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(54) **METHOD FOR ELECTRODEPOSITION OF METAL AND GRANULAR ABRASIVE ON A TOOL.**

(57) A method in which a granular abrasive, together with a deposited metal, is deposited on a base metal for an electro-deposition on a tool by electroplating. A cathode chamber (4) is provided in an electrolytic tank (1) in such a manner that a portion of the cathode chamber (4) projects beyond the anolyte surface Sa. A granular abrasive layer (8) is formed on the bottom of the cathode chamber (4). A portion of an anolyte in an anode chamber (7) is circularly poured into the cathode chamber (4) from the upper side thereof such that a head difference (Sc-Sa) is formed between the catholyte surface Sc and the anolyte surface Sa, whereby such plating conditions as the pH of the catholyte and the metal concentration are controlled such that the granular abrasive (8) is deposited on a base metal (3) without diffusing the granular abrasive layer (8). The method is suitably employed to manufacture an electrodeposition plated tool in such a manner that a granular abrasive, such as diamond, cubic boron nitride or fine ceramic is deposited on a base metal for various grinding, polishing or cutting tools, together with a metal, such as nickel or copper.

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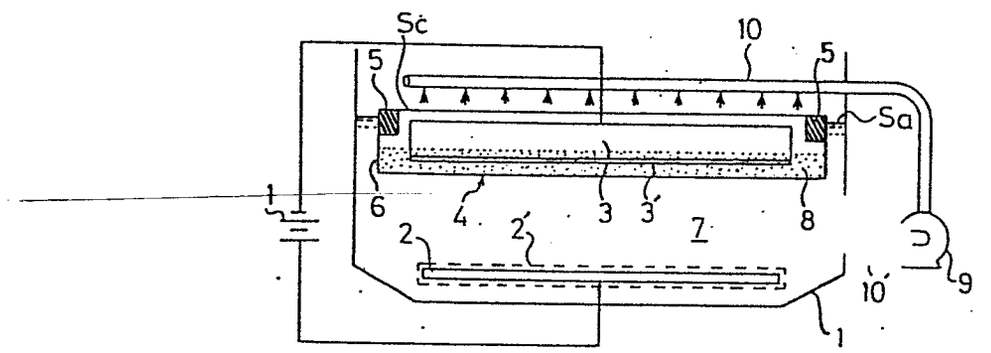
FIG. 1



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DESCRIPTION

METHOD OF MANUFACTURING ELECTROPLATED TOOLS

TECHNICAL FIELD

The present invention relates to a method of manufacturing electroplated tools, and more particularly to a method of codepositing and bonding abrasive particles together with a deposited metal onto the base metal of an electroplated tool by means of an electroplating process.

BACKGROUND ART

Heretofore, electroplated tools of this kind have mainly been manufactured by the methods mentioned as follows (Japanese Patent Application Laid-Open Publication No.66,668/83) :

(A) Method of carrying out electroplating while abrasive particles are suspended in an electroplating liquid, to codeposit the abrasive particles together with a metal ;

(B) Method of chemically electroplating abrasive particles, and thereafter carrying out electroplating while said abrasive particles are suspended in an electroplating liquid, to deposit the abrasive particles ;

(C) Method of bonding abrasive particles onto a base metal by means of an adhesive, thereafter subjecting,

or without subjecting the base plate to a preliminary treatment by chemical plating, and subsequently securing the abrasive particles by electroplating.

An electroplating tank has been used for manufacturing the electroplated tools, which is generally so arranged that a cathode (a base metal) and an anode are dipped into the electroplating bath stored therein without specifically parting the same to carry out the electroplating while the bath are agitated by an impeller disposed in the bath.

However, in the method (A) the adjustment of the mixing ratio of abrasive particles is very difficult, while in the method (B) the adhesion and binding force of abrasive particles are insufficient, and furthermore, the method (C) encounters such a disadvantage, for example, that the binding strength of abrasive particles is weak. Accordingly, with these conventional methods it has been difficult to uniformly and firmly bond the abrasive particles onto a base metal under stable operating conditions.

