An apparatus, system, and method thereof for precision material positioning and precision shaping of materials. The apparatus includes a positioning device which includes a precision rotatable positioning of a group of material shaping devices, such as grinding wheels and the like. The system includes both the aforementioned device and a second device which has a two-section positioning device which allows precision positioning of an engaged workpiece.
PRECISION MATERIAL POSITIONING AND SHAPING APPARATUS, SYSTEM, AND METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS


FIELD OF INVENTION

[0002] The present invention relates to generally a precision material positioning and shaping apparatus, precision material positioning and shaping system, and method thereof. The present invention is for use in precision shaping of materials such as for cutting or polishing gems, shaping profiles on materials, grinding or sharpening tools, and grinding lenses.

BACKGROUND OF INVENTION

[0003] Currently, when a workpiece (e.g., a lens, a scissors, a gem, a cuticle cutter, etc.) is positioned precisely for material shaping (e.g., sharpening, faceting, cutting, grinding, polishing, making, manufacturing, etc.) it is inaccurate and slow to both precisely position the workpiece in a general manner for work thereon, and precisely move and position the material workpiece symmetrically about various axes of rotation for further material shaping. Additionally, precise shaping of materials, such as gem faceting or the copying of gem facets from an existing gem to a new gem, is currently tedious and not readily possible when attempting to facet a gem with an odd number of faces.

[0004] Accordingly, there is a need for an improved device, system, and method of positioning and shaping of materials.

SUMMARY OF INVENTION

[0005] The present invention provides an apparatus, positioning and precision shaping system and method for positioning and shaping materials. One can position and shape materials using the invention for activities such as cutting or polishing gems, shaping profiles on materials, grinding or sharpening tools, and grinding lenses.

[0006] A first general aspect of the invention provides an apparatus comprising:

[0007] a plurality of material shaping devices;

[0008] a holder for the plurality of material shaping devices; and

[0009] a positioning device for rotatably positioning said plurality of material shaping devices for engagement with a workpiece.

[0010] A second general aspect of the invention provides a material shaping apparatus comprising:

[0011] a plurality of material shaping devices each having an axis of rotation;

[0012] a positioning device for precision positioning of the plurality of material shaping devices.

[0013] A third general aspect of the invention provides a method of precision positioning for material shaping comprising:

[0014] providing a plurality of material shaping devices;

[0015] attaching a holder to the plurality of material shaping devices; and

[0016] rotating the holder with a positioning device for rotatable positioning of said plurality of material shaping devices.

[0017] A fourth general aspect of the invention provides a system comprising:

[0018] a first apparatus including:

[0019] a positioning system having a first section and a second section, wherein at least one of said first section and said second section includes at least one depression for rotatable positioning along a path;

[0020] a second apparatus operatively engageable with said first apparatus including:

[0021] a plurality of material shaping devices;

[0022] a holder for the plurality of material shaping devices; and

[0023] a positioning device for rotatably positioning said plurality of material shaping devices for engagement with a workpiece.

[0024] The foregoing and other features of the invention will be apparent from the following more particular description of various embodiments of the invention.

BRIEF DESCRIPTION OF DRAWINGS

[0025] Some of the embodiments of this invention will be described in detail, with reference to the following figures, wherein like designations denote like members, wherein:

[0026] FIG. 1 depicts a front view of a material positioning and shaping apparatus, in accordance with the present invention;

[0027] FIG. 2 depicts a top view of a material positioning and shaping apparatus, in accordance with the present invention;

[0028] FIG. 3 depicts a front end view of a material positioning and shaping apparatus, in accordance with the present invention;

[0029] FIG. 4 depicts a rear end view of a material positioning and shaping apparatus, in accordance with the present invention;

[0030] FIG. 5 depicts a side view of a front aspect of a material positioning and shaping apparatus, in accordance with the present invention;

[0031] FIG. 6 depicts a sectional view of a portion of a material positioning and shaping apparatus, in accordance with the present invention;

[0032] FIG. 7 depicts a top view of a portion of a material positioning and shaping apparatus, in accordance with the present invention;
FIG. 8 depicts a top sectional view of a main mount portion of a material positioning and shaping apparatus, in accordance with the present invention;

FIG. 9 depicts a side sectional view of a main mount portion of a material positioning and shaping apparatus, in accordance with the present invention;

FIG. 10 depicts a rear sectional view of a main mount portion of a material positioning and shaping apparatus, in accordance with the present invention;

FIG. 11 depicts a side view of a rear detent of a material positioning and shaping apparatus, in accordance with the present invention;

FIG. 12 depicts a side view of a front detent of a material positioning and shaping apparatus, in accordance with the present invention;

FIG. 13 depicts a side view of a “unrolled” front detent pattern of a material positioning and shaping apparatus, in accordance with the present invention;

FIG. 14 depicts a perspective view of an alternative embodiment of a rear detent of a material positioning and shaping apparatus, in accordance with the present invention;

FIG. 15 depicts a rear sectional view of an alternative embodiment of a material positioning and shaping apparatus, in accordance with the present invention;

FIG. 16 depicts a top view of an alternative embodiment of a material positioning and shaping apparatus, in accordance with the present invention;

