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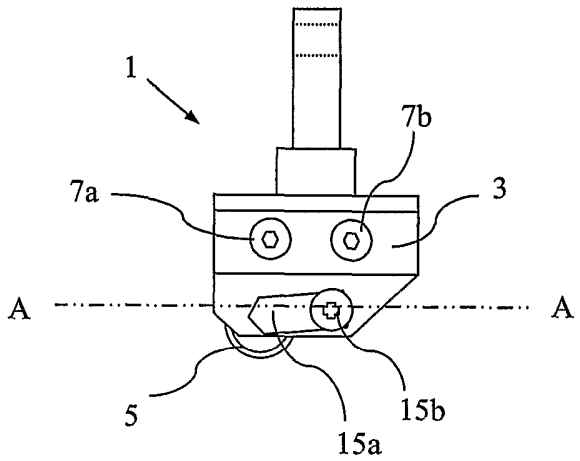
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(54) **Title:** APPARATUS AND METHOD FOR SCORING



(57) **Abstract:** Apparatus and methods for scoring brittle materials such as glass and ceramics are described. A cutter head that has a wheel assembly comprising a rotatable scoring element with a magnetic field and a magnetic field sensor is used to monitor the status of the scoring element. Measuring how the magnetic field associated with the scoring element varies with time during a scoring operation can be used monitor the rotation and status of the scoring element.

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APPARATUS AND METHOD FOR SCORING

This invention relates to apparatus and methods for scoring a surface. In a preferred embodiment the apparatus is a glass cutter comprising a magnetic cutter wheel and a magnetic field sensor.

When a brittle material such as glass or ceramic is cut, the cutting operation may include the steps of first scoring a line upon the surface of the material and subsequently snapping the material so that it breaks along the line of the score. Apparatus for scoring a surface is known as a scoring tool and comprises a scoring element such as a wheel, stylus or chip mounted in a housing. Where the scoring element is a wheel the combination of the element and the housing is referred to as a wheel assembly. Apparatus for scoring a glass surface is known as a glass cutter. A glass cutter commonly comprises a wheel assembly which comprises an axle about which the cutter wheel rotates.

During the production of glass by the float glass process, the continuous ribbon of glass is cut into sheets using glass cutters typically mounted downstream of the annealing lehr to score the ribbon both in the direction of travel of the ribbon and across the width of the ribbon. The cutter wheels used in glass cutters are usually made from tungsten carbide and are available as items of commerce. Tungsten carbide cutter wheels are used to score a ribbon of float glass continuously but become blunt relatively quickly. To ensure a consistent cutting operation the cutter wheel can be replaced frequently, often every 8 to 48 hours. This requires manual intervention and can disrupt the manufacturing process, adding additional cost to the glass making operation and reducing the amount of cut glass which is produced.

New types of cutter wheel have been developed which do not become blunt so quickly. Tungsten carbide cutter wheels which have had a surface treatment such as nitridation have extended wheel lives. Cutter wheels comprising diamond have recently become commercially available but are more expensive than those based on tungsten carbide. These diamond cutter wheels are much harder than tungsten carbide cutter wheels and as a consequence can be used to score a float glass ribbon for a longer time before the wheel becomes blunt and needs replacing. This can result in a reduction of the overall costs associated with glass cutting. However a diamond cutter wheel can be in service for much longer than a tungsten carbide cutter wheel so there is more likelihood that the cutter wheel can jam due to small fragments of glass or other debris wedging against the cutter wheel thereby preventing it from rotating. If there is a period of non-rotation of the cutter wheel during the scoring operation, the quality of the score line will be reduced which can result in the glass sheet having a lower quality cut edge. This can have a negative effect upon subsequent processing operations, for example lamination and toughening. A period of non-rotation of sufficient duration during the scoring operation can lead to increased wear of the wheel at the point of glass contact and can ultimately lead to the formation of a blunt portion on the wheel, known as a flat. If the cutter wheel develops a flat this can reduce the quality of the score line, even if the wheel subsequently becomes unjammed and can rotate freely again because the glass surface will not be scored adequately in the vicinity of the flat. To ensure that a continuous score line of the desired quality is produced on the glass surface the rotation of the cutter wheel should be monitored so that any period of non-rotation can be immediately identified and any debris jamming the cutter wheel can be removed with the minimum disruption to the

cutting operation. Additionally if a period of non-rotation of the cutter wheel was of a sufficient duration to produce a flat the cutter wheel should be replaced without delay.

USP 3,880,028 describes a method and means for detecting sound waves emitted during the mechanical scoring of glass, whereby the sound energy is picked up and translated into an electrical signal which is a function of the intensity of the sound. The signal may be used directly to activate automatic control of the scoring tool pressure.

Surprisingly we have now discovered that certain cutter wheels have magnetic properties and are either inherently magnetic or capable of being permanently magnetised by a magnetic field. Providing the cutter with a sensor to measure the variation of the magnetic field strength in the locality of a cutter wheel as a function of time during a scoring operation provides a means of monitoring the rotation of the cutter wheel.