An object of the present invention is to eliminate the above-mentioned disadvantages inherent to the conventional technology, and to provide a method which makes it possible to positively stabilize the electroplating conditions such as, pH value, metal concentration ratio, etc., in the electroplating bath, such that the codeposited amount of the abrasive particles with respect to the plating metal is controlled

at a constant value, and a necessary but minimum amount of abrasive particles is used as the starting material that are uniformly and firmly bonded onto the base metal, thereby allowing an economical and continuous manufacture, with a high degree of efficiency, of electroplated tools which can fully exhibit the functions of various tools, such as grinding, polishing and cutting capabilities, etc.

DISCLOSURE OF THE INVENTION

The inventors made precise review on the manufacturing process of electroplated tools, and found that the above-mentioned object can be attained by carrying out the electroplating in such a way that a part of the anode liquid is introduced into, and circulated through a cathod chamber specifically arranged in an electroplating bath, while maintaining the cathode liquid level to be slightly higher than the anode liquid level.

More particularly, the present invention provides the method of manufacturing electroplated tools, which includes the step of subjecting a tool base metal to a plating regist in a predetermined shape, codepositing and bonding onto the tool base metal abrasive particles together with a deposited metal by dipping the tool base metal in an electroplating bath containing the abrasive particles,

which method is characterized in that a cathode chamber is specifically arranged in the electroplating bath so as to partly project from the liquid surface of the electroplating bath, and part of an anode liquid is supplied into the cathode chamber from the above, and circulated therethrough so as to hold the abrasive particles in the bottom section of the cathode chamber while the electroplating is carried out such that the abrasive particles are secured onto the tool base metal.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an explanatory view schematically illustrating one example of electroplating tank used in the method of the present invention ;

Fig. 2 is a perspective view explaining the arrangement of the cathode electrode chamber in the electroplating tank shown in Fig. 1 ; and

Fig. 3 is a cross-sectional view illustrating the cutting edge portion of a band saw blade after the plating is completed and the abrasive particles secured with the use of one embodiment of the present invention.

BEST MODE OF CARRYING OUT THE INVENTION

The present invention will now be explained in detail with reference to the accompanying drawings.

An electroplating tank used in the method of the present invention is provided, in an electroplating bath, with a cathode chamber which projects partly from the liquid surface of the electroplating bath and into which part of circulated anode liquid is supplied from the above so as to maintain the level of a cathode liquid higher than that of the anode liquid (difference between the heads), thereby substituting the liquid in the cathode chamber to be returned into the anode chamber.

Fig. 1 is an explanately view illustrating one embodiment of electroplating tank used in the method of the present invention. In the drawing, reference numberal 1 denotes the electroplating tank which consists of an anode chamber 7 and a cathode chamber 4, an anode metal plate 2 being disposed in the bottom part of the anode chamber 7 while a tool base metal 3 as a cathode being disposed in the cathode chamber 4 with both electrodes connected to an electric power source 11. Further, a conduit 10'is disposed on one side wall of the electroplating tank 1, and is connected with a conduit 10 through a pump 9 made of material which is free from the affection of electroetching, so that part of an anode liquid is sucked up by the pump 9 and introduced into the conduit 10 to be discharged through a number of fine holes or slits formed in the conduit 10, into the cathode chamber 4 over substantially the entire

area thereof. The conduits 10', 10 may be made of acid-resisting materials, and a filter may be connected in series with the pump 9.

Furthermore, depending upon the shape of the base metal of the electroplated tool to be manufactured, the metal plate 2 as the anode is disposed at that location of the base metal which is opposed to the cathode surface, and is to be applied with the abrasive particles, such as both right and left surfaces, the bottom surface, or both sides thereof. In this case, in order that sludges formed by the anode metal plate 2 is prevented from diffusing in the plating liquid, it is desirable to enclose the anode metal plate 2 within a cloth 2' having a suitable mesh size.

On the other hand, as shown in Fig. 2, the cathode chamber 4 comprises a frame 5 made , for example, of wood, plastics, etc., and assembled into a suitably shaped configuration, having its inner or outer side adhered with a filtering paper or cloth (which will be hereinafter denoted generally as "cloth") made of acid-resisting cloth or paper or cloth consisting ,for example, of tetron, polyethylene and the like, with a great number of extremely fine gaps distributed all over the surface thereof and having a size inhibiting the abrasive particles stored inside thereof from passing therethrough. The abrasive particles are disposed in the bottom section of the cathode chamber so

as to form an abrasive particle layer 8 whose height is adjusted by filling the abrasive particles such that it is slightly higher than that of a layer 3' of the base metal 3 to be applied with the abrasive particle, i.e. that part 3' of the base metal which is not subjected to masking, so as to completely embed in the abrasive particle layer 8 the portion to be desirably secured with abrasive particles.