FIG. 17 depicts a front view of an alternative embodiment of a material positioning and shaping apparatus, in accordance with the present invention;

FIG. 18 depicts an end view of an alternative embodiment of a material positioning and shaping apparatus, in accordance with the present invention;

FIG. 19 depicts a front perspective view of a portion of an alternative embodiment of a material positioning and shaping apparatus, in accordance with the present invention;

FIG. 20 depicts a perspective view of a material positioning and precision grinding apparatus, in accordance with an embodiment of the present invention;

FIG. 21 depicts a front view of a material positioning and precision grinding apparatus, in accordance with an embodiment of the present invention;

FIG. 22 depicts a rear view of a back plate portion of a material positioning and precision grinding apparatus, in accordance with an embodiment of the present invention;

FIG. 23 depicts a front view of an armature piece portion of a material positioning and precision grinding apparatus, in accordance with an embodiment of the present invention;

FIG. 24 depicts a partial sectional side view of a material positioning and precision grinding apparatus, in accordance with an embodiment of the present invention; and

FIG. 25 depicts a top perspective view of a material positioning and precision shaping system, in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Although certain embodiments of the present invention will be shown and described in detail, it should be understood that various changes and modifications may be made without departing from the scope of the appended claims. The scope of the present invention will in no way be limited to the number of constituting components, the materials thereof, the shapes thereof, the relative arrangement thereof, etc., and are disclosed simply as an example of an embodiment. Although the drawings are intended to illustrate the present invention, the drawings are not necessarily drawn to scale.

FIG. 1 shows a front view of a material positioning and shaping apparatus, in accordance with the present invention. The apparatus is generally designated 10. The apparatus 10 employs a positioning system which allows the apparatus 10 to position and shape a workpiece 5 (not shown). Part of the apparatus 10 can include a material shaping device. A material shaping device is a device that either adds, deletes, or some combination thereof, to the original material resulting in a change in the original material. Examples of the material shaping device include a gem cutter, a grinding wheel, a lens grinder, polisher, profile shaper, etc. The apparatus 10 may have a positioning head attached to a base, of some sort. The positioning system may be made up of at least two sections, in this embodiment a head piece 30 and a stage 40. An embodiment shown in FIG. 1 is made up of a main mount 20 which has a head piece 30 rotatably attached thereto. Rotatably attached to the head piece 30 is the stage 40. Typically the workpiece 5, be it a gem, scissors, lens, or other material that may require shaping is placed on the apparatus 10. The workpiece 5 is held in place on the workpiece platform 45 of the stage 40. The workpiece 5 can be held in place by a plurality of clamps 41. There is a plurality of clamps 24 (i.e., 24A, 24B) which activate various pinions (not shown). The pinions, in turn, communicate with various ball detents which, in turn, communicate with various depressions. Thus, the ball in the ball-detent system of the invention is a type of movement means for causing rotational positioning of the positioning head. The movement of the various ball detents, likewise, cause movement in both the various depressions, and with the various pieces on which the depressions reside on, or are connected to. Thus, the positioning head can rotate, or move, along a path due to the depressions on part of the positioning head. For example, the front ball 51 of the front ball detent 50 rides in various depressions 43. The depressions 43 are on the front detent 42, which is part of the stage 40. Upon movement of the front ball 51, the stage 40 rotates and the workpiece 5 attached thereon. The stage 40 rotates about a pin 44 that extends from the top of the main mount 30 through the axial center of the front detent 42 through to the bottom portion of the main mount 30. The main mount 20 can either be moveably, slidably, rotatably attached, or fixed to additional support means. In the embodiment shown, the main mount 20 is attached to a slide 22, with two adjustable slide stops 23 located at either end of the slide 22. Alternatively the main mount 20 can be fixed to a base (not shown) or to other slides and other support systems. As the follow-
ing will show, the plurality of precise ball and detent systems on the apparatus 10 will allow both precise general positioning of a workpiece 5 and for the precise symmetrical positioning of the workpiece 5 about various axes of rotation on the apparatus 10.

[0053] As shown in FIG. 2, a top view of the apparatus 10 according to the present invention, the stage 40 has a workpiece platform 45 on which various workpieces 5 (shown in phantom) are placed for shaping, sharpening, grinding, etc. Typically, the workpiece 5 can be held on the workpiece platform 45 of the stage 40, via a clamp 41. There may be a plurality of clamps 41 thereby allowing positioning of the workpiece 5 in multiple directions. As shown in FIG. 2 a cuticle cutter can be the workpiece 5. As the two phantom views of the cuticle cutter 5 show, the cuticle cutter 5 can be placed partially open and held via the top clamp 41. The cuticle cutter 5 can also be placed on its side and held in place via the side clamp 41. The placement can depend on which edge of the cuticle cutter 5 elects to sharpen or grind. On the inboard side of the stage 40 is a front detent 42 (not shown). The front detent 42 which is circular or elliptical in section has a bore through which a threaded pin 44 is inserted to rotatably attach the stage 40 to the trunnions on the head piece 30, thereby allowing rotation of the front detent 42 about its longitudinal axis while it is held within the head piece 30. The front ball detent 50 has a front ball 51, or other tracking means, residing thereon. The front ball 51 is spring-biased so as to assert pressure against the front detent 42. The front ball 51 will ride or track in various depressions 43 residing on the exterior of the front detent 42. The front ball detent 50 is located within a bore in the head piece 30. Although the cross section of the front ball detent 50 is shown as circular, virtually any cross section shape may be employed. A section of the front ball detent 50 can be omitted to provide a substantially flat surface that acts as a rack 52. The surface of the rack 52 is knurled to provide improved purchase for the operatively attached front pinion 53.

