



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
10.11.2010 Bulletin 2010/45

(51) Int Cl.:
C11B 1/06 (2006.01) **C11B 1/02** (2006.01)
B30B 9/12 (2006.01)

(21) Application number: **10161927.8**

(22) Date of filing: **04.05.2010**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
BA ME RS

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(30) Priority: **08.05.2009 IT MC20090104**

(54) **High-efficiency kneading system for olives**

(57) The present invention relates to a high-efficiency kneading system for olives, wherein the olive paste

coming from a crushing station (F) is heated in a conveyor device (1) designed to transfer it towards the kneading station (10).

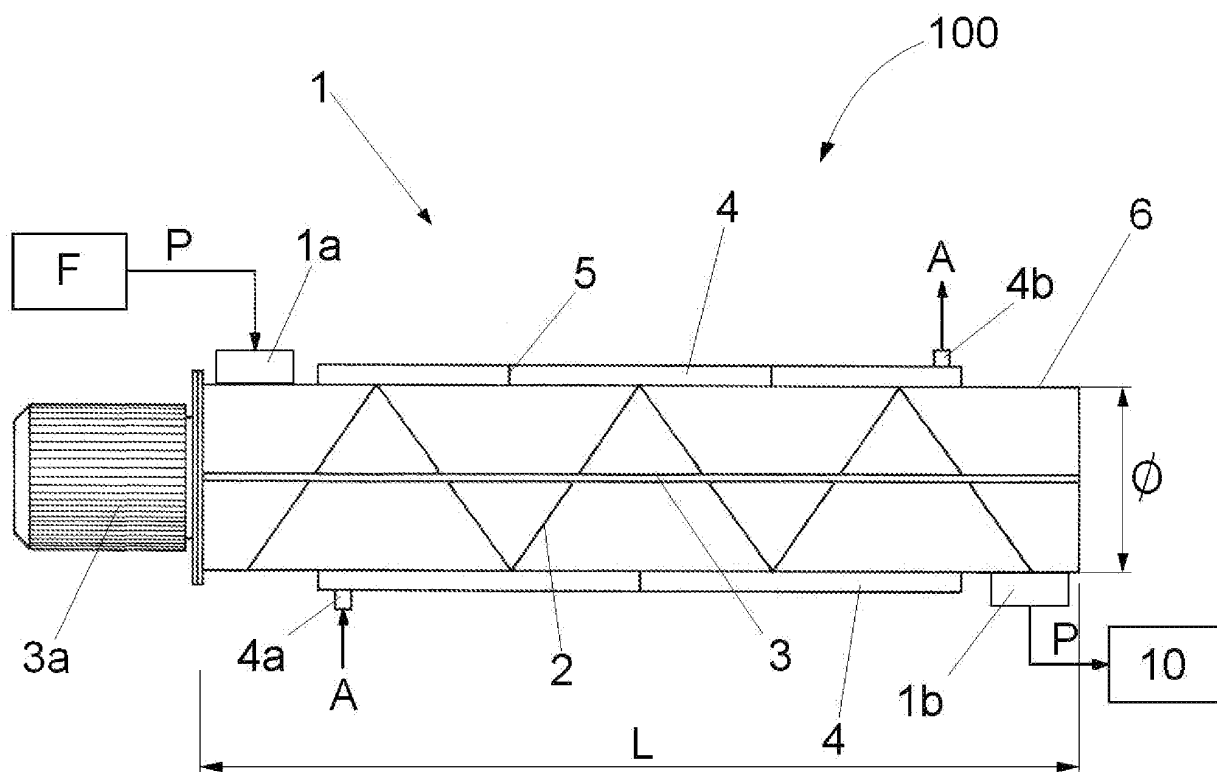


FIG. 1

Description

[0001] The present patent application for industrial invention relates to a high-efficiency kneading system for olives.

[0002] The peculiarities and advantages of the present invention will become evident following to a description of the prior art.

[0003] As it is known, olive processing for oil production is traditionally composed of three operating phases, called crushing, kneading and oil extraction.

[0004] The crushing phase is used to break olives in the desired size and generate the formation of "raw" olive paste.

