fluid contained within the tank, housed within a special seat -6- formed through one of the front walls of the tank. Such a shaft is characterised by possessing, in the part coupling with the rotor, a particular shape -3a- having the role of direction spinner for the fluid flow. The transversal "membrane"-1- through special side ducts -1d- formed in it, form, connected with the longitudinal "membranes"-10- themselves also equipped with, but at the ends opposite from those present in the transversal membrane, special outlets, and with the anterior walls, the separate two-way sections -8-8b- for the fluid or rather the recirculation of the same or rather the separation between the area of suction and outward pumping of the kinetic energy transmission rotors. On the posterior wall -12-, or in close proximity to the outlets -8a- of the longitudinal membranes -8- is formed a special conductance contour for the fixed or moving dynamic fluid flows. In such a manner, according to the direction of rotation of the rotors, the fluid (chemical compound) present inside the tank may be driven by a longitudinal motion with a positive or negative vector (right-left) or *vice versa*, in such a manner as to allow flow along all the surfaces of the material to be treated immersed within the bath. The profile design of the rotor propellers -2- is such as to allow a fluiddynamic output in two directions, with limited tolerances of performance. The profile design of the rotor propellers -2- together with the nature of their motion (rotational velocity) likewise allow for fluid velocity conditions with Re values comprised of between 1000 and 7000.

[0017] Within the fluid recirculation duct -8- and possibly in the area between the transversal "membrane"-1- and the anterior wall -11- it is likewise possible to house an appropriate body removable, for maintenance, for the filtration of the fluid (chemical compound) in question. The materials constituting parts -1-, -2-, -3-, -4-, -5-, -6-, -9-, -10-, -11-, -12- are characterised by having high resistance to chemical corrosion due to at-

tack of the compound in direct contact with them and hence they are drawn from the category of plastics, glass and porcelain materials.

Claims

1. A process for the treatment of materials to be subjected to finishing processes (pre-treatment) which envisage placing said material in contact with at least one fluid in at least one container or treatment tank (bath), said container being equipped with at least one reversible kinetic energy conferring organ with equivalent output in both directions and is equipped, within its inner chamber, with at least one separation membrane.
2. The process according to claim 1, **characterised in that** said kinetic energy conferring organ is a pump.
3. The process according to claim 2, **characterised in that** said pump is of the screw propeller form type with the capacity for conferring an axial and/or radial motion to the fluid.
4. The process according to claim 1, **characterised in that** said separation membrane extends for at least 50% of the length of the container itself.
5. The process according to claim 4, **characterised in that** said separation membrane extends for 70% of the length of the container itself.
6. The process according to claim 1, **characterised in that** within its inner chamber is provided with at least two separation membranes.
7. The process according to claim 1, **characterised in that** said container is equipped with at least two pumps each positioned on one opposing side of said container and with at least two separation membranes.
8. The process according to claim 7, **characterised in that** each of said membranes extends for a length of less than 50% with respect to the length of the container itself.
9. The process according to claim 8, **characterised in that** each of said membranes extends for a length of equal to 40% with respect to the length of the container itself.
10. The process according to claim 7, **characterised in that** it is equipped with at least four separation membranes.
11. Use of the process according to claim 1 for the pre-treatment of materials intended for the subsequent finishing stage.
12. The process according to claim 3, **characterised in that** said screw propeller form pumps confer an axial and/or radial motion to the fluid and a velocity such as to have an Re value comprised between 1000 and 7000.
13. The process according to claim 2, **characterised in that** the transmission of motion to said pumps takes place outside of said container through couplings with coaxial elasticised joints, splines, keys, cogwheels or the like and not with respect to the shaft of the pumps themselves.
14. The process according to claim 1, **characterised in that** said separation membranes are formed in the lateral and/or lower areas of said containers.
15. The process according to claim 2, **characterised in that** the number and the arrangement of said pumps is variable said pumps being positioned casually over all the surfaces of said container.
16. The process according to claim 1, **characterised in that** the motion of the fluid, during the cycle, inverts the orientation of a velocity vector, and for brief periods assumes a value equal to zero.
17. The process according to the preceding claims, **characterised in that** it may be applied to already existing plants.
18. The process according to claim 1, **characterised in that** within said separation membranes, special fixed/moving deflectors for the regulation of the direction of said fluid flow are installed.
19. The process according to claim 1, **characterised in that** within said separation membranes are housed appropriate (removable for maintenance) fluid filtration systems.
20. A container or treatment tank (bath) for materials to be subjected to finishing processes (pre-treatment) equipped with at least one reversible kinetic energy conferring body with equivalent output in both directions and equipped, in its inner chamber, with at least one separation membrane.
21. The use of the container as per claim 20, for the pre-treatment of materials to be subjected to finishing processes.
22. Equipment for the treatment of materials to be subjected to finishing processes (pre-treatment) which

