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- as to applicant's entitlement to apply for and be granted
a patent (Rule 4.1 7(H))
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(54) **Title:** MULTIPLE DIAMOND PLANNING AND BRUTING MACHINE

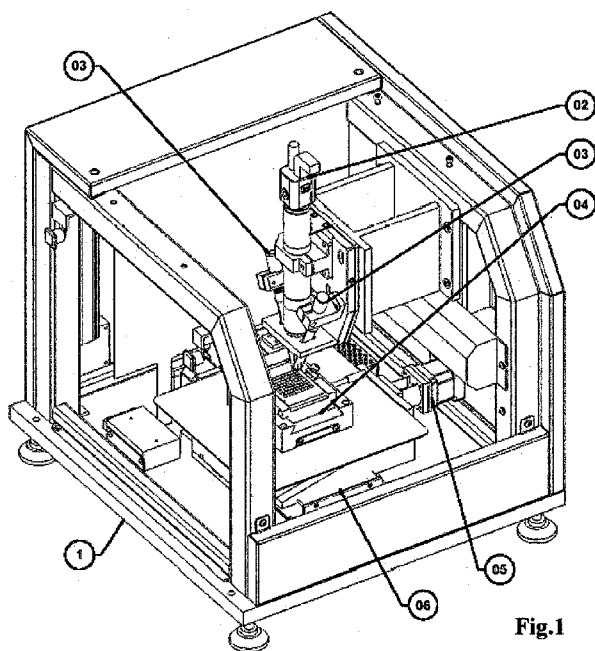


Fig.1

(57) **Abstract:** Multiple Diamond planning and Brating Machine is used to scan the multiple diamond on the single machine so, it reduce the labor and production cost. The invention mainly comprised in two parts; Flat scanner setup, Multi brut machine wherein flat scanner setup comprises machine frame (1), camera assembly (2), line laser (3), fixture device (4), X axis (5) and Y axis (6) which is used for the scanning the stone with the help of camera unit capturing images while two different line laser modules throws LASER beams on the stone and generates 3D images of the stone; wherein the multi bruter machine comprises with frame (14), laser source (15), galvo (16), air & LED holder assembly (17), camera assembly (18), fixture (19), X-axis (20), Y- axis (21) and Z- Axis (22) which used use the data which generated at the time of flat scanner scanning process.

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Multiple Diamond planning and Bruting Machine

Filed of the Invention:

The present invention relates to laser planning and bruting machine
5 for multiple diamonds. The present invention use in diamond
industries for the planning and bruting of multiple gemstones on the
single machine, which is cost effective and time & space saving
machine. It relates more specifically to a device per-fection, in which
means are provided to perform most of the process steps in an
10 automated fashion, resulting in saving steps, labor and also use
outside any improvement of the rough gemstone and gem quality
improved. The present invented device comprises three main
elements, means for preparing the gemstones for bruting including
the determination of all necessary parameters of the gemstones,
15 using computers for storing information and acquired a machine
bruting automatic, which is operated by computer and is capable of
bruted a series of several gems one after another on the bases of
selection.

20 Background of the invention

In the conventionally many of the diamond industries, For a bruting,
the gemstone is being mounted on a pin that can be rotated by a
drive motor, the center of rotation coinciding with the cylinder head
(or center) of the finished stone. With some machines, the operator

holds a hand tool, generally perpendicular to the axis of rotation to bruted stone. This system is disadvantageous because it requires considerable power and is a task intention, which takes time.

- 5 The South African patent 87/2.615 describes the developed bruting automatic machines where the machine has two horizontal spindles mounted parallel to each other and end to end. A pin (side of stone) includes bruted stone mounted on one end and one pin (the side tool) has a tool (which is often another stone) mounted on the end.
- 10 The spindle tool than turning to stone and a pin, usually the tool side, a movement back and forth in its axial direction. The rotation axes are kept parallel to each other but a pin can be moved gradually to the other during the operation bruting.
- 15 In the diamond industries of automatic machines bruting is a single operator can simultaneously operate a number of these machines. Indeed, a skilled operator can control all eight machines or more, moving from one machine to another to check progress, removing stones over, get new stones, and complete similar tasks. This means
- 20 that a workstation for a single operator to take say 5 to 10 meters of working area and the operator is obliged to travel a considerable distance to go to all machines. This increases operator fatigue.
- Another development relates to a semi-automatic device provided with means of stroboscopic inspection giving the worker a "still

picture" during bruting. This therefore constitutes a valuable aid in the decision process bruting itself.

