Title: SCREW PRESS WITH INTEGRATED FILTER FUNCTION

Abstract: The present invention relates to a method for separating matter, consisting of dry fractions and liquid fractions, in at least two fractions. The liquid fractions are filtered in the process, while the dry fractions are transported and stored for further processing. Furthermore, the invention relates to the device for carrying out the inventive method as well as use of such a device in the inventive method. The invention has been developed for pressing oils from oleaginous fruits, with subsequent burning of the dry matter, but is in principle applicable for other media, for example for pressing lipids from animal products, where the dry matter could be burned or used for other applications.
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
SCREW PRESS WITH INTEGRATED FILTER FUNCTION

DESCRIPTION

5 Background of the invention

The present invention relates to a method for separating matter, consisting of dry fractions and liquid fractions, in at least two fractions. The liquid fractions are filtered in the process, while the dry fractions are transported and stored for further processing. Furthermore the invention relates to the device for carrying out the inventive method as well as use of such a device in the inventive method.

The invention has been developed for pressing oils from oleaginous fruits, with subsequent burning of the dry matter, but is in principle applicable for other media, for example for pressing lipids from animal products, where the dry matter could be burned or used for other applications.

Description of prior art

20 The separation of oil- or lipid holding matter in one or more dry fractions and one or more liquid phases, by mechanically applying pressure to the matter, is known in many applications, like piston presses, screw presses and various pump systems. The most common approach when producing plant oils, is using a screw press for the separation, followed by sedimentation of the oil phase. This is necessary as a fraction of dry matter is being expelled from the press along with the oil phase. After sedimentation, the result is an oil phase, ready for filtering, and an oil rich sediment.

25 The main part of the dry matter leaves the press elsewhere, and can be used for further processing (like chemically extracting more oil) and/or be used for animal fodder or fuel for burners.

30 During the pressing of the matter in the screw press heat will build up inside the screw press due to the forces exacted on the matter and the friction between the matter and the walls of the screw press and the screw.
The above technique is used mainly in larger production facilities with high capacity, delivering animal fodder for the agricultural sector, and oils for the food and transport industry.

Other, smaller scale production is seen on farms, were systems with down to 15-20 kg seed/hour produces protein rich fodder for animals, and were the oil is used for transport or/and heating of houses.

Common for the two described situations is, that when the press has been stopped and has cooled down, it is impossible or very difficult, to restart it, because of compressed and hardened dry matter in the compression zone of the device. Therefore, the press needs to be disassembled and cleaned after use, preferably while it is still warm from process heat.

Technical challenges

The prior art in this field makes the decentralized use of oleaginous fruits, or animal by-products, as an alternative energy source, very difficult, cumbersome, unpractical and for practical purposes un-economically viable.

The main obstacle for a widespread use of this environmentally friendly and renewable energy source in family houses, is the lack of suitable technical solutions.

The state of the art relating to the extraction of useful oils or lipids from organic matter such as for example fruits or animals, leaves the following challenges:

- In the average modern family, there are seldom animals enough (if any), to utilize the dry matter produced when making oil for heating or transport. Another use of the dry matter has to be found.

- The sedimentation process needed for the oil to be clean enough for subsequent filtering produces an oil rich sediment. This sediment becomes a waste problem, even though it has a high energy content, caused by the oil fraction. The production of this by-product must be eliminated, or reduced substantially.

- The trouble of disassembling and cleaning the press after use makes it unrealistic to use prior art devices in a decentralized, family based production. To automate the starting and stopping of the process, the need for disassembling and cleaning must be eliminated.

- Prior experience with burning oleaginous seeds such as for example rapeseed or the like in traditional burners of the “stoker” type (with automated infeed of dry matter) has
shown, that the oil is released in such a way, that it does not burn right away. Instead, it melts and runs out in places, were it proves a fire hazard, and other practical problems. Thus a unit for burning the dry matter in a safe manner, has to be developed.

Summary of the invention

The above described challenges have all been met by the invention shown in this paper. The principal solutions are described as follows.

