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Description

This invention relates to a new and improved apparatus for rapidly sharpening knives and similar tools to create a superior cutting edge. As used herein, the term knife shall be defined to include any sort of blade such as chisels, plane edges, scissors, razor blades, and similar precision edges or cutting tools.

There are a wide variety of known means for sharpening knives some of which are discussed in my copending EPA 85102759.9. The large number and wide variety of existing means for sharpening knives is testimony to the complexity and difficulty of sharpening knives in a fast, convenient and satisfactory way that will consistently produce a sharp cutting edge. There is today in fact no known available means for the unskilled to produce rapidly and consistently razor-like cutting edges on knives.

Rapid sharpening requires a means to remove rapidly the material of composition of the knive—often a high carbon steel or a stainless steel. The rate of metal removal is related to the inherent hardness of the abrasive used, the particle size, or grit as it is commonly called, of the abrasive, the applied pressure on the knive edge, and the linear velocity of the abrasive particles across the edge being formed or sharpened. The hardest material commonly used for metal removal is diamond with a hardness of 10 on the Mohs' scale, compared to about 5.5 or so for many steel alloy knives. Other materials such as alumina, high density alpha alumina, carborundum, certain natural stones and the like also are harder than most steels and hence can be used for sharpening through abrasive action against the metal.

Creation of the finest cutting edges on the order of 0.00254 mm (one tenthousandth of an inch) in width can be accomplished with these abrasive compositions, but a fine grit must be used and the velocity of the abrasive must be held below a critical limit to avoid overheating the thin and fine edge being created by the abrasive action. An abrasive system and apparatus designed to create fine edges such as that described in the copending application cited above will remove metal at a rate lower than a system where the abrasive particles are larger and moving at higher velocities.

Because creation of the finest cutting edges involves inherently a slower metal removing rate, any process designed to create such edges is not optimum for the task of initial metal removal such as where a knife is first being formed or where the blade is particularly dull. Consequently, to reduce the total elapsed time needed with a very dull knife to create a thin and fine edge of a thickness limited only by the composition of knife and its crystalline structure, one usually resorts to a series of different and time consuming grinding and sharpening operations. None of the integrated sharpening equipment existent today are satisfactory for the rapid generation of fine edges on the order of 0.00254 mm (1/10,000 inch) on otherwise very dull knives.

Much prior art has been concerned with disk type sharpeners for rapid sharpening such as described in U.S. Patent No. 3,680,264. They have proved unsatisfactory because of serious control problems inherent with disks which manifest difficulties in positioning the knife accurately, in controlling the angular relationship of the knife with the disk face, and in creating excessive heating of the knife edge during sharpening. A most serious disadvantage has been the tendency of the disk to "grab" the knife when its edge is rested on the flat surface of the disk and to grind undesirable scallops or grooves along the knife edge in an uncontrolled manner. Such grabbing occurs if there is instability in the control of the angle that the knife face makes with the disk face, or inadequate means to hold the knife guide parallel to the flat surface of the disk, or poor control over the consistency of force applied to the knife edge by the disk or operator during sharpening.

A major cause of poor sharpening with disk sharpeners is poor control of knife angle relative to the rotating disk such as exemplified in prior art U.S. Patent No. 2,496,139 that actually allows the knife guide to wobble and the sharpening angle to be determined more by operator skill or by the knife width and thickness. Poor control of the knife edge parallel to disk face or poor control of the angle of knife face relative to the principal plane of a disk sharpener is unacceptable if one wished to optimize blade edge sharpness and to avoid gouging.

To minimize such uncontrolled gouging and grabbing of knives sharpened with disks, the prior art commonly has resorted to maintaining contact of the knife edge only with the corner edge of the disk such as described in U.S. Patent No. 3,334,446 and deliberately avoiding a planar contact between the knife edge facet and the disk face perpendicular to its axis of rotation. In that patent the described disk is spring loaded to help reduce gouging and the knife is positioned on a rigid holder by means of a leaf spring pressing against the knife. A guiding means in this sharpener on one side of the disk edge limits the movement of the knife towards the disk. Even with these precautions, by deliberately avoiding planar contact with the disk face perpendicular to its axis of rotation there is only a point or limited line of contact between the blade and abrasive during sharpening and there is a strong tendency to gouge the knife edge. The abrasive passes the knife edge in essentially one fixed direction which leaves burrs and unacceptable large serrations on the blade edge.

A common version of this approach is described in U.S. Patent No. 2,775,075 where the edge of the abrasive disk is beveled to enlarge the line of contact along that bevel of the knife edge with the abrasive. The tendency of such sharpeners to gouge knife blades is well known and at best the resulting knife edge is poorly defined and serrated. In all such sharpeners the abrasive passes the knife edge in essentially one fixed direction which creates the serration and a sizeable burr on the knife edge.

A complex sharpener covered by U.S. Patent No. 2,519,351 contains two pair, a total of four (4) abrasive blocks, one pair of which is biased to move toward the other, that sharpens by a reciprocating rectilinear motion simultaneously both cutting edge facets of a knife. The knife is held by three sets of jaws in a positioning means designed to be free floating in lateral position between the abrasive pairs and to moderate insertion of the blade into the positioning means by engaging the sides of the knife in one or more of three (3) grooved blocks. In addition to its complexity this sharpener has the disadvantages inherent in all rectilinear motion sharpeners which leaves a serrated knife edge which cuts by tearing and has poor wear characteristics. The free floating design of the positioning means and the inherent tendency of the two cutting edge facets of the blade to jam in the grooved block makes this inapplicable in virtually any other sharpener. Because both sides of the knife or sides of its cutting edge facets are used to moderate the degree of knife insertion into the sharpener, and because of the free floating lateral motion, this prior art positioning means is inapplicable where a precise positioning of the knife edge is necessary. The degree of insertion of the knife edge and hence its position depends on the width of the knife, on the width and angle of its cutting edge facet and on the degree of manual pressure applied during insertion and movement of the knife.

U.S. Patent No. 2,751,721 describes a sharpener with a drum shaped abrasive element where the knife cutting edge facet is sharpened against annular portion of the drum surface that rotates in a plane perpendicular to the axis of rotation of the drum. The abrading force on the cutting edge is determined solely by the degree of hand pressure applied to the knife by the operator which leads to significant inconsistencies in abrading rate, poor edge formation, and gouging of the edge—problems common to much of the prior art. Position and stability of the knife within the holder and angular control of the cutting edge facet against the abrasive surface is poor because of their dependency on the amount of pressure applied by the operator and by the profile of the several bevel faces common to the existent variety of commonly available knives.