A number of problems still exist in the current bruting machines and
5 can include manual centering of the stone after loading in the machine unloading thereof, visual inspection and the consequent decision by the operator of the moment to complete the bruting. To overcome the above stated problems, the parent invention "Multiple Diamond planning and Bruting Machine" has been invented.

10

The present invention is described with greater specific and clarity with reference to following drawings:

- Fig.1 represents the elevation view of the flat scanner setup
15 device
- Fig.2 represents the elevation view of the glass cassette fixture tube with their fixing device
- Fig.3 represents the top view of the glass cassette
- Fig.4 represents the elevation view of the glass cassette with
20 X-Y travel
- Fig.5 represents the elevation and front view of the camera assembly.
- Fig.6 represents the galvo assembly
- Fig. 7 represents the air & led holder assembly

In the present invented multi bruiting machine mainly comprised in two parts.

1. Flat scanner setup
- 5 2. Cutting machine

As shown in Fig.1, the flat scanner setup comprises machine frame (1), camera assembly (2), line laser (3), fixture device (4), X axis (5) and Y axis (6). In the present invention the scanner basically scans
10 the stone motion take place in X and Y direction. The whole scanning process takes place with the help of camera assembly (2). Then the captured images are given as an input to software module, which uses these images to perform the pixel count and gives 3D images of the stone. As shown in the Fig.1, the fixture device (4) is
15 mounted on the machine frame (1), wherein the fixture device (4) can travel X axis (5) and Y axis direction (6) as per the requirements by the stepper motor (13). The Fixture assembly is shown in Fig.2, the fixture assembly is consists of fix fixture plate (7), fixture sliding plate (8), fixture glass plate, fixture sliding plate locking knob (9) and
20 fixture plate locking knob(10), wherein the glass cassette fixture plate (7) fitted between the fixtures sliding plate (8), by the fixture plate locking knob (9). Fixture sliding plate locking knob (10) is use for fixing the movements in required X axis (5) and Y axis (6) direction.

As shown in Fig.2 & 3, to scan the multiple diamond gemstones at the same time in the present invention the multiple diamond gemstones mounted on the glass cassette fixture plate (7), for the gemstones diamond whose tables has already prepared. The glass cassette has provided with multiple gemstone position (Small Size Holes) in rows and columns to hold the multiple gemstones. The multiple gemstones positioned with the glue on the holes of glass cassette at gemstones positions (11). In the glass cassette, gemstones positions(11) are bounded by laser mark squares which are mounted in rows and columns which shown in Fig.2 & 3. Each glass cassette fixture plate (4) has provided with cross reference (12) at two opposite corner of the glass cassette as shown in Fig.2 & 3, which are used specifically to match the multi diamond scan data with scan image of the gemstone before bruting operation on the cutting machine. In the present invention as shown in Fig. 1 the camera assembly (2) is mounted on the main base plate (19), which is further connected with machine frame (1) for the scanning the gemstones diamond. The camera assembly (2) is separately shown in Fig. 5. As shown in Fig. 5, in the scanning procedure, first the match the plate's cross hair reference with camera cross hair. Then as per the selection of gemstone command to scan the axis will move to start reference position automatically and the scanning process will start for

specified no of position out of all the rough gemstone diamond. This camera assembly unit mainly consists with two parts.

1. Tele centering device and
2. Back light

5

The tele-centering device made of special lens used for the scanning purpose, which has a depth of field range. The tele centering device focuses on solution to disadvantage of conventional imaging for diamond scanning machine and how to achieve ultra precise
10 measurements from tele-centric imaging system. In the conventional imaging means create the image of the sample by using diverging optical lens system. In this types of imaging technique optical system can create the view in broad angle, medium or narrow angle, most probably in surveillance application broad angle image is
15 effective and in machine vision application medium or narrow angle imaging is effective. The view of imaging system is depends on single or multi optical lenses and size of image sensor or camera. Simply in conventional imaging, if the object is near to vision system then it looks big in image and if object is far from vision system then
20 it looks small in image. The main object of the tele- centering system is to keep image size of diamond exactly same in near or far condition from the vision system and center position. Technically the field of view and magnification must remain necessary to consider require tele-centric range and focus range as per size of

diamond in which magnification cannot change and image remain in focus.