[0005] To that purpose, crushers normally available on the market are used, the most popular one being probably the so-called hammer crusher.

[0006] Kneading is the second operating phase, which comprises heating, mixing and most of all, as main purpose, formation of olive paste from which oil can be easily separated from de-oiled residues (the latter being composed of a liquid part, called vegetable water, and a semi-solid part, called pomace and essentially containing crushed pits and pulp).

[0007] During the last phase of the operating process oil is extracted from the previously processed product, mainly using centrifugation devices.

[0008] In particular, a similar operation is composed of two consecutive phases, i.e. refinement and finishing.

[0009] An especially critical aspect has been identified within such a consolidated technology during the kneading phase.

[0010] However, in order to illustrate the specific problem, it is necessary to describe the traditional execution mode of this specific operating phase in details.

[0011] According to the traditional art, kneading is carried out in a "kneader reactor", consisting in a cylindrical or semi cylindrical tank with horizontal direction in which raw olive paste that has been previously obtained remains for a period of time normally comprised between 30 and 90 minutes.

[0012] In such a period of time the paste is continuously mixed by a series of blades joined to a rotating shaft coaxial to the cylinder or semi cylinder of the tank. The blades are disposed according to a typical arrangement, in such a way to guarantee maximum movement of the paste inside said kneader, without causing any forward movement or transportation of the paste.

[0013] Moreover, the external lateral area of such a kneader is provided with a space designed to heat the olive paste loaded inside it by means of hot water circulation. The heating of the olive paste guarantees the best result of the kneading process.

[0014] It must be noted that, inside each olive, oil is contained in microscopic membrane sacs, called vacuoles, which cannot be appropriately broken by crushing alone. Kneading is necessary in order to break the membranes of the vacuoles, heat the oil reducing its viscosity,

in such a way to make extraction of oil from the olive paste easier, and increase the size of drops by coalescence.

[0015] It must be noted that the breaking of the membranes is completed through the combined effect of a mechanical action (caused by the action of the rotating blades on the olive paste) and a chemical action (favoured by the enzymes contained in the olives). Both actions are favoured by the temperature increase of the olive paste inside the kneader, which favours the reduction of viscosity of olive paste and oil in order to facilitate oil extraction from the membranes.

[0016] The above explains the consolidated need to heat the walls of traditional kneaders with hot water circulation. The increase of the radial dimensions of the kneader corresponds to a reduction of the heat transfer area in relation to the mass of olive paste, thus extending the time necessary for efficient kneading.

[0017] Kneading temperature is normally fixed according to the variety and ripening status of the olives and to oil quality. The duration of the kneading phase is determined by the time necessary to make oil emerge on the paste during kneading. Such emergence of oil on olive paste indicates a profitable separation of oil from paste.

[0018] With very good olives, in order to obtain good oil, the temperature of the paste during kneading must be approximately 30-35°C, and in any case not higher than human body temperature. In order to obtain cold-extracted oil, the Italian legislation establishes a kneading temperature not higher than 27°C. Therefore, considering that generally the temperature of olive paste from crushing does not exceed 17°C, the olive paste inside the kneading tank must suffer a thermal gradient of at least 10°C to achieve efficient kneading.

[0019] The aforementioned critical aspect of the traditional technology consists in the fact that the current permanence time of olive paste in the tank of a kneader (comprised between 30 and 90 minutes) is objectively excessive. Lamentably, the long permanence of the olive paste inside the kneader extends the total duration of the entire oil extraction process.

[0020] Moreover, the prolonged permanence in a heated environment tends to favour the onset of dangerous chemical and enzymatic reactions in the olive paste (with consequent oil peroxidation) that may jeopardise the quality of the oil obtained from the entire process due to the development of aliphatic alcohols.

[0021] Nevertheless, no solution has been found so far to considerably reduce the permanence time of olive paste inside a traditional kneader.

[0022] In particular, such a possibility seems to be prevented because of the unfavourable ratio between the mass of olive paste contained in the kneader tank and the reduced area of heat transfer between paste and heating water. It must be considered that in all known kneaders the heating action is generated only in the walls of the tanks, directly affecting only the "peripheral" areas of the mixed mass, and not the centre of said mass.