U.S. Patent No. 2,645,063 describes a sharpener with a drum surface and a guide mechanism which provides stops that position the knife by bearing directly on the cutting edge itself. Such stops are impractical because of the constant dulling effect on the edge created by rubbing it directly across and normal to one surface of the guide. This patent and U.S. Patent No. 2,751,721 describes sharpeners that incorporate a magnet. The magnetic field does not support or guide the knife.

In accordance with the invention there is provided a knife sharpening apparatus for sharpening a knife having a face terminating at a cutting edge facet comprising a disc-like sharpening member having an abrasive surface, said sharpening member being perpendicularly mounted to a shaft having an axis of rotation, drive means operatively connected to said shaft for imparting a rotational motion to said abrasive surface characterized by, a magnetic knife guide having a magnetic guide surface in a plane disposed at a predetermined angle to and intersecting said abrasive surface to form a line of intersection therewith and biasing means for urging the sharpening member toward the magnetic guide surface or for urging the guide surface toward the sharpening member, said magnetic guide surface having two opposite polarity magnetic poles comprising a north pole and a south pole oriented such that each lies along a line which is substantially parallel to said line of intersection, one of said north and said south poles being disposed along a portion of said magnetic guide surface which is remote from said abrasive surface and the other of said north and said south poles being disposed along a portion of said magnetic guide surface which is contiguous to said abrasive surface to create a magnetic field at said abrasive surface of a strength to provide a thrust to move the cutting edge facet into contact with said abrasive surface and a force to hold the cutting edge facet in contact with said abrasive surface while said abrasive surface is in motion.

The apparatus as described here can produce quickly in hands of the inexperienced a well defined and reasonably sharp edge with reduced risk of gouging, overheating, or damaging the general contour and shape of the knife edge.

The knife guide acts on just one of the cutting edge facets as part of a knife control system that uniquely positions one knife cutting edge facet in contact with and parallel to that face of an abrasive disk which is perpendicular to its axis of rotation. The guide, simultaneously controls precisely the angle of the knife face relative to that face of the disk, and preferably in conjunction with a biasing means acting on the disk controls the level and consistency of force of the abrasive disk against the knife cutting edge facet, and avoids the serious problem of gouging the knife edge common to prior disk sharpeners. The disk and guide means are positioned precisely with the knife removed to be contiguous, defined here as immediately adjacent but restrained from touching. The separation of the disk face and guide is quite small, usually less than 1.59 mm (1/16 inch). In a preferred embodiment the guide and stop means as created therewith are aligned so as to insure that the length of the knife cutting edge facet remains parallel to the plane of the disk face while allowing either the disk or the guide means to move relative to the other against a biasing means. Such biasing means is defined here to include a spring, a solenoid, magnetic effects of a motor armature or other force means that while urging the disk and guide to move closer allows a finite displacement of the disk against the biasing means to insure that biasing force is being applied during sharpening. Biasing action of this sort provided by a spring or other force device in conjunction with the precision stop mechanism insures that the rotating disk will rotate against one edge facet of the knife with a consistent and predetermined force during the sharpening process and thereby establishes precisely the level of abrading force applied. This unique disk sharpener generates rapidly a knife edge on the order of 0.0254 mm (1/1000 inch) or less in thickness, the actual thickness depending significantly on the knife material, abrasive grit size and other factors.

The disk in one configuration is equipped with a central hub that protrudes sufficiently beyond the face of the disk to prevent knives from being scored or scratched if they are improperly handled during use of the disk sharpener. In another configuration an extension of the housing surrounding the disk serves a similar function.

Following the use of a disk sharpener which removes large masses of metal, further sharpening with an orbiting sharpener incorporating an accurate knife guide or holder permits rapid further metal removal for creation of a knife edge on the order of 0.00254 mm (1/10,000 inch) or less in thickness. The ultimate width of the edge is established primarily by the properties and quality of steel or other material used in the knife. The guide used to position the knife in this orbital sharpening step commonly positions the face of the knife relative to the plane of the orbiting abrasive surface at an angle, referred to herein as the second sharpening angle, preferably larger than the first sharpening angle between the face of the knife and the plane of the abrasive disk used in the preceding disk sharpening step, referred to herein as the first sharpening angle. This will cause the orbiting abrasive to sharpen the knife cutting edge facets at a slightly greater total included angle than their existing total angle after the disk sharpener.

The combination of disk and orbital sharpening is unique because of the overall speed with which a very fine edge is formed. The disk sharpener disclosed here can quickly preform the knife edge which is then passed through the orbital sharpener to develop rapidly a razor like edge.

The invention, will be more fully understood from the following description when read together with the accompanying drawings.

Brief description of the drawings

Fig. 1 is a top plan view of an improved disk style sharpener according to this invention.

Fig. 2 is a cross sectional side elevational view taken along line 2—2 of Fig. 1.

Fig. 3 is a cross sectional view in elevation taken along line 3—3 of Fig. 1.

Fig. 4 is a cross sectional view of a typical double bevel faced knife.

Fig. 5 is a cross sectional view of an alternative disk and knife guide constructed according to this invention.

Fig. 6 is a cross sectional view of a knife with a 45° total angle at edge indicating sharpening to be made at 34° by the disk sharpener.

Fig. 7 is a cross sectional view of resultant knife with a 34° total angle at edge formed by first stage disk sharpener indicating sharpening to 40° in the next orbital sharpening step according to this invention.

Fig. 8 is a cross sectional view of a resultant knife showing the 34° and 40° angles formed along cutting edge facets formed respectively by the disk sharpening step and the first orbital sharpening step, according to this invention.

Fig. 9 is a cross sectional view of the knife cutting edge facet (high enlargement) showing the resulting 34° and 40° angles formed along the cutting edge facets and indicating a 45° total angle to be placed on the cutting edge facets by second orbiting sharpening step.

Fig. 10 is a cross sectional view of finished knife cutting edge facets with 34°, 40° and 45° angles formed on the facets as created by the disk sharpener followed by two orbiting sharpening steps according to this invention.

Fig. 11 is a plan view of a combined disk sharpener and a two stage orbiting sharpener in a single apparatus constructed according to this invention.

Fig. 12 is a cross sectional elevation view taken along line 12—12 of Fig. 11 of a combined disk sharpener and a two stage orbiting sharpener in a single apparatus constructed according to this invention.

Fig. 13 is an elevation of a knife guide with a protrusion to prevent accidental abrasion of knife face.