Further, in the case wherein an elongate base metal 3 is to be continuously treated, it is of course that inlet and outlet openings are formed in the side walls of the cathod chamber 4 for introducing and discharging the base metal 3, respectively, with an abrasive particle supply device disposed of a suitable location.

Upon operation of thus formed electroplating tank, part of the anode liquid is filled in the cathode chamber from the above through the filling conduit 10 by means of the pump 9, as mentioned above, so that the liquid in the cathode chamber is returned into the anode chamber 7 through the cloth 6 of the cathode chamber. Preferably, the filling amount of the liquid is controlled such that the rise of the pH of the liquid in the cathode chamber is limited so as to maintain an appropriate pH value (for example, 2 to 4) which is suitable for the main plating, while preventing the diffusion of the abrasive particle layer 8 in the bottom section of the cathode chamber. In order to

positively prevent the diffusion of the abrasive particle layer, the anode liquid discharged from the fine holes or slits of the filling conduit 10 is filled preferably in a shower-like form. By these measures, even with a substantial filling amount of the liquid, since the liquid overflows in part over the top edge of the cathode chamber is returned into the anode chamber, and no diffusion of the abrasive particle layer takes place, the pH control in the cathode chamber by the adjustment of the filling amount can be effected easily.

Further, upon the circulatory filling of the anode liquid in part, the liquid level Sc in the cathode chamber is maintained to be slightly higher (for example, about 5 to 10 mm) than the liquid level Sa in the anode chamber due to the resistance of the cloth 6. As a result, substantial part of the anode liquid filled in the cathode chamber is substituted with the liquid in the cathode chamber due to the head difference (Sc - Sa), and is returned into the anode 7 as a liquid having a pH slightly higher than the pH of the filled anode liquid. Therefore, by substantially the same liquid management as that upon the normal plating work, carried out with respect to the anode liquid, the pH in the cathode chamber can always be maintained in a condition which is suitable for the main plating. That is, due to the use of the cloth having

extremely fine gaps distributed over the entire surface thereof as mentioned above, for the cathode chamber, permeability for the plating liquid would become insufficient if the anode liquid is not recirculated, resulting in that the concentration of metal ions decreases and the pH increases in the cathode chamber since no metal ions corresponding to the metal deposited on the cathode electrode are supplied from the anode liquid, whereby the plating condition cannot be appropriately maintained or tends to deviate. Particularly, when using finer abrasive particles, this tendency is further enhanced and in some cases basic salt is formed on the cathode surface which causes the deposition of metal itself to cease competely.

By the recirculation of the anode liquid as in the method according to the present invention, however, the abovementioned problems are completely eliminated, and uniform and appropriate electroplating can be carried out even with fine abrasive particles are used, thereby providing fully satisfactory results.

EXAMPLE

One example of the method according to the present invention will be explained below. While this example relates to the manufacturing process of band saw blades having a diamond layer at the cutting edge thereof, it is of course that the present invention is also applicable

to the production of various types of other tools, by making use of various kinds of abrasive particles, such as diamond, cubic boron nitride, fine ceramics, etc.

In this example, band saw blades were manufactured through the process steps mentioned below, and with the electroplating tank in Figs. 1 and 2.

(1) A rigid material consisting, for example, of carbon steel, stainless steel, etc., is processed to have the shape and hardness of a tool to be manufactured, and the surface of the material is polished with a buff or the like, so as to form a base metal.

(2) Portions of the base metal, for which electroplating of abrasive particles is unnecessary, are masked with plating regist ink by a conventional method.

(3) Then, the base metal is applied with electrolytic or chemical degreasing to the base metal as in the usual preplating treatment, and further, with acid-cleaning thereto. When the material consists of stainless steel, activation treatment is applied thereto by electrolysis or acid-dipping.