[0023] In view of the above, only a prolonged and repeated mixing by means of rotating blades can guarantee that the entire mass of olive paste homogeneously absorbs the heat emitted by the heated walls of the kneader tank.

[0024] On the other hand, it would be impossible to accelerate such a process, imposing a higher revolution speed to the shaft responsible for rotation of said rotating blades, since in such a case the olive paste would favour undesired emulsion between vegetable water contained in olives and oil, that is to say the contrary effect compared to the desired effect of kneading.

[0025] The Spanish patent application ES 438 927 discloses a system for olive oil production comprising a crushing station that feeds the olive paste with pit to a pre-kneader. A screw conveyor transports the olive paste, which is partially kneaded by the pre-kneader, to a kneading station where the paste is subjected to final kneading. The pre-kneader acts as "lung" and the olive paste inside the pre-kneader is subjected to a first kneading by means of the blades of the pre-kneader.

[0026] As it is known, the blades of the pre-kneader are identical to the blades of the kneader and must knead the paste, without transporting it. Transportation of paste from pre-kneader to kneader is carried out by a small screw conveyor with horizontal axis arranged under pre-kneader and by a longer screw conveyor with vertical axis downstream the pre-kneader.

[0027] If the pre-kneader is heated, as it is known in the art, the olive paste passing through the two screw conveyors cools down by heat transfer with the external area of the conveyor. In any case, as it is known in the art, the diameter of the pre-kneader tank is usually the same as the diameter of the kneading tanks. Consequently, both in pre-kneader and kneader, the heat transfer between the heated area of tank and olive paste subjected to kneading is not efficient. Therefore, the olive paste must remain for a long period of time in the pre-kneader and/or kneader to achieve the ideal working temperature that favours kneading. It is evident that such a system provides for a very long working cycle, due to the high permanence time of olive paste both in pre-kneader and kneader.

[0028] The British patent application GB 711 352 discloses an oil production system, especially studied for fish-liver oil. Although such a document refers to olive oil, it is evident that it refers to olive paste diluted with oil and without pits. Said system comprises a tank containing the oleous liquid material that is fed to a homogenizer and a centrifugation device. A plate heat exchanger (the heating fluid is not specified) or steam heat exchanger (with direct contact of steam with oleous liquid) can be installed upstream or downstream the homogenizer.

[0029] The homogenizer is of turbulent whirl type. The oleous liquid is fed to the exchanger by means of a pump. Said system is not suitable for olive oil processing with paste containing olive pits. In fact, because of the presence of pits, said paste cannot be fed with a pump into

a plate exchanger since it would clog up the exchanger. Moreover, the paste would be subjected to an excessive thermal shock. Similarly, in case of a steam exchanger, the olive paste must not get in direct contact with the steam. The turbulent whirl homogenizer cannot be used for olive paste because it is impossible to use said turbulent whirl homogenizer with olive paste. Moreover, the homogenizer would cause the undesired emulsion of paste before centrifugation.

[0030] The US patent US4,522,119 discloses a system to extract olive oil from pulp after pit separation. The pulp without pit is heated from 27 to 44 °C in a shell and tube heater and then sent to a screw extractor that extracts the liquid part. It is evident that such a system is not suitable for olive pulp with pit. In fact, a shell and tube heater cannot be used because of clogging problems. Additionally, a screw extractor cannot be used because it cannot hold solids with respect to oil (in practical terms, it cannot make separation).

[0031] A critical evaluation of the prior technique has led to devise the new system of the invention, wherein the peculiar inventive idea consists in the decision to heat olive paste with pit from crushing, at a different time and in a different environment with respect to those typically dedicated to kneading by means of a (blade) kneader.

[0032] In such a case, the paste that is poured in traditional kneaders would already be at a higher temperature than the typical temperature of the paste when entering the kneader. Said temperature would be obtained in less time than in the kneader, thus ensuring the good quality of kneading, which could be carried out rapidly without requiring a long permanence of the mass (due to the slowness of the heating operation inside the kneader). Obviously, the reduction of permanence time of the olive mass inside a kneader involves the double advantage of accelerating the execution of the entire oil extraction process and preventing the olive paste from being subjected to the aforementioned degenerative chemical reactions.