Fig. 14 is an elevation view of yet a further embodiment of this invention.

Fig. 15 is a cross sectional view taken through Figure 14 along the line 15—15.

Detailed description

The apparatus of this invention is described first in their broadest overall aspects with a more detailed description to follow.

This invention is based on a disk type sharpener used so that the knife edge and cutting edge facet is held parellel to that flat face of an abrasive disk perpendicular to its axis of rotation. That face which is perpendicular to the axis of rotaion of the disk and contains the predominant number of surface abrasive elements will be referred to herein as the disk's principal plane. A disk used in this manner has an inherently favorable characteristic compared to grinding wheels, bevel-edge disk sharpeners and rectilinear motion sharpeners in that the abrasive disk as disclosed here moves abrasive elements simultaneously across portions of the knife edge in a variety of directions such as essentially into the knife edge, away from the edge, and in one direction parallel to the edge. This characteristic has the advantage of minimizing burr formation and removing substantial portions of any burr that is formed compared to a strictly rectilinear motion. The abrasive action of the disk however lacks the true balanced omnidirectional abrading action characteristic of the orbital action used in the combination apparatus described here. A disk so used with a knife positioning system comprised of a guide and two stops for the cutting edge facet of the knife as described herein has further advantage because of the surface planarity of the disk and because of the sizable surface area in contact with the knife edge thereby maximizing the opportunity to retain a straight edge on the knife and minimizing the chances of "grabbing" the knife cutting edge facet and gouging or scalloping the edge.

The disk sharpener claimed in this present invention overcomes, through unique design, the disadvantages of prior art abrasive disk sharpeners. Sharpening is carried out on the disk's face perpendicular to it axis of rotation with inherent advantages of varied abrasive motion relative to the knife edge, surface planarity, and low burr formation as compared to sharpening on the level edge of the disk. This is accomplished first by employing with the abrasive disk a contiguous precision magnetic knife guide but in the absence of the knife there is a small gap usually less than 1.59 mm (1/16 inch) between the guide and disk. The guide suitably designed can control reliably the knife at a predetermined position and fixed angle relative to the principal plane of the disk irrespective of the knife thickness or shape and contour of the face of the knife. Because the guide is contiguous to the disk and because its guide face extends along and across the entire disk surface near the sharpening line, it gives unusually good support to the knife and allows precision sharpening of virtually the entire knife edge even with short knives. The knife must be held firmly enough by the guide and in a manner that maintains invariently the relative knife/disk sharpening angle along the entire length of the edge facet being sharpened. This guide is of the magnetic type disclosed in the copending application cited above. This guide together with other improvements described here assist in eliminating the tendency of prior art disks to grab and often forceably cause the user to lose physical control of the knife when positioned parallel to the disk face, to lose control of the edge sharpening angle and to gouge, scallop or put undesirable grooves in the knife blade.

Gouging and scalloping with disk sharpeners can occur due to lack of control of the amplitude of applied force between the knife and the rotating disk. The applied force in prior art disk sharpeners is a strong function of the operator's techniques and skill, the knife thickness and geometry, and other design factors. To eliminate this in the present invention, the handle of the knife is positioned by the operator so that the face of the knife rests on the contiguous guide plane established by the face of the guide, and the knife face is moved downward and toward the disk until the first cutting edge facet contacts the rotating disk, moves the disk some distance against an appropriately selected biasing force, and then comes to rest firmly against two precisely located stops appropriately located contiguous to, defined here as immediately adjacent to but not touching, the circumference of the disk that limit further movement of the knife toward the disk and forceably align that cutting edge facet parallel to the principal plane of the rotating disk. The principal plane of the disk face during displacement remains parallel to its plane in the rest position. The extent of displacement of the disk is determined by the position of the disk face in its rest position and by the location of the stops that act only against the first cutting edge facet, that facet which is also in contact with the face of the disk. The use of such stops across which the cutting edge face of the knife is moved precisely locates that facet during sharpening and in no way damages the cutting edge itself. With the guide contiguous to the disk surface and with stops that act only on the one cutting edge facet, the sharpening angle is maintained precisely without any error introduced by knife thickness or curvature of the bevel face of the knife.

The rotating disk mounted on the armature shaft of a suitable motor is biased to urge it toward the guide by a means such as a spring, or the force of motor magnetic effects acting on the armature, but means are provided to limit the disk motion so that in rest position with the knife removed the disk face is immediately adjacent to but not touching the knife guide. The force constant of the spring or other biasing means acting on the disk directly or indirectly uniquely determines the force applied by the disk face on the knife cutting edge facet as the knife moves the disk laterally and the cutting edge facet comes to rest on the provided stops. In this manner the disk remains at all times "spring loaded" against the cutting ege facet during sharpening. When the disk is attached rigidly to the motor armature shaft, the motor can be designed to permit enough uninterrupted lateral motion (end play) of the armature and its shaft to accommodate the lateral displacement of the disk between its rest position and its displaced position as established by the position of the cutting edge facet when against the stops. It is convenient to use a leaf spring against the end of the armature shaft opposite the disk to apply the desired biasing force to the disk. The spring can, of course, be located alternatively so as to press directly on the back face of the disk or on some other point along the shaft that supports the disk. The spring force can be essentially uniform with spring displacement or it could be constructed to be non-uniform.

There are many physical configurations that will provide the same biasing action. For example, the motor can be supported so it can be moved by springs biased in direction of the disk. Similarly the disk can be mounted on a separate shaft and driven by means of gears or belts, etc., from the motor shaft where a spring system could act directly on the rear of the disk or on its separate shaft. The stop arrangement disclosed here which acts on the cutting edge facet minimizes the extent of free travel of the disk needed to accommodate the wide variety in size and styles of household knives.

Equivalent ability to control the force of the knife's cutting edge facet during sharpening can be realized by allowing the knife holder to move away precisely from stationary disk to accommodate knives of different thicknesses. The disk is stationary in this latter example in that it is not free to move laterally in a direction along its axis of rotation. In that case a spring or other biasing means would act on the holder in a manner to press it in the direction toward the stationary disk. However in rest position with knife removed the holder would be contiguous to but not allowed to touch the disk.

Regardless of the means used to control the abrading force during sharpening it is important that the design be such that the required movement of the disk or holder can be realized without any change to the sharpening angle, defined here as that angle formed by the plane of the guide on which the face of the knife rests relative to the principal plane of the abrasive disk, irrespective of blade thickness, width, or length. Neither the disk face or the holder should be allowed to tilt as their relative separation distance changes. For example, where the disk is the moving element, the principal plane of the abrasive disk should, during lateral motion of the disk, remain parallel to the principal plane of the disk in its rest position.

