

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
16 August 2007 (16.08.2007)

PCT

(10) International Publication Number
WO 2007/091136 A1

(51) International Patent Classification:
B28B 11/04 (2006.01) *B41J 3/54* (2006.01)
B41M 1/34 (2006.01)

AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(21) International Application Number:
PCT/IB2007/000125

(22) International Filing Date: 11 January 2007 (11.01.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
MO2006A000038 7 February 2006 (07.02.2006) IT

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(71) Applicant (for all designated States except US): SYSTEM S.P.A. [IT/IT]; Via Ghiarola Vecchia 73, I-41100 Modena (IT).

(72) Inventor; and

(75) Inventor/Applicant (for US only): STEFANI, Franco [IT/IT]; Via P. Ferrari, 1, I-41049 Sassuolo (IT).

(74) Agent: GIANELLI, Alberto; Bugnion S.p.A., Via Emilia Est 25, I-41100 Modena (IT).

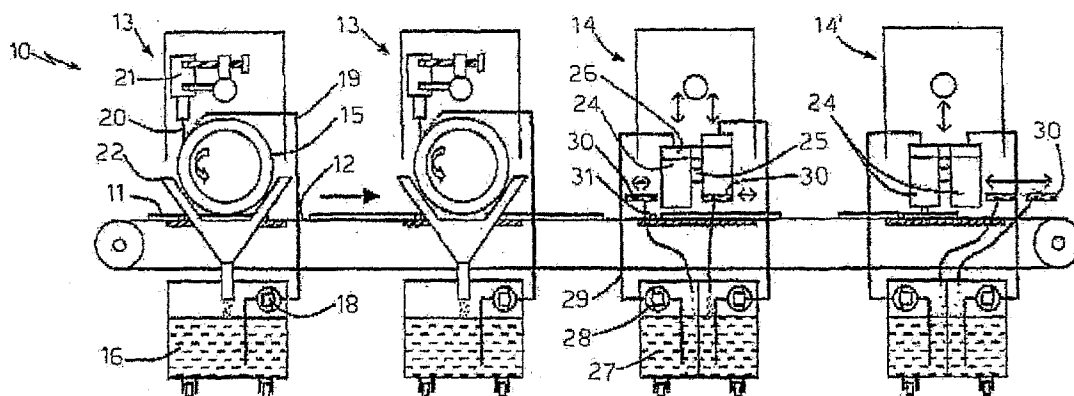
Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

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.

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

(54) Title: AN APPARATUS FOR DECORATING CERAMIC PRODUCTS



(57) Abstract: An apparatus (10) for decorating ceramic tiles (11) includes combined use of printing heads (13) consisting of elastic silicone cylinders (15) provided with recessed cell matrices, and inkjet-type printing heads (14, 14'), arranged sequentially above a conveyor belt (12) bearing the tiles to be decorated. The inkjet nozzles are electronically commanded according to activation rhythms and times suitable for continuously producing patterns and graphics having a length congruent with the length of the patterns and graphics produced by the elastic recessed cell matrices, the activation of the nozzles further being suitably synchronised with the angular position of the cylinders and of the conveyor belt. The above-mentioned apparatus provides, alongside a high level of reliability and limited financial outlay, a considerable production flexibility, typical of inkjet machines



WO 2007/091136 A1

-1-

Description

An Apparatus for Decorating Ceramic Products.

Technical Field

The invention concerns an apparatus for decorating ceramic products.

In particular, the invention can be usefully applied to decorating ceramic tiles of various types on highly flexible production programmes.

Background Art

5 As is well-known, the decoration of products of the ceramics industry takes place principally either using the traditional screen-printing technique, using plate or rotary machines, or by using rotary machines provided with engraved elastic matrices functioning either according to the flexographic or the rotogravure process, in which the glaze to be transferred to the tile is
10 placed respectively on the protuberances of the matrix, or in its cavities.

Compared with the other above-mentioned techniques, the technique of recessed cell matrices has particular characteristics and advantages, such as the possibility of decorating in proximity of the edges of the tiles, the easy obtaining of gradations of colour or half-tones, greater speed of execution,
15 and further it requires less maintenance and adjustment.