[0033] The pre-heating of the olive paste poured in traditional kneaders does not exclude the use of the typical heating space in kneader walls.

[0034] In the case of the process of the invention, however, the function of said heating walls is no longer to entirely carry out the necessary heating of the mass to be kneaded, but only to prevent said mass from losing, throughout the short permanence in the kneader, the temperature that it has previously achieved during the transfer from the crushing station.

[0035] For the implementation of such an inventive idea, a device has been devised, which is used to both transfer (from the crushing station to the kneading station) and heat the olive paste.

[0036] More precisely, it is a screw conveyor with closed tubular structure, the walls of which are provided with a space for hot water circulation with high ratio between exchange area and mass of olive paste. It is understood that the olive paste travelling along said con-

veyor is subjected to sudden, efficient and homogeneous heating because of the high ratio between exchange area and mass of the olive paste.

[0037] Such an advantageous effect is generated not only because said conveyor has a closed tubular structure, which minimizes heat dispersion, but also because of its reduced cross-section in order to optimize the ratio between the volume of the forward-travelling olive paste and the area of its heated walls. Also the mixing imposed to the forward-travelling olive paste by the turns of the screw contributes to ideal heating of said paste.

[0038] In order to maximize the advantageous heating effect, the shaft of said screw conveyor could be given a tubular structure in order for it to be crossed by a hot water flow. In such a way, the heat that affects the shaft directly would be also transferred to the turns of the screw conveyor. This would bring the heat to the centre of the forward-travelling olive paste, thus improving heat transfer and achieving more homogeneous heating between "central" and "peripheral" areas of the paste.

[0039] Moreover, helicoidal partitions or multiple continuous helicoidal surfaces (auger with multiple threads) could be inserted inside said space. In such a way, with the same capacity, hot water would have higher speed on the exchange wall, thus ensuring a higher heat transfer coefficient through the wall that separates the paste from hot water, and consequently, a higher heating action.

[0040] Moreover, the loading of olive paste inside the screw conveyor could be made under pressure by means of a suitable pump. The thrust given by said pump to each insertion of olive paste in the conveyor would favour the expulsion of the previously loaded quantity of olive paste and, most of all, prevent the formation of stagnation or incrustations of said paste on the conveyor walls.

[0041] Finally, it must be noted that said conveyor device for olive paste heating can be also made of multiple parts (or sections) arranged in series, in order to increase the differential thermal gradient of the paste between inlet and outlet in such an embodiment of the conveyor of the invention.

[0042] For purposes of clarity, the description of the invention continues with reference to the enclosed drawing, which is intended for purposes of illustration only and not in a limiting sense, wherein:

Figure 1 is a diagrammatic view of the system of the invention;

Fig. 2 is a cross-sectional view of a kneading tank of the system of Fig. 1.

[0043] Referring to Fig. 1, the system of the invention, which is generally indicated with numeral (100), comprises:

- a crushing station (F) to crush olives and obtain a paste (P) composed of pulp and olive pit,
- a kneading station (10) to knead paste (P), and

- a conveyor device (1) to transport the paste (P) from the crushing station (F) to the kneading station (10).

[0044] The crushing station (F) is of traditional type and may comprise a hammer crusher.

[0045] The kneading station is of traditional type and, as shown in Fig. 2, comprises at least a basically cylindrical tank (11) with rotating blade (12) supported by a shaft (13) arranged in axial position in the tank. The blades mix the paste (P) that remains in the tank (11) until the vacuoles of the pulp are completely broken at a temperature of about 27-35°C. To allow for correct kneading, the tank (11) generally has an external diameter of approximately 60 cm and a length of approximately 2-3 m.

[0046] The conveyor (1) combines the aforementioned capacity of conveying the olive paste (P) with the function of subjecting said olive paste (P) to efficacious homogeneous heating, which is useful to guarantee the ideal rapid execution of kneading.

[0047] The conveyor (1) comprises a cylindrical pipe (6) that houses a worm conveyor (2), the bearing shaft of which (3) is actuated by a suitable motor reducer (3a) and practically extends from one end to the other end of the conveyor (1).

