(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 945 219 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.09.1999 Bulletin 1999/39

(51) Int. Cl.[6]: **B24B 37/04**

(21) Application number: **99105045.1**

(22) Date of filing: **23.03.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **24.03.1998 JP 7600298**

(71) Applicant: **Speedfam Co., Ltd.**
Kanagawa 252-1123 (JP)

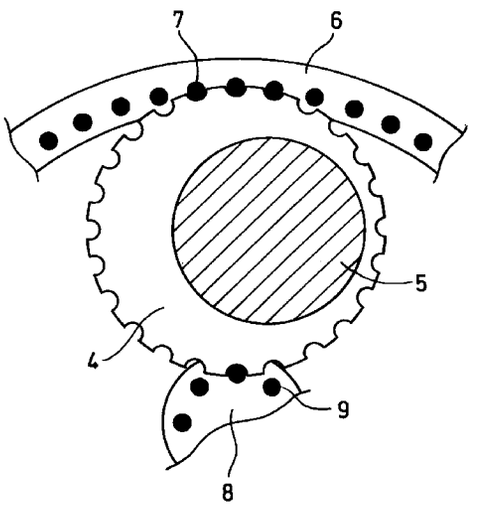
(72) Inventors:
- **Seino, Toshihiro**
  Ayase-city, Kanagawa pref. 252-1123 (JP)
- **Amano, Kenji**
  Ayase-city, Kanagawa pref. 252-1123 (JP)

(74) Representative:
Weisert, Annekäte, Dipl.-Ing. Dr.-Ing. et al
Patentanwälte
Kraus Weisert & Partner
Thomas-Wimmer-Ring 15
80539 München (DE)

(54) A double sided processing machine

(57) The present invention is the pin drive type double sided processing machine which drives to rotate a carrier (4) by pins (7,9), wherein the pin (7,9) is composed by a pin shaft (10) and a collar (12) which can rotate freely surrounding said pin shaft (10), and said collar (12) is made of specialty ceramics or specialty ceramic film coated metal. Further the surface roughness of the collar (12) is desirably smaller than 2.0 μm Ra, and the materials of said specialty ceramics is desirably at least one selected from the group composed by aluminum oxide, chrome oxide, zirconium oxide, aluminum nitrate, boron nitrate silicon nitrate, tungsten carbide, titanium carbide and titanium boride.

FIG.2



EP 0 945 219 A1

Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to the mechanism of a processing machine which processes both surfaces of a plate shape work-piece to have precise flatness and parallelism at one time, more in detail, relates to an improvement of the parts to drive a carrier which holds and rotates a work-piece.

DESCRIPTION OF THE PRIOR ART

[0002] In general, the surface processing of a plate shape work-piece made of glass, metal, semi-conductor, ceramics or carbon which is required to have precise flatness and parallelism is carried out by a processing machine having a platen or a platen on which polishing pad is stuck both at upper and lower position. The work-piece is held and pressed between said upper and lower platens, the platens and the work-piece are rotated under the constant supply of aqueous slurry containing fine abrasive grains. By the rotating and pressing action, the work-piece is flattened and improved precise flatness and parallelism can be obtained. As the concrete processing method, lapping, polishing or grinding can be mentioned. In a case of grinding method, a grinding stone lapping which uses platens to which synthetic grinding stones are mounted can be mentioned.

[0003] The mechanism of these mentioned processing machine is simply illustrated by FIG.1. The machines have an upper and a lower platen which are placed as to be faced, and between two platens a plate shape work-piece is held and pressed, while said work-piece and platens are rotated under the constant supply of aqueous slurry containing fine abrasive grains. By the action of abrasive grains, the both surfaces of the work-piece are removed gradually and a surface with flat and precise surface roughness is generated.