Therefore from a first aspect the invention provides a scoring tool comprising a wheel assembly with a rotatable magnetic scoring element, an axle about which said scoring element rotates and means to measure the magnetic field in the locality of the scoring element.

Rotation of the scoring element about the axle creates a variation in the magnetic field which can be measured and which will repeat with each revolution of the wheel. Deviations from this pattern provide a means of indicating that the scoring element is not rotating freely.

The scoring element may be inherently magnetic or have an induced magnetism. In the preferred embodiment the scoring element is inherently magnetic. Typically the tungsten carbide used in scoring elements is a composite material comprising aggregates of particles of tungsten carbide bonded with a ductile metal such as cobalt or nickel via liquid-phase sintering. Harder scoring elements can be made by replacing some or all of

the tungsten carbide with particles of diamond. Tungsten carbide and diamond are not magnetic but the cobalt binder can be magnetised to provide a magnetic scoring element. In the event of a non-magnetic metal being used as a binder, particles of a magnetic material may be added to the composite. Preferably the scoring element comprises a metal chosen from a group including cobalt, nickel, neodymium, samarium, and iron. The magnetic field pattern can be a simple dipole on the periphery of the scoring element although more complex magnetisation patterns are possible such as more than one dipole on the scoring element periphery. Typically the scoring element has a magnetic field strength between 0.00001T and 0.1T, more preferably between 0.0001T and 0.02T, most preferably between 0.003T and 0.01T.

In addition to inducing permanent magnetism, the scoring element can be provided with a separate magnetic source that may increase the strength of the magnetic field of the scoring element or provide the scoring element with a magnetic component. The separate magnetic source should preferably rotate at the same rate as the scoring element. Preferably the separate magnetic source comprises one or more sources chosen from a group including at least one magnet fixed to a portion of the cutter wheel surface, a magnetic paint covering a portion of the cutter wheel and at least one magnet in contact with a portion of the axle.

The invention is especially applicable to scoring elements that do not become blunt easily such as those comprising diamond, tungsten carbide or steel. Such elements are designed to operate over an extended period and it is advantageous to monitor their performance and to react to any deviation from the norm.

The preferred scoring element is a disk-like cutter wheel. To maximise the coupling with the magnetic field of the scoring element, the magnetic field detection

means is located near to the scoring element without impeding the operation of the scoring element. The magnetic field detection means should not inhibit the rotation of the scoring element or interfere with any lubricating means that assists the operation of the scoring element. It is preferred that when viewed along the axle the magnetic field detection means is located outside the periphery of the scoring element. Preferably the magnetic field detection means is attached to the wheel assembly by a securable releasable means to allow rapid removal in the event of repair. The selection and arrangement of the materials used in the construction of the wheel assembly can be used to either shield the scoring element from external magnetic fields or to concentrate its magnetic field on the magnetic field detection means.

The magnetic field detection means preferably comprises one or more device chosen from a group including a Hall effect sensor, a magnetoresistive device, a wire coil, a flux gate or an atomic magnetometer. Preferably the magnetic field detection means comprises at least one Hall effect sensor.

The scoring tool may be used to score a surface of a brittle material such as glass, glass-ceramic, ceramic and semiconductor wafer. In a preferred embodiment the apparatus is used to score float glass, preferably in the form of a continuous ribbon, a flat glass sheet or a curved glass sheet. The score line that is effected by the tool may be straight or curved.

According to a second aspect of the invention there is provided a method of scoring a surface with a scoring tool, said tool comprising a rotatable magnetic scoring element mounted on an axle, the method comprising contacting the surface with the scoring element and applying pressure to the tool in the direction of the surface whilst moving the scoring element relative to the surface thereby causing the scoring element to

rotate about the axle to effect a score line wherein a magnetic field detection means detects the magnetic field strength during the scoring operation and generates an electric signal that is a function of the magnetic field strength. The electric signal may be used to indicate the status of the scoring element and as a basis for overhauling or replacing the scoring tool.

Preferably the electric signal is used to indicate the total distance scored by scoring element, D_s. When D_s exceeds a predetermined distance D_f the electric signal is used to indicate that the scoring element needs to be replaced. Alternatively the electric signal can be used to indicate the total time spent scoring by the scoring element T_s. When T_s exceeds a predetermined duration T_f the electric signal is used to indicate that the scoring element needs to be replaced. In another embodiment the electric signal is used to indicate the total number of revolutions of the scoring element R_s. When R_s exceeds a predetermined number of revolutions R_f the electric signal is used to indicate that the scoring element needs to be replaced.