(4) The primary plating is conducted under the following conditions, although this is made as necessary and may thus be omitted:

Electrolyte :	Hydrochloric Acid	100 to 200 g/l
	Nickel Chloride	200 to 300 g/l

Electrolytic Condition :

Temperature	Normal temperature
Cathode Current Density	3 to 20 A/dm^2
Time	1 to 5 min

(5) The base metal is immediately rinsed with water.

(6) For securing abrasive particles, a composite plating is conducted under the following conditions. First of all, a required amount of diamond abrasive particles with the size of more than about 40μm, which have already been made hydrophilic by a boiling water treatment or the like, are charged into the cathode chamber so that the portion of the base metal, on which the abrasive particles are to be secured is completely embedded in the abrasive particle layer. Then, a required amount of the plating liquid having bath compositions mentioned below is filled into the anode chamber and the cathode chamber within the electroplating tank, and is heated to a suitable temperature, and thereafter part of the anode liquid is supplied by means of the pump and through the filling conduit, is poured in a shower-like manner from above the cathode chamber over the entire surface area of the cathode chamber.

Bath compositions :	Hydrochloric Acid	240 to 320 g/l
	Nickel Chloride	45 to 90 g/l
	Boric Acid	30 to 80 g/l
	Brightener	Suitable amount

Electrolytic Condition :

Temperature : 30 to 70 deg.C

pH 2.0 to 4.5

Cathode Current Density : 1 to 12 A/dm^2

Time of Electrolysis : about 30 to 90 min.

(subject to considerable variation depending upon particle sizes.)

(7) Finishing Electrolysis : the base metal to which the codepositing electrolysis for the bonding of the abrasive particles is completed, is subjected to the final electroplating in the same electroplating tank with the whole cathode chamber removed therefrom or with the abrasive particles removed from the cathode or in another electroplating tank separately prepared, utilizing the electroplating bath having the same compositions and the same electrolytic conditions as those of the above-mentioned step (6). In this case, although the time for effecting the electrolysis considerably varies depending upon the particle size of the abrasive particles, that time is so determined that the covering rate of the plating metal with respect to the abrasive particles becomes about 60 to 90% in accordance with the purposes of the use.

(8) The base metal to which the finishing treatment is completed is immediately rinsed with water and then dried, and moreover, when the hydrogen embrittlement

due to slight amount of hydrogen absorbed by the plating metal particularly comes into a problem, the base metal is further subjected to heat treatment at 200°C for about four hours.

(9) If the regist ink remains on the base metal, it is removed therefrom and, if necessary, the base metal is further cleaned with the use of thinner, for example, to completely remove the regist ink.

(10) When an additional working (for example, endless-connection working for a band saw blade) is required, the required working is made to obtain the product.

After completion of the process step (6), as shown in Fig. 3, diamond particles 8 are uniformly secured onto the cutting edge part of the band saw blade through the intermediary of a nickel plated layer 12, excepting the masked parts 13 of the base metal, which band saw blade was thereafter satisfactory.

As explained above in detail, according to the present invention, the cathode electrode chamber of the above-mentioned structure is specifically disposed in the electroplating bath and part of the anode liquid is re-circulated and filled in the cathode chamber from the above such that the abrasive particles are held in the bottom section thereof and prevented from diffusion. Consequently, the plating conditions such as, for example pH, metal concentration, etc. in the cathode chamber can be stabilized

and controlled, so that the deposition of the abrasive particles can be controlled at a constant amount while the abrasive particles can be bonded onto the base metal uniformly and evenly. Further, without agitation as conventionally used for uniformly distributing abrasive particles in the plating bath, the abrasive particles are automatically held as a layer having a constant height in the bottom part of the cathode chamber by simply charging the abrasive particles into the cathode chamber, and the same effect as that obtained by agitation can be achieved by circulating the liquid through the layer so that not only the plating conditions in the cathode chamber can be stabilized, but also the abrasive particles to be used need be prepared by a necessary but minimum amount, thereby permitting on economical production. Furthermore, since the operating conditions can be controlled and stabilized, the present invention provides an optimum method for manufacturing electroplated tools, in that the tools can be continuously manufactured, etc.