[0004] The work-piece is not only held and pressed between upper and lower platen which rotates by different motions, but also is rotated by planetary motion, that is, by rotating and revolving motion. The polishing is progressed by a friction force caused by said rotating action and mechanical force of abrasive grains. To drive a work-piece by planetary motion, the work-piece is fitted into a holding hole formed in a carrier, and the carrier is rotated. At the outermost periphery of the carrier, gears are formed and the gears can gear into pins arranged on a sun wheel placed at the center of the platen and pins arranged on an internal wheel placed along with the outermost periphery of the platen. By rotating said sun wheel and internal wheel voluntarily, the carrier and the work-piece can be driven by planetary motion.

[0005] As above mentioned, the role of a carrier is to drive a work-piece as to process the work-piece by friction and mechanical power which are generated between work-piece and platen by driving the work-piece by different motion from the motion of upper and lower platen. Therefore, the carrier is required to be strong and tough as to bear the mechanical motion, further the gears formed at the outermost periphery of the carrier must not be damaged and worn out by the driving motion. Furthermore, to achieve the role of the carrier, the thickness of the carrier must be thinner than that of work-piece. In a case that the work-piece is a silicon wafer, since the surface area is relativery wide and the thickness is very thin, the materials of the carrier is very limited. Concretely, for the lapping use, metal materials such as SK steel or blue steel which is superior in a mechanical intensity are used, and for the polishing use which uses chemical agents, materials such as epoxy resin, glass fiber reinforced epoxy resin, polycarbonate or teflon coated SUS can be used. As the materials of a pin which is arranged on a sun wheel and an internal wheel, to prevent the problem of damage and worn out, cast iron is commonly used. As the materials of a pin which are arranged on a internal wheel and a sun wheel as to gear with the gear formed at the outermost periphery of the carrier, cast iron is generally used.

[0006] Recently, so called pin drive type double sided processing machine mentioned above is becoming popular, because it is superior to the conventional type double sided processing machine which uses a sun gear and an internal gear of monolithic structure made of conventional hardened steel. That is, when one pin which is arranged on a sun wheel or on an internal wheel is damaged, said wheels can be repaired only by changing the damaged pin. Further, by making a pitch of the gear formed at the outermost periphery of carrier wider, mechanical intensity of the carrier can be relatively improved. At the actual processing action of the double sided processing machine, gears formed at the outermost periphery of carrier are driven and rotated by the motion of pins arranged on a sun wheel or an internal wheel, and high load is loaded to the gears. During the actual run of machine, the surface of pins and gears are contacted dynamically, and high stress is loaded to the contacted portion, however, since this motion is only a mechanical gearing motion and does not cause friction between pin and gears unless there is not a big idler between pin and gears. Therefore, it is common to use the hardened steel which is strong to the mechanical stress and has a good friction resistance.

[0007] As the improved type of said conventional type double sided processing machine, the use of a rotatable columnar shape pin roller instead of a fixed pin is proposed in Japanese Patent laid open publication 1-252356, in which the technique to reduce the resistance by allowing the freely contact of gears to pins is disclosed. Further, in Japanese Pat-

ent laid open publication 9-207063, the technique is disclosed which reduces the friction resistance and prevents from the metallic contamination caused by fine particles of metal generated by the contact of pin and carrier, by an use of a resin roller or a resin coated roller.

[0008] However, even if the machine is an improved pin drive type double sided processing machine, there is a problem that fine particles of abrasive grain enter into a narrow gap between carrier and pin and partially damage the surface. Furthermore, in a case of mechano-chemical polishing which uses the corroding ability of chemicals contained in it, the following problem is pointed out, that is, by the corroding effect of chemicals, a striped thin grave is formed on the surface of pin along with the contact line to the carrier at the long term use. In this case, the rotation of a carrier becomes to lack of smoothness, the machine gets out of order and the motion of a work-piece becomes uneven, therefore the normal action of machine can not be expected. Furthermore, small amount of fine particles of metal which are generated according to the wear of carrier and pin are dispersed over the surface of work-piece, and especially in a case of silicon wafer processing, the dispersed metal fine particles causes serious metal contamination problem. To prevent above mentioned problems, it is necessary to change the pins and carrier to new one frequently, therefore these are not sufficient from the economical view point and from productivity. The use of a roller whose surface is coated with special resin can prevent a problem of metal contamination, however, since the durability of the coated roller is inferior to that of steel, other problems can not be solved.