In any case, whether using the screen-printing technique or the engraved elastic matrix technique, new decorative motifs can only be achieved by creating new printing templates, whether they consist of screen-printing screens or rollers or of new matrices, and this obviously means a
20 considerable commitment in terms of materials and time.

-2-

These problems are overcome by the latest inkjet printing machines, which comprise a manifold of nozzles commanded by a computerised control unit in a memory of which is stored the appropriate command sequence of the nozzles for obtaining the design or graphic desired on the tile.

5 With these machines the graphic can be changed without the need to replace any tools or components, simply by varying the electronic command sequence stored in the memory of the control computer; it is further possible to obtain decorated special pieces, since there is no contact between the surface to be decorated and the printing head, and in addition glaze waste is
10 significantly reduced. All this is achieved however with significantly higher plant costs than those of rotary machines, alongside the risks associated with as yet unperfected technology.

A principle aim of this invention is to provide an apparatus for decorating ceramic tiles, in which the forms of decoration can easily be varied using a
15 low-cost structure of proven reliability.

A further aim of this invention is to propose an apparatus for decorating ceramic tiles, or the like, which can easily be integrated and used in existing production plants.

The above aims and still others are attained by a machine for decorating
20 ceramic tiles, or like products, characterised in that it comprises, in various sequence, printing heads consisting of rotary elastic matrices and printing heads consisting of inkjet nozzles commanded by electronic control units in sequences and command times suitable for performing decorations on the tiles which decorations have a length congruent with the length of the
25 decorations printed by said rotary printing heads. The different printing heads, whether rotary or inkjet, are reciprocally synchronised according to a predefined phase relation in order to ensure that the parts of decoration

-3-

produced by each single head fit together to form the overall desired decoration. Synchronisation according to a given phase relation can also take place between the printing heads and the conveying means of the products to be decorated. The electronically-commanded nozzles are preferably arranged in contiguous rows, above the means for conveying the tiles, the length of each row of nozzles corresponding to the maximum width of surface to be decorated. The nozzles are uniformly spaced, in the contiguous rows, in such a configuration that the nozzles comprised within a row are staggered, in the advancement direction of the tiles, relative to the nozzles of the adjacent rows. The command sequence of the nozzles of a given printing head is such as to perform successive rows of the decoration following a continuous electronic scan of an electronic map of the decoration stored in the memory of the printing head control unit. The scan is repeated in succession, in such a way as to produce the same result as would be produced by a continuously revolving roller bearing the same decoration. A photocell capable of detecting the presence of the tile below the printing head enables or disables the jet of ink from the various nozzles of the head. The correct phase relation between the nozzle activation sequence and the angular positions of the rotary elastic matrices present in the apparatus is stored and then automatically called up and reset to start when the apparatus is activated.

From the foregoing it is evident that the apparatus of the invention offers indubitable advantages compared with prior art apparatus, regarding both the quality and variety of the decorations that can be obtained, and regarding its overall reliability.

Disclosure of Invention

-4-

Further characteristics and advantages of the invention will emerge more clearly from the detailed description that follows of a preferred, but not exclusive embodiment of the invention, illustrated purely as a non-limiting example in the accompanying figures, in which:

5 Figure 1 shows a schematic side elevation of the apparatus for decorating of the invention;

Figure 2 shows a plan view from above of the apparatus in Figure 1.

Figure 1 illustrates an apparatus 10 in particular for decorating ceramic tiles 11. The tiles 11 are advanced along the production line by a conveyor belt
10 12.

The apparatus 10 comprises printing heads 13 of the type known as Rotocolor, and printing heads 14, 14', of the inkjet type.

The Rotocolor printing heads 13 comprise an elastic silicone cylinder 15 bearing the matrix with cavities upon which the figure to be transferred to
15 the tile 11 has been obtained; glaze of the appropriate colour is collected from the collection tray 16 using the pump 18 and distributed, through the feeder conduit 19 into the cavities exhibited on the surface of the cylinder 15 with the aid of a doctor 20 supported and positioned by appropriate means
21. The excess glaze flows back to the tray 16 through the collection
20 channels 22.