[0054] FIG. 3 depicts a front end view of a material positioning and shaping apparatus 10, in accordance with the present invention. The rear ball detent 55 can be seen beyond the workpiece platform 45 and clamp 41. The rear ball detent 55 is moved by rotation of dial 24B.

[0055] FIG. 4 depicts a rear end view of a material positioning and shaping apparatus 10, in accordance with the present invention. Both dials 24A, 24B rotate pinions (not shown). Rotation of dial 24A rotates a pinion, which ultimately causes rotation of the stage 40 and workpiece 5 thereon. Rotation of dial 24B rotates a pinion, which ultimately causes rotation of the head piece 30.

[0056] FIG. 5, a side view of the stage 40 taken from the ‘inboard’ side of the stage, shows one configuration of the depressions 43 on the front detent 42. There may be a plurality of depressions 43 (e.g., 43A, 43B, 43C). As shown, a center depression 43B is offset and parallel to the axis of rotation of the front detent 42. Symmetrical to the center depression 43B are two helical depressions 43A, 43C. The helical depressions 43A, 43C are helical about the axis of rotation of the front detent 42. The depressions 43 can be of a plurality of lengths (e.g., long lines, short slots, dimples, holes, etc.) and patterns (e.g., helical, straight, jagged, etc.). In cross section, the depressions 43 can be a channel, a groove, semi-circular, individual dimples, or other configuration. The patterns and length of the depressions 43 determine the path along which portions of the apparatus 10 will be rotatably positioned. Similarly, there may be a plurality of depressions 43 at various angles about the center depression 43B. Further, the depressions 43 can be either symmetrical or asymmetrical about the center depression 43B. The depressions 43 can have either a constant or variable slope. Ultimately, the configuration of the depression 43 may dictate the path of rotation in which the front detent 42, the stage 40, and ultimately the workpiece 5 thereon, takes. Because the work piece platform 45 and front detent 42 are fixed to each other, rotation of the front detent 42 causes similar rotation of the work platform 45, and vice versa. The stage 40, work platform 45, and front detent 42 are typically one fixed unit that rotates in unison.

[0057] FIG. 6 depicts a side sectional view of the front portion of the apparatus 10. Rotation of dial 24A causes rotation of a front pinion 53, as indicated by rotational arrow “A”. Rotation of the front pinion 52 can be made by manual or automated means. At the other end of the front pinion 52 is a knurled surface 54 similar to the knurled surface of the rack 52 on the front ball detent 50. The knurled surface 54 is rotatably attached to the rack 52 of the front ball detent 50. Thus, rotation of the front pinion 52 results in transverse movement of the front ball detent 50 within a bore of the head piece 30. A spring-biased front ball 51 on the front ball detent 50 rides in the track of various depressions 43 on the front detent 42. The transverse movement of the front ball detent 50 and front ball 50, attached thereto, then causes rotational movement in the front detent 42 about the pin 44.

[0058] FIG. 7 depicts a top view of a portion of the apparatus 10. If the front ball 51 is riding in either of the helical depressions 43A, 43C, in lieu of the center depressions 43B, then the workpiece 5 will be moved off the center axis of symmetry, as shown in directional arrow, “B”. The operator then can take hold of, and rotate the stage 40 so that the front ball 51 overcomes its placement in the first helical depression 43A, 43C in which it resides. The operator then rotates the stage 40 so that the front ball 51 passes the center depression 43B and ultimately rides in the second helical depression, 43C, 43A. This rotation of the stage 40 allows for perfectly symmetrical rotation about the center axis of both the stage 40 and workpiece 5, if originally centered properly on the work platform 45, as indicated by directional arrow, “B”. This symmetrical movement allows for symmetrical shaping of materials, such as, the precise sharpening of tools or faceting of gems.

[0059] FIG. 8 depicts a top sectional view of the rear portion of the apparatus 10. A central bore of the main mount 20 houses a rear detent 60 and the front pinion 53. The front pinion 53 is connected to the front ball detent 50. Similar to the front detent 42 system, the rear detent 60 system utilizes a rear dial 24B. Rotation of the rear dial 24B causes the rear pinion 58 to likewise rotate. The end of the rear pinion 58 has a knurled surface 59 (See FIG. 10) which engages with a rack 57 of the rear ball detent 55. Imbedded in the rear ball detent 55 is a spring-biased rear ball 56. Thus, rotation of the rear dial 24B and rear pinion 58 results in transverse movement of the rear ball detent 55 and the rear ball 56, attached thereto. This rear detent 60 allows for at least one additional degree of freedom for the stage 40. Similarly, the transverse movement of the rear ball detent 55 causes the
rear ball 56 to ride in the various depression 61 residing on the exterior of the rear detent 60.