SUMMARY OF THE INVENTION

[0009] The inventors of this invention have carried out an intensive study to overcome the above mentioned problems and found that the worn-out and the damage of a carrier and a pin is mainly caused not by the friction but by the strong mechanical stress. To against said strong mechanical stress, it is effective to use a material which has higher hardness and smaller friction coefficient and to devise the structure of a pin which prevents the formation of partial striped thin groove on the surface of pin and prevents the defacement of carrier. Thus, the inventors have found that the substantial durability of double sided processing machine can be obtained by carrying out above mentioned items, and accomplished the present invention. Namely, the object of this invention is to provide a pin and a structure of the pin which has a good friction resistance to carrier, makes the life time of a pin and a carrier longer and reduces the metal contamination.

[0010] Above mentioned object can be accomplished by a double sided processing machine which processes both surfaces of a plate shape work-piece at one time holding said plate shape work-piece which is fitted into a holding hole of a carrier between an upper and a lower platen placed as to be faced, said carrier has gears at the outermost periphery which are geared into pins arranged on a sun wheel placed at the center of the platen and pins arranged on an internal wheel placed along with the outermost periphery of the platen and is driven to rotate by the rotating motion of said sun wheel and said internal wheel, wherein said pin is composed by a pin shaft and a collar which can rotate freely surrounding said pin shaft, and said collar is made of specialty ceramics or specialty ceramic film coated metal. At the actual carrying out of the invention, the surface roughness of said collar made of specialty ceramics or specialty ceramic film coated metal is desirably finer than 2.0 μm Ra, and more desirably finer than 1.2 μm Ra. Further, said specialty ceramics is desirably at least one selected from the group composed by aluminum oxide, chrome oxide, zirconium oxide, aluminum nitrate, boron nitrate, silicon nitrate, tungsten carbide, titanium carbide and titanium boride.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0011]

FIG.1 is the partially sectional view of the machine of this invention
FIG.2 is the partially plan view of the machine of this invention
FIG.3 is the sectional view of the pin of this invention

[0012] In the drawings, each numerical number indicates,

1 : upper platen
2 : lower platen
3 : work-piece
4 : carrier
5 : gear
6 : internal wheel
7 : pin (on internal wheel)
8 : sun wheel

9 : pin (on sun wheel)
10 : pin shaft
11 : cap
12 : collar

DETAIL DESCRIPTION OF THE INVENTION

[0013] The double sided processing machine used in this invention is illustrated by FIG.1 and FIG.2. The machine has a rotatable upper platen 1 and a rotatable lower platen 2 as to be faced, a carrier 4 which can be driven by planetary motion and an internal wheel 6 and a sun wheel 8 which drive said carrier 4. The work-piece 3 for example silicon wafer is fitted into a holding hole formed in a carrier and is processed by the removing force of abrasive grain generated by the pressure and the rotating motion of the platen. The object of the processing is to correct the uneven thickness of work-piece such as silicon wafer, remove the heights and to obtain an excellent flatness and parallelism. At the outermost periphery of the carrier 4, gears 5 are formed and the gears can be geared into pins 7 and pins 9 arranged at same intervals on the internal wheel 6 placed at the outer side and on the sun wheel placed at the inner side. By driving said internal gear 6 and sun gear 8 voluntarily, the work-piece 3 and carrier 4 can be rotated by planetary motion.