In a second preferred embodiment the electric signal is used to indicate that there has been one or more period of non-rotation of the scoring element during the scoring operation. When there has been one or more period of non-rotation the scoring element may have jammed during the scoring operation. The electric signal may be used to indicate the number of times the scoring element was not rotating during the scoring operation, the duration of each of the one or more periods of non-rotation and/or the total period of time the scoring element was not rotating during the scoring operation. When the duration of one of the one or more periods of non-rotation of the scoring element exceeds a predetermined threshold T_1 it may be that the scoring element has a flat and the electric signal may be used to alert the operator to this possibility. The predetermined

threshold T_1 depends upon the relative speed between the scoring element and the surface as well as the amount of pressure applied to the scoring tool. A scoring element which has a flat can be replaced. Alternatively the scoring tool could be replaced with a scoring tool comprising a scoring element without a flat. The replacement of the scoring tool or the scoring element may be carried out manually or automatically. If the quality of the score line is critical the scoring tool wherein the scoring element has developed a flat should be replaced. If the quality of the score line is not critical a scoring element which has developed a flat need not be replaced until the quality of the score which it is producing falls below an acceptable level. Surfaces with score lines produced with a scoring element that has a flat can be recorded and segregated from surfaces that have high a quality score line.

The time taken for the scoring element to complete one revolution is denoted as T_r and depends upon the diameter of the scoring element and the relative speed between the scoring element and the surface. During the time interval T_r there is a characteristic variation of the magnetic field strength at a fixed position in space that depends on the number of magnetic dipoles N_m on the scoring element and the location of the magnetic dipoles on the scoring element. If the duration of each of the one or more period of non-rotation exceeds $T_r / (2N_m)$ but does not exceed T_1 the scoring element jammed during the scoring operation and the scoring tool may be overhauled to remove any debris that is jamming the scoring element so that it is free to rotate about the axle. If during the scoring operation the total period of non-rotation exceeds a predetermined threshold T_2, any debris jamming the scoring element should be removed so that the scoring element is free to rotate about the axle and the scoring element should be examined for any sign of a flat and replaced with a scoring element without a flat if necessary. The debris jamming

the scoring element can be removed manually or by directing a jet of fluid towards the scoring element. Alternatively the debris could be removed by engaging the scoring element with a surface and forcing the scoring element to rotate counter to the direction of rotation during the normal scoring operation so that the scoring element is free to rotate.

When replacing the scoring element there is an additional benefit of the scoring element having a magnetic field because the scoring element is magnetically attracted to any magnetically permeable materials used in the scoring tool making it less likely to misplace the scoring element.

Before the scoring tool is used to score a surface, the magnetic field strength of the scoring element can be measured by the magnetic field detection means as the scoring element makes one complete revolution about the axle. These field strength measurements can be used to construct a pattern of the magnetic field strength around the scoring element providing an additional means of monitoring the rotation of the scoring element. By measuring the magnetic field strength during a scoring operation, when the scoring element stops rotating it is possible to identify which part of the scoring element is in contact with the surface by comparing the measured field strength with the pattern of the magnetic field strength. This provides another means of indicating that the scoring element has a flat if the same portion of the scoring element is in contact with the surface during periods of non-rotation.

In the foregoing description the one or more period of non-rotation does not include periods when it is known that the scoring tool is not in use and that the scoring element is not in contact with the surface, such as when the scoring tool is deselected or during an interrupt period. It is possible to combine electric signals from other devices associated with the scoring operation to judge the occasions when the scoring element

should be rotating or is able to be rotated. The electric signal from the magnetic field detection means could be used to indicate that there is a problem with the surface or the associated production apparatus because the scoring element is not rotating when the scoring tool should be in use.

When the scoring operation is complete a bending moment is applied across the score line to separate or snap the sheet along the line. Brittle material cut where the score line was of lower quality due to the scoring operation being completed with a scoring element with a flat can be segregated and not used in a secondary processing application where the quality of the cut edge is critical. Preferably the brittle material is glass, glass-ceramic, ceramic or semiconductor wafer.

Embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings, in which:

Figure 1 shows a side elevation of a standard wheel assembly that is used in a cutter head.

Figure 2 shows an exploded front elevation of the standard wheel assembly shown in figure 1

Figure 3 shows a view of the standard wheel assembly shown in figure 1 along the line A-A where the scoring element has been displaced.

Figure 4 shows a side elevation of a modified wheel assembly incorporating a Hall Effect sensor

Figure 5 shows a view of the modified wheel assembly shown in figure 4 along the line A-A.

Figure 6 shows a side elevation of a modified wheel assembly head with a Hall Effect sensor in position.

Figure 7 shows a view of the modified wheel assembly shown in figure 6 along the line A-A.

Figure 8 is a graph showing the magnetic field strength as a function of time when five score lines were made on a static sheet of float glass with a glass cutter that had a cutter head incorporating the wheel assembly shown in figure 6.

Figure 9 is a graph showing the magnetic field strength as a function of time when four score lines were made on a moving ribbon of float glass with an on-line glass cutter that had a cutter head incorporating the wheel assembly shown in figure 6.