comprises at least one container or tank as per claim 20.

- 23.** Material to be subjected to finishing treatment subjected to the process as per claim 1.

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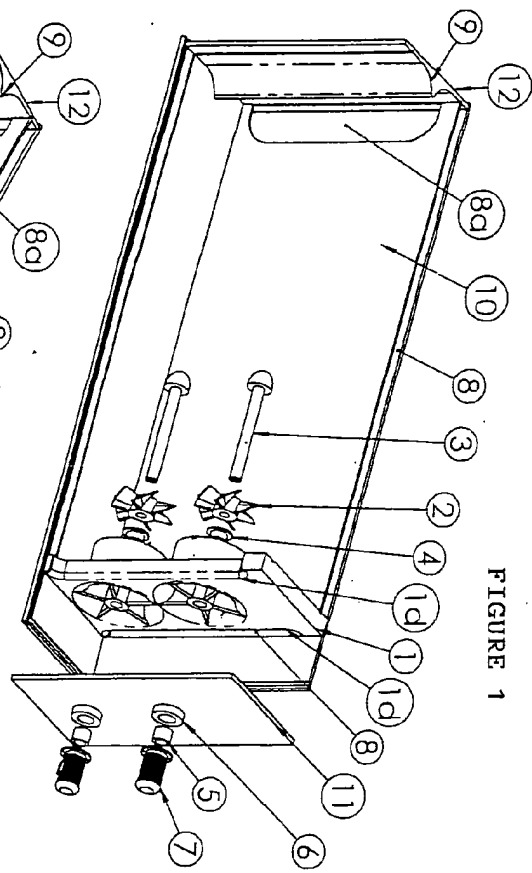


