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(54) **Die for cold-working a sheet made of high-tensile strength material, and related method for working said sheet**

(57) The present invention relates to a die for cold-processing a sheet (1) made of high-tensile strength material, preferably high-tensile strength steel, said die comprising:

- a die block (10) secured to a lower portion of said die;
- a sheet press (20) which can be movably connected to an upper portion of said die;
- a punch (30) for processing, in particular shearing

and/or punching, the sheet (1);

- heating means (40) adapted to tempering the material of the sheet (1).

The invention is characterized in that said heating means (40) are associated with means (50,51,52) for collecting a scrap (2) obtained after the sheet (1) has been processed by the punch (30). A method for cold-working a sheet made of high-tensile strength material is also disclosed.

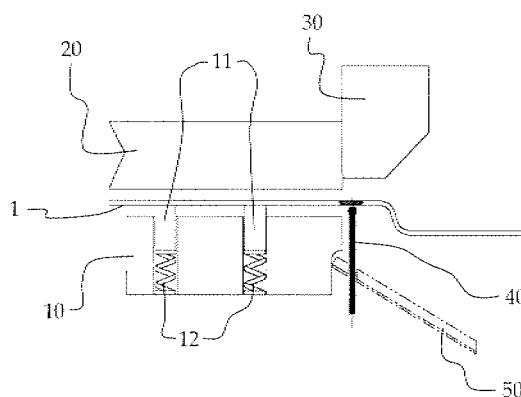


Fig. 1A

Description

[0001] The present invention relates to a die for cold-processing a sheet made of high-tensile strength material, in accordance with the preamble of claim 1. Also, the present invention relates to a related method for processing a sheet made of high-tensile strength material.

[0002] Sheet cold-processing represents one of the most widespread processes employed for manufacturing metal components, e.g. in the automotive, household appliance and general equipment fields.

[0003] In particular, sheet cold-processing includes a plurality of specific processes, such as shearing and punching.

[0004] Shearing is a process which allows to cut prearranged flat sheet sections into squares or bands; it is carried out on a die comprising a fixed die block and a punch associated with a sheet press, said sheet press being movably connected to the die. After the sheet press has been lowered onto the sheet in order to lock it onto the die block, the punch is activated until it penetrates the sheet and goes through it, thus cutting the prearranged sheet section.

[0005] As far as punching is concerned, it is carried out in a manner substantially similar to the shearing process; the main difference being that in this case, when the punch is activated, it penetrates the sheet, removes a portion of material having a shape substantially matching the punch cross-section, and then enters into a corresponding opening provided in the die block.

[0006] Following the shearing and/or punching process, the removed sheet portion is collected as a scrap into a suitable portion typically located in the lower portion of the die, in particular in the lower portion of the die block, and is then evacuated.

[0007] A remarkable increase has been recently recorded in the use of sheets made of high-tensile strength material, i.e. having a high strength/weight ratio, such as light and ultra-light alloys and high-tensile strength steels; an example of such materials is boron steel.

[0008] Such high-tensile strength sheets are difficult to be cold-processed, in particular by means of the shearing and punching techniques known in the art, since they are generally characterized by low formability and determine considerable die wear. As a consequence, high-tensile strength sheets are usually processed, in particular cut and/or perforated, by using laser equipment; however, this latter type of equipment has some drawbacks, too, in that it is rather costly and delicate.

[0009] Consequently, special dies have been developed for cold-processing high-tensile strength sheets, said dies comprising means adapted to heat a portion of the sheet in order to tempering the high-tensile strength material and facilitate the shearing and/or punching process.

[0010] In particular, Japanese patent application no. JP2007319912 has disclosed a die for cold-processing

sheets made of high-tensile strength material, said die comprising a die block secured to the die and a sheet press movably connected to the die. The sheet press has an aperture for inserting a punch adapted to perforate the sheet. In order to allow the tempering of the sheet material and more easily processed, the sheet press also features a heating bushing made of conductive material; said bushing is arranged in said aperture of the sheet press and in turn comprises an aperture for letting the punch pass through.