[0060] As FIG. 11 indicates, the rear detent 60 can have a plurality of depressions 61, thereon. The shaft of the front pinion 53 acts as a rotation pin for the rear detent 60. On one side of the rear detent 60 there are three depressions 61A, 61B, 61C. A centering depression 61B is centered between two helical depressions 61A, 61C. The opposite side of the rear detent 60 can have a similar configuration of depressions 61D, 61E, 61F, wherein the centering depressions 61E is centered between two helical depressions 61D, 61F. The rear detent 60 is fixed to the headpiece 30 so that rotation of the rear detent 60 results in rotation of the headpiece 30. Depending on which depression 61 the rear ball 56 rides in determines the path of rotation of the rear detent 60 and headpiece 30. For example, if the rear ball 56 is riding in the first helical depression 61A, the path of rotation of the rear detent 60, headpiece 30 will be a rotation about the longitudinal axis of the rear detent 60. The operator can then rotate the headpiece 30 so that the rear ball 56 rides out of the first helical depression 61A. The headpiece 30 can then be rotated so that the rear ball 56 passes the centering depression 61B and ultimately rests in the second helical depression 61C. This rotation of the headpiece 30 allows for symmetrical material shaping of a workpiece 5 in a second axis of rotation (i.e., the longitudinal axis of the rear detent 60). The second set of depressions 61D, 61E, 61F on the opposite side of the rear detent 60 allows for precise rotation of the headpiece 30, stage 40, and the workpiece 5 on another set of paths. Because the rear detent 60 can rotate a full 360° about its axis of rotation, the full exterior face of the rear detent 60 can be utilized for depression paths or detent points 61. As with the front detent 42, the helical paths 61 can either symmetrical or asymmetrical with respect to the centering depression paths (i.e., 61B, 61E). Similarly, the angle of the helical depressions (e.g., 61A, 61C, 61D, 61F) can either constant or variable. As with the front detent 42, the rear detent 60 could also have a configuration similar to that in FIG. 12 and FIG. 13 utilizing detent points 46.

[0061] FIG. 12 depicts another embodiment with a view similar to that of FIG. 5 (i.e., inboard side view of front detent 42). In this embodiment the front detent 42 has a plurality of detent points 46 in lieu of depression paths 43. The detents points 46 are configured so that there are several rows of detents points 46 longitudinally surrounding the exterior of the front detent 42. Each row of detents points 46 can have a different quantity of detent points 46. FIG. 13 depicts essentially the same view as in FIG. 12 except, in which, the front detent 42 has been “unrolled” for clarity purposes. For example, the first row of detent points 46A could be three detent points 46 where two of the detent points 46 are equivalent from the center detent point 46. The next row of detent points 46B, moving longitudinally down the front detent 42, has three detent points 46, whereas the two outer detent points 46 are much closer to the center detent point 46 than in the first row of detent points 46A. The third row of detent points 46C moving down the front detent 42 shows five detent points 46 each placed symmetrically about the center detent point 46. Similarly, the next row of detent points 46D can have another quantity of detent points 46 spaced about the circumference of the front detent 42. The front detent 42 thus can have a limitless number of rows of detents points 46 of successive quantities of detent points 46 in each row. The center column of detent points 46 can act as a tracking column for a ball 51 so that the operator can move the ball 51 from row to row via this centering column of detent points 46. In another embodiment, the spacing of the various detent points 46 around the circumference of the front detent 42 need not be uniform or symmetrical.

[0062] FIG. 14 depicts a perspective view of a rear detent 60 in another embodiment of the apparatus 10. In lieu of the helical depression paths 61 shown in FIGS. 8 and 11, a plurality of depressions 61 (e.g., 61A, 61B, 61C, etc.) in the shape of slots are located on the outer circumference face of the rear detent 60. The various series of detent depressions slots (i.e., 61A, 61B, 61C, etc.) can have different quantities of depression slots 61 in the various series surrounding the circumference of the rear detent 60. Thus, for example if the rear ball 56 is engaged with the first depression 61A series, there will be a greater quantity of depression slots 61 than if the rear ball 56 is engaged with the second depression 61B series. The quantity of depression slots 61 surrounding the rear detent 60 determines the quantity of discrete rotational movements that the rear detent 60, headpiece 30, workpiece platform 45, and workpiece 5 thereon can make in one full rotation of the rear detent 60. In addition to a dial 24A at the end of the rear detent 60 there can also be a ratchet wheel 62.

[0063] An embodiment of the apparatus 10 has an indexable means for rotational positioning of the rear detent 60 and the headpiece 30, attached thereto. The indexable means allows for known, precisely discrete movement of the position apparatus 10. As FIG. 15 shows, the indexable means in this embodiment is a pawl and ratchet wheel system. A plunger mechanism 65 which utilizes a pawl 68 which is operatively attached to the ratchet wheel 62. At one end of the plunger mechanism 65 is a thumbpad 69 with spring 66 and cable 65 attached thereto. The pawl 68 is attached to the opposite end of the cable 65. Thus, the operator can press the thumbpad 69 which causes the pawl 68 to forward the ratchet wheel 62. Depending on which of the series of depression slots 61 is engaged by the rear ball 56 determines how much the rear detent 60 rotationally advances per each pressing of the thumbpad 69.