In figure 1 a standard wheel assembly (1) comprises a holder assembly (3) that houses a scoring element (5). The holder assembly consists of two holder members (3a) and (3b) joined by blanked screws (7a) and (7b). Holder member (3b) comprises a pillar (9) for attaching the wheel assembly to a cutter head (not shown). An axle (11) slots through hole (13a) in holder member (3a) and extends into holder member (3b) through hole (13b). The axle is pointed at one end and the pointed end fits into hole (13c) in holder member (3b). The hole (13c) has a smaller diameter than the axle (11). A metal pointer (15a) is attached to the holder member (3a) by a screw (15b). The metal pointer encloses the axle in the holder assembly. The scoring element (5) in this embodiment is a disk-like cutter wheel and it is mounted on the axle in between holder members (3a) and (3b). Either side of the cutter wheel there are inserts (17a) and (17b) of a hard material such as tungsten carbide or steel which are bonded to each holder member to prevent excessive wear of the holder assembly as the cutter wheel rotates. Figure 2 shows an exploded view of the wheel assembly shown in figure 1. Figure 3 shows a view of the wheel assembly shown in figure 1 along the line A-A.

Figure 4 shows a modified wheel assembly (20) where a rectangular portion has been removed from the holder assembly. A groove (22) running substantially parallel to the plane of rotation of the cutter wheel (5) was introduced into the holder assembly to accommodate a Hall Effect sensor (24). The groove extends through the body of the holder assembly so that the Hall Effect sensor head (24a) can be located near to the cutter wheel (5). The output from the Hall Effect sensor is made via cable (24b) which can be connected to a meter or the like. Depending upon the type of magnetic field detection means used, the cable could be replaced by brushes, sprung contacts and/or capacitive coupling onto electrically isolated regions of pillar (9). The output from the sensor head could be used to activate a miniature LED, the output of which could be detected by a photodiode located on the cutter head to avoid the use of cable (24b). Figure 5 shows a view of the modified wheel assembly shown in figure 4 along the line A-A.

Figure 6 shows the modified wheel assembly (20) with the Hall Effect sensor in position. The Hall Effect sensor (24) is mounted to the holder assembly by a plate (26) with a raised portion (26a) opposite groove (22). The plate is secured to the holder assembly by releasable screws (28a) and (28b) which clamps the Hall Effect sensor head (24a) in place. The Hall Effect sensor head is placed near to the cutter wheel to ensure there is good coupling with the magnetic field of the cutter wheel. The choice of material for the inserts (17a) and (17b) can be made to concentrate the magnetic field onto the Hall Effect sensor head or to shield the Hall Effect sensor from external magnetic fields. The electric signal from the sensor could be AC coupled since it is often necessary to only detect the changing field at the sensor head. The magnetic field detection means could include a miniaturised amplifier circuit to provide a current or voltage output or it could incorporate processing circuitry to output a digital signal or a signal that is proportional to

the angular velocity of the cutter wheel. Figure 7 shows a view of the modified wheel assembly shown in figure 6 along the line A-A.

A specific example of a commercially available Hall Effect sensor with which the invention has been successfully practised is a model BH-208 Axial Hall effect sensor available from F. W. Bell. The output from the sensor was linked to a gaussmeter to display the data. A 5mm diameter diamond cutter wheel and compatible axle, both available from Mitsuboshi Diamond International Co., Ltd were used in the wheel assembly.

A series of five score lines were made to the surface of a static sheet of float glass and the results shown in figure 8 using the embodiment of the invention shown in figure 6. The cutter wheel (5) rotates as it traverses the glass surface causing a variation in the magnetic field that is detected by the Hall effect sensor. This is translated into an electric signal that the gaussmeter uses to display a magnetic field strength reading. Data can be output directly to a computer via a RS232 link. A period of rotation of the cutter wheel (30) is observed as a variation of the magnetic field strength with time. When the cutter wheel is stationary the magnetic field does not change with time (32).

The wheel assembly was used in an on-line glass cutter. A series of four score lines were made on a moving ribbon of float glass and the results shown in figure 9. Each score line produced a variation in the magnetic field strength with time (40) that was detected by the Hall Effect sensor. Periods of non-rotation did not produce a variation in the magnetic field strength with time (42).

The variation in the magnetic field strength during the periods when the cutter wheel is not in contact with the glass, that is when it is not rotating, is related to the strength of the magnetic field at the point on the wheel which stops opposite the Hall

effect sensor head. For the particular wheel used in this particular embodiment, this was anywhere between 0.0045T and 0.0075T.

Claims

1. A scoring tool comprising a wheel assembly with a rotatable magnetic scoring element, an axle about which said scoring element rotates and means to measure the magnetic field in the locality of the scoring element.

2. A tool according to claim 1 wherein rotation of the scoring element about the axle creates a variation in the magnetic field which is measured by the magnetic field detection means.