In order to avoid accidental damage to the sides of the knife in certain disk type sharpeners, in the event the sharpener is used carelessly, a part of this invention is a central hub, usually of plastic, on the disk that protrudes just sufficiently from the principal plane of the disk to stop the face of the knife at some point above the cutting edge facet of the knife before it can accidentally contact the abrasive on the disk. The hub must be designed so that it offers this protection without interferring significantly with the ability to place and hold the blade edge against the annular portion of the disk. The hub is applicable in disk sharpeners where the edge of the knife contacts the disk substantially below the center of the disk and where the face of the knife passes during sharpening in front of the axis of rotation of the disk. Other protective means are described that are useful irrespective of knife location on the disk.

As further protection against damage to the knife edge from overheating during sharpening, it is desirable to use a motor with adequate power for sharpening but not of such higher power as to cause serious damage to the edge if the knife accidentally jams and stalls the disk. The disk diameter determines in part the force delivered to the knife, and the velocity and mass of the rotating system also influences the force and kinetic energies involved at knife edge if the disk stalls. A disk diameter of 25.4 to 76.2 mm (1 to 3 inches) and a motor with running torque on the order of 63553.95 µNm (9 inch-ounces) works well and minimizes the danger of damaging the knife. A disk diameter of this order provides adequate flat area to spread the sharpening energy over a sufficient knife length to give uniform sharpening action along the cutting edge facet. Disks of other diameters can be used with appropriately selected motors. A friction clutch can be used as another means to control the forces, torques, and energy deliverable to the disk.

Figures 1 through 3 illustrate, by way of example, a preferred configuration of an abrasive disk sharpener 20 incorporating the improvements discussed here. On a base plate 22 is mounted a motor 24 whose left shaft 26 drives disk holder 28 on whose face is mounted an abrasive surfaced disk 30. The disk holder 28 and the abrasive disk are surrounded by plastic enclosure 60 open to expose the abrasive disk to the knife and fastened by screws, not shown, to base plate 22. The base plate 22 is supported on rubber feet 32. The motor shaft 26 and the right armature shaft extension 44 pass through vertical structural support members 34 and 36 attached by screws (not shown) or other means to base 22 and ride in sleeve bearings 38 and 40. A biasing means in the form of a leaf spring 42 supported on the base plate 22 acts against rear armature shaft extension 44 to apply spring force and pressure to rear armature shaft extension 44, free to move some distance laterally, through thrust bearing 46 or other means. The knife 48 in Figures 2 and 3 rests against the knife guide 50 with its cutting edge facet parallel to and against the facet of disk 30 rotating in a plane perpendicular to its axis of rotation. Hub 52 on the disk protrudes slightly from the face of disk 30 and prevents accidental contact between a side or upper face of the blade and the abrasive surface of the disk.

Stops 54, integrally part of the vertical faces of plastic enclosure 60 opposite the knife guide 50, as shown in Figures 1 through 3, establish in a positive manner the limit of motion of vertical cutting edge facet of the knife in the direction of the abrasive disk 30 and establish positively the position of the cutting edge facet on the disk 30 during sharpening. The stops 54 act only on the vertical cutting edge facet. Those portions of the vertical faces of enclosure 60 that act as the stops 54, are positioned so that when the vertical cutting edge facet is against the enclosure 60 at those points designated as stops 54, the line of that facet is parallel to the principal plane of the abrasive disk. The stopping action can be obtained by designing and locating stops 54 independent of the enclosure 60 but in any event, the stops 54 should be contiguous to but not touching the circumference of the disk holder 28. The stops 54 if made of material independent of enclosure 60 can be made of any of a wide variety of materials such as a high lubricity plastic, a metal such as martensitic steel, a metal roller, or even a mild abrasive material similarly located that will remove burrs or mildly abrade the facet surface at it is moved over the surface of the stop.

A plastic housing 58 encloses the motor 24 and the supporting members 34, 36, etc. The plastic enclosure 60 used to enclose most of the rotating disk holder 28 serves also to minimize any safety hazard from the rotating disk 30.

Figure 2 includes in cross section the illustrative knife guide 50 that contains in plastic structure 51 a rigid magnetic element 62 that attracts the knife and establishes a guide plane for the face of the knife. The angle of the face of the knife 48 resting on the guide plane is established relative to the plane of the disk by the rigid magnetic element 62 located at a position primarily adjacent to the knife's lower bevel face 68 as defined graphically in Figure 4. The guide opposite disk 30 is contiguous to but not in actual contact with the face of the abrasive disk 30, separated therefrom by a small gap 56. As can be seen the guide plane is disposed at a predetermined angle to and intersecting the plane of the abrasive disk 30 to form a line of intersection therewith. As is disclosed in copending application 85102759.9 the magnetic element 62 is arranged with its magnetic field oriented so that one of the magnetic poles is disposed along a portion of the magnetic guide surface which is remote from the surface of the abrasive disk 30 and the other of the magnetic poles is disposed along a portion of the magnetic guide surface which is contiguous to the surface of the abrasive disk. This results in a magnetic field which pulls the knife's cutting edge facet into contact with the abrasive surface and holds the cutting edge facet in contact with the abrasive surface while the disk 30 is in motion. As part of guide 50, the lower guide extensions 49 whose upper faces are set as extensions of the guide plane established by the magnetic element 62 to guide the knife face, are in intimate contact with the face of enclosure 60 on each side of disk holder 28. The illustrative knife 48 in Figure 4, has an upper bevel face 66 and a lower bevel face 68. The cutting edge facets 70 of the illustrative knife, Figure 4, converge to form the cutting edge. Movement of the abrasive on the face of rotating disk 30 creates forces on the knife 48 in contact with disk 30 that tend to cause the lower knife bevel face 68 to rest naturally on the rigid magnetic element 62. It has been shown to be more difficult, less stable and less precise to control the sharpening angle by resting the knife's upper bevel face 66 against the holder face. With knives that might have only a single bevel face such as 66 of Figure 4 for example and no lower bevel face 68, the single face would extend to the edge facets 70 and such knives are of course very stable in the guide.

The disk 30, Figures 1 through 3, rotates preferably at a speed that generates linear circumferential speed of the abrasive particles not greater than 243.8 m (800 feet) per minute, the speed above which burning of the knife edge can occur readily.