[0064] FIGS. 16-18 depicts various views of another embodiment of the apparatus 10. In this embodiment the workpiece 5, which might be a gemstone requiring cutting, grinding, or polishing is connected to a dop 32. The dop 32, in turn, has a rack (not shown) on which an extension of the dial 24A acts as a pinion to engage with the rack on the dop 32 so that the dop 32 and attached rear detent 60 can together move laterally, as shown by directional arrow “C” in FIG. 17. This lateral movement allows the rear ball 56 to engage in the various series of depression slots 61. As mentioned above, depending on which series of depression slots 61 the rear ball 56 is engaged with, determines the amount of rotation of the workpiece 5 per each pressing of the thumbpad 69. The use of the dial 24A or the plunger mechanism 65 with the pawl 68 and ratchet wheel 62 allow the sequential controlled rotation of the dop 32 and the workpiece 5 attached thereto, as shown by directional arrow “D” in FIG. 17.

[0065] FIG. 19 depicts a top perspective view of the front portion of another embodiment of the apparatus 10 according to the present invention. A portion of the head piece 30 is shown. The front ball detent 50 is shown which is operationally attached to the front detent 42. In lieu of
clamps 41 attached to the workpiece platform 45 as in some of the previously mentioned embodiments, a series of parts is attached to the workpiece platform 45. These series of parts provide additional degrees of freedom to the apparatus 10. Directional arrows “E” and “I” indicate the rotation to the front detent 42 and head piece 30 respectively. These rotations are provided by rotation of dials 24 or rotational plunger 65, as discussed above. In this embodiment a gemstone 5 is held by a dop 32. The dop 32 is connected to a housing which has a plurality of dials 24. A plunger mechanism 65 is attached to the housing. As mentioned in previous embodiments, depending on which depression slot 61 is engaged, pressing of the plunger mechanism 65 causes discrete rotation of the dop 32, and the workpiece 5 thereon, as indicated by rotational arrow “E”. The housing, with the dop 32 and workpiece 5 thereon can additionally be placed on two rotation gauges which allow for two additional degrees of freedom. The rotation of these two gauges is shown by rotational arrows “G” and “H”. Although not depicted in FIG. 19, the apparatus 10 may be further attached to two slides 22 which, similar to previously mentioned embodiments, allow for movement in the “X” and “Y” directions, as indicated by directional arrows “J” and “K”. Thus, this embodiment will allow for at least four degrees of freedom. Shown in the figure are seven degrees of freedom. Additional degrees of freedom can be provided for in the apparatus 10. 

Another embodiment of the apparatus 10 according to the present invention can be used for grinding of various materials. In this embodiment (not shown), the main mount 20 is attached to a plurality of slides 22. The first slide 22 allows sliding movement in one direction. The first slide 22 is similarly attached to a second slide 22 whereby allowing sliding movement of the apparatus 10 in a second direction. The two slides could be normal to each other, thus allowing full movement in a "X-Y" coordinate system. The apparatus 10 could similarly be attached to rotation means, thereby allowing rotation of the stage 40 and workpiece 5 about one or more of the three principal axes, "X", "Y", and "Z". The slides 22 are further attached to a base. The base has a motor means which, through a pulley, can operate a series of material shaping devices (e.g., grinding wheels, buffing wheels, etc.). Thus, in this embodiment, various tools that may require sharpening can be held by the clamps 41 on the workpiece platform 45 for precise positioning and sharpening in any position. 

In operation, the apparatus 10 can provide uniform, precise, and symmetrical shaping of the workpiece 5. For example a set of cuticle cutters can be the workpiece 5 that is placed on the workpiece platform 45. The workpiece 5 is fixed on the workpiece platform 45 via a clamp 41. The cuticle cutter 5 can be set open symmetrically about the front detent 42 by placing a standard hexagonal nut on the workpiece platform 45 between the cuticle cutter handles and the outboard side of the front detent 42 (See FIG. 2). By using the series of slides 22 the workpiece 5 can be moved so as to be adjacent to one of the plurality of grinding wheels. The user can rotate the dial 24A thereby causing the stage 40, front detent 42, workpiece platform 45, and the cuticle cutters 5 thereon to rotate so that one of the cuticle cutters' blade edges is parallel to one of the grinding wheels. During the grinding of this first edge on the first blade of the cuticle cutter 5, the front ball 51 will be residing in the path of one of the two helical depression paths 43A, 43C on the front detent 42 due to the angle of the cuticle cutter blade. When the operator has completed grinding the first edge on the first blade of the cuticle cutter 5, the operator can move the main mount 20 on the series of slides 22 so that the cuticle cutter is temporarily distanced from the grinding wheels. The operator can take hold of, and rotate the stage 40 so that the front ball 51 overcomes the first helical detent path 45A, 45C in which the front ball 51 resides and then rotate the stage 40 sufficiently so that the front ball 51 eventually resides in the second helical detent path 45C, 45A. This step, results in the stage 40, front detent 42, workpiece platform 45, and workpiece 5 thereon to rotate about an longitudinal axis of rotation so that the second position of the workpiece 5 is exactly symmetrical about the centering detent path 43B with the first position of the workpiece 5. 