The invention provides a novel and inventive solution to the problems stated above by providing a method which is peculiar in that a method for separating matter is disclosed, where the matter comprises a dry fraction and a liquid fraction, wherein the matter is introduced into a screw press device, where a screw arrangement is rotatably arranged inside a cylinder; where the matter is introduced into the screw device through an inlet, into an inlet zone in which inlet zone the screw arrangement has a first characteristics and that by rotation the matter is moved in a transport direction inside the screw press device to a packaging zone wherein the matter is compacted and in which zone the screw arrangement has a second characteristics, and that by further rotation the matter is transported by the screw arrangement into a filter zone in which zone the screw arrangement has a third characteristics, wherein the compacted matter is relieved of a part of or all of its liquid content, which liquid is drained off by a filter arranged integral in the inner cylinder wall where an outlet and a collection vessel is arranged in connection with the filter, after which the dry fraction and the remaining liquid fraction if any liquid is remaining in the separated matter is by further rotation of the screw arrangement transported to a pressure and press cake zone in which zone the screw arrangement has a fourth characteristics, and in which zone the matter is further compressed whereby additional liquid may be squeezed out of the matter and guided to the filter, and that by means of an outlet provided in the cylinder wall the remaining matter is forced through the outlet, whereby the matter is shaped into cylindrical pellets.

Further advantageous embodiments of the method are disclosed in the dependent claim 2.

The invention also discloses a device for use in carrying out the method, where the device is peculiar in that the device for separating a liquid fraction from a dry fraction when treating matter, comprises the following features:

- an inlet arranged in a first end of a cylinder;
- an outlet arranged in a second end of the cylinder, said second end being opposite the first end;
- a screw arrangement arranged for rotation inside said cylinder, where said screw arrangement has varying characteristics along its length;
- a filter means arranged integral with the cylinder wall at a predetermined distance from the second end of the cylinder, where said filter has a drain to a storage vessel.

Further advantageous embodiments of the inventive device are disclosed in the dependent claims 4 to 6.

The invention further concerns the use of the method and device disclosed above, and in the claims 1 to 6 in an assembly, which assembly is particular in that an assembly comprising a device according to any of claims 3 to 6, where said device operates according to the method of claims 1 and/or 2, where said assembly further comprises:
- means for providing matter to be separated to the inlet of the device, where the means may be a hopper, a feed conveyor or the like;
- means for collecting the separated liquid fraction, for example in a storage vessel;
- means for feeding a burner arrangement, such as a stoker unit, with the pellets from the nozzle and optionally also supplying all or a part of the separated liquid to the burner arrangement.

Further advantages of the assembly is disclosed in the dependent claim 8.

The invention utilizes the dry matter resulting from the oil/dry matter separation for room- and water heating, by burning it in a stoker type of burner. By making the invention relevant to households, that have no animals to feed, it opens up a new market for using oleaginous seeds and lipid rich animal waste for decentralized heating in smaller households. The resulting oil fraction can be used for additional heating through the use of an oil burner, or it can cover the households need for transportation, by using the oil in modified diesel engines.

The traditional need for sedimentation of the produced oil fraction is almost eliminated, by the principle of integrated filtering build into the press. The filtering is made possible with a screw geometry that builds up an internal pressure in the filter zone, so that the filter mesh can be much finer than seen in prior art presses. The finer the filter mesh, the lesser dry matter is expelled with the oil. The filter is designed, so the screw keeps it clean at all times, without clogging.
When most of the sediment never leaves the press with the oil, it goes with the rest of the dry matter to the stoker burner.

When the oil leaves the press, a final filtering is needed. The very small fraction of sediment settling in the filter tank, is being removed with a specially developed system of rubber scrapers, without stopping the after filtering process, and it is done at large time intervals.

The press is designed with a small diameter screw, and with very small and specific internal tolerance to the body of the press. The small diameter screw makes it possible to brake down the hardened press cake, without the press cake “floating” back, were it could block or damage the filters. The small and specific internal tolerance between the screw and surrounding body helps achieving this.

Due to this design, the need for disassembling and cleaning after use is eliminated, making it possible to automate the process. In this application the process is controlled only by the household energy need for heating. When there is a need for heating energy, the press starts and feeds the burner, and when the need is fulfilled, the process stops automatically. Igniting the dry matter in the burner is done automatically, with the use of a hot air gun, so no manual operation is needed.

The problems earlier experienced when burning oleaginous seeds in traditional stoker type burners are solved, partly by removing part of the oil phase prior to burning (with use of the press), and partly by supplying the press cake in very small portions, so that the oil cannot run out without being burned.

The filtered oil from the automated process is collected in a storage tank, ready for use in an oil burner or a modified diesel engine, or other applications.