The hub 52 Figures 1 through 3 that extends from the abrasive surface by a carefully chosen distance, t, (as defined in Figure 5) can be attached to the disk surface as shown or press fitted as a short rod into a center hole in the disk 30 and disk holder 28 of Figures 1 through 3. This hub 52 must not be so thick that it causes the knife 48, Figure 2, to jam between the hub 52 and the face of guide 50 or prevents the cutting edge facet 70 of knife 48 from extending sufficiently toward the gap 56 and against the surface of the abrasive disk 30. However, the thickness, t, of hub 52, Figure 1, is commonly about 0.254 to 0.508 mm (10 to 20 thousandths of an inch) thick with a 1.77 cm (1—2 inch) diameter disk—enough thickness to prevent the lower knife bevel 68 from accidentally being jammed against the face of rotating disk 30. Commonly the hub thickness will be less than a few percent of the disk diameter.

The hub 52 of Figures 1 through 3 by virtue of its thickness of 0.254 to 0.508 mm (10 to 20 thousandths of an inch) restricts insertion of knife 48 to that space within the clearance angle γ, Figure 2, which by this example would be on the order of 3° less than the sharpening angle θ, commonly about 20°, Figure 2. Sharpening angle θ is that angle defined by the knife-guiding face of knife guide 50 in Figure 2 and the face of abrasive disk 30. Clearance angle γ is defined by the knife guiding face of knife guide 50 and a line from the cutting edge facet to the leftmost edge of hub 52. The disk 30 can be of any diameter and rotated as any RPM preferably chosen in combination so that the maximum linear speed of abrasive particles on the disk 30 is less than 4 m/s (800 feet per minute). It is necessary that the knife cutting edge facet 70 of Figure 4 be in contact with the disk sufficiently far from the disk center that it does not encounter the hub. Typically the disk might have a diameter between 1.77 to 7.62 cm (1/2 to 3 inches) and the hub a diameter of 1.59 to 6.35 mm (1/16 to 1/4 inch), a diameter of around 10 percent of the diameter of the abrasive disk itself. While the hub can be made of any material, ideally it is of a plastic or similar composition that will not scratch or mar the surface of the knife during sharpening if the knife blade should come in contact with it.

The position of the cutting edge of knife 48 relative to where it crosses the face of abrasive disk 30, as shown in Figure 3, is controlled by the height of that point where the guide plane for the face of the knife intersects the plane of the stops for the vertical cutting edge facet. The cutting edge will normally be slightly above that point. The abrasive particles of disk 30 move multidirectionally across the cutting edge facet of the knife. That is, the move across some portions of the knife edge facet in a direction more or less into the edge (upward in Figure 3), while other portions of the knife experience abrasive elements either moving predominantly away from the edge (downward in Figure 3), and in the central area of contact with the knife particles of the abrasive disk more essentially parallel to the knife edge.

Because the various means described in this invention permit for the first time precise controlled sharpening of a knife without gouging on the flat surface of the disk perpendicular to its axis of rotation it is possible to realize the advantages of this multidirectional abrasive action just described that results in minimum burr formation on the knife edge. For this reason, this disk sharpener is uniquely suited to presharpen the knife before subsequent orbital sharpening steps that through true omnidirectional abrasive action places a finer edge on the knife on the order of 0.00254 mm (1/10,000 inch) edge width.

Referring to Figures 1 and 2 and recalling that the disk 30 is biased by a restraining force such as a leaf spring 42 pressing in the direction of the holder, it is clear that as the knife 48 held in guide 50 is pressed down the plane of the guide face until the knife's cutting edge facet meets stops 54 on the face of enclosure 60 the face of disk 30 is forced by the cutting edge facet 70 to move laterally from its rest plane X—X against the biasing means to the right. The force that the disk 30 exerts against cutting edge facet 70 is determined solely by the force of the leaf spring 42. The free travel of the disk 30 and the spring 42 must be large enough to avoid forcing the disk 30 and supporting shaft 26 to reach the travel limits before the knife cutting edge facet rests on the stops 54.

It is important to emphasize that mechanical modifications can be made to that the knife guide 50c will position the knife cutting edge facet 70c against the face of disk 30c on a line above the disk center as shown in Figure 13. In that event a hub such as 52a of Figure 5 will not be necessary. The knife guide 50c of Figure 13 has a magnetic element 62c located in the surface of the guide 50c at a point above the center of the abrasive disk 30c so as to position the knife's vertical cutting edge facet 70c above the center line of disk 30c. Movement of knife 48c down the face of guide 50c causes the knife's vertical cutting edge facet 70c to contact the face of abrasive disk 30c in its rest plane X—X Figure 13 and to move the disk to the right against biasing means, not shown, that insures full restraining force of spring or other means on the knife vertical cutting edge facet but avoids pushing the disk 30c beyond its limit of free lateral travel to avoid excessive pressures on the knife cutting edge facet and possible gouging of the edge as described herin. By causing the knife's vertical cutting edge facet 70c in Figure 13 to rest on the stops 54c shown as integral parts of the vertical faces of disk enclosure 60c, that is one on each side of the disk, it is possible to position the cutting edge facet parallel horizontally to the face of the disk 30c without any physical contact with the cutting edge itself. The face of stops 54c of enclosure 60c of Figure 13 can be made to be parallel vertically to surface of the disk 30c and hence parallel to the vertical cutting edge facet during sharpening; alternatively the face of stops 54c of enclosure 60c on each side of the disk 30c can be sloped vertially slightly (a few degrees) toward the knife guide 50c so that the heel of the knife's vertical cutting edge facet 70c contacts and slides along the face of stops 54c; or the faces of stops 54c can be sloped vertically slightly away from the knife guide to be more effective in removing burrs and/or abrading slightly the cutting edge facet particularly adjacent to the cutting edge. Stops that function in an equivalent manner need not necessarily be a part of enclosure 60c but could be of separate construction and attachment to base 22c as described herein.

Irrespective of whether the sharpening is carried out above the center of the disk, as shown in Figure 13, or otherwise on the disk, it is possible to provide protection for the face of the knife by a protective projection 72 that can be attached to enclosure 60c located about 0.635 to 1.27 cm (1/4 to 1/2 inch) above the normal location of vertical cutting edge facet during sharpening and protruding toward the knife guide 50c a distance d, on the order of 0.0254 to 1.524 mm (one to sixty (60) thousandths of an inch) beyond the principal plane of the abrasive and beyond that line across the face of enclosure 60c where the knife's vertical cutting edge facet is stopped during sharpening. This projection 72 can be physically part of the enclosure 60c, Figure 13, or a separate physical structure without deviating from the sense of its function here.