[0048] The conveyor (1) comprises an inlet mouth (1a) to load the olive paste (P) coming from the crushing station (F) and an outlet mouth (1b) to unload the olive paste (P) towards said kneading station (10).

[0049] The main peculiarity of the conveyor (1) is that it is provided on the lateral walls with a space (4) to favour hot water circulation (A) provided by means of an inlet union (4a) and an outlet union (4b) at the ends of the space (4). The hot water circulation (A) guarantees a hot water temperature of approximately 35-40°C. In fact, a higher temperature would cause excessive thermal shock to the olive paste (P).

[0050] The continuous circulation of hot water inside the space (4) of the conveyor of the invention (1) ensures the desired heating of the olive paste that travels forwards inside it. Advantageously, the space (4) is provided with helicoidal partitions (5).

[0051] Advantageously, the shaft (3) of the worm conveyor has an internally empty tubular structure and is crossed by hot water in order to heat also the central part of the flow of olive paste (P) transported by the conveyor (1).

[0052] Advantageously, the system may be provided with a pump upstream the conveyor (1) to press the paste (P) inside the conveyor. The pressure of the paste inside the conveyor allows the paste to transit in full conveyor condition to guarantee better heat transfer with the heated walls.

[0053] Advantageously, the pipe (6) of the conveyor has internal diameter (Φ) lower than half of the internal diameter of the kneading tank (11), preferably one third of the diameter of the kneading tank.

[0054] The pipe (6) of the conveyor has length (L) high-

er than four metres, preferably six metres, to allow for suitable heating of the paste (P) inside the conveyor, with thermal gradient of about 10°C from the inlet to the outlet of the conveyor, in a very short transit time, for instance 1-2 minutes.

[0055] In view of the above the paste (P) reaches the kneading station (10) at an ideal temperature of about 20-30°C and kneading is shorter, approximately 10-20 minutes, with consequent energy and time saving.

Claims

1. High-efficiency kneading system (100) for olives, comprising:

- a crushing station (F) to crush olives and obtain a paste (P) composed of pulp and olive pit,
- a kneading station (10) comprising at least one basically cylindrical tank (11) with rotating blades (12) supported by a shaft (13) arranged in axial position in the tank to knead the paste (P), and

- a conveyor device (1) comprising a cylindrical tubular structure (6) that houses a worm conveyor (2) provided with bearing shaft (3) actuated by a corresponding motor reducer (3a); said conveyor device (1) comprising an inlet mouth (1 a) to load olive paste (P) coming from the crushing station (F) and an outlet mouth (1 b) to unload the olive paste (P) towards the kneading station (10),

characterized in that

in correspondence of its walls said conveyor device (1) comprises a space (4) for hot water circulation (A) because of the presence of an inlet union (4a) and an outlet union (4b) inserted at the ends of said space (4) to homogeneously and rapidly heat the olive paste (P) fed to said kneading station (10).

2. System as claimed in claim 1, **characterized in that** said cylindrical tubular structure (6) of the conveyor has internal diameter (Φ) lower than half of the internal diameter of the kneading tank (11).

3. System as claimed in claim 1 or 2, **characterized in that** said cylindrical tubular structure (6) of the conveyor has length (L) higher than four metres.

4. System as claimed in any one of the above claims, **characterized in that** said hot water circulation in the space (5) of the conveyor is arranged in such a way to maintain water temperature of approximately 35-40°C.

5. System as claimed in any one of the above claims, **characterized in that** said conveyor device (1) is

formed of multiple parts in serial arrangement.

6. System as claimed in any one of the above claims, **characterized in that** the bearing shaft (3) of the worm conveyor (2) is internally empty and provided with hot water circulation because of the presence of corresponding inlet and outlet unions.

7. System as claimed in one or more of the above claims, **characterized in that** said conveyor device (1) is assisted by a pump for pressurised loading through said inlet mouth (1 a) of the olive paste (P) coming from the crushing station (F).

8. System according to one or more of the above claims, **characterized in that** the conveyor device (1) is provided, inside the space (4), with continuous or discontinuous helicoidal partitions (5) and/or continuous single or multiple helicoidal surfaces.