FIGURE 1

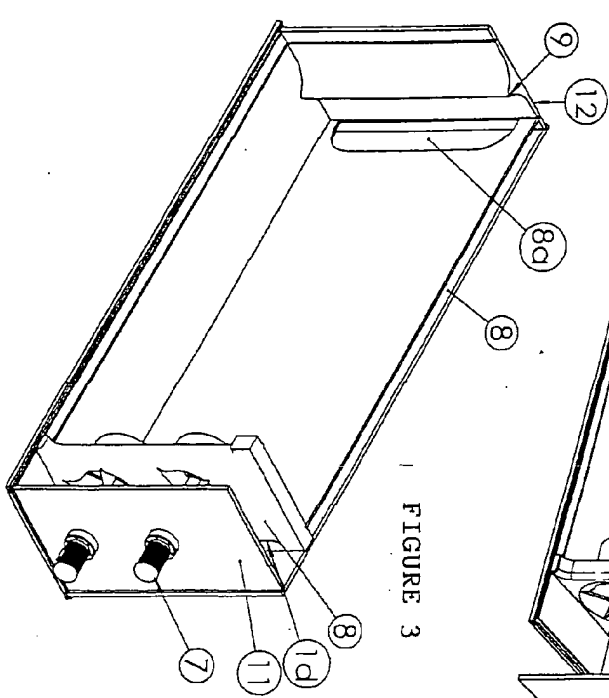


FIGURE 3

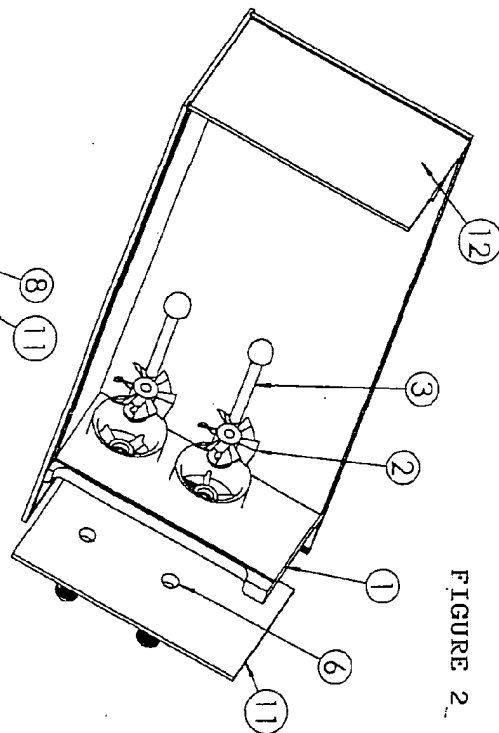


FIGURE 2

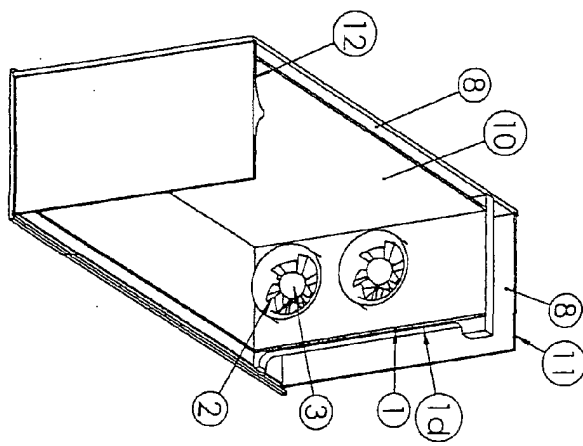


FIGURE 4

FIGURE 5