The inkjet printing heads 14, 14' comprise one or more groups 24 of nozzles distributed in contiguous rows. The groups of nozzles 24 which constitute the actual inkjet printing heads are anchored to a supporting body 25 independently of each other as in the case of the head 14, or constrained to
25 move together as is the case with head 14'. A self-replenishing tank 26 associated with each of the groups, or printing heads 24 is continually fed from the main tank 27 by a suitable pump 28 and top-up conduit 29. A

-5-

sponge 30 is further associated with each of the printing groups, or heads 24, for protection and cleaning. A photocell is further arranged near the surface of the conveyor belt 12, to detect the presence of the tile 11 between the two terminals, the transmitter and the receiver 31, 32 of the photocell.

5 In the embodiment illustrated herein, the apparatus comprises a set of four printing heads, two of the Rotocolor type and two of the inkjet type, distributed in the sequence indicated in the attached table of the figures of the drawing.

According to specific production requirements, and therefore to the type of
10 tiles and to the decorations to be performed, the apparatus of the invention can be formed by a greater or smaller number of printing heads, variously distributed.

The functioning of the apparatus of the invention takes place as described below.

15 When the form and the tones of colour of the decoration to be transferred have been defined, it is opportunely decided which part of the overall figure, and which shade of colour, is to be carried out by a which printing head, the criteria for assigning and selecting being linked to the skill and experience of the personnel and the characteristics of the plant available.

20 The part of the figure to be realised using a given Rotocolor printing head is obtained using a well-identified elastic matrix engraved with the above-mentioned part of the decoration to be performed.

The part of the figure to be effected using a given inkjet printing head is obtained by subdividing the part of the figure into a certain number of
25 successive lines of printing of a predetermined thickness, where each of the said rows of printing can be obtained with a given combination of commands to the nozzles included in the printing head. The successive

-6-

combinations of commands relating to the successive lines of printing are then stored in the memory of the command unit of the nozzles, thus creating an electronic map of the figure to be executed. This is in practice achieved simply by "reading" in succession the various lines of the map and
5 activating the nozzles according to the command combinations included in each line.

The printing head, then, behaves exactly like a continuous printing roller since the "reading" of the various lines of the electronic map recommences from the first of the said lines each time it reaches the last of them.

10 Obviously the speed of printing is linked to the frequency of reading of the various lines and the times of execution of the single line of printing, the speed having to be appropriately calculated in relation to, and synchronised with, the speed of advancement of the tile 11 on the belt 12.

It is also evident that the length of the decoration obtainable with a given
15 inkjet printing head must be equal to, a multiple of, or in any case congruent with, the length of the decoration obtainable with a Rotocolor printing head which is part of the same apparatus; and that, in order to ensure an exact match of the parts of the decoration performed by the different printing heads, the reading or scanning of the electronic map associated with a given
20 inkjet printing head must commence at a predetermined angular position on the cylinder of a given Rotocolor printing head. In other words, the pointer to the line of printing of an inkjet printing head varies according to the signal produced by the position encoder associated with a Rotocolor printing head cylinder present in the same apparatus.

25 In this connection it must be borne in mind that the rotary elastic matrix printing heads, when present in the apparatus in a number greater than one, as in the illustrated case, are synchronised with each other according to a

-7-

given phase relation on the basis of the known Master/Slave techniques, in which a given reference position (Master) can be obtained from the position of the conveyor belt (Real Master) or from an electronic signal generator of the reference signal (Virtual Master).

5 It should also be noted that if an exact phase relation is predetermined between the angular position of the printing cylinders and the position of the tile on the belt, well-defined and repeated decorations are obtained on the various tiles, while when such a phase relation does not exist, but there is simply synchronism between the speed of rotation of the cylinders and the
10 speed of advancement of the conveyor belt, the decorations or parts of decorations obtained are printed randomly on the various tiles. This is also true for the parts of decoration performed with the inkjet printing heads, which, as stated above, behave exactly like virtual synchronised cylinders, in a given phase relation with the Rotocolor cylinders.