[0014] As mentioned above, pins 7 and pins 9 arranged on the internal wheel 6 and the sun wheel 8 are composed to gear exactly into the gears formed at the outermost periphery of carrier, and is illustrated in FIG.2. As obviously understood by the drawing, gears 5 are tightly contacted to pins 7 and 9 at the actual run, and the carrier is driven to rotate by driving these pins. Each pin is composed by a pin shaft 10 which is placed at the center, a cylindrical collar 12 which cover said pin shaft and a cap 11 which prevent the collar 12 from falling off. The material of the pin shaft 10 is not restricted, however, it is desirable to use hardened steel which has strong mechanical intensity and good shock resistance, for example SK4 steel or SK5 steel is preferably used. And when the collar is a specialty ceramic coated metal, the base metal is also desirable to be the hardened steel which has strong mechanical intensity and good shock resistance. The outer diameter of pin shaft 10 and inner diameter of collar 12 must be nearly same in the limit to allow the rotation of collar 12, and is required not to remain the vacant space. At the actual use, when abnormally high stress is loaded to the carrier 4 and pins 7 and 9, said collar of mentioned shape rotates and disperses the abnormal stress, further by the rotation the position of collar which contacts to the gears of carrier is changed and can avoid the partial defacement of pins. Furthermore, the friction coefficient between said collar 12 and the pin shaft 10 can be reduced by engraving small grooves on the surface of pin shaft or by using the pin shaft of uneven surface, and can make the rotation of collar more smooth.

[0015] At the actual run, the collar 12 always contacts dynamically with gears 5 of carrier 4, and the important point of this invention is to restrict the materials of collar 12 to the specialty ceramics. The specialty ceramics of this invention is quite different from a conventional ceramics (general pottery) produced by a conventional pottery industry. The starting materials of said specialty ceramics is a high pure compound of metal oxide, metal nitrate, metal carbide, metal boride or a mixture of these compounds. Fine particles of these compounds are kneaded and molded, and the molded substance is sintered by high temperature and thus the specialty ceramics can be obtained. The obtained specialty ceramics have unique physical features, for example, a mechanical feature, an electrical feature, an optical feature, an electronic feature and a chemical feature. In the present invention, a specialty ceramics which has high hardness and high mechanical intensity, toughness, friction resistance and chemical resistance is preferably used. Concretely, specialty ceramics which are produced using at least one selected from the group composed by aluminum oxide, chrome oxide, zirconium oxide, aluminum nitrate, silicon nitrate, silicon carbide, tungsten carbide, titanium carbide and titanium borate can be mentioned. These ceramics have high hardness and strong mechanical intensity, and can bear to the strong stress generated between carrier and pin.

[0016] Mhos hardness of the specialty ceramics or the composite which are made of chrome oxide, silicon carbide, tungsten carbide, titanium nitrate, titanium borate, aluminum oxide (Alumina, sapphire and ruby) are bigger than 9 and are harder than that of abrasive grains which are used at the ordinary lapping or polishing. Therefore, if the fine particles of abrasive grains enter into a narrow gap between carrier and pin, since the pin has harder hardness than abrasive grain, the pin can not be easily worn or damaged. The generation of fine particles of metal caused by wearing or damaging is remarkably reduced, and the metal contamination of the surface of work-piece is also improved. Further, the conventional ceramics whose starting materials is silicate have a serious problem of alkaline resistance, on the contrary, these specialty ceramics has a good alkaline resistance and in a case of mechano-chemical polishing which uses abrasive slurry dispersed in alkaline solution the pin can be used without a problem of corrosion.

[0017] The shape of above mentioned collar 12 made of specialty ceramics is perfect cylindrical shape without eccentricity and distortion so as to promise the smooth contact with the gears 5 of carrier 4, further desirably the surface of it is to be finished to very precise level. It is not restricted, but desirably the surface roughness Ra (numerical average roughness) is to be smaller than 2.0 μm. This surface corresponds to the super finishing surface. An use of the pin composed by the collar having super finishing surface make the gearing of collar and gears of carrier very smooth, and not

only the damage of collar is reduced but also the bad effect to carrier is lightened and wear of it is remarkably improved. Therefore, if a metal carrier is used, the generation of fine particles from the carrier is reduced. If the surface roughness is bigger than 2.0 μm Ra, the protection against a metal contamination and a wear of the carrier are not sufficient, and a problem of lack of shock resistance raises.