3. A tool according to either of claims 1 or 2 wherein the scoring element has a permanently induced magnetic field.

4. A tool according to any of the preceding claims wherein the scoring element comprises a metal chosen from a group including cobalt, nickel, neodymium, samarium, and iron.

5. A tool according to any of the preceding claims wherein the scoring element has a magnetic field strength between 0.00001T and 0.1T, more preferably between 0.0001T and 0.02T, most preferably between 0.003T and 0.01T.

6. A tool according to any of the preceding claims wherein the scoring element comprises a material capable of being magnetised.

7. A tool according to any of the preceding claims wherein the scoring element comprises diamond, tungsten carbide or steel.

8.A tool according to any of the preceding claims wherein the scoring element is a disk-like cutter wheel.

9. A tool according to any of the preceding claims wherein the magnetic field detection means is located near to the scoring element without impeding the operation of the scoring element.

10. A tool according to claim 9 wherein when viewed along the axle the magnetic field detection means is located outside the periphery of the scoring element.

11. A tool according to any of the preceding claims wherein the magnetic field detection means is attached to the wheel assembly by a securable releasable means.

12. A tool according to any of the preceding claims wherein the magnetic detection means comprises one or more device chosen from a group including a Hall effect sensor, a magnetoresistive device, a wire coil, a flux gate and an atomic magnetometer.

13. A tool according to any of the preceding claims wherein the magnetic detection means is at least one Hall Effect sensor.

14. A method of scoring a surface with a scoring tool, said tool comprising a rotatable magnetic scoring element mounted on an axle, the method comprising contacting the surface with the scoring element and applying pressure to the tool whilst moving the scoring element relative to the surface thereby causing the scoring element to rotate about the axle to effect a score line wherein a magnetic field detection means detects the magnetic field strength during the scoring operation and generates an electric signal that is a function of the magnetic field strength.

15. A method of scoring a surface according to claim 14 wherein the electric signal is used to indicate the total distance scored by the scoring element D_s.

16. A method of scoring a surface according to claim 15 wherein when total distance scored by the scoring element D_s exceeds a predetermined distance D_f the electric signal is used to indicate that the scoring element needs to be replaced.

17. A method of scoring a surface according to either of claims 15 and 16 wherein the electric signal is used to indicate the total time spent scoring by the scoring element T_s.

18. A method of scoring a surface according to claim 17 wherein when total time spent scoring by the scoring element T_s exceeds a predetermined duration T_f the electric signal is used to indicate that the scoring element needs to be replaced.

19. A method of scoring a surface according to any of claims 14,15 or 17 wherein the electric signal is used to indicate the total number of revolutions of the scoring element R_s.

20. A method of scoring a surface according to claim 19 wherein when total number of revolutions of the scoring element R_s exceeds a predetermined number of revolutions R_f the electric signal is used to indicate that the scoring element needs to be replaced.

21. A method of scoring a surface according to any of claims 14 to 20 wherein the electric signal is used to indicate that there has been one or more period of non-rotation of the scoring element during the scoring operation.

22. A method of scoring a surface according to claim 21 wherein the electric signal is used to indicate the duration of each of the one or more period of non-rotation.

23. A method of scoring a surface according to either of claims 21 or 22 wherein the electric signal is used to indicate the total period of time the scoring element was not rotating during the scoring operation.

24. A method of scoring a surface according to any of claims 21 to 23 wherein the electric signal is used to indicate the number of times the scoring element stopped rotating during the scoring operation.

25. A method of scoring a surface according to any of claims 21 to 24 wherein if the duration of one of the one or more period of non-rotation of the scoring element exceeds a predetermined threshold T_1 the scoring element is replaced.

26. A method of scoring a surface according any of claims 21 to 24 wherein if the duration of one or more of the periods of non rotation of the scoring element exceeds a predetermined threshold the scoring tool is replaced.

27. A method of scoring a surface according to claim 21 wherein if the duration of each of the one or more period of non-rotation or the total period of time the scoring element was not rotating exceeds $T_r / (2N_m)$ but does not exceed T_1 the electric signal is used to indicate that the scoring element jammed during the scoring operation.

28. A method of scoring a surface according to claim 27 wherein the scoring tool is overhauled to remove any debris that is jamming the scoring element so that it is free to rotate about the axle.

29. A method of scoring a surface according to claim 27 wherein if during the scoring operation the total period of non-rotation exceeds a predetermined threshold T_2, any debris jamming the scoring element is removed so that the scoring element is free to rotate about the axle.