The main object of the tele-centric lens is that image magnification does not change as object distance varies. A tele-centric lens views and displays the entire object from the same prospective angle, therefore, three dimensional features will not exhibit the perspective distortion and image position errors present when using a standard lens. Object inside deep holes are visible throughout the field, undistorted, therefore, tele centric lenses are extremely useful for inspecting tree dimensional objects or scenes where image size and shape accuracy are critical.

And the back light flashlight used for the initial video scan process. In the beginning while flashlights are on, camera device captures the image of the stone and do the image processing to computer the boundary of the stone, white flashlight makes the threshold process easy. It brings clarity in the vision.

As shown in Fig.3 in the flat scanner setup, the fixture plate has two directional travel axes X & Y(5 & 6), which travels by stepper motor(13). A top camera which is connected with the lens assembly (15) for the adjustment of focal length to scan the multiple gemstone diamond mounted on the fixture plate which is shown in Fig. 4. ,

which is further connected with the camera fitting brackets (16). As shown in Fig. 4 in the present invention two laser lines with laser line fitting brackets (17) provided for the accurate & precise scanning of the rough gemstone diamond. . In the present invention first
5 multiple diamonds which positioned on the glass cassette are scan the size of the gemstone diamond not through the conventional rotary motion video scan and then laser light is used to scan the each and every point of the gemstones one by one or on selected bases. When the multiple diamonds are scan rough stone with the help of
10 camera (14) and laser line (3) and generate 3D point cloud from it. After that in the present invention computer program generates 3D surface mesh from these scattered points and find best polish diamond with maximum mass.

15 In the present invention multiple raw diamonds scan on single plate or more raw diamonds are scan if the diamond size is small. In the present invention two laser lines were used to scan the raw diamonds so, it does not required to do center calibration of both laser lines. In the Fig.1 the matrix of the raw diamond positioned on
20 glass cassette fixture plate. Here all the bubble number represents stone on plate. On selection of click any bubble then axis moves to the stone position. First video scanning is done from the top camera and it catch only outer border of the raw stone. Then the laser line scanning is done. After such video and laser line scanning, it

generates a 3D image of stone. On the bases of scanned 3D image the following geometric properties were calculated.

- i.e. the total weight of the raw gemstones,
- the weight of the scanned gemstones,
- 5 the total height of the gemstones,
- the numbers of the gemstones,
- the most optimizes shape of the gemstones(oval, Heart, Pears, Marques, Rectangle, Emerald, princess, tillient, baguette, trapeze, square cut, single cut, happy eight, dshape, princess Ex, round 06,
- 10 round)

After completion of the scanning process of diamond on the glass plate, operator needs to take the plate off the scanner and put it inside the bruting machine. The data that software has generated at

15 the time of scanning process will be used as an input for cutting parameter. After the operator will match the reference points again in the multi bruting machine and got the final result as per the scanning data. The multi-bruting machine consists with frame (14), laser source (15), galvo (16) , air & LED holder assembly (17), camera

20 assembly (18) , fixture (19), X-axis (20) , Y- axis (21) and Z- Axis (22). In the multi bruit machine the laser source (15) used for cutting purpose is a fiber laser source which is capable of producing 20 W o/p at 20.2 KHz frequency.

The Galvo assembly as shown in Fig. 6 consists with main body (23), Bender (24), laser collimator (25), collimator fitting holder (26), Z - Axis (22), Z- Axis motor (27), Air & LED holder (17) and Galvo fitting Bracket (28). The function of the galvo unit (16) is to position
5 the laser beam at required X-Y dimension with help of two motorized mirrors. Laser beam generated through collimator strikes on one mirror which according to program sets its position in such a way that final X position of the laser can be obtained. Now beam is reflected to wards second mirror which same way defines the Y
10 position of mirror. Then the beam collides to another mirror which is not part of the galvo known as bender. Bender as name suggests, beads or reflectors to beam at 45° to make it fall vertical on the diamond. Z,,axis provided for vertical positioning of the galvo assembly allowing travel up to 50 mm and motion is given by
15 stepper motor.

Air & LED holder assembly is shown in Fig.7. It is provided as a coolant when cutting process takes place. Air enters in to the bracket from the input connection (22) and moves in the groove provided on
20 the circumference of the bracket and comes out in such an angle that it gets concentrated at the point of cutting. Air flow is set by the operator every time manually as per requirement. LEDs are provided to ensure the better vision of video into the LED bracket(23).