**List of illustrations:**

The invention will now be explained with reference to the accompanying drawing, wherein:

- Illustration 1: Principal sketch of press.
- Illustration 2: Illustration of internal tolerance.
- Illustration 3: Illustration of cone shaped holes in sheet metal filter plate.
Illustration 4: Process diagram.
Illustration 5: Oil yield as function of distance between screw end and nozzle.
Illustration 6: The assembly of a preferred embodiment of the press.
Illustration 7: Illustration of the filter tank principle.
Illustration 8: Alternative embodiment for achieving packing effect in the inlet zone.
Illustration 9: Preferred embodiment of combined press, sedimentation and burner.
Illustration 10: Cross sectional cut through the press, illustrating the assembly of the press housing.

Detailed description of a preferred embodiment

On the press (ill. 1) the SCREW (02) is designed so that the seeds, running into the press though the INLET zone (A), are compressed in the PACKING zone (B), just enough to form an “airlock” for the air and oil trying to escape back through the inlet, were the pressure is lower than in the FILTER zone (C). Another alternative way of building up pressure internally in the press is illustrated in (ill.8), and described under “other preferred embodiments.

Without further compression, the seeds move on through the FILTER zone (C), and into the PRESSURE zone(D), were very high (500-1000 bar) mechanical pressure is applied to the seeds. This causes the oil to leave the dry matter, and because of the oils ability to float, it can move backwards through the “incoming” seeds, towards the lower pressure. The viscosity of the dry matter is higher, so it is captured in the PRESSURE zone (D), and pushed forwards through the NOZZLE (05) where it is formed to a pellet.

The before mentioned small and specific internal tolerance between the SCREW (02) and PRESS HOUSING (03) is defined by the differences in viscosity between the oil and the dry matter. To small tolerance will obstruct the back running of oil, and thereby reduce the yield of oil otherwise obtainable from the seeds. With rapeseeds, the internal tolerance between the screw an the press body wall has to be more than 0,1 mm, if a yield of more than approx. 20 % has to be achieved.

On the other hand, if a safe “cold start” of the press without prior cleaning is desired, the tolerance must not be too large, otherwise, the dry matter will be able to escape backwards, and block the filters, or in other ways damage them. See ill. 2 for illustration of tolerance (T).
The upper tolerance to avoid dry matter flow back depends heavily on the wanted yield, so that if a low yield is of interest, the tolerance can be larger than if a high yield is wanted. Again, with rapeseeds, it is estimated, that a tolerance above approx. 1 mm will cause cold-start problems with yields above 30%.

Cleanliness of oil and ability to cold-start is influenced by the position of the filter too, in the way that the longer the distance from the tip of the screw (8) to the filter, the safer the cold-start is, and the cleaner the oil. The distance is limited by the backflow of oil, which requires backflow pressure proportional to the distance.

Type and condition of the seeds will always have great influence on the process, hence the difficulty of giving specific figures for tolerances.

If the tolerance is designed correctly, oil yield can be adjusted within an interval, by increasing or reducing the space (pressure zone) between the tip of the screw (8) and the nozzle (5). In the present preferred embodiment, this is achieved by screwing the nozzle in or out of the press housing (See ill. 2). Using nozzles with different hole sizes makes it possible to increase or decrease yield within different intervals. See “technical details” for further description.

The oil flowing back against the direction of the seeds is moving towards the lower pressure in the FILTER zone (C). The press walls in the FILTER zone are made from sheet metal, with very finely cut holes in it. The finer the holes the oil can be made to go through, the less dry matter is expelled with the oil to give subsequent problems with sediment. Adversely, the smaller holes, the higher pressure has to be applied to ensure sufficient draining of oil. This is why building up some pressure in the FILTER zone is of interest.

Also, the more holes made, the higher oil draining capacity can be obtained. The limitation to the amount of holes in the filter material is partly technical, because there is a limit to how many holes can be produced per area unit of sheet metal. But there is also a geometrical limit, because the filter has to follow the surface of the screw, in order for the passing seeds to have a cleaning function for the filter. The screw itself does not touch the filter surface.

The filter holes are cone shaped, opening up in direction out of the press housing, to prevent clogging from expelled dry matter. This is illustrated in figure 3, where the hole size “Y” is bigger than the hole size “X”.

The cone shape is achieved, partly by the nature of laser cutting, which produces a slightly cone shaped cut, looking at the cross section of the cut. The cone shape is then opened up even more when the sheet metal plate is bent to follow the cylindrical surface of the screw. See ill. 3 for principle of filter holes.

Transferring the dry matter to the burner is done with a coreless screw of relatively small diameter, approx. 40 mm. It rotates at a speed that ensures only one pellet at a time is feed into the burner.