15 The photocell predisposed to detect the presence of the tile under a given inkjet head, enables or disenables output of the ink jet from the various nozzles of the head, with the aim of preventing costly and useless waste of glaze. The signal produced by the photocell upon arrival of the tile can also determine the positioning of the pointer at the line of printing for that inkjet
20 head, and thus in this case on each tile a well-defined part of the decoration is performed, always matching up with the parts of decoration effected using the other heads of the apparatus.

Once the phase relation between the various printing heads of the apparatus, whether of the one type or the other, has been set and activated with the
25 appropriate operation of setting/registering, it is stored and automatically called up at each successive start up of the apparatus, up until it is reset.

-8-

Obviously various and diverse electronic maps can be stored in the memory of the control unit of an inkjet printing head and can be selected according to the type of decoration to be made.

The apparatus for decoration of the invention offers clear advantages, in terms of the extreme flexibility and quality of the production processes achievable, and also regarding the reduction of the costs of materials used in the process and in limiting overall plant costs, thanks to the transformation or adaptation of rotary machines already in existence.

The various memory maps can obviously be stored in memory means of the control unit or in external memory means that can be entered into, or connected to, the control unit when a particular operation of decoration is carried out.

The characteristics and the operational advantages associated with the apparatus of the invention continue to be protected even if modifications or variations are introduced to the embodiment described above.

For example, the dimensions of each printing group or head-24 could vary according to the applications; the number or groups of nozzles could also vary in a same printing head 14, 14'.

Also, the number of rows of nozzles present in each group, and thus the resolution obtainable, could obviously vary according to the applications.

The means for actuating the various groups of inkjet nozzles could be of various types, and the same applies to the means for translation of the tiles, or similar products, on which the decoration is to be effected.

The synchronisation of the various printing heads with one another and with the means for advancing the products to be decorated can be done place using sensors and techniques that are different from those illustrated above by way of example. Also the sensors used simply to detect the tile

-9-

below the printing head can differ from the photocell sensors used in the above example.

Claims.

- 1). The apparatus for decorating ceramic tiles, or similar products, advanced on conveyor belts or other means for conveying, wherein it comprises, in various order, printing heads constituted by rotary elastic matrices and printing heads consisting of ink jet nozzles commanded by electronic control units with command sequences and times suitable for performing decorations upon a surface of the products, the decorations having a length that is congruent with a length of the decorations printed by the said rotary elastic matrices.
- 2). The apparatus (10) of the preceding claim, wherein the printing heads (13), (14), (14') are also synchronised with one another, in a predetermined phase relation, in order to ensure that the parts of decoration produced by each single head match the others so that the the overall decoration desired is produced.
- 3). The apparatus (10) of the preceding claim, wherein the printing heads (13), (14), (14') are also synchronised, according to a predetermined phase relation, with the means for conveying (12) of the products to be decorated (11).
- 4). The apparatus (10) of one of the preceding claims, wherein the printing heads (14), (14'), constituted by inkjet nozzles commanded by electronic control units, comprise groups (24) of nozzles arranged in one or more contiguous rows, above the means for conveying (12), the length of each group of nozzles corresponding with the maximum width of the surface to be decorated.

-11-

5). The apparatus (10) of the preceding claim, wherein the groups of nozzles (24) comprising one particular printing head (14) are fixed to a support frame (25) in such a way that they are mechanically independent of each other.

6). The apparatus (10) of claim 4, wherein the groups of nozzles (24) comprised in a particular printing head (14') are fixed to a support frame (25) in such a way as to be mechanically connected to each other.

7). The apparatus (10) of claim 5 or 6, wherein the nozzles included in a group of nozzles (24) are uniformly spaced in contiguous rows in such a way that the nozzles comprising one row are staggered in relation to adjacent rows of nozzles in the advancement direction of the conveyor belt.