Figure 1

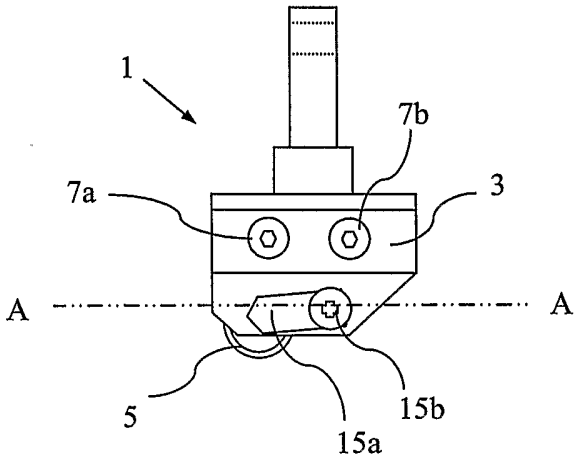


Figure 2

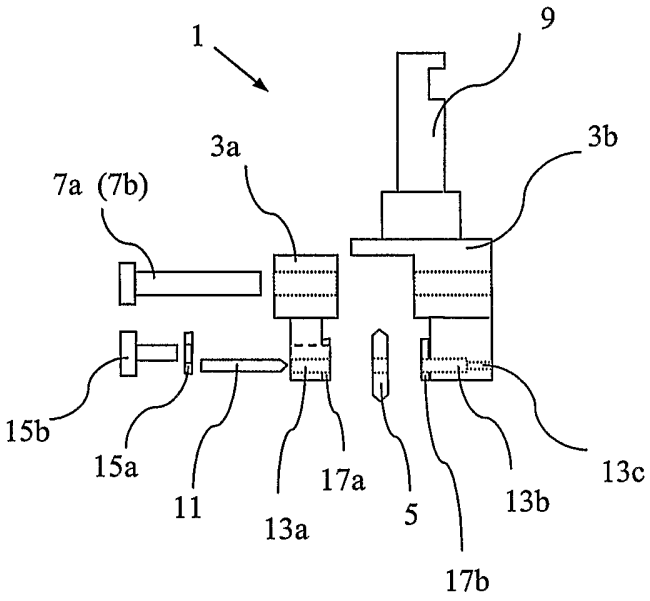


Figure 3

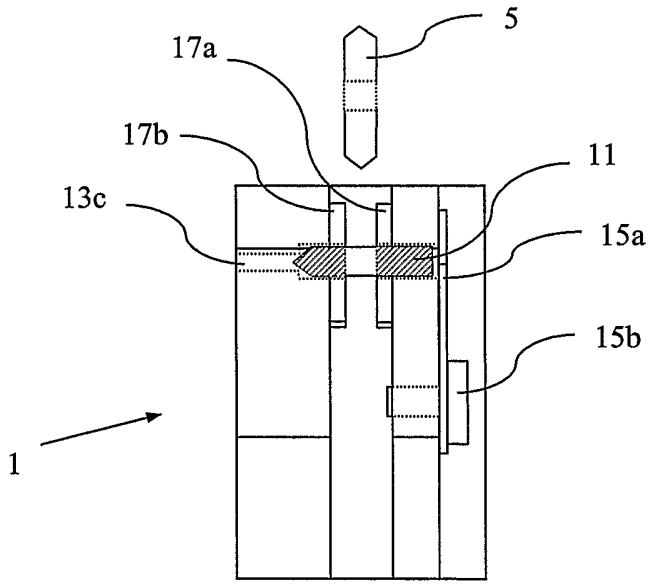


Figure 4

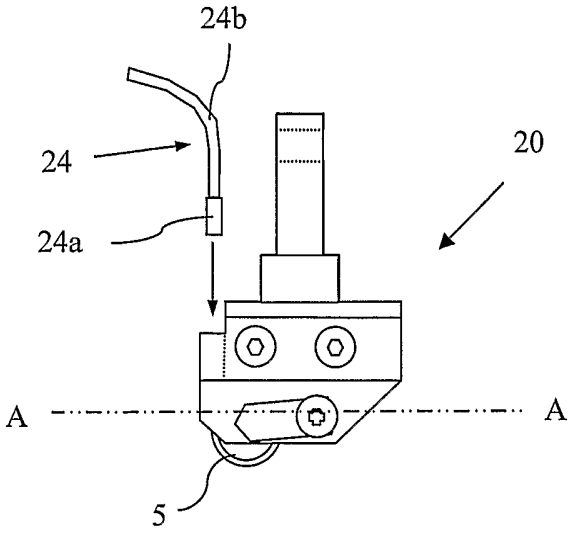


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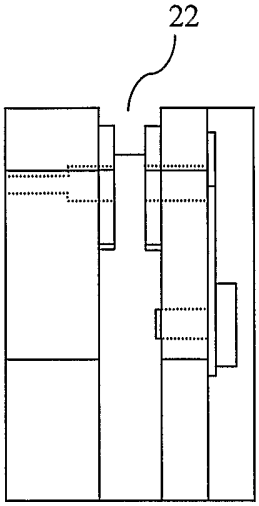