[0011] Consequently, the die described in Japanese patent application no. JP2007319912 operates as follows:

- the sheet is positioned onto the die block;
- the press sheet is lowered until it presses the sheet against the die block;
- the heating bushing, placed in contact with the sheet, is turned on for a preset time period in order to heat the sheet;
- the punch is activated in order to perforate the sheet.

[0012] However, the die described in said Japanese patent application suffers from several drawbacks.

[0013] In particular, since the sheet is heated by means of a bushing, the heating occurs a fraction of time before the punch is activated for perforating the sheet; hence, the tempering of the sheet cannot be optimal, because a tempering cycle carried out on a high-tensile strength material must necessarily include a heating period followed by an air-cooling period.

[0014] Moreover, since an adequate sheet air-cooling period is not provided for, all die components in contact with the heated sheet suffer multiple heating and cooling cycles, which inevitably impair the mechanical properties of such components, in particular of the cutting tool represented by the punch.

[0015] A further drawback of the die described in said Japanese patent application is that, for the punch to go through the aperture obtained in the heating bushing, some clearance must necessarily exist between the heating bushing and the punch for the purpose of avoiding any friction between said elements. This inevitably implies that the sheet press cannot be designed in the most appropriate manner, because said clearance moves the sheet press away from the point where the sheet must be sheared or punched by the punch; this distance between the sheet press and the point where the punch must be applied does not allow the sheet to be sheared or punched in the most appropriate manner. This defect of the sheet press is especially important when a hole must be made near edges or different slopes of the sheet.

[0016] Another drawback of the die described in the aforementioned Japanese document is that, in order to heat the sheet by induction, the bushing must necessarily be made of conductive material; as known, such a material wears out rapidly and is not suitable for making a sheet press.

[0017] Yet another drawback of the above-described die is that the heating means with which it is fitted cannot be easily adapted for different sheet processing configurations; in fact, for the tempering of the sheet and then processed (sheared and/or punched) according to different configurations and/or shapes, it is necessary to fully modify or change both the sheet press and the heating bushing. As a consequence, the heating means of the above-described die cannot be easily applied to existing dies, since they need to be designed ad hoc and according to a predefined shape.

[0018] In this frame, it is the main object of the present invention to overcome the above-mentioned drawbacks by providing a die for cold-processing a sheet made of high-tensile strength material, as well as a related method for processing said sheet, so designed as to ensure an optimal tempering thereof.

[0019] It is another object of the present invention to provide a sheet for cold-processing a sheet made of high-tensile strength material and a related method for processing said sheet which allow the sheet to be adequately cooled in air, thus preventing any die components from suffering multiple heating and cooling cycles.

[0020] It is a further object of the present invention to provide a die for cold-processing a sheet made of high-tensile strength material and a related method for processing said sheet which allow to prevent the mechanical properties of the die components from suffering any decay, so that such components are not subject to rapid wear.

[0021] It is yet another object of the present invention to provide a die for cold-processing a sheet made of high-tensile strength material and a related method for processing said sheet which can be easily adapted for different sheet processing configurations without necessarily having to change the components of said die.

[0022] Said objects are achieved by the present invention through a die for cold-processing sheets made of high-tensile strength material and a related method for processing said sheets incorporating the features set out in the appended claims, which represent an integral part of the present description.

[0023] Further objects, features and advantages of the present invention will become apparent from the following detailed description and from the annexed drawings, which are supplied by way of non-limiting example, wherein:

- Figs. 1A, 1B, 1C and 1D show the different steps of a method for cold-processing, in particular shearing and/or punching, a sheet made of high-tensile strength material through a first embodiment of a die according to the present invention;
- Figs. 2A, 2B, 2C and 2D show the different steps of a method for cold-processing, in particular shearing and/or punching, a sheet made of high-tensile strength material through a second embodiment of a die according to the present invention.

[0024] Figs. 1A to 1D and 2A to 2D show the different components of a first and a second embodiments, respectively, of a die (not shown as a whole) for cold-processing a sheet 1 made of high-tensile strength material, preferably high-tensile strength steel, according to the present invention.