This gives at least two advantages; there is no pile of pellets close to the fire, so no oil is melting of. Plus, since there is plenty of extra capacity in the screw, it is possible to mix the pellets with other burnable dry matter, like grain or wood pellets on the way, through an additional supply connection.

Ignition of the dry matter during start up is obtained with a hot air pistol, started and stopped by the control unit. The use of hot air ensures efficient heat transfer to the dry matter, without the heating element touching this. This prevents dry matter from burning on to the heating element, which in case would reduce efficiency and shelf life of the heating element. The drying phase, where moisture is removed from the dry matter before ignition, is also efficient, since the hot air removes the evaporated moist immediately. The hot air also supplies the needed oxygen for the ignition. These things ensures fast efficient ignition, which is important to keep environmental pollution and smoke development at a minimum.

Caused by the internal filtering, the oil coming from the press is clean enough to go directly to final filtering, without the prior art sedimentation.

This filtering is needed, to prepare the oil for use in diesel engines or oil burners. In the present, preferred embodiment, the secondary filter unit is combining minor sedimentation with filtering, by transferring the oil to a small tank (10), wherein a filter (11) is submersed in the oil. With a small pump vacuum is applied to the clean side of the filter, and the oil passes through the filter material, while residual impurities partly settles in the bottom of the tank (10), partly is held back by the filter material. The advantages over pressure filtering are several;
- The pump transports the filtered oil away from the filter, instead of having to move the unfiltered oil into the filter unit. This gives better operating conditions, and longer life to the pump.

- When using bag type filters, the residue material stays on the outside, where part of it settles on the tank bottom, where it can be removed, without interrupting the filtering process.

- When changing the filter, a minimum of oil is lost, since the oil inside it is clean, and can be transferred directly to the storage tank.

- Absolute vacuum makes a pressure difference of only 1 bar to atmosphere, which ensures, that the filter (11), when dragged over a perforated inner body, will not collapse or puncture, no matter if it gets clogged with residue material. Hence, in case of clogging, the process simply stops, without contaminating the already filtered oil in the storage tank (10), or damaging the filter pump.

Since the filtering is an online process, needed capacity is very low, and small, cheap components can be used, making it possible to produce a complete, integrated cost efficient filtering system directly adjacent to the burner.

In the preferred embodiment, (shown in ill. 7) removal of the settled residue material is designed, so it can be removed without emptying the filter tank, or interrupting the filtering process. Caused by the sloping bottom of the tank (10), the residue settles in the half round cavity in one side of the tank. In the cavity, a rod (12) with several perpendicularly mounted discs (13) is provided. The residue (14) settles between the discs, and when removal of residue is needed, the rod is pulled through the side of the tank, the residue is scraped out, and the rod is pushed back in. To prevent the oil (16) from running out during residue removal, a piece of tube is placed over the hole in the outside of the tank. The length of the tube being an outlet cylinder (15) corresponds at least to the distance between the discs on the rod, so there is always at least one disc in the tube, blocking for the oil. Hence, the residue can be removed when needed, without interfering with the filtering process.

The filter (11) is placed in a vertical position, inside a tube (17) that has an open bottom placed under the oil level (16), so that when a vacuum is applied to the inside of the filter, the oil is sucked up in the tube, and through the filter material. In this way, the sedimentation process goes on all the way up through the column formed by the tube, while the sedimented material goes down into the sedimentation tank, where it is removed as described.
An overall flow diagram of the combined processes in the preferred embodiment is shown in ill. 4.

**An applied example**

A house having a floor surface of 150 m² is provided with a central heating unit that supplies room heating and warm water for the household.

Press capacity: 2.5 kg rapeseed/hour, total released effect from seed, approx. 16 kW.

With press yield adjusted at 10 % oil, 0.25 kg/hour oil is produced, which will take a modified diesel car 4.5 km at 17 km/ltr.

2.25 kg press cake is produced, and with a high content of residue oil, the released effect in the burner is 14.5 kW.

When more oil for transport is needed, the oil yield is increased:

Press yield adjusted to 35 %, 0.875 kg oil/hour is produced, taking the mentioned diesel car 15.8 km.

Press cake equalling 8.4 kW released effect in the burner is produced.

With the given characteristics of the system, it is possible to make a system setup that covers a very large portion of the households, equipped with a central heating system and a need for daily transportation. Different system capacity can be obtained through changing press screw or rotational speed of press screw.