Alternative embodiments allow for the shaping of various materials in addition to sharpening tools. In addition to a work piece platform 45 and clamp 41 embodiment as aforementioned, other material holding systems can be employed. These include a dop or collet to facet gem stones or to grinding lenses and the like. 

Further features in some embodiments include an indicator (not shown), which can either be visual or aural. The indicator displays the detent location of the apparatus 10. In the case of the visual indicator, the indicator could be a digital readout, or an optical window, or other device. The operator is able to determine, for example, the particular facet on the gemstone 5 that is being shaped, cut, or polished. Further, the operator can determine how many total facets are being shaped (i.e., cut, ground, polished, etc.) from the indicator. This helps the operator, in particular, on very complicated shaping projects to avoid losing track of where in the project the operator currently is using the apparatus 10. For example, if the operator elected to cut a 7-sided gemstone 5, after installing the gemstone 5 onto the dop 32, the operator could adjust laterally the dop 32, via the rack and pinion means. Then the rear detent 60 is adjusted to the desired row of detent slots 61 that has 7 points surrounding the detent 60. The readout would then read “7-sided” or “7” or “1 of 7” or “1/7” or similar notation. Upon completing the cutting or faceting of the first face of the gemstone 5, the operator then either operates the plunger mechanism 65 or rotates a hand dial 24A one “click” on the ball 56 and rear detent 60 system. The rear detent 60, dop 32, and gemstone 5, attached thereto, would then rotate, in this example, an additional one seventh of the circumference of the dop 32 and gemstone 5. The readout would then read “2 of 7” or “2/7” or similar notation. 

Although several embodiments discussed involve a ball and depression type of arrangement, there are other alternative embodiments possible. For example, instead of a male (e.g., ball 51, 56) element being located on the various ball detents (e.g., 50, 55) and a female (e.g., depression 43, 61) element being located on the various detents (42, 60), the arrangement can be reversed. For example, instead of a ball (51, 56) being on the ball detent (e.g., 50, 55), the ball detent 50, 55 could have a female-type follower. Similarly, instead of a depression (43, 61) being on a detent (e.g., 42, 60), the detent 42, 60 could have a male-type guide. Thus, the detent 42, 60 may have a guide and the ball detent 50, 55 may have a follower. The relative position of the follower with respect to the guide, in part, determines the positioning of the
various sections of the apparatus 10. The guide can be a depression 43, 61. An alternative way to describe this embodiment is that the guide also, instead of being an absence of material in the case of a depression 43, 61, can be an addition of material (i.e., a male type guide) on the surface of the detent 42, 60. Similarly, the follower, instead of being an addition of material in the case of a ball 51, 56, can be an absence of material (i.e., a female type follower) on the surface of the ball detent 50, 55. The guide is operatively attached to the follower.

[0071] Another embodiment of the apparatus 10 allows for the guides or depressions to reside on a first detent piece. This first detent piece can be square, rectangular, or other shape. This first detent piece resides in a slide, or some sort. In this embodiment this first detent piece is moved (e.g., rotated, laterally moved, etc.) by the operator’s actions. The operator’s actions could be rotating a dial, operating a motor, etc. A tracking follower (e.g., ball, pin, etc.) can be attached to a second piece in which the workpiece 5 is operatively attached. The tracking follower is operatively attached to the guides (i.e., depression, detent, etc.). Thus, when the operator slides the first detent piece, by virtue of the follower on the second piece being operatively attached to the guide(s) on the first piece, will allow for the second piece, and workpiece 5 thereon, to move in an accurate predetermined path.

[0072] Another embodiment of the apparatus 10 uses other material handling devices to handle the workpiece 5. Aside from the workpiece platform 45 and plurality of clamps 41 or a dop 32, a drill, a collet, a stage, a clamping means, or other holding means can be utilized to handle the workpiece 5. The clamping means can be a vise, clamp 41, or similar device.

[0073] Another embodiment is a gemstone dop 32 transfer station (not shown) is made possible for the copying of facets of an existing gemstone 5 on to another gemstone 5. By mating two adjacent apparatuses 10 each using dops 32, with the plunger mechanism 65, along with a system of lock screws, the facets of one gemstone 5 can be copied to a second gemstone 5. Each apparatus 10 could typically be both mated to the first gemstone 5 via their respective dops 32. A second gemstone 5 would be attached to one of the apparatuses 10. Thus, two gemstones 5 can be made identical via this system of apparatuses 10.

[0074] Fig. 20 depicts a front perspective view of a precision material positioning and precision shaping apparatus, hereinafter referred to as 100. Included as part of the apparatus 100, in this particular embodiment, is a motor 130 which is operatively attached to a plurality of material shaping devices. In this embodiment, the material shaping devices are grinding wheels 102 (e.g., 102a, 102b, 102c, 102d). The series of grinding wheels 102 are sandwiched between a cover plate 110 and a back plate 115. The cover plate 110 and back plate 115 thus serve as a holder for the material shaping devices (e.g., grinding wheels 102). Between the back plate 115 and the motor 130 is an armature piece 120 from which extends an armature extension 125. In the armature extension 125 resides an adjustment slot 122 which allows for adjustable attachment of the apparatus 100 to additional precision positioning and shaping system(s) and apparatuses, such as the apparatus 10 mentioned above. Operation of the motor 130 causes rotation of the plurality of grinding wheels 102, as denoted by directional arrows “T”. Additionally, the entire construct of the cover plate 110, back plate 115, and grinding wheels 102 can be rotated, either manually, or by automated means, about an axis, as denoted by directional arrow “R”. A hand dial 124 is removed from this figure to allow full viewing of screws 111 and cover plate 110.