INDUSTRIAL APPLICABILITY

As mentioned above, the method of manufacturing electroplated tools, according to the present invention, is suitable for manufacturing various tools for grinding, polishing, cutting, etc., wherein abrasive particles made

of diamond, cubic boron nitride, fine ceramics,etc. are codeposited and bonded together with a metal such as nickel or copper, onto the base metals of various tools by electroplating.

CLAIMS:

1. A method of manufacturing electroplated tools, wherein a tool base metal is subjected to plating regist in a predetermined shape, and is dipped in an electroplating bath added with abrasive particles so that the abrasive particles are codeposited and bonded together with deposited metal onto the base metal, characterized by the steps of providing a cathode chamber projected partly from the liquid surface of said bath, circulating and filling part of anode liquid into said cathode chamber from above thereof to hold said abrasive particles in the bottom section of said cathode chamber, and carrying out electroplating so as to bond said abrasive particles onto said tool base metal.

2. The method according to claim 1, wherein said cathode chamber has a frame to which is adhered a cloth or paper having extremely fine gaps distributed over the entire surface thereof, and inhibiting said abrasive paticles stored in said cathode chamber from passing therethrough.

3. The method according to claim 2, wherein said cloth or paper is acid-resistant.

4. The method according to claim 1, wherein said abrasive particles held as a layer whose height is made higher than at least the height of that portion of said tool base metal which is to be bonded with said abrasive particles.

5. The method according to claim 1, wherein part of said anode liquid is filled into said cathode chamber from the above in a shower-like form.

6. The method according to claim 5, wherein said part of anode liquid is filled through fine holes formed in a filling conduit which is laid above said cathode chamber.

7. A method according to claim 1, 2, 3, 5 or 6, wherein said part of anode liquid is circulated into said cathode chamber through a pipe by means of a pump.