[0018] The pin shafts 10 are arranged and fixed at same intervals on the circumference line of the sun wheel 8 and the internal wheel 6 as to be geared into gears 5 of carrier 4, and the method to fix the pin shafts is not restricted. However, from the view point of the maintenance of machine, it is desirable to make the freely installing and removing to the machine possible, for example, fixing method by a screw can be mentioned. As indicated by FIG.3, a collar 12 made of specialty ceramics or specialty ceramic film coated metal is placed as to cover a pin shaft 10 and the top of the collar is fastened by a cap 10 to prevent the collar from falling off or jumping out from the pin shaft. By using a pin of above mentioned structure, when one collar is damaged, only damaged collar must be changed, and the changing method of pin is very easy. And in a case of regular maintenance, only the collars must be changed. Therefore, the pin of this structure is useful from the productivity and from the economical view point.

[0019] In the present invention, as above mentioned, the contact of the carrier 4 to the collar 12 whose surface is specialty ceramics is very smooth and can reduce the stress to the carrier caused by rotation, and additionally the function to convey the motion of sun wheel and internal wheel to the carrier trough pins becomes very smooth. With respect to the shape of gear 5 of carrier 4, the height of gear is sufficient to be same to the diameter of pin or smaller. And by making the shape of gear as mentioned above, idle clearance between carrier and pin is reduced and the wear and damage of carrier can be further reduced. The positional relationship between carrier 4 and pin is clearly indicated in FIG.2.

DETAIL DESCRIPTION OF THE EXAMPLE

[0020] The present invention will be understood more readily with reference to the Example, however the Example is intended to illustrate the invention and not be construed to limit the scope of the invention.

Example and Comparative Example

[0021] A cylindrical specialty ceramic collar specimen of 14mm outer diameter, 2mm thickness and 40mm height made of silicon carbide is prepared. The mechanical properties of the collar are as follows,

apparent density :	3.1 g/cm^3
Vickers hardness :	3100 kgf/mm^2
fracture toughness :	5.6 MPa • m$^{1/2}$
flexural strength :	86.7 kgf/mm^2
surface roughness Ra :	0.4 μm

[0022] Friction coefficient and wear of this specimen are measured by Thrust type friction tester. Measuring of friction coefficient is carried out by the condition of 30m/min sliding speed and 50kPa load. Water is used as a lubricating film and SK steel which is used as a material of carrier is used as a friction material. Referring to the measurement of wear is carried out using #1200 Alumina (Al_2O_3) abrasive grain prescript in JIS R 6001 by 10m/min processing speed and 50kPa load.

[0023] As the comparative specimen, a collar made of SKD-3 steel which are used as a material of conventional pin having same dimension and surface roughness to the collar of this invention is prepared. And same measurement is carried out.

[0024] The obtained results are summarized in Table 1.

Table 1

	friction coefficient (η d)	wear (μm/min)
Example	0.2~0.45	0 (not worn out)
Comparative Example	0.3~0.6	0.3 (remarkably worn out)

[0025] Pins with said collar made of specialty ceramics are arranged to a pin drive type double sided lapping machine, and the machine is used for the lapping of silicon wafer for long term. The consumption of carriers made of blue steel is reduced to 50 ~70% and it is confirmed that the damage of collar is very little.

[0026] As mentioned above, by the double sided processing machine of this invention, the motion of driving part to

rotate the carrier by planetary motion becomes very smooth and the frequency for changing of pins and a carrier is improved. Further, since the generation of fine particles of metal from pin and carrier is reduced, the problem of metal contamination of silicon wafer by metal impurity can be solved. Concretely, the life time of carrier becomes 1.5 to 2 times and the changing interval of pins is prolonged from one year to two years. That is, the effect of this invention is obvious. Further, the effect of this invention can be maintained for long term. For instance, the effect of the resin coated collar is effective for very short term, while the effect of this invention is effective for very long term.