The camera assembly is provided to capture the video while cutting procedure takes place. The cutting process can be seen on the computer screen that gives full control of cutting process to the operator. If any cutting line needs to be changed at the time of cutting operator hold down the cutting process and change the cutting line.

X-Y axes are provided for horizontal and vertical motion of a fixture. M Drive stepper motors provide the motion to the axes with travel of 50mm.

Summary of the invention

Multiple Diamond planning and Bruting Machine is used to scan the multiple diamond on the single machine so, it reduce the labor and production cost. In this invention, the cutting machine to able to control the laser beam according to the diamond profile. In conventional method of laser cutting, when the laser beams strikes it cuts the surface regardless of surface height difference with respect to laser's focus point. So even if there is a dent or protruded surface on which laser beam does not focus, it tries to cut the stone. As this height is not the same as focus length the amount of energy will not be in proper amount at that particular surface. This can result into improper cutting and some time also in breakage of the stone. At the

same time in super Gizmo, 3D profile has already been calculated by the software and that gives the input to the machine about when to generate the LASER and when not to, so if there is any uneven surface come it stops laser beam to strike. As an advantage, the chances to stone to be damaged are reduce to great extent.

5

I claim :

1. **Multiple Diamond planning and Bruting Machine** mainly comprised in two parts;

- 5 1. Flat scanner setup
 2. Multi bruit machine

wherein flat scanner setup comprises machine frame (1), camera assembly (2), line laser (3), fixture device (4), X axis (5) and Y axis (6) which is used for the scanning the stone with the help of camera unit
10 capturing images while two different line laser modules throws LASER beams on the stone and generates 3D images of the stone;

wherein the multi bruite machine comprises with frame (14), laser source (15), galvo (16), air & LED holder assembly (17), camera
15 assembly (18), fixture (19), X-axis (20), Y-axis (21) and Z-Axis (22) which used after completion of the flat scanning process of the diamond of the glass plate and use the data which generated at the time of flat scanner scanning process.

20 2. **Multiple Diamond planning and Bruting Machine** as claimed in claim 1, the flat scanner setup the fixture device (4) is further consists with glass cassette fixture plate (7), fixture sliding plate (8), fixture plate locking knob (9) and fixture sliding plate locking knob (10) to ensure the precise movement of the glass plate;

and multiple diamond gemstones are positioned in rows and columns which are bounded by the laser mark squares wherein two cross marks at the opposite corner on the glass plate are provided for referencing purpose.

5

3. **Multiple Diamond planning and Bruting Machine** as claimed in claim 1 and 2, in the flat scanner setup the fixture device (4) is mounted on another sliding fixture plate (8) and fixture plate locking knob (9) and fixture sliding plate locking knob (10) are provided to hold down the sliding fixture plate as well as fixture glass plate (4).

4. **Multiple Diamond planning and Bruting Machine** as claimed in claim 1, in the flat scanner setup, X-Y Axes(5 & 6) are provided for horizontal and vertical motion of a fixture and M deive stepper motors are provide the motion to the axes.

5. **Multiple Diamond planning and Bruting Machine** as claimed in claim 1, wherein in the flat scanner setup, camera assembly unit (2) is mounted on the base plate which is further connected with the machine frame(1) and which consists of mainly two parts with tele-centric device where the image magnification does not change as object distance varies and back light which is

used for the initial video scan process and to compute the boundary of the stone .

6. **Multiple Diamond planning and Bruting Machine** as
5 claimed in claim 1, wherein laser line modules for line scanning are used to flash laser lines on the stone to compute the surface of the stone from two different directions.

7. **Multiple Diamond planning and Bruting Machine** as
10 claimed in claim 1, in the multi bruiteer machine the laser source used for cutting purpose which is a fiber laser source, is capable of producing 20 W o/p at 20.2 KHz frequency.

8. **Multiple Diamond planning and Bruting Machine** as
15 claimed in claim 1, in the multi bruiteer machine, the galvo assembly consists with main body (23), bender (24), laser collimator (25), collimator fitting holder (26), Z - Axis (22), Z- Axis motor (27), Air & LED holder (17) and Galvo fitting Bracket (28), which is used to position the laser beam at required X-Y dimension with help of two
20 motorized mirrors.