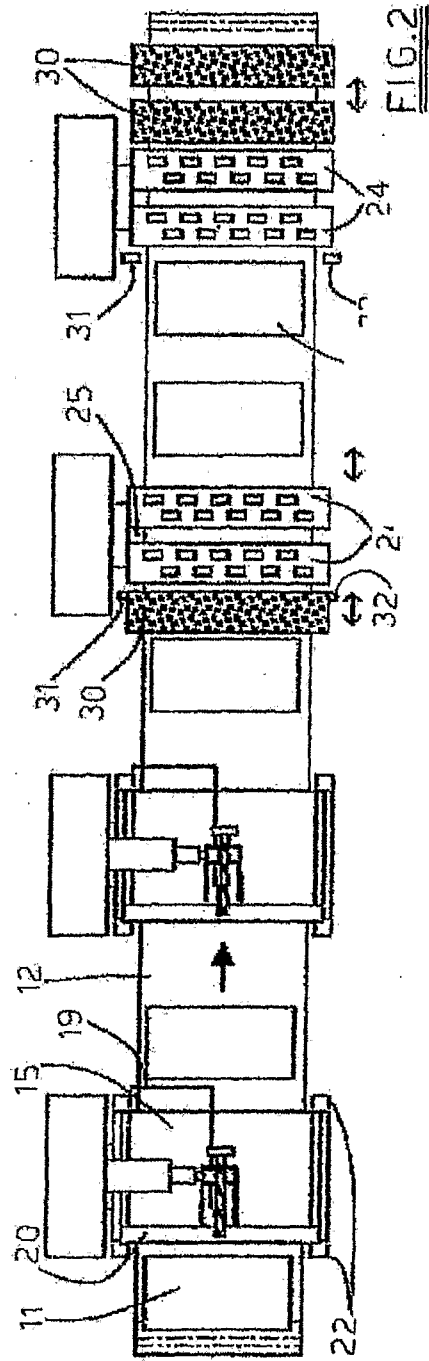
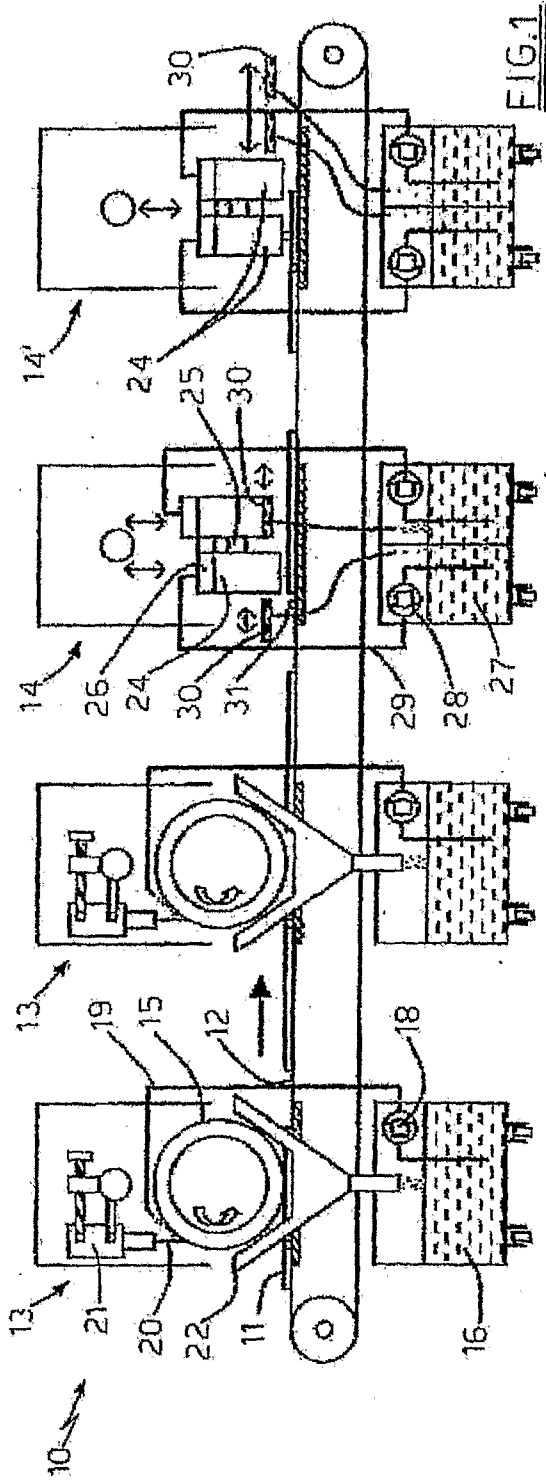
8). The apparatus (10) of any one of the preceding claims, wherein the nozzles of each printing head (14), (14') are commanded according to a command sequence in such a way that they execute successive lines of the decoration, after an electronic scan of lines into which an electronic map of the decoration stored in the memory of the control unit of the printing head is subdivided.