Since the system only operates, when there is a need for heating energy, there is no need for storage of the press cake, which has a short shelf life. Instead, the energy is kept as seeds, a stable solution for energy storage, because from nature’s hand, the seed is “designed” for containing the energy, for years under the right conditions. Furthermore, the density of energy on this form is so high, that 10 m³ of storage space is enough for one year’s energy consumption in most households. This means, that the energy needed can be purchased once a year, at the time where it is cheapest, normally at harvest. Transported directly from the field to the final storage place, this makes the shortest, most environmentally friendly energy chain possible.
If the same energy was kept as wooden pellets, the 10 m³ storage place would have to be refilled 2-3 times a year, and you would have to by energy at times, where it is not cheapest. Also transportation costs would be higher.

The oil resulting from the process is stored in a tank, ready for use in a modified diesel engine. Kept in a cool, dark place, the oil has a shelf life of at least a year.

**Other preferred embodiments**

1. The above mentioned internal tolerance can be obtained either by reducing the screw diameter as described, or the same effect could be obtained by enlarging the housing. In both cases, yield will go up, until press cake goes back and blocks the filters.

2. The yield develops like the curve in **ill. 5**, as a function of the distance between screw end and nozzle.

3. When running the system with the burner, achieving the highest possible yield is normally not relevant. Instead, the screw is designed, and the press is adjusted, so that the amount of oil produced equals the need for transportation, while the rest of the oil goes with the press cake into the burner, where it is transformed to heating energy.

4. In one preferred embodiment, **ill. 6**, the press is mounted with the screw in an upright position, with the transport direction downwards. In this case, oil filters (4) can be effective along the whole perimeter of the press housing (3), which approximately doubles the filter area. When placed in a horizontal position, the filter area on the top of the housing (3) is not as efficient as the filter area in the bottom of the housing. Also, in the upright position, gravity helps increasing the oil pressure inside the housing, so smaller filter holes can be used, giving better oil quality.

5. To ensure good transportation through the press, it is important to ensure that no seed is rotating with the screw. Therefore, an important function for the internal surface in the housing (3) is, to prevent any radial movement of the incoming seed, an make as little resistance to axial movement as possible. In a preferred embodiment, this is obtained by riffling the internal surface of the housing. The rifling can be straight, longitudinal tracks, or helix shaped, to further improve seed movement.

6. In **ill. 6** the press housing (3) is made from 2 identical halves, that are bolted together. This construction makes access to the internal press housing easy while manufacturing the press housing, and makes cleaning and inspection quick and easy. In a preferred embodiment, the back end of the press halves is locked together in an opening in the bearing housing (18), while the front end is held together with 4 screws (19) mounted in open
slots, so the screws are released and removable with only half a turn counter clockwise. Hence, complete disassembly of the press can be done in a matter of seconds.

7. The present design is modular, in the way that placing more than one screw in the same block is easy. Multiple screws operating by the same transmission gives higher capacities, without compromising cold-start abilities, and general optimisation, since the same screw/housing design can be reused.

8. The mentioned automatic ignition of the dry matter in the burner can be obtained with electrical heat as mentioned elsewhere, but another applicable method is integrating an oil burner in the system, preferably but not exclusively a burner operating on the oil produced by the press. This burner can then be used for igniting the dry matter, but can also produce the heating energy needed, in the case where operation of the press is not of interest, or additional capacity is needed.

9. The described packing effect in the press can also be obtained as shown in ill. 8, by introducing a toothed belt (20) in conjunction with the press screw. The teeth of the belt have a convex surface, making a perfect fit with at least part of the screw surface, which has a concave shape packing against the screw core.
CLAIMS

1. Method for separating matter, where the matter comprises a dry fraction and a liquid fraction, wherein the matter is introduced into a screw press device, where a screw arrangement is rotatably arranged inside a cylinder; where the matter is introduced into the screw device through an inlet, into an inlet zone in which inlet zone the screw arrangement has a first characteristics and that by rotation the matter is moved in a transport direction inside the screw press device to a packaging zone wherein the matter is compacted and in which zone the screw arrangement has a second characteristics, and that by further rotation the matter is transported by the screw arrangement into a filter zone in which zone the screw arrangement has a third characteristics, wherein the compacted matter is relieved of a part of or all of its liquid content, which liquid is drained off by a filter arranged integral in the inner cylinder wall where an outlet and a collection vessel is arranged in connection with the filter, after which the dry fraction and the remaining liquid fraction if any liquid is remaining in the separated matter is by further rotation of the screw arrangement transported to a pressure and press cake zone in which zone the screw arrangement has a fourth characteristics, and in which zone the matter is further compressed whereby additional liquid may be squeezed out of the matter and guided to the filter, and that by means of an outlet provided in the cylinder wall the remaining matter is forced through the outlet, whereby the matter is shaped into cylindrical pellets.