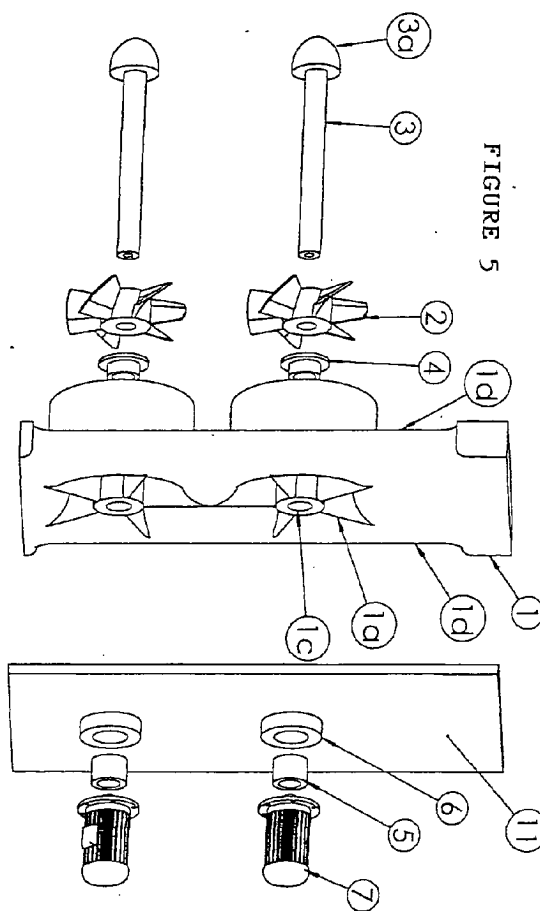


FIGURE 6

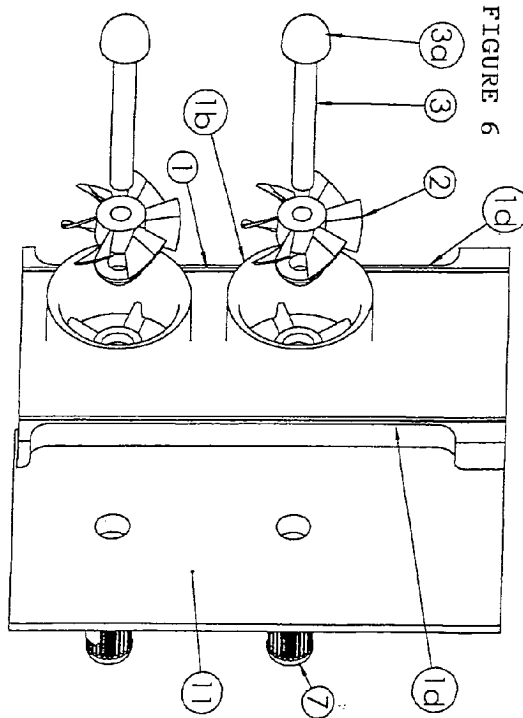


FIGURE 7

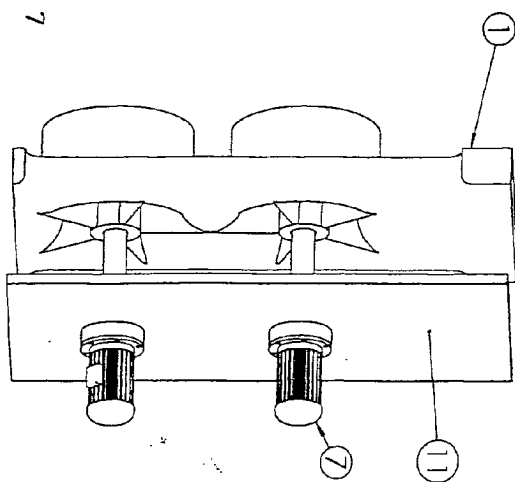
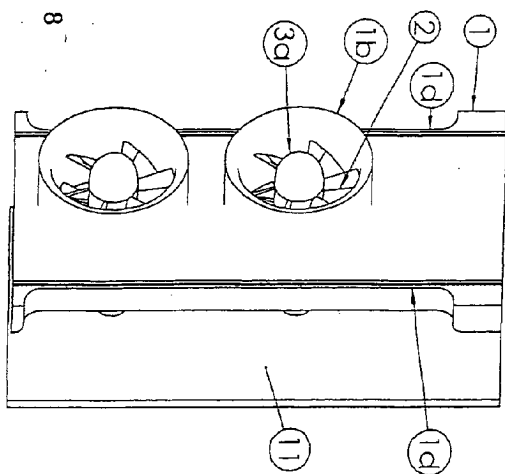


