

EXAMINING A GEM STONE

The Invention

The invention provides methods as set forth in Claim 1, 3 or 5 and systems as set forth in Claims 6, 8 or 10.

- 5 The remaining Claims set forth preferred features of the invention.

The word "image" is used broadly in the Claims and includes a shadow.

- Bruting is the procedure of cutting or grinding a girdle
10 on a rough stone, after the stone has been sawn (the
sawn stone is called a "sawn half"). Coning is forming
a cone on the culet or table side of the stone.

- The make is the shape and size of the stone, including
the angles and sizes of the parts of the stone as a
15 whole and of the facets.

Using the invention, the make of the stone can be
determined very quickly and without requiring special
skills. For instance, the invention can be used for
examining stones of 10-12 point (about 1/8 carat and

about 3 mm. diameter), or larger, and down to e.g. 1 point (diameter about 1.3 mm.); in particular, the latter stones would be very difficult to examine manually.

- 5 In the case of a rough stone or sawn half, one can determine the largest possible cut (i.e. polished) stone of given proportions which can be fitted inside (this can be associated with centering for subsequent bruting or coning, and more details are given in GB 2 080 712 A)
- 10 - this can also take account of grain and of unwanted areas such as pique' (an inclusion within a stone).

Although the invention can be used for centering, it will be noted that no centering is required for the examination in general, and it is merely necessary that

15 the stone should be fully within view, i.e. in a defined window. The outline of the stone is examined.

Using the invention, the following parameters can be determined in addition to the make, but this list is not exhaustive:

- 20 the profile, in general terms;
the maximum and minimum girdle diameters;
the average or mean girdle diameter;

the table diameter as a percentage of the average or mean girdle diameter;

the crown height as a percentage of the average or mean girdle diameter;

- 5 the girdle width (the dimension measured normal to the table);

the pavilion depth;

the pavilion angle;

the angles or lengths of the secondary facets;

- 10 the volume;

particularly but not exclusively in the case of a fancy stone, i.e. a stone of irregular shape, the size and shape of the recess in the setting for receiving the stone, employed for instance when driving a

- 15 numerically-controlled cutter to cut the correct blank or when shaping a mould for casting a suitable mount for the stone.

In the case of bruting, the invention can in addition to be used to re-measure the bruted stone e.g. to brute

- 20 further or to determine the correct angle for polishing.

In the case of a rough stone or sawn half, the following parameters can be determined in addition to the largest size cut stone(s), but this list is not exhaustive:

suitable proportions or angles for the polished stone;

suitable "swindling", specially if reentrants or other defects are present - "swindling", is a term covering e.g. having the culet off centre, having girdle out of round or tilting the girdle.

- 5 The proper measurement of the make and other parameters in many cases depends upon there being no reentrant in the stone, and this can be determined manually or the presence of a reentrant can be automatically signalled in certain cases though in others (such as the presence
- 10 of kinks in the crown), the system may be unable to detect reentrants fully automatically. However, once a reentrant, e.g. a hole, has been detected by say visual examination, the bottom can be sensed say with a stylus or focussing arrangement, and the information so derived
- 15 can be superimposed on other data furnished by the system. Alternatively more information can be derived if the method is carried out at least twice, one series of images being provided at one angle to the axis and another series of images being provided at a different
- 20 angle to the axis (two different fixed viewers can be used or a single lens system with two sets of sensors such as charge couple devices, though it is preferred to tilt one viewer for _____

the second examination) or by subsequently rotating the stone about a different axis, say at 90° to the first axis, though expensive processing may be required to correlate the data.

5 With two viewers, a type of stereoscopic examination can be made, the images being suitably combined; also, the top of the stone could be examined. As a further possibility, the reentrant can be avoided by removing material around it, prior to examining the stone.

10 In a simple embodiment, the stone is relatively rotated, and should be rotated through at least 180° . The rotation may be discontinuous rotation, i.e. indexing or incremental rotation, or continuous (e.g. with strobed illumination). Though it is preferred to keep the viewer stationary and rotate the stone, it would be possible to keep the stone stationary and rotate
15 the viewer around the stone - thus the rotation of the stone is referred to as "relative".

However, it would be possible to have multiple viewers, viewing a stone supported on a support or each receiving an image of a falling stone when it reaches a predetermined plane, the
20 viewers being fixed and spaced through e.g. 180° . As a further possibility, the stone could rotate through θ/n° , there being n equispaced fixed viewers in an arc of θ , θ being 180° or more and preferably 180° .

The edge of the image is preferably sensed at seventeen different positions in 180° , e.g. for cut diamonds which have eight-fold rotational symmetry with a mirror plane, seventeen positions being the most efficient number.

5 However, the number of different angular positions depends upon the manner in which the stone has been cut, when cut stones are being viewed, and the number may be different for different cuts. Furthermore, as the number of positions has a broad range, a larger number
10 of positions, e.g. 25 to 200, can be used for rough stones.

Description of Preferred Embodiments

The invention will be further described, by way of example, with reference to the accompanying drawings, in
15 which Figure 1 is a schematic representation of a system in accordance with the invention; and Figure 2 shows how a rough stone can be examined.

In Figure 1, a polished (brilliant cut) diamond 1 is shown in profile, supported by the end of a rotary
20 spindle 2 which is driven by e.g. a stepping motor 3. The speed can be up to 1000 steps per second say 400 steps per second, the rotational movement occupying

only a small fraction of the total time. The examination need only take 5 seconds. If desired, the spindle 2 can be hollow and the arrangement can be such that the diamond 1 is held on the end of the spindle 2 by light suction.