9. **Multiple Diamond planning and Bruting Machine** as
claimed in claim 1 and 8 , in the multi bruiteer machine, the laser beam collides to the bender, which further bends or reflects to beam

at 45° to make it fall vertical on the diamond and Z axis provided for vertical positioning.

10. **Multiple Diamond planning and Bruting Machine** as
5 claimed in claim 1, in the multi bruiteer machine, air & LED holder assembly is provided under galvo assembly for the coolant during the cutting process, wherein the air enters into the bracket and moves in the groove provided on the circumference of the bracket.

10 11. **Multiple Diamond planning and Bruting Machine** as claimed in claim 1, in the multi bruiteer machine, camera assembly is provided to capture the video while cutting procedure takes place and it can be seen on the computer screen that gives full control of cutting process to the operator.

15

12 **Multiple Diamond planning and Bruting Machine** substantially as herein described with reference to the foregoing description and the accompanying drawings.

20

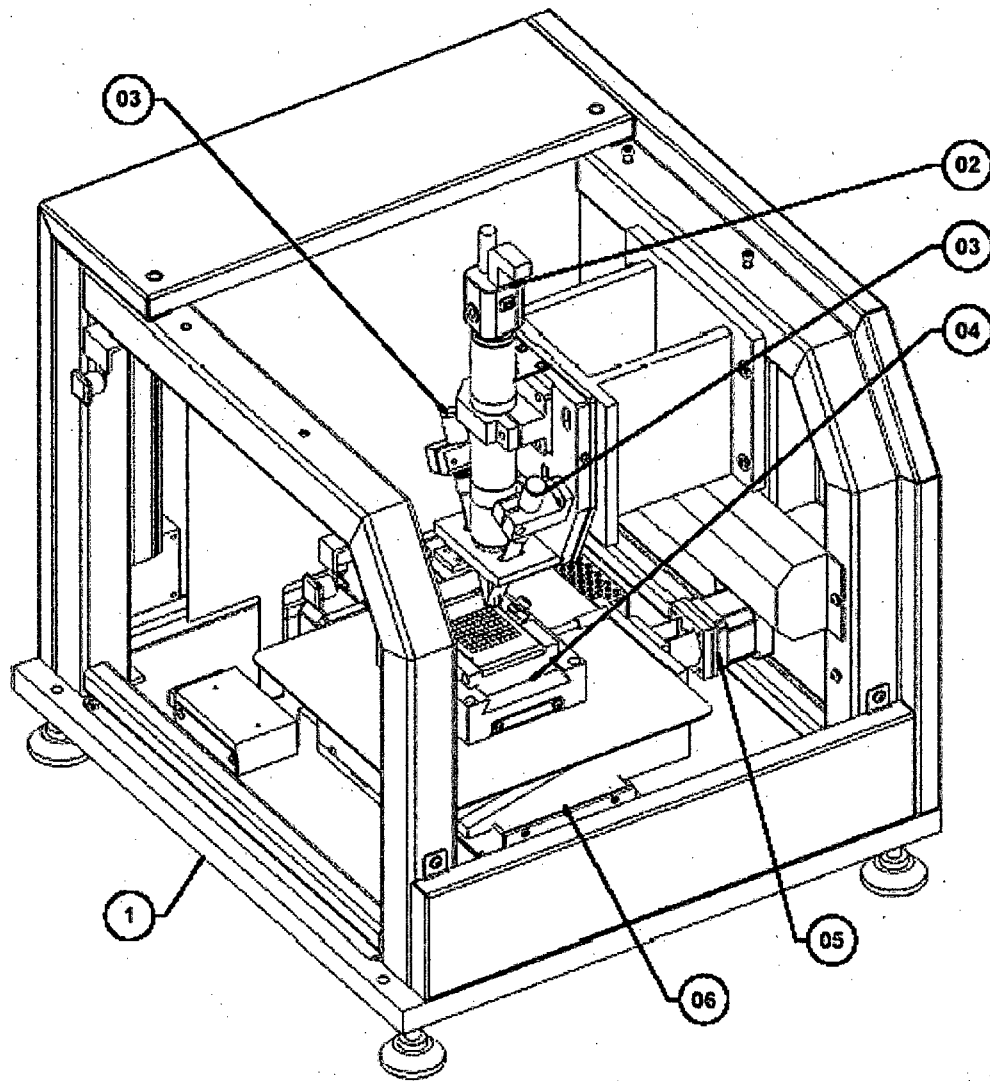


Fig.1

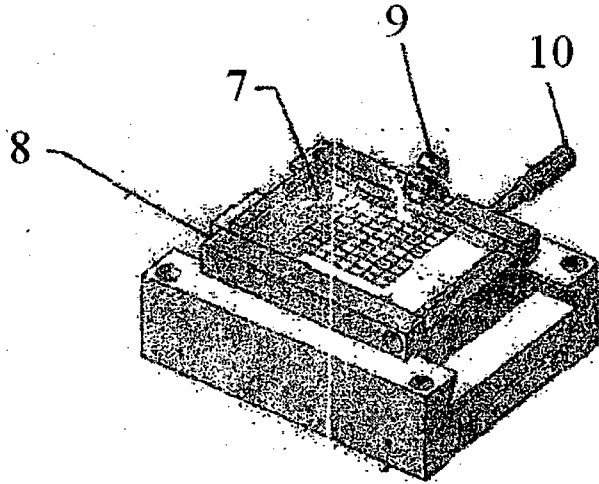


Fig.2

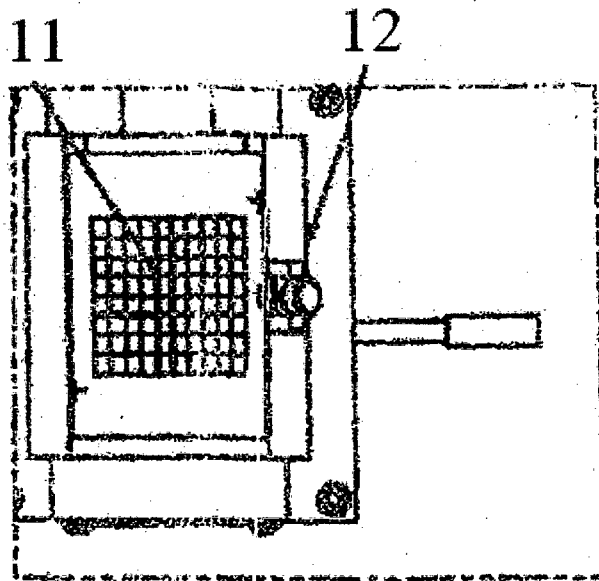


Fig.3

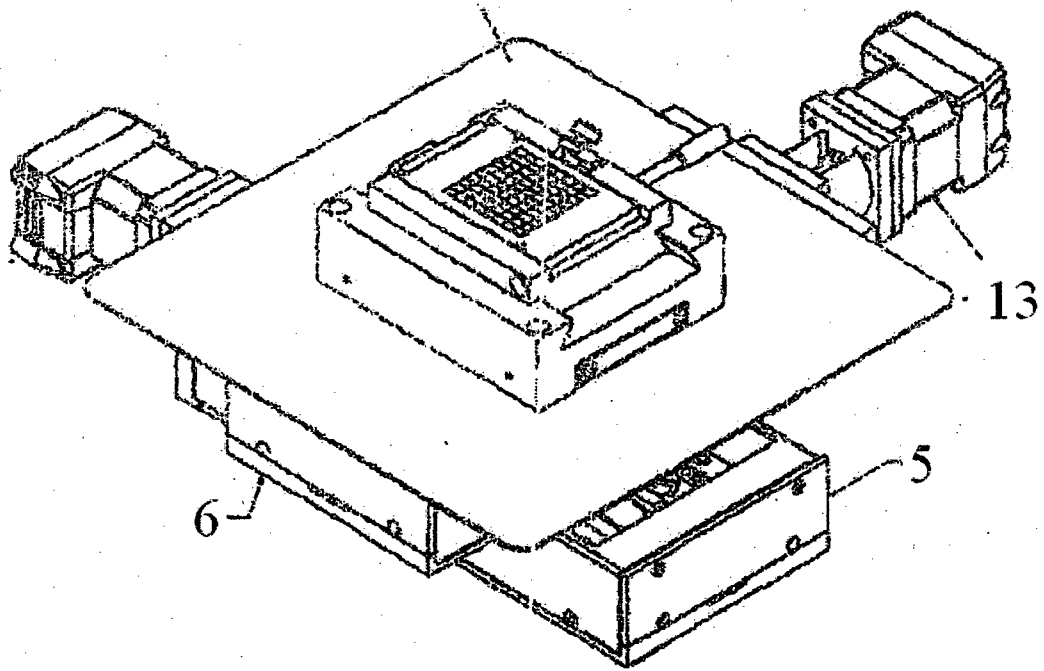


Fig.4

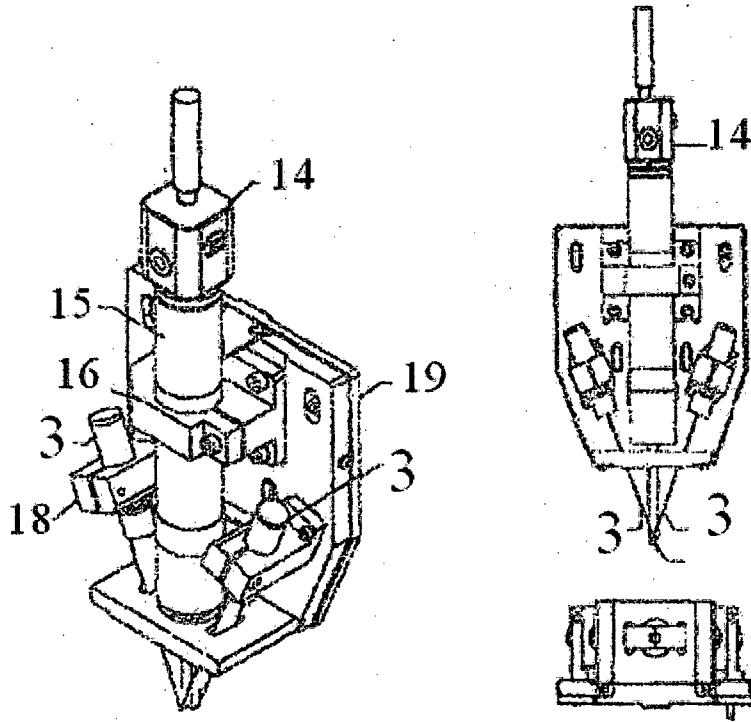


Fig.5

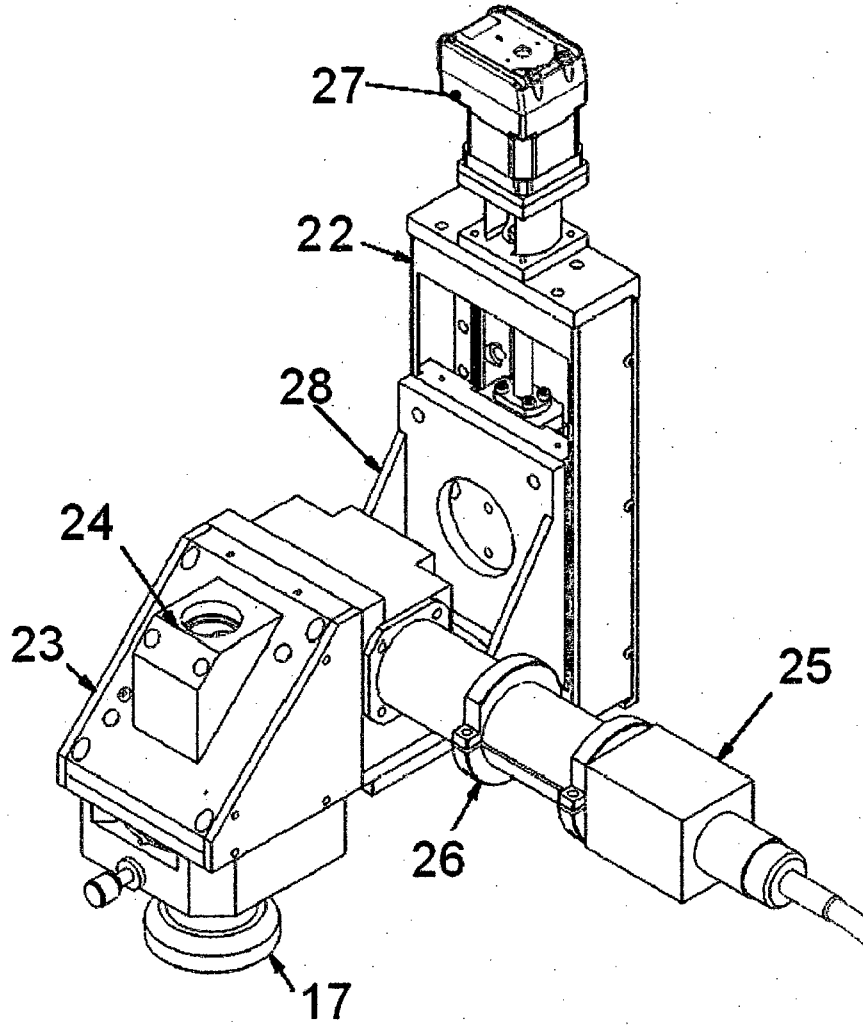


Fig.6

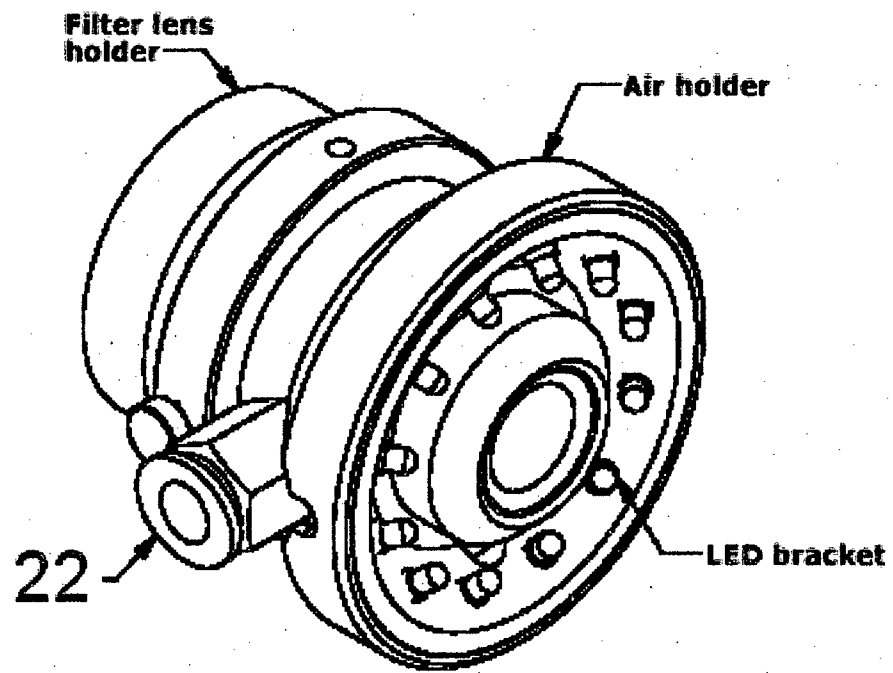


Fig.7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN 2010/000632

A. CLASSIFICATION OF SUBJECT MATTER

IPC⁸: **B28D 5/00** (2006.01); **B23K 26/38** (2006.01)

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)
IPC⁸: B28D, B23K, A44C 17