FIG. 1

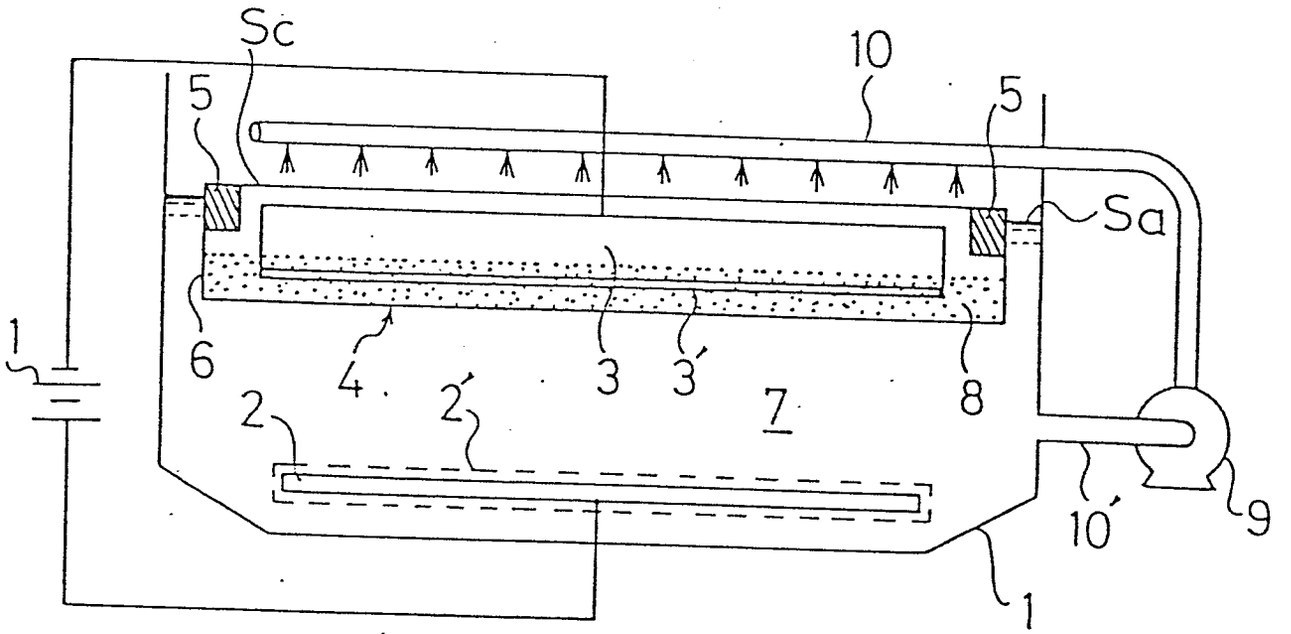


FIG. 2

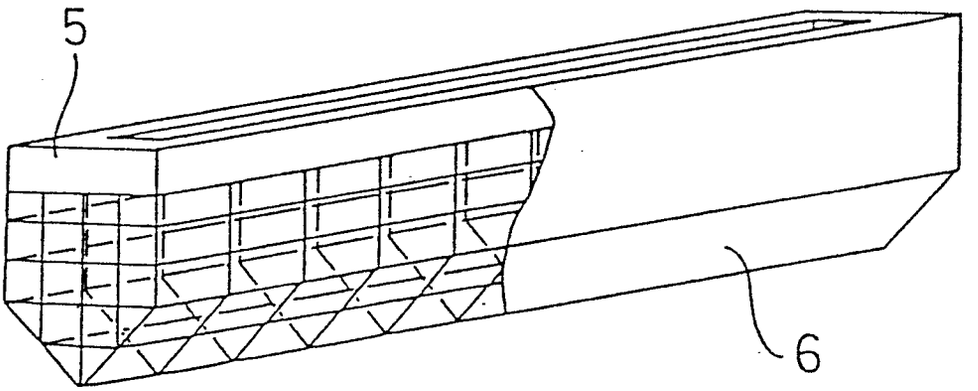
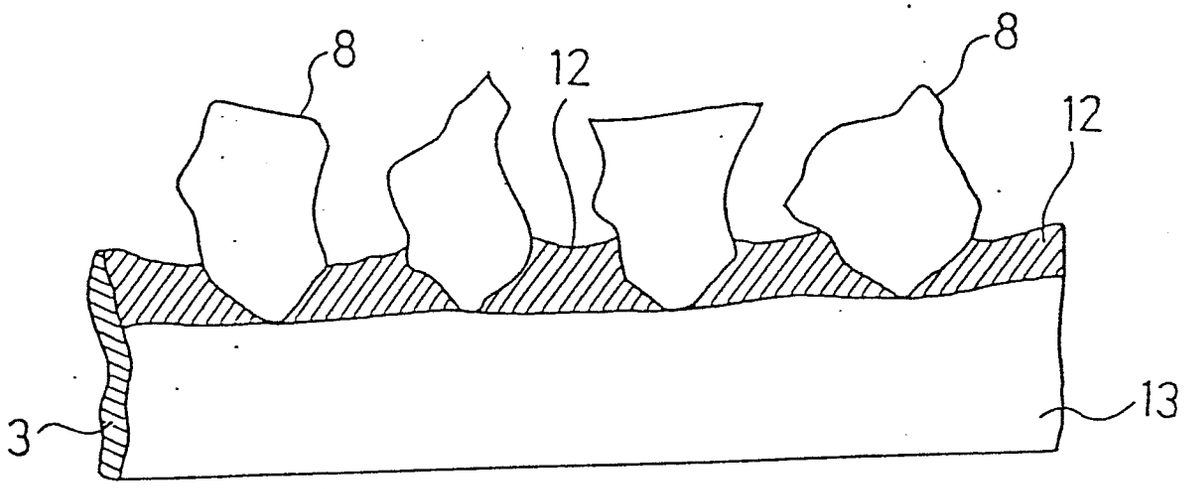


FIG. 3



INTERNATIONAL SEARCH REPORT

0185091

International Application No. PCT/JP84/00517

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl[4] B24D 3/06

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC	B24D 3/06

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

Jitsuyo Shinan Koho 1926 - 1984
Kokai Jitsuyo Shinan Koho 1971 - 1984

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category*	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	JP, B1, 51-754 (Inoue Japax Research Inc.) 10 January 1976 (10. 01. 76) (Family nashi)	1,5,6,7

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"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

"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

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
January 16, 1985 (16. 01. 85)	January 28, 1985 (28. 01. 85)
International Searching Authority [1]	Signature of Authorized Officer [20]
Japanese Patent Office	