Biasing action such as created by a spring that applies force on the knife edge during sharpening can be realized either by applying that force to the disk drive and support system as described avove where the disk is free to move laterally, and the guide is stationary, or a similar result can be obtained by applying the biasing action and restraining force to the knife guide while maintaining the disk in a stationary position.

Figure 5 shows a knife guide 50a and a stationary disk 30a where the guide 50a is free to slide laterally along the surface 82 of base plate 22a while being pressed to the right by a compression spring 86 located behind the knife guide 50a. In use the face of knife 48a resting on the guide surface as shown in Figure 5, is moved down the plane of the guide surface toward the abrasive surface until the vertical cutting edge facet contacts the surface of abrasive disk 30a. Any further force than displaces the guide 50a to the left in Figure 5, against the biasing action of compression spring 86 until the lower cutting edge facet contacts stops 89 which are extensions of the guide on each side of the disk. The slope of the upper face of stops 89 is selected normally to be essentially parallel to the lower cutting edge facet. Hence, the upper face of stops 89 is at an angle to the principal plane of the abrasive substantially greater than the angle that the plane of the magnetic element 62a makes with the principal plane. When the lower cutting edge facet comes to rest on the face of stops 89 the knife position is stabilized and the full force of spring 86 is acting to hold the vertical cutting edge facet against the abrasive disk 30a. The user can sense when the lower cutting edge facet is against stop 56a since a much greater force must be applied to the knife in order to obtain further displacement of the knife holder 50a beyond that point. The slope of the upper face of stops 89 can alternately be set at an angle essentially perpendicular to the knife edge to provide a more definitive stopping action. Disk 30a of Figure 5 is stationary in that it is not free to move laterally in a direction parallel to its axis of rotation. When the knife 48a is removed, the guide 50a moves to the right a distance determined by the guide stop 90 which establishes the rest position of guide 50a and insures that the knife guide 50a will not move against the surface of the stationary rotating disk 30a but remains contiguous to it separated from it by a finite gap 56a. Alignment of the knife guide 50a relative to disk 30a is maintained by shaft 92 that moves through bearing hole 94 in support member 96 fastened to base plate 22a. More than one spring and shaft can be utilized to increase the accuracy of alignment and freer motion of the guide. Stops 89 that act on the lower cutting edge facet, Figure 5, should be positioned so that parallel alignment of the vertical knife cutting edge facet 70a relative to the principal plane of the abrasive disk is maintained during sharpening. A hub 52a is shown that functions the same as hub 52 of sharpener 20 of Figures 1, 2 and 3. Angle θ is the sharpening angle that is the angle between the face of knife guide 50a and the principal plane of the abrasive disk 30a. Angle γ of Figure 5 is the angle between the face of the knife guide 50a and a line extended from the upper terminus of the cutting edge facet 70 to the face of hub 52a.

The improved disk sharpener of preferred embodiment shown in Figures 1 through 3 disclosed here has been shown to produce very quickly a good edge on a wide variety of knives without scoring, gouging, or otherwise damaging the knife. It has been found also that it produces a minimum burr compared to unidirectional abrasive actions of grinding wheels, beveled disks, hard stones, and the like. This rapid action, the good quality edge, convenience of use, and reduced burr make this an ideal sharpener to be used in combination with the orbital sharpener described in the copending patent application cited above. The orbital sharpener while a relatively fast sharpener removes metal at a slower rate than the disk sharpener for a given grit size. The disk commonly has a relatively coarse abrasive in the range of 100—180 grit. The orbital sharpener can rapidly generate a superior fine, thin edge on the order of 0.00254 mm (1/10,000 inch) wide after first presharpening the knife in the disk sharpener. The absence of a sizeable burr allows final edge formation to occur rapidly with an orbital sharpener. There are many other sharpeners known in the art that can be used to place an edge on the blade prior to the use of the orbital sharpener, however, the improved disk sharpener is a particularly unique choice because of reasons discussed herein.

In particular for sharpening knives that are dull or have a poorly formed edge the unique combination of an improved disk sharpener as disclosed here with an orbital sharpener as disclosed in the copending patent application cited above will form rapidly a superior 0.00254 mm (1/10,000 inch) wide edge on a blade. The apparatus as shown in Figures 11 and 12 combines these two unique processes into a single sharpener that can be used by the inexperienced to produce reliably and rapidly razor-sharp edges.

The improved disk sharpener in combination with an orbital sharpener is shown, by way of example, in Figures 11 and 12. Base plate 22b, Figure 12, supports motor 24b, fastened to base plate 22b by screws or other means (not shown), whose left shaft 26b drives disk holder 28b on which is mounted abrasive disk 30b that rotates about 3000 RPM but at a maximum surface abrasive circumferential velocity of less than about 4 m/s (800 ft./minute) to reduce the risk of overheating the knife edge. Fan 100 mounted on shaft 26b serves to cool motor 24b. Air enters the apparatus through the annulus 102 between upper cover 104 and lower cover 106 and exhausts out a base opening 108 in the base plate 22b which is supported on rubber feet 32b.

Vertical support members 34b, 112, and 36b, Figure 12, secured to base 22b by structural adhesive or screws (not shown) support upper horizontal support members 116 which in turn supports the knife guide assembly 118 through the knife guide base 120 that is fastened securely to upper horizontal support member 116 by one or more screws 122 as shown. Drive gear pulley 124 mounted on right armature shaft extension 44b, Figure 12, drives two gear pulleys 126 (one shown) synchronously by means of timing belt 128 (toothed). The armature shaft extension 44b and shafts 130 for attached gear pulleys 126, ride in sleeve bearings 132 inserted into vertical support members 112 and 36b. A more detailed description of the orbiting drive system is included in the copending patent application cited above. Two synchronously driven cranks 134 machined onto the end of shafts 130 ride within the glass filled fluorocarbon sleeve bearings 138 inserted in drive plate 136 and generate an orbital motion of drive plate 136. Ther are shown in Figure 12 two sets of the three (3) or more support bearings 139 held by bracket 141, horizontal support member 116, and support 36b bear slidingly of drive plate 136 to hold drive plate 136 in a vertical plane with minimum motion transverse to that plane as described in the copending patent application. Attached to drive plate 136 by means of screw 140 is an orbiting yoke assembly 142 which has upper arms 144 on which is mounted orbiting abrasive material 146. Through this structure the orbital motion generated in drive plate 136 creates orbital motion of abrasive material 146.