- 5 The diamond 1 is viewed by a TV viewer 4 connected to an electronic unit 5 associated with a computer 6 (direct memory access transfer) and a screen 7. As shown in dashed lines, the viewer 4 can be tilted through an angle α , though the preferred viewing position is the horizontal position shown, at 90° to the axis
- 10 2' of the spindle 2. Though the axis of viewing is shown intersecting the middle of the diamond 1, it is not very critical and could for instance intersect the girdle or the table (i.e. the top of the spindle 2).

- Controls can be provided for defining the area on the screen
- 15 7 which is occupied by the image of the diamond 1, the image of the diamond 1 being as with bright illumination in radial view, i.e. generally at right angles to the axis of rotation of the spindle 2. The image of the diamond 1 on the screen 7 can be enhanced optically or electronically to give a well
- 20 defined edge. For instance, the image can be video-sliced and the edges only detected or sensed. The best discrimination is obtained with the stone 1 dark against a light field (a silhouette), looking at the rise time of the edge of the image and triggering at the correct point, e.g. at the point where
- 25 the intensity is 75% of that of the field. It will be appreciated

that although an image appears on the screen 7, the image whose edges are sensed will be that in the viewer 4. The viewer 4 may be for instance a two-dimensioned charge couple device, producing a purely electronic signal.

- 5 The system senses the edge of the image at a number of different angular positions of the diamond 1, as discussed above. The edge of the image is sensed at the minimum number of positions required for the measurement required - for instance, the corners of the profile at the culet, at the girdle and at the table
10 can be detected. The required parameters can be provided at the output of the computer 6. If for instance a blank is being cut or a mould formed preparatory to setting a fancy stone, the computer 6 can be linked directly to the machine tool 8 or can produce a magnetic or punched card for controlling
15 the machine tool 8.

- In Figure 2, a rough diamond 11 is shown on the spindle 2, a case being chosen where the axes of the stones 12, 13 are not parallel to that of the spindle 2. Two stones 12, 13 are shown fitted into the rough stone 11, and the system can
20 determine the angle of the cutting plane 14 (one can laser cut along any plane and abrasive saw along any planes up to say 5° from the optimum cutting plane), the heights of the cutting plane 14 and of the two tables 15, 16 from a reference point such as the top of the spindle 2, and the culet angles.
25 For a rough stone, the most important parameter is the minimum

diameter at various heights above the top of the spindle 2.

However it will be noted that the two stones 12, 13 have slightly different culet angles.

The computer 6 can be programmed in any convenient manner.

5 However one suitable algorithm is as follows:

- a) Read in a picture of just the spindle 2 and detect the start of the spindle 2;
- b) Place stone 1 table down on spindle 2 and read in a picture of the stone 1 on the spindle 2 (312 TV lines in total);
- 10 c) Detect culet from first line from top of picture that contains data;
- d) Work down right hand side of the image. As the girdle is perpendicular to the table, detect top and bottom of the girdle at the points where the data changes from being a sloping
15 line (at about $34^\circ - 45^\circ$ to the table plane) to a line making about $85^\circ - 95^\circ$ to the table plane, and then back to a sloping line;
- e) The table coordinate is calculated from the first line above the spindle 2;
- 20 f) The left hand side is calculated similarly to (d);
- g) This provides a set of coordinates for the culet, the girdle top and bottom edge, left hand side and right hand side, and the table extreme left hand side and right hand side. From this it is possible to calculate the proportions of the diamond
25 by simple geometry;

h) By taking several views, the asymmetry of the diamond can be calculated, in particular the out-of-roundness of the girdle.

The girdle is not faceted and ideally should be cylindrical, usually left not polished. It is however assumed that the

5 stone is reasonably good.



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Claims

1. A method of determining the make of a cut gem stone, comprising;

providing respective images of the stone, as seen

5 generally normal to an axis, at a number of different relative angular positions of the stone about the axis;

sensing the edges of the images; and

automatically determining the make of the stone making use of information derived from sensing the edges of the

10 images.

2. The method of Claim 1, and used to determine the shape of a setting for receiving the stone.

3. A method of determining the largest cut gem stone(s) of given proportions which can be fitted within an uncut

15 stone being examined, comprising:

providing respective images of the uncut stone, as seen generally normal to an axis, at a number of different relative angular positions of the stone about the axis;

sensing the edges of the images; and



automatically determining the largest cut stone(s) which can be fitted within the uncut stone, making use of information derived from sensing the edges of the images.

4. The method of any one of the preceding Claims,

5 wherein the stone is rotated relative to a viewer without centering the stone.

5. A method of examining a gem stone, substantially as herein described with reference to, and as shown in, Figure 1 or Figure 2 of the accompanying drawing.

10 6. A system for determining the make of a cut gem stone, comprising:

means for providing respective images of the stone, as seen generally normal to an axis at a number of different relative angular positions of the stone about
15 the axis;

means for sensing the edges of the images; and

means for automatically determining the make of the stone from information derived from sensing the edges of the images.



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7. The system of Claim 6, and further comprising means for forming a setting for a stone, the arrangement being such that the determining means causes a forming means automatically to form a setting in accordance with the shape of the stone.

8. A system for determining the largest cut gem stone(s) of given proportions which can be fitted within an uncut stone being examined, comprising:

means for providing respective images of the uncut stone, as seen generally normal to an axis at a number of different relative angular positions of the stone about the axis; means for sensing the edges of the images; and

means for automatically determining the largest cut stone(s) which can be fitted within the uncut stone, from information derived from sensing the edges of the images.

9. The system of Claim 6 or 8, and comprising at least one viewer and a support for supporting the stone, the support being rotatable relative to the viewer(s).

10. A system for examining a gem stone, substantially as herein described with reference to, and as shown in, Figure 1 or Figure 2 of the accompanying drawing.