Figure 6

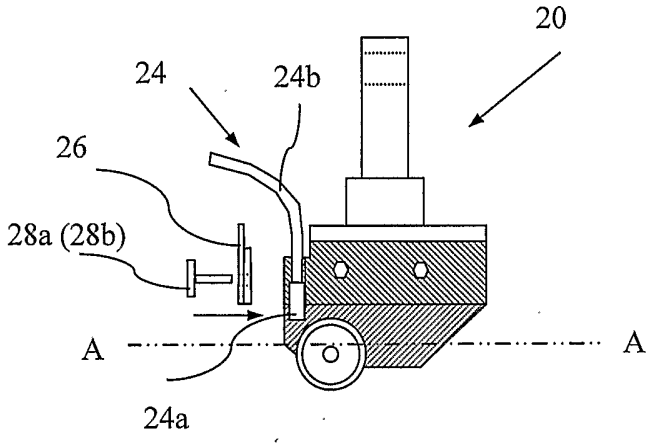


Figure 7

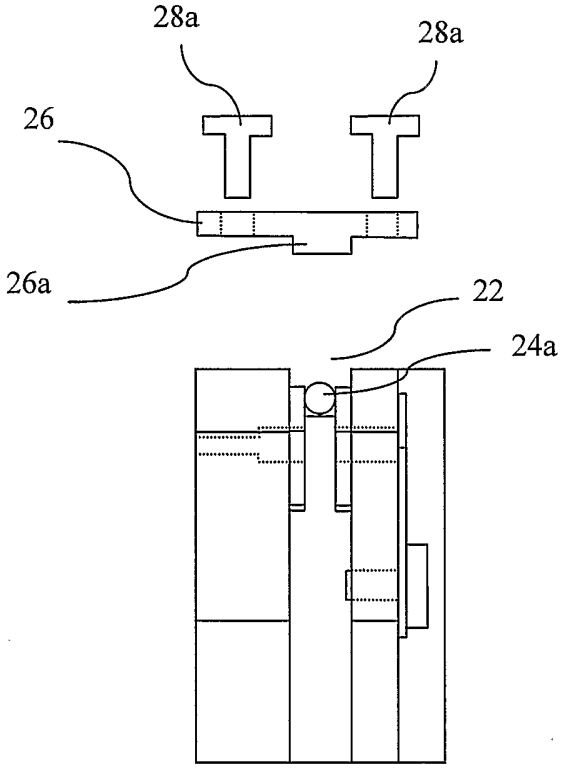


Figure 8

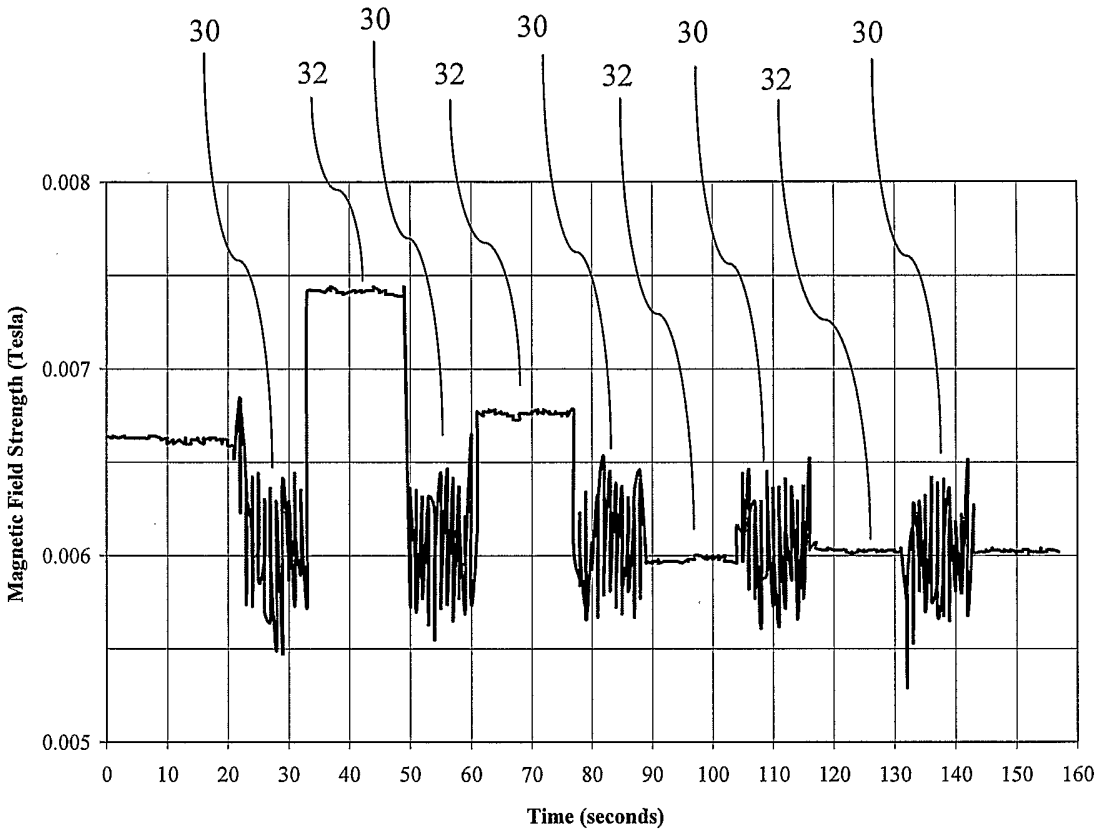
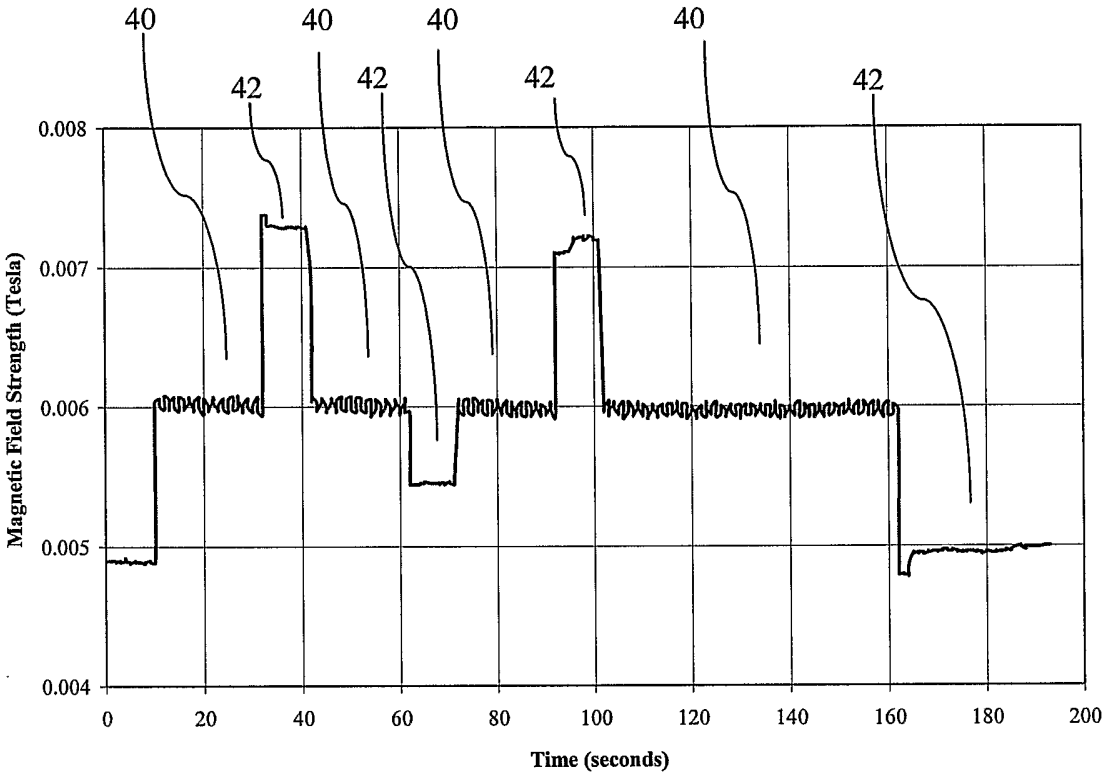

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32
30
32
30
32
30
32
30
0.008
0.007
0.006
0.005
Magnetic Field Strength (Tesla)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
Time (seconds)

Figure 9


40
40
40
40
42
42
42
42
0.008
0.007
0.006
0.005
0.004
Magnetic Field Strength (Tesla)
0
20
40
60
80
100
120
140
160
180
200
Time (seconds)

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2006/000811

A. CLASSIFICATION OF SUBJECT MATTER
INV. C03B33/10 B28D1/22

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)
C03B B28D

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, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3 880 028 A (FREDERICK, JR. ET AL) 29 April 1975 (1975-04-29) the whole document -----	1-29
Y	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 10, 31 October 1997 (1997-10-31) -& JP 09 141649 A (TOKYO SEIMITSU CO LTD), 3 June 1997 (1997-06-03) abstract -----	1-29
A	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 11, 3 January 2001 (2001-01-03) -& JP 2000 219526 A (HITACHI LTD), 8 August 2000 (2000-08-08) abstract; figure 2 ----- -/--	1-29

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 May 2006	22/05/2006

Name and mailing address of the ISA/	Authorized officer
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	Marrec, P

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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2006/000811

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	EP 0 513 437 A (MITSUBISHI MATERIALS CORPORATION) 19 November 1992 (1992-11-19) column 3, paragraph 1	1-29
Y	EP 0 535 296 A (MITSUBISHI MATERIALS CORPORATION) 7 April 1993 (1993-04-07) column 3, lines 10-30	1-29

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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