[0025] In particular, Figs. 1A to 1D refer to a die for shearing sheet 1, whereas Figs. 2A to 2D refer to a die for punching sheet 1. In these drawings, the same reference numerals are used for designating corresponding components of the first and second embodiments of the die according to the present invention.

[0026] Said die comprises:

- a die block 10 secured to a lower portion of said die;
- a sheet press 20 which can be movably connected to an upper portion of said die;
- a punch 30 for processing, in particular shearing and/or punching, said sheet 1;
- heating means 40 adapted to temper the material of sheet 1.

[0027] According to the present invention, said heating means 40 are associated with means 50, 51, 52 for collecting a scrap 2 obtained after sheet 1 has been processed by punch 30.

[0028] In particular, said collection means comprise a chute 50 for collecting scrap 2, said chute 50 featuring an aperture 51 for inserting said heating means, in particular an inductor 40.

[0029] Referring now to the first embodiment, illustrated in Figs. 1A to 1D, it must be pointed out that both inductor 40 and aperture 51 may have different configurations, so as to allow the tempering of sheet 1 and then sheared according to a predefined shape.

[0030] In a preferred embodiment of the present invention, die block 10 comprises supporting elements 11 fitted with an elastic member 12 for holding sheet 1 uplifted above die block 10 as said sheet 1 is being tempered.

[0031] As shown in Figs. 2A to 2D, said collection means comprise an aperture 52 obtained in die block 10 in the area corresponding to said punch 30. When punching sheet 1, said aperture 52 allows:

- inductor 40 to pass through in order to temper the material of sheet 1;
- punch 30 to be inserted into die block 10 in order to remove a portion of material having a shape substantially matching the cross-section of punch 30 from sheet 1;
- scrap 2 resulting from the punching of sheet 1 to be unloaded.

[0032] According to the present invention, the method for cold-processing, in particular shearing and/or punching, a sheet 1 made of high-tensile strength material comprises the following steps:

- a) positioning said sheet 1 onto a die block 10 of a die;
- b) inserting heating means, in particular an inductor 40, into an aperture 51 of a chute 50 for collecting a scrap 2 obtained by processing sheet 1;
- c) activating said heating means 40 for heating said sheet 1 up to a preset temperature;
- d) withdrawing said heating means 40 through said aperture 51 down to an area underneath said chute 50;
- e) waiting for a predetermined period of time for sheet 1 to be air-cooled and for tempering the material of said sheet 1;
- f) lowering a sheet press 20 for locking said sheet 1 onto said die block 10;
- g) activating a punch 30 for processing sheet 1.

[0033] In a preferred embodiment of the present invention, during said step a) sheet 1 is positioned onto supporting elements 11 fitted with an elastic member 12 for holding sheet 1 uplifted above die block 10 as said sheet 1 is being tempered.

[0034] In addition, said steps b) and d) may provide for inserting heating means 40 into an aperture 52 obtained in die block 10, in particular said insertion into aperture 52 being carried out for punching sheet 1.

[0035] It is also clear that the preceding steps of the method according to the present invention may be handled by a control system, in particular an electronic programmable and/or preselectable one, which can be connected electrically and/or mechanically to the die for cold-processing sheets made of high-tensile strength material.

[0036] The advantages of a die for cold-processing sheets made of high-tensile strength material and of a related method for processing said sheets according to the present invention are apparent from the above description.

[0037] In particular, one of such advantages is that an optimal tempering of the sheet is achieved because the activation of punch 30 for processing sheet 1 does not occur immediately after said sheet 1 has been heated; on the contrary, sheet 1 is allowed to cool in air for an optimal period of time.

[0038] Another advantage is that, since sheet 1 is allowed to cool adequately in air, the die components are not subject to multiple heating and cooling cycles which would impair the mechanical properties thereof, in particular of punch 30.

[0039] A further advantage is that sheet press 20 acts exactly where sheet 1 must be sheared or perforated by punch 30; this allows to obtain an optimal shearing and/or punching of sheet 1, even when a hole must be made near edges or different angles of said sheet 1.

[0040] An additional advantage is that sheet press 20 can be made of a material not subject to wear, since it is not required to include portions made of conductive material.