The knife guide assembly 118, Figures 11 and 12, contains plastic structures 148 that support magnetic elements 150 which attract and establish a guide plane for the face of the knife. The knife guide assembly 118 also includes knife stops 152, shown in Figure 11, that serve a variety of functions as described in the copending application cited above. The knife guide 50b used with the abrasive disk 30b contains plastic supporting structure 154 that extends and contacts the face of enclosure 60b. It contains a magnetic element 62b to control the angle of the face of knife relative to the abrasive disk 30b. The magnetic element 62b which attracts the knife and establishes a guide plane for the face of the knife is essentially as described with Figure 2. In use the cutting edge facet of the knife placed on guide 50b rests on the stop 54b on the face of enclosure 60b. The drive cranks 134 can be an integral part of shaft 130 as described above or be a separate part affixed thereto. The motor 24b, Figure 12, must be selected such that its armature and shaft 26b, which on the right of the motor is shown as armature shaft extension 44b, has sufficient end-play to allow the necessary movement or displacement of disk 30b in direction along its axis of rotation to accommodate without reaching a travel-limit the thickest knife to be sharpened. Free end-play on the order of 1.59 mm (1/16 inch) has proven adequate with most knives to allow the disk 30b to be displaced to the right in Figure 12 without reaching the limit of travel permitted by the free end-play.

In this manner, when a knife is inserted between the guide 50b, Figure 12, and the rotating abrasive disk 30b so that the knife cutting edge facet rests on stops 54b, the disk 30b is displaced to the right and it is floating against the biasing force of spring 42b that applies that force to shaft extension 44b through thrust bearing 46b which force is transmitted through the motor armature to shaft 26b and to the disk 30b. Without adequate free end-play in the motor armature displacement of the disk 30b could force the motor armature against its internal stop, not shown, which is usually a thrust bearing, and the disk displacement would then be stopped, thereby generating excessively high forces on the knife by the rotating abrasive disk 30b causing gouging or other physical damage to the knife edge. The spring loading concept employed here in conjunction with the stops 54b on the face of enclosure 60b and the blade guide system provides relatively constant force on the blade edge while being sharpened and uniform sharpening action along the length of knife edge without gouging. The enclosure 60b for the disk shown on lower left is designed to provide a safety cover and structure for stops 54b but without interfering with free knife edge insertion between disk 30b and guide 50b and free contact of the cutting edge facet against the surface of disk 30b.

By combining these two unique sharpeners into a single apparatus it is possible to incorporate knife guides that optimize the sequential sharpening angles θ in a manner that provides the unskilled with a highly sophisticated contour on the cutting edge facets and a knife of superior cutting performance. Angle θ is determined by the plane of the guide face on which the blade rests and the plane of the moving abrasive surface, described in the copending patent application cited above, and shown in Figures 2 and 5. It was found that by using a carefully controlled and slightly larger sharpening angle in successive sharpening steps it is possible to decrease markedly the total sharpening time and insure a superior cutting edge on the blade. Although not essential it is preferable that the construction of the knife guides for the disk and subsequent orbiting abrasive sharpening steps be very similar so as to position and hold the knife in an essentially uniform manner in each sharpening position except for deliberate changes in the sharpening angle.

Many factory produced kitchen knives have, by way of example, a total cutting angle as formed by the intersection of cutting edge facets 70 of Figure 4, greater than 40°. Only rarely does the owner know the actual total angle of cutting edge facets, so any practical means for sharpening must be capable of rapid and foolproof sharpening independent of and without knowledge of the initial edge angle. If it is desired to produce a razor edge, a fine grit abrasive is desirable for finishing the knife, but fine abrasives remove metal slowly. If one did know the initial total angle of the edge facets of the knife and could control the sharpening angle, it would be feasible and practical to use fine abrasive and to sharpen the knife at an angle 1—2 degrees greater than the initial angle so that only little metal need be removed and only in the immediate vicinity of the edge. However, repeated resharpening would have to be done at ever increasing angles if one is to avoid need to remove large quantities of metal, and such resharpenings would ultimately result in a blunt, dull knife. The present invention addresses this problem for the first time in a manner that insures rapid sharpening of a blade to a razor sharp edge without prior knowledge of the initial angle of the cutting edge. To accomplish this, the blade is given an initial sharpening with a coarse grit disk sharpener but at a precisely determined edge angle that is less than the sharpening angle used in the orbital sharpener that uses generally a finer grit size, a lower velocity of the abrasive elements, and the unique orbital motion that produces a razor-like edge.

To illustrate the advantages of this invention in an actual sharpening case and referring to Figure 6 and assuming, by way of example, the knife to be sharpened has its cutting edge facets meeting at an initial total angle of 45°, a popular angle for kitchen knives, it is desirable first that the disk sharpener sharpen the knife to create a precisely known total angle at the knife edge as established by the two cutting edge facets 70 of Figure 4. This angle should be less than the angle to be created on the facet in subsequent orbiting sharpening stages. A convenient angle of choice might be 34° by way of this example as shown in Figure 6. This sharpening step entails removal of a substantial amount of metal from the edge, a task the disk sharpener with say 100—180 grit is ideally suited to do rapidly with creation of only little burr on the edge. If by chance the initial total blade angle were less than 34°, the disk sharpener would nevertheless generate a 34° angle on the blade. The resulting blade edge shown in Figure 7 with a 34° total included angle then can be sharpened to a razor edge in either a one step or multiple step orbital sharpener. The use of two orbital sharpener steps following disk sharpening makes it possible to use first a faster-working coarser grit followed by a finer grit to leave a smoother edge.