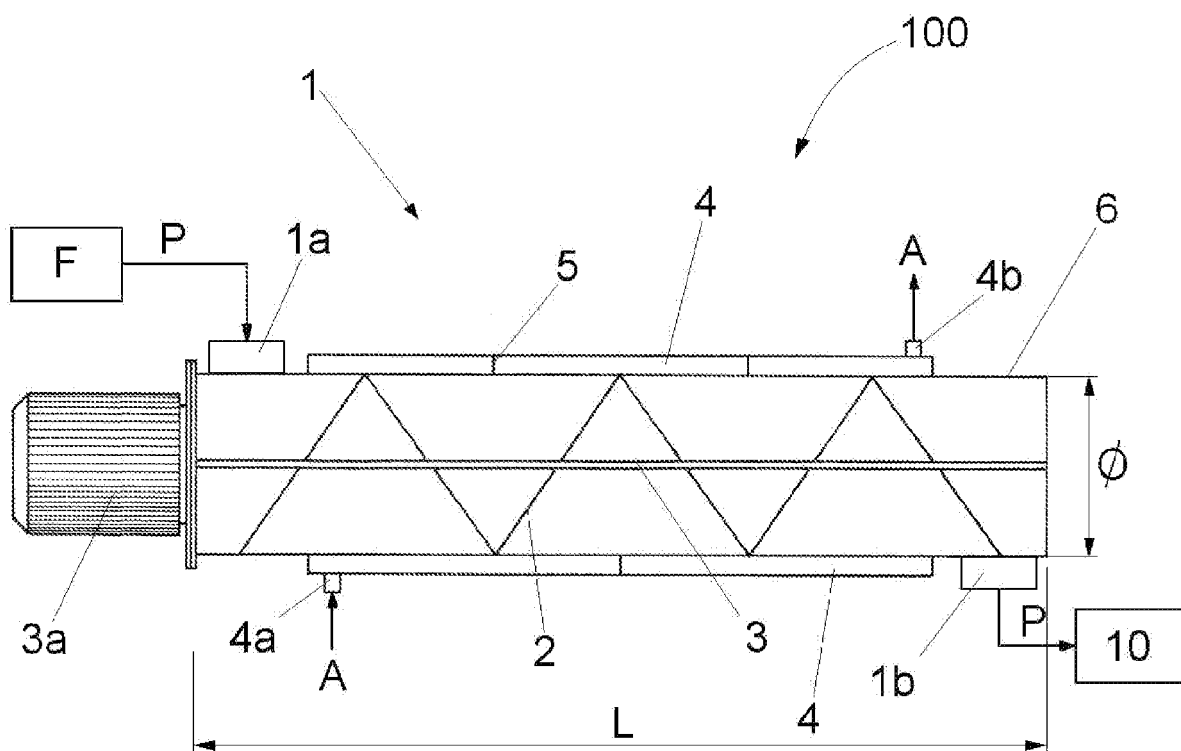


FIG. 1

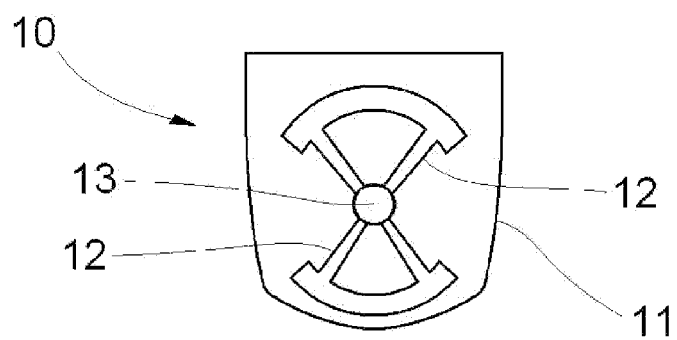


FIG. 2



EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 17 September 2010	Examiner Saettel, Damien
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)



EUROPEAN SEARCH REPORT

Application Number
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Place of search		Date of completion of the search	Examiner
The Hague		17 September 2010	Saettel, Damien
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 10 16 1927

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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