[0041] Yet another advantage offered by the die ac-

cording to the present invention is that it can be easily adapted for different sheet processing configurations and can comprise heating means which may be easily associated with existing dies, since it is not necessary to totally modify or change the pre-existent components of said die.

[0042] It is apparent that the present invention is not limited to the die for cold-processing sheets made of high-tensile strength material and to the related method for processing said sheets as described above, but may be subject to many modifications, improvements or replacements of equivalent parts and elements without departing from the inventive idea, as clearly specified in the appended claims.

Claims

1. Die for cold-working a sheet (1) made of high-tensile strength material, preferably high-tensile strength steel, said die comprising:

- a die block (10) secured to a lower portion of said die;
- a sheet press (20) which can be movably connected to an upper portion of said die;
- a punch (30) for working, in particular shearing and/or punching, the sheet (1);
- heating means (40) adapted to tempering the material of the sheet (1),

characterized in that said heating means (40) are associated with means (50, 51, 52) for collecting a scrap (2) obtained after the sheet (1) has been processed by the punch (30).

2. Die according to claim 1, **characterized in that** said collecting means comprise a chute (50) for collecting the scrap (2), said chute (50) featuring an aperture (51) for inserting said heating means (40).
3. Die according to claim 1, **characterized in that** said heating means comprise an inductor (40).
4. Die according to claim 1, **characterized in that** said collecting means comprise an opening (52) obtained in the die block (10) in the area corresponding to said punch (30).
5. Die according to claim 1, **characterized in that** said die block (10) comprises supporting elements (11) fitted with an elastic member (12) for holding the sheet (1) uplifted above the die block (10) as said sheet (1) is being tempered.
6. Method for cold-working, in particular shearing and/or punching, a sheet (1) made of high-tensile strength material, said method comprising the fol-

lowing steps:

- a) positioning said sheet (1) onto a die block (10) of a die;
 - b) inserting heating means, in particular an inductor (40), into an aperture (51) of a chute (50) for collecting a scrap (2) obtained by the processing of the sheet (1); 5
 - c) activating said heating means (40) for heating said sheet (1) up to a preset temperature; 10
 - d) withdrawing said heating means (40) through said aperture (51) down to an area underneath said chute (50);
 - e) waiting for a predetermined period of time for the sheet (1) to be air-cooled and for the tempering of the material of said sheet (1); 15
 - f) lowering a sheet press (20) for locking said sheet (1) onto said die block (10);
 - g) activating a punch (30) for working the sheet (1). 20
7. Method according to claim 6, **characterized in that** said step a) is accomplished by positioning said sheet (1) onto supporting elements (11) fitted with an elastic member (12) for holding the sheet (1) up- 25
lifted above the die block (10) as said sheet (1) is being tempered.
8. Method according to claim 6, **characterized in that** said steps b) and d) are accomplished by inserting said heating means (40) into a hollow (52) obtained 30
in the die block (10), in particular for punching the sheet (1).
9. Method according to one or more of claims 6 to 8, **characterized in that** said steps are handled by a control system, in particular an electronic program- 35
mable and/or preselectable one, which can be connected electrically and/or mechanically to the die. 40
10. Die for cold-working a sheet (1) made of high-tensile strength material, preferably high-tensile strength steel, and related method for cold-working said sheet (1) according to the innovative teachings of the present description and of the annexed drawings, 45
which represent a preferred embodiment of the claimed invention. 50
- 55