[0075] Fig. 21 depicts a front elevation view of the apparatus 100 with the cover plate 110 removed. The plurality of grinding wheels 102a, 102b, 102c, 102d are spaced around a drive wheel 108. The drive wheel 108 communicates with the motor 130 which resides behind the back plate 115. A serpentine belt 103 transmits the rotational force of the drive wheel 108 to the plurality of grinding wheels 102, thereby causing rotation of all the grinding wheels 102. Tension in the belt 103 is provided, in part, by a fixed idler pulley 104 and a pair of adjustable idler pulleys 105a, 105b. Tension in the belt 103 can be adjusted via adjustment of the adjustable idler pulleys 105a, 105b. The adjustable idler pulleys 105a, 105b are, in turn, adjusted via adjustment screws 106a, 106b, respectively. In alternative embodiments, other quantities of the grinding wheels 102 may be employed as can grinding wheels 102 of differing hardnesses. Similarly, other material shaping devices than grinding wheels 102 can be used. For example, precision buffing wheels (not shown) or rotating cutting heads (not shown) for shaping profiles on materials can be used. Additionally, more than one type of material shaping device can be held in the holder. Alternatively, a system of gears, or other translational means can be used to translate the rotation of the motor 130 to the rotation of the material shaping devices. Additionally, in lieu of the direct drive gear system, other translational means can be provide wherein only a selected grinding wheel 102 rotates. For example, a clutch mechanism (not shown) or other translational means can be used so that the motor 130 only causes engagement and rotation of the single grinding wheel 102 being used for material shaping at the particular time, while the remaining grinding wheels 102 are disengaged and at rest.

[0076] Fig. 22 depicts a rear view of the back plate 115. The view shown is from the perspective of the motor 130 (i.e., rear of the apparatus 100). Arranged on the rear surface of the back plate 115 are a plurality of detent balls 116 (e.g., 116a, 116b, 116c, 116d) uniformly situated around a center opening 109, through which passes a drive shaft 112. Although four detent balls 116 are depicted, any quantity of balls 116 can be employed. Also, the detent balls 116 can be arranged symmetrically, or asymmetrically around the axis of rotation. Additionally, other shapes and configurations of the back plate 115 can be used. For example, the back plate 115 can be square.

[0077] Fig. 23 depicts a front view of an armature piece 120. The face of the armature piece 120 shown in Fig. 23, mates with the face of the back plate 115 shown in Fig. 22. Extending off laterally from the armature piece 120 is an armature extension 125 in which is an adjustment slot 122. The adjustment slot 122 allows for attachment and adjustment of the apparatus 100 to other various systems. The armature piece 120 also serves as a covering for the motor 130. Arranged symmetrically around an opening 123 are a plurality of detents 121. The quantity of detents 121, like the quantity of balls 116, can vary. Similarly, the detents 121 can be symmetrically, or asymmetrically, arranged around the
The shape, cross-section, and configuration of the detents 121 can vary. For example, the cross-section of the detents 121 can be V-shaped, U-shaped, channelled, round, square, etc. As with the back plate 115, an opening 123 on the armature piece 120 allows for the drive shaft 112 to pass through. Alternatively, the detents 121 may be situated on the back plate 115 and the balls 116 may be situated on the armature piece 120. Together the balls 116 and detents 121 serve as a positioning device which allows for rotatable positioning of the material shaping devices (i.e., grinding wheels 102).

Fig. 24 depicts a side sectional view of the apparatus 100. Above the motor 130 is the armature piece 120 with the armature extension 125 extending therefrom. Above the armature piece 120 is the back plate 115. Sandwiched between the back plate 115 and cover plate 110 are the plurality of grinding wheels 102. The plurality of balls 116 rest in the plurality of detents 121. The plurality of grinding wheels 102 rotate about axes 107. A plurality of screws 111 hold the cover plate 110 to the back plate 115. A hand dial 124 is attached to the cover plate 110 and facilitates the rotation of the construct comprising the back plate 115, grinding wheels 102, and cover plate 110 around an axis of rotation. The drive shaft 112, which extends through openings 123, 109, is connected to the drive wheel 108 and motor 130.

Various items such as gem stones, hand tools, (e.g., cuticle cutters, scissors, tweezers, etc.), lenses, and the like can be shaped by this apparatus 100. The apparatus 100 provides for precise and accurate positioning of the various grinding wheels 102 that are required when shaping a hand tool such as the cuticle cutter. The apparatus 100 described in Figs. 20 through 24, when used in particular with apparatus 10 such as those described in Figs. 1 through 19 above, provide for additional degrees of freedom in the precision positioning and shaping of various materials, such as hand tools, gems, etc.