Claims

1. A double sided processing machine which processes both surfaces of a plate shape work-piece at one time holding said plate shape work-piece which is fitted into a holding hole of a carrier between an upper platen and a lower platen placed as to be faced, said carrier has gears at the outermost periphery which are geared into pins arranged on a sun wheel placed at the center of the platen and pins arranged on an internal wheel placed along with the outermost periphery of the platen and is driven to rotate by the rotating motion of said sun wheel and said internal wheel, wherein said pin is composed by a pin shaft and a collar which can rotate freely surrounding said pin shaft, and said collar is made of specialty ceramics or specialty ceramic film coated metal.

2. The double sided processing machine of claim 1, wherein the surface roughness of the collar made of specialty ceramics or specialty ceramic film coated metal is smaller than 2.0 μm Ra.

3. The double sided processing machine of claim 1, wherein the materials of said specialty ceramics is at least one selected from the group composed by aluminum oxide, chrome oxide, zirconium oxide, aluminum nitrate, boron nitrate silicon nitrate, tungsten carbide, titanium carbide and titanium boride.

4. The double sided processing machine of claim 1, wherein the pin shaft is engraved small grooves on the surface, or of an uneven surface.

FIG.1

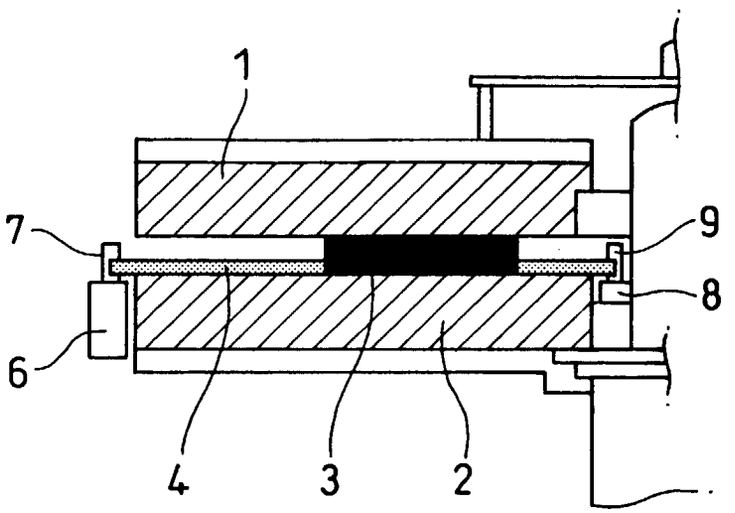


FIG.2

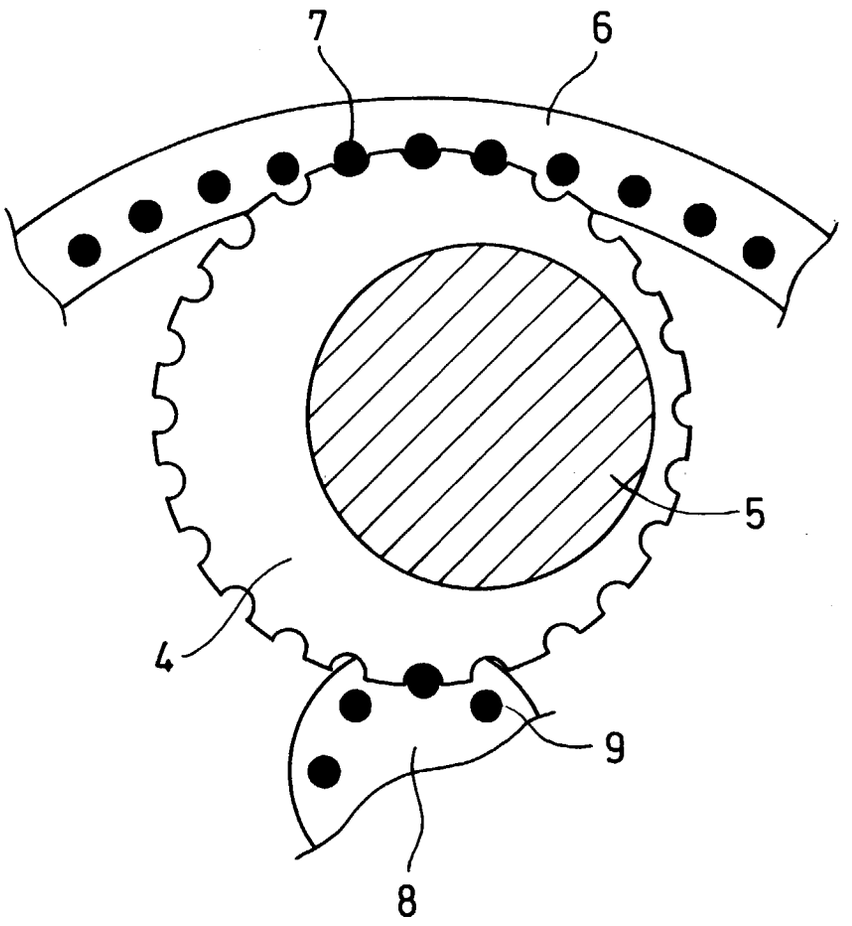
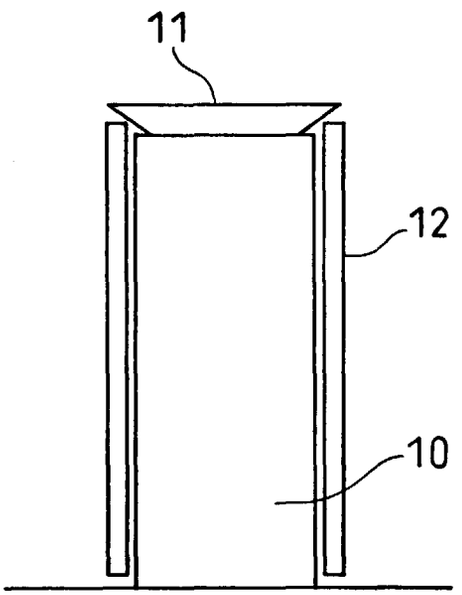


FIG.3