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 practicable, search terms used)
wpi, epodoc

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/048764 A1 (DIAMSCAN N.V.) 2 June 2005 (02.06.2005) <i>page 8: lines 8-12; page 9: lines 26-31; page 14: lines 10-13</i>	1, 6
A	--	2 - 5, 7 - 11
A	WO 2009/068354 A1 (IDEALSCOPE PTY LTD) 4 June 2009 (04.06.2009) <i>page 15: lines 1-21; page 19: lines 5-10</i>	1 - 11
A	WO 2004/105999 A1 (PATEL ARVINDBHAI LAVJIBHAI) 9 December 2004 (09. 12.2004) <i>abstract</i>	1 - 11

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

* Special categories of cited documents:

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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
3 March 2011 (03.03.2011)Date of mailing of the international search report
14 March 2011 (14.03.2011)Name and mailing address of the ISA/ AT
Austrian Patent Office
Dresdner Straße 87, A-1200 ViennaAuthorized officer
PAVDI C.

Facsimile No. +43 / 1 / 534 24 / 535

Telephone No. +43 / 1 / 534 24 / 374

Continuation of first sheet

Continuation No. II:

Observations where certain claims were found unsearchable

(Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

Claims Nos.: 12 because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

The subject matter of claim 12 does not fulfil the requirement of Rule 6.2 (a) PCT, which states that: "Claims shall not rely on references to the description or drawings. In particular, they shall not rely on such references as: "as described in part ... of the description," or "as illustrated in figure ... of the drawings."

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN 2010/000632

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