Fig. 25 depicts a top perspective view of a precision material positioning and precision shaping system 200 which includes both the first precision material positioning and shaping apparatus 10 with the second precision material positioning and shaping apparatus 100. A support base 130 has both apparatuses 10, 100 attached thereto. A plurality of slides 22a, 22b allow the apparatus 10 to move in both the X and Y directions, as denoted by directional arrows “X” and “Y.” Due to the top surface of the support base 130 being on an angle, allows for some movement of the apparatus 10 along the slide 22a in the Z direction. A rotatable base 127 placed between the slides 22a, 22b allows for rotation of the apparatus 10 around the “Z” axis, as denoted by directional arrow “O”. A material positioning and precision shaping apparatus 100 is further attached to the support base 130. The armature extension 125 extends through a slot 129 in the top of the support base 130. A locking bolt 126 secured to the adjustment slot 122 (not shown) on the armature extension 125 allows the apparatus 100 to be locked in a desired position. A work light 131 is located on the top surface of the support base 130 beneath the grinding wheels 102 in order to provide additional illumination to the working area. An electric plug 140 provides electric power to the motor 130 and work light 131.

A cuticle cutter 5 is shown as the workpiece in Fig. 25 wherein the system 200 can be utilized to shape the various blades on the cuticle cutter 5. After the cuticle cutter 5 is placed on the apparatus 10 and clamped down, the apparatus 10 is moved via a plurality of devices to a desired shaping position. For example, the two slides 22a, 22b are operated to move the apparatus 10 in the X and Y direction, shown by directional arrows “X” and “Y.” The rotatable base 127 is rotated, denoted by directional arrow “O”. Further, the head 30 of the apparatus 10 may be rotated about the Y-axis, as denoted by directional arrow “T”, and the head can be further rotated around the Z-axis, as denoted by directional arrow “S”. Thus, by using the plurality of slides 22, and various rotational devices on the apparatus 10, the cuticle cutter 5 is moved to a desired, precise position for shaping. By rotating the hand dial 124, the desired material shaping element (e.g., grinding wheel 102) of a plurality of material shaping elements is moved into a desired position.

As the grinding wheel 102 is motor driven, the shaping of the cuticle cutter 5 may be begun. After shaping the cuticle cutter 5 a desired amount, the operator can rotate the hand dial 124 to, in turn, rotate the same material shaping element (i.e., grinding wheel 102) to a further desired precise position. Tuning of the hand dial 124 causes the balls 116 to overcome their purchase with their respective detents 121. The hand dial 124 can be rotated until the grinding wheel 102 has found a second, desired position wherein the balls 116 reside in a particular detent 121. In should be obvious to one skill in the art, that between rotation of a particular grinding wheel 102 and/or rotation to a different grinding wheel 102, that the operator may further adjust the precise positioning of the workpiece via all the aforementioned positioning devices (i.e., slides 22 and rotational means) in the apparatus 10. In an alternative embodiment, a mecha-
nized means can be employed to provide rotational means in lieu of the hand dial 124. For example, a automated plunger with a ratchet and pawl (not shown) can be used instead to rotate the construct that includes the grinding wheels 102.

While this invention has been described in conjunction with the specific embodiments outlined above, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, the embodiments of the invention as set forth above are intended to be illustrative, not limiting. Various changes may be made without departing from the spirit and scope of the invention as defined in the following claims.

I claim:

1. An apparatus comprising:
   a plurality of material shaping devices;
   a holder for the plurality of material shaping devices; and
   a positioning device for rotatably positioning said plurality of material shaping devices for engagement with a workpiece.

2. An apparatus according to claim 1, wherein at least one of the plurality of material shaping devices is a grinding wheel.

3. An apparatus according to claim 1, wherein the plurality of material shaping devices are grinding wheels.

4. An apparatus according to claim 1, wherein the positioning device includes a ball detent system.

5. An apparatus according to claim 1, further comprising a motor operatively attached to the plurality of material shaping devices.
6. An apparatus according to claim 1, wherein the plurality of material shaping devices are at least three grinding wheels of varying hardnases.

7. An apparatus according to claim 1, wherein the plurality of material shaping devices are selected from the group consisting of grinding wheel, buffer, gem cutter, profile shaper.

8. An apparatus according to claim 1, wherein the positioning device provides precision rotatable positioning.

9. An apparatus according to claim 1, wherein the holder is operatively attached to said positioning device.

10. A material shaping apparatus comprising:

   a plurality of material shaping devices each having an axis of rotation;

   a positioning device for precision positioning of the plurality of material shaping devices.

11. A method of precision positioning for material shaping comprising:

   providing a plurality of material shaping devices;

   attaching a holder to the plurality of material shaping devices; and

   rotating the holder with a positioning device for rotatable positioning of said plurality of material shaping devices.

12. The method as in claim 11, further comprising:

   engaging at least one workpiece to at least one of said plurality of material shaping devices.

13. A system comprising:

   a first apparatus including:

   a positioning system having a first section and a second section, wherein at least one of said first section and said second section includes at least one depression for rotatable positioning along a path;

   a second apparatus operatively engageable with said first apparatus including:

   a plurality of material shaping devices;

   a holder for the plurality of material shaping devices; and

   a positioning device for rotatably positioning said plurality of material shaping devices for engagement with a workpiece.

* * * * *