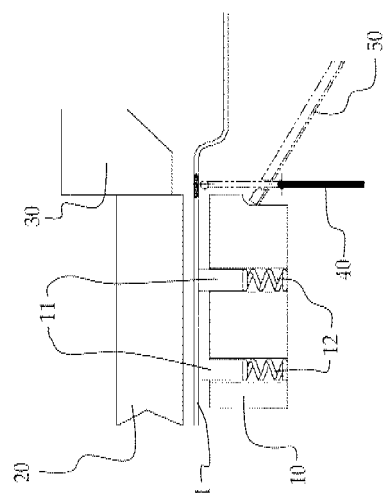


Fig. 1B

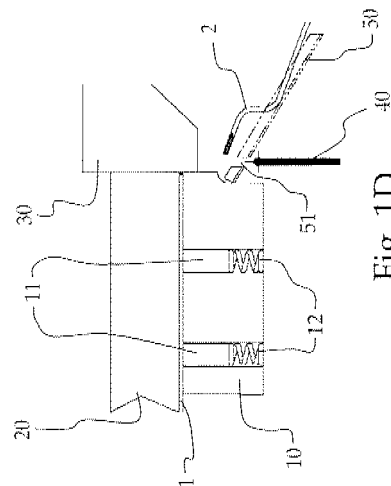


Fig. 1D

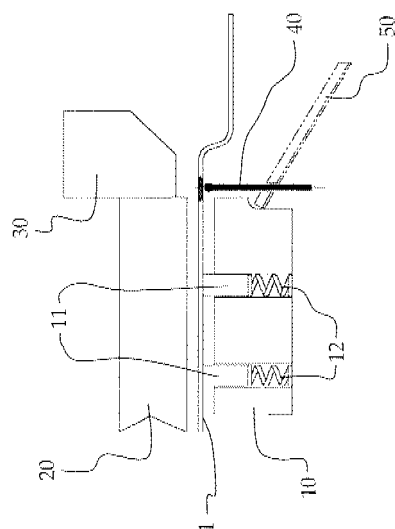


Fig. 1A

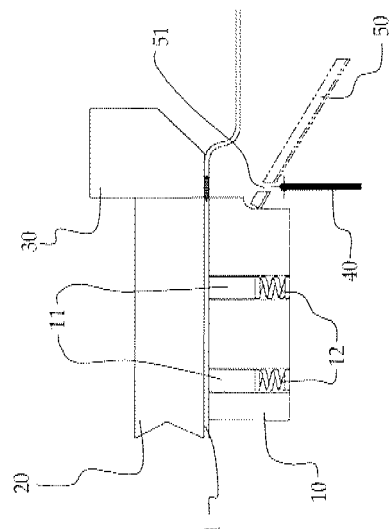


Fig. 1C

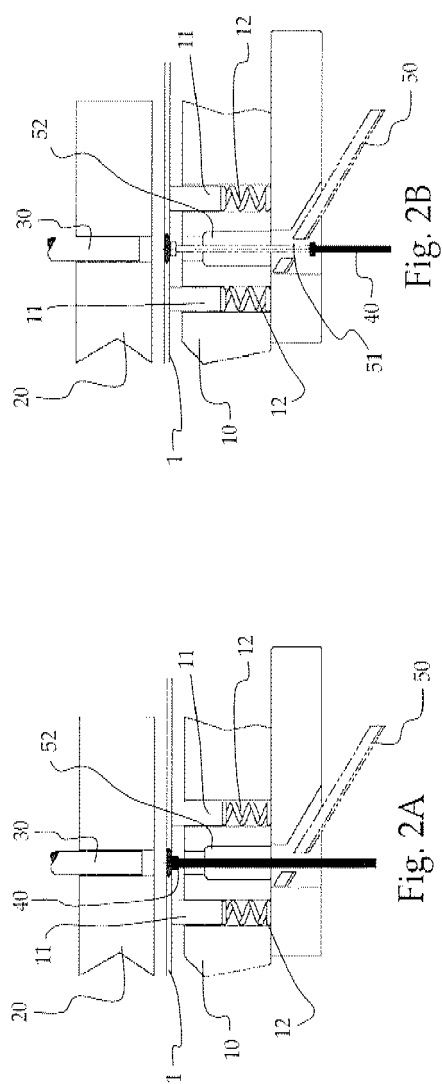


Fig. 2A

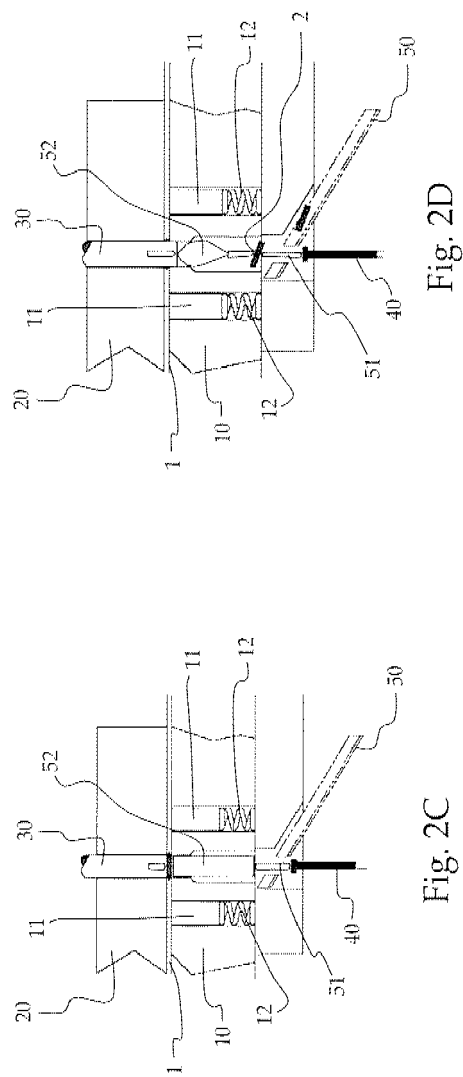


Fig. 2B

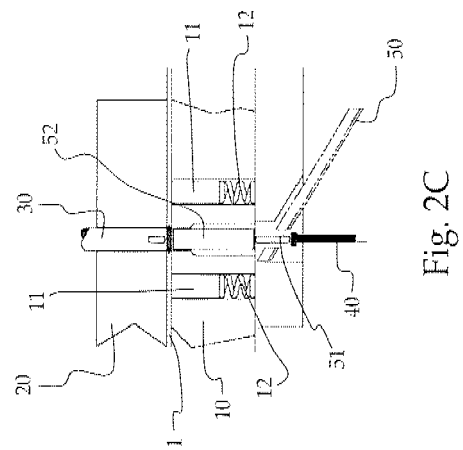


Fig. 2C

**PARTIAL EUROPEAN SEARCH REPORT**

Application Number

which under Rule 63 of the European Patent Convention EP 09 17 3592
shall be considered, for the purposes of subsequent
proceedings, as the European search report

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
D,X	JP 2007 319912 A (MAZDA MOTOR) 13 December 2007 (2007-12-13)	1,3,4	INV. B21D43/28 B26D7/18 B21D28/14 B21D28/24
A	* figures 1-7 *	2,5-9	
X	DE 10 2004 019693 A1 (VOLKSWAGEN AG [DE]) 17 November 2005 (2005-11-17)	1,3,4	
A	* paragraph [0019] - paragraph [0021]; figures 1-3 *	2,5-9	
A	JP 2005 248253 A (UNIPRES CORP) 15 September 2005 (2005-09-15) * the whole document *	1-9	
A	JP 2002 153922 A (AMADA CO LTD) 28 May 2002 (2002-05-28) * the whole document *	1-9	
			TECHNICAL FIELDS SEARCHED (IPC)
			B21D B26D
INCOMPLETE SEARCH			
The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC to such an extent that a meaningful search into the state of the art cannot be carried out, or can only be carried out partially, for these claims. Claims searched completely : Claims searched incompletely : Claims not searched : Reason for the limitation of the search: see sheet C			
Place of search		Date of completion of the search	Examiner
Munich		25 November 2009	Vinci, Vincenzo
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 (P04E07)



**INCOMPLETE SEARCH
SHEET C**

Application Number

EP 09 17 3592

Claim(s) not searched:
10

Reason for the limitation of the search:

The formulation of claim 10 is vague and unclear and leaves the reader in doubt as to the effective combination of technical features for which protection is sought. This lack of clarity is of such an extent that no meaningful search was possible.

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

EP 09 17 3592

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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25-11-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2007319912 A	13-12-2007	NONE	
DE 102004019693 A1	17-11-2005	NONE	
JP 2005248253 A	15-09-2005	NONE	
JP 2002153922 A	28-05-2002	NONE	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2007319912 B [0010] [0011]