9). The apparatus (10) of the preceding claim, wherein the scan is effected continuously, recommencing from a first of the lines when a last has been reached, in such a way as to effect decorations continuously, in a way that is similar to the operation of the printing heads (13) consisting of rotary elastic matrices.

10). The apparatus (10) of any one of the preceding claims, wherein the printing heads (14), (14') constituted by inkjet nozzles commanded by electronic control units comprise photocells, or sensors, for detecting a presence of a tile at the printing head, in order to enable or disable output of a jet of ink from the nozzles of the head.

-12-

11). The apparatus (10) of the preceding claim, wherein a signal emitted by the photocells, or by the sensors, on arrival of the tile also determines the positioning of the pointer at the line to be printed with that printing head.



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2007/000125

A. CLASSIFICATION OF SUBJECT MATTER

INV. B28B11/04 B41M1/34 B41J3/54

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)

B28B B41M B41J

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 038 689 A1 (TOMAS CLARAMONTE JOSE VICENTE [ES]) 27 September 2000 (2000-09-27)	1,2,4-9
Y	paragraph [0017] paragraph [0022] - paragraph [0034]; figures	3,10,11
P,X	WO 2006/027212 A (TIVA SACMI COOPERATIVA MECCANI [IT]; RICCI CLAUDIO [IT]; ACERBI PIERUG) 16 March 2006 (2006-03-16) page 8, line 3 - page 9, line 2; claim 1; figures	1-9
Y	WO 95/18020 A (CAMORANI CARLO ANTONIO [IT]; ALGERI MARIS [IT]) 6 July 1995 (1995-07-06) page 15, line 3 - page 18, line 1; figures 13-20	3,10,11
	-/--	

 Further documents are listed in the continuation of Box C. See patent family 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.
- *&* document member of the same patent family

Date of the actual completion of the international search

23 May 2007

Date of mailing of the international search report

04/06/2007

Name and mailing address of the ISA/

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

Authorized officer

Orij, Jack

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2007/000125

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 223 151 A2 (ELETTRONIC SOFTWARE S R L [IT]) 17 July 2002 (2002-07-17) paragraph [0045] - paragraph [0060]; claim 11; figure 1 -----	1-3,10, 11
A	EP 1 336 480 A (GRUPPO CONCORDE S P A [IT]) 20 August 2003 (2003-08-20) paragraph [0039] - paragraph [0041]; figures 7,8 -----	3

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2007/000125

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1038689	A1	27-09-2000	BR 9907779 A 10-10-2000
			DE 69916234 D1 13-05-2004
			DE 69916234 T2 14-04-2005
			ES 2152167 A1 16-01-2001
			WO 0021760 A1 20-04-2000
			ES 2219068 T3 16-11-2004
			PT 1038689 T 31-08-2004
			TR 200001743 T1 21-12-2000
WO 2006027212	A	16-03-2006	NONE
WO 9518020	A	06-07-1995	AU 1317895 A 17-07-1995
			EP 0738215 A1 23-10-1996
EP 1223151	A2	17-07-2002	DE 60203417 D1 04-05-2005
			DE 60203417 T2 09-03-2006
			ES 2240576 T3 16-10-2005
			IT B020010003 A1 05-07-2002
EP 1336480	A	20-08-2003	IT FI20020029 A1 18-08-2003