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 10 5045

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 787 562 A (SHINETSU HANDOTAI KK) 6 August 1997 * column 8, line 44 - column 9, line 34 * * column 10, line 52 - line 54; figures 10,11 *	1-4	B24B37/04
A	US 3 578 828 A (ORKIN ET AL.) 18 May 1971 * column 2, line 69 - column 3, line 5 * * column 3, line 51 - line 63 *	1,3	
A	US 3 938 868 A (VANWYK) 17 February 1976 * column 2, line 52 *	2	
A	US 4 184 720 A (ZACHERL) 22 January 1980 * column 3, line 48 - line 50 *	1,3	
A	EP 0 422 786 A (WING HIGHCERA KK) 17 April 1991 * column 3, line 44 - line 52 *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B24B
F16C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30 June 1999	Garella, M

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 10 5045

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

30-06-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0787562 A	06-08-1997	JP 9207063 A	12-08-1997
		JP 9254026 A	30-09-1997
US 3578828 A	18-05-1971	DE 1946911 A	10-09-1970
		FR 2035500 A	18-12-1970
		GB 1279827 A	28-06-1972
		JP 50013904 B	23-05-1975
		SE 360441 B	24-09-1973
US 3938868 A	17-02-1976	NONE	
US 4184720 A	22-01-1980	DE 2648328 A	27-04-1978
		FR 2369454 A	26-05-1978
		GB 1558941 A	09-01-1980
		SE 431777 B	27-02-1984
		SE 7712012 A	27-04-1978
EP 0422786 A	17-04-1991	JP 3129119 A	03-06-1991
		AT 119249 T	15-03-1995
		CA 2026185 A	13-04-1991
		DE 69017342 D	06-04-1995
		KR 9508332 B	27-07-1995
		US 5127745 A	07-07-1992

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82