2. Method according to claim 1 wherein the pressure applied to the matter in the screw press device is adjustable, either by utilising a screw arrangement having different third and/or fourth characteristics or by adjusting a free volume provided between the outlet and the end of the screw arrangement.

3. Device for separating a liquid fraction from a dry fraction when treating matter, where the device comprises:
   - an inlet arranged in a first end of a cylinder;
   - an outlet arranged in a second end of the cylinder, said second end being opposite the first end;
   - a screw arrangement arranged for rotation inside said cylinder, where said screw arrangement has varying characteristics along its length;
   - a filter means arranged integral with the cylinder wall at a predetermined distance from the second end of the cylinder, where said filter has a drain to a storage vessel.
4. Device according to claim 3 characterised in that the filter comprises a sheet in which sheet a plurality of apertures are formed, where each aperture has a smaller opening area facing the inside of the cylinder, and a larger opening facing away from the cylinder, and that said sheet comprises means for being fastened to the interior wall of the cylinder.

5. Device according to claim 3 characterised in that the outlet is in the shape of a nozzle, which nozzle is arranged coaxially with the rotation axis of the screw arrangement, and that between the end of the screw arrangement and the nozzle a free volume is arranged, and that further the free volume may be adjusted, by moving the nozzle relative to the end of the screw arrangement.

6. Device according to any of claims 3 to 5 characterised in that a secondary filter and sedimentation unit is arranged between the filter and the storage vessel, where said secondary filter and sedimentation unit comprises an inlet which is connected with a tank;
   - where the tank has four side walls, and that the walls of two opposing sides converge towards the bottom of the tank, and that at the bottom of the tank a rod having discs arranged at intervals along a substantial part of the rod is provided;
   - that the discs has a shape corresponding to the shape of the bottom where the two converging side walls meet;
   - and an outlet cylinder having a length at least corresponding to the distance between two discs arranged on the rod, is arranged outside the tank corresponding in shape to the discs, where said outlet is arranged such that the rod may be pulled/pushed through the outlet cylinder, whereby the discs will seal the interior from the exterior of the tank, and whereby any sediments at the bottom of the tank will be scraped out of the tank by the discs.

7. Assembly comprising a device according to any of claims 3 to 6, where said device operates according to the method of claims 1 and/or 2, where said assembly further comprises:
   - means for providing matter to be separated to the inlet of the device, where the means may be a hopper, a feed conveyor or the like;
   - means for collecting the separated liquid fraction, for example in a storage vessel;
   - means for feeding a burner arrangement, such as a stoker unit, with the pellets from the nozzle and optionally also supplying all or a part of the separated liquid to the burner arrangement.
8. Assembly according to claim 7 where the matter is rapeseed and that the liquid fraction is a combustible oil, where said oil after having passed a secondary sedimentation and filtering unit may be used as an alternative fuel for internal combustion engines and/or as fuel source for the stoker burner.
Illustration 4.

Illustration 5
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B30B9/12 B01D29/82

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 B01D B30B

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

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 4 024 168 A (HOMANN ET AL) 17 May 1977 (1977-05-17) figure 2</td>
<td>3-5</td>
</tr>
<tr>
<td>A</td>
<td>GB 1 000 773 A (STANLEY HILLER) 4 March 1963 (1963-03-04) figures 1,2 page 6</td>
<td>1,3</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents:
* A* document defining the general state of the art which is not considered to be of particular relevance
* E* earlier document but published on or after the International filing date
* L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
* O* document referring to an oral disclosure, use, exhibition or other means
* P* document published prior to the international filing date but later than the priority date claimed

* T* later document published after the International filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
* X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
* Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
* S* document member of the same patent family

Date of the actual completion of the International search: 12 April 2005

Date of mailing of the International search report: 19/04/2005

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel: (+31-70) 940-2040, Tx: 31 651 epo nl, Fax: (+31-70) 940-3016

Authorized officer

Hilt, D
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>KR 189808 Y1</td>
<td>01-08-2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 9926493 A1</td>
<td>03-06-1999</td>
</tr>
<tr>
<td>GB 1000773</td>
<td>A</td>
<td>NONE</td>
<td></td>
</tr>
</tbody>
</table>