FIGURE 8



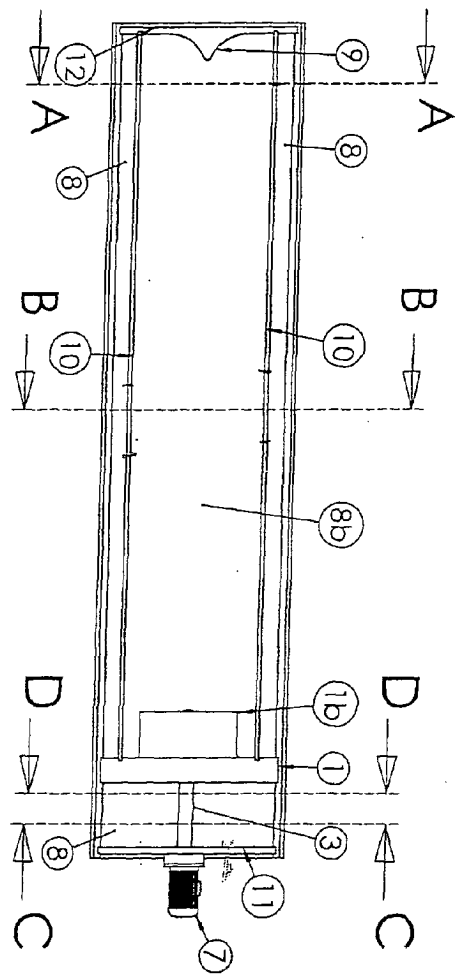


FIGURE 9

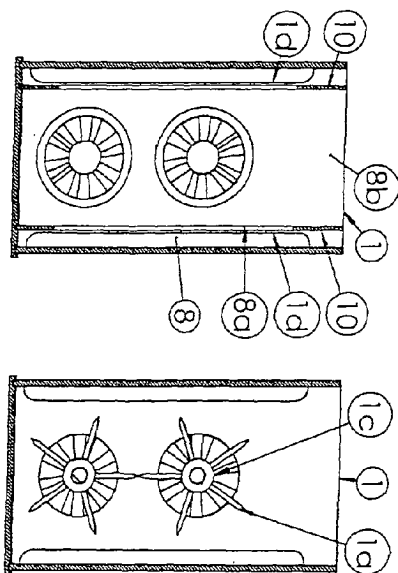


FIGURE 10 SECT.-A-A

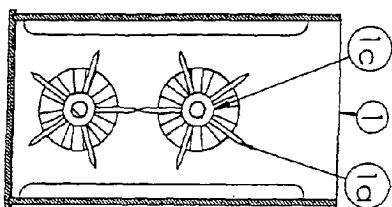


FIGURE 11 SECT.-C-C

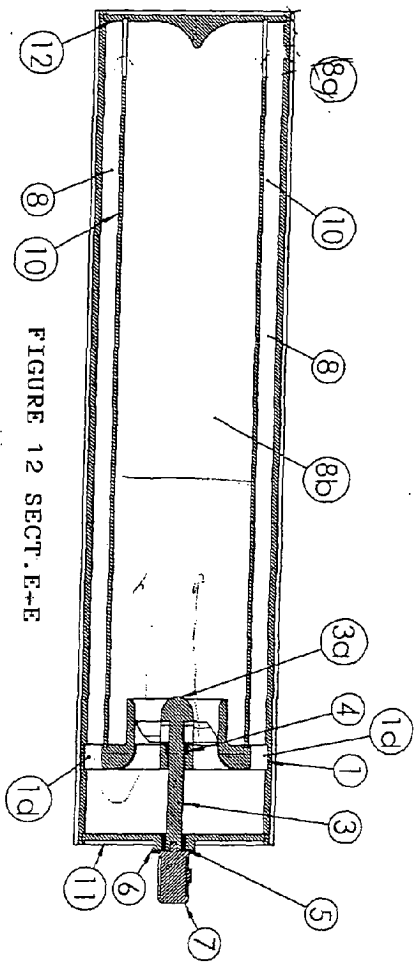


FIGURE 12 SECT.-E-E

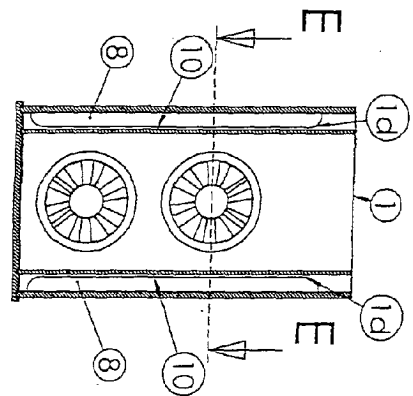


FIGURE 13 SECT.-B-B

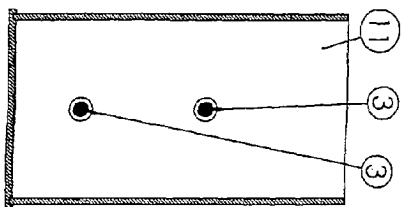


FIGURE 14 SECT.-D-D