Illustrating with a two step orbital sharpener, first the knife of Figure 7 with a 34° total angle is sharpened to a 40° total angle which can be done rapidly with an orbiting abrasive of about 180 grit. This step need entail removal of only a small amount of metal near the edge of the cutting edge facets as seen in Figure 7, compared to the amount of metal removed in the preceding disk sharpener operation. The resulting blade Figure 8 has a 34° total angle along the rear of the cutting edge facet and 40° total angle nearer to the cutting edge itself. In the final orbital sharpening step we can for example use a finer abrasive of say about 600—1500 grit, to create the original 45° angle adjacent to the very cutting edge as seen in Figure 9 (enlarged) by removal of only a very little additional metal. Because this series of sharpening steps is incorporated in a single apparatus, it is possible for the manufacturer to incorporate precision knife guides that sharpen in each successive step with a slightly greater angle so that only the disk sharpener has the burden of removing substantial quantities of metal. The orbiting sharpener has to remove only relatively smaller amounts of metal while placing a fine edge on the knife. Each sharpening step is employed to to what it can do best and the overall result for the inexperienced is rapid formation of a knife with a fine, razor-like edge. The resulting knife edge of this example shown in Figure 10 and highly enlarged compared to the scale of starting blade of Figure 6 has three micro bevels along each cutting edge facet 70 that form total angles of 34°, 40°, and 45° respectively as one views the knife cutting edge facets at positions progressively closer to the cutting edge. Because that length along the cutting edge facet that is beveled at 45° is very small, usually less than 0.762 mm (0.030 inches), it can be sharpened rapidly with the fine grit orbital sharpener leaving essentially no burr on the edge. Any final microburr on the blade edge can be readily removed by pushing the knife edge over and in sliding contact with the knife stops 152 of Figure 11 before the blade edge facet is abraded by the orbiting abrasive 146. For resharpening a knife once sharpened as described the orbital positions designed to create the 40° and 45° total angles will usually regenerate quickly a fine superior edge without recourse to the disk sharpening stage, and only after a series of resharpenings or hard use would it be necessary to use the lower angle disk sharpener again.

A knife sharpened as just described has a significantly superior cutting quality compared to knives sharpened by more conventional means. A knife sharpened according to this example will have three distinct micro bevels on the cutting edge facet as shown in Figure 10. Superior cutting qualities of a cutting edge facet with multiple micro bevels are attributable to the fact that the decreasing bevel angles toward the rear of the cutting edge facet offers angular relief immediately behind the edge that allows the material being cut to tend to move away from or to bear less firmly on the rear portions of the cutting edge facet. A knife with appropriate micro cutting edge facets as created by this invention can remove readily a very fine shaving of material from the surface of a material as contrast to a greater tendency of a knife to split the surface and dig below the surface if the cutting edge facets are planar as a result of being sharpened only at a single angle.

One can see from the foregoing the uniqueness of combining the new improved disk sharpener with the orbiting sharpener in a single apparatus. Even a very dull knife can be sharpened rapidly by the inexperienced and the resulting knife edge is razor sharp on the order of 0.00254 mm (1/10,000 inch) wide.

Figures 14—15 show an alternative form of the invention using a split disk arrangement. The double disk design has proven particularly effective to permit the operator to sharpen conveniently both cutting edge facets of a knife from the same side of the sharpener. In this arrangement two disks 30d, 30d are secured and positioned back to back on a driven shaft 26d and held apart against stops in their rest positions by a biasing mechanism, such as spring 100, located between the two disks forcing the disks apart. Travel of each disk along the shaft axis is limited in one direction by the stop or pin 101 located on the shaft and in the other direction by the position of the second disk or the biasing mechanism. The permissable travel of each disk against the biasing mechanism and toward the opposite disk must be sufficient to avoid the possibility of the disk reaching its limit of travel against the biasing mechanism at any time while the knife being sharpened is displacing the disk against the biasing mechanism. The disks secured to the stops can slide independently on their common shaft while each is forced to rotate at the shaft speed by a pin 101 fastened to or through the shaft, that engages within a slotted portion 102 of the hub of each disk. That pin 101 also can serve as a stop to control position of the disks in this rest position. Other means of driving the disks at shaft speed while allowing the disks to slide on the shaft will be obvious to those skilled in mechanical arts. Abrasive mounted on the outside faces of each disk 30d, 30d rotating on the shaft 26d is pressed against the knife cutting-edge facet during sharpening by a force determined by the spring or other biasing means. For a given knife and type abrasive, the rate of metal removal during sharpening depends on the biasing force and on the size and speed of the abrasive particles.

Although not illustrated in Figure 14, it is to be understood that the stops 54 (Figure 2) may be extended sufficiently toward the disks to prevent the knife blade from being inserted too far and to provide support for the vertical facet. Stops 54 thus would limit the degree of insertion of the knife and limit the displacement of the disk against the spring.

The invention may also be used by mounting any suitable number of disks on each shaft to achieve different types of abrading action such as coarse and fine or any intermediate treatments.

The present embodiments and those described here are to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

Claims

1. A knife sharpening apparatus for sharpening a knife (48) having a face terminating at a cutting edge facet (70) comprising a disk-like sharpening member (30) having an abrasive surface, said sharpening member (30) being perpendicularly mounted to a shaft (26) having an axis of rotation, drive means operatively connected to said shaft for imparting a rotational motion to said abrasive surface characterized by, a magnetic knife guide (50) having a magnetic guide surface (62) in a plane disposed at a predetermined angle to and intersecting said abrasive surface to form a line of intersection therewith and biasing means for urging the sharpening member (30) toward the magnetic guide surface (62) or for urging the guide surface toward the sharpening member, said magnetic guide surface having two opposite polarity magnetic poles comprising a north pole and a south pole oriented such that each lies along a line which is substantially parallel to said line of intersection, one of said north and said south poles being disposed along a portion of said magnetic guide surface (62) which is remote from said abrasive surface and the other of said north and said south poles being disposed along a portion of said magnetic guide surface (62) which is contiguous to said abrasive surface to create a magnetic field at said abrasive surface of a strength to provide a thrust to move the cutting edge (70) facet into contact with said abrasive surface and a force to hold the cutting edge facet in contact with said abrasive surface while said abrasive surface is in motion.

2. Apparatus according to claim 1, characterized by a pair of stops (54) for the cutting edge facet (70) positioned contiguous to and spaced along the circumference of the abrasive surface (30) to limit movement of the first cutting edge facet in the direction of the sharpening member and to control the position of the cutting edge facet (70) on the abrasive surface.

3. Apparatus according to claim 1, characterized by biasing means (42) for urging the abrasive surface (30) toward the magnetic guide surface (62), said biasing means (42) comprising a spring acting on the end of the shaft, and said shaft being a motor shaft having adequate free end-play to accommodate unobstructed motion of the abrasive surface during insertion of the blade.

4. Apparatus according to claim 1, characterized by the fact that the abrasive surface (30) is circular and has a concentric hub (52) of finite diameter on the order of 10 percent of the abrasive surface diameter and protrudes beyond the abrasive surface by a distance of more than 0.0254 mm (one thousandth of an inch) and less than 5 percent of the surface diameter.

5. Apparatus according to claim 2, characterized by the fact that the stops (54) are roller bearings.

6. Apparatus according to claim 2, characterized by the fact that the abrasive surface (30) is circular and defines a principal plane perpendicular to the axis of rotation of the shaft, said abrasive surface having a protective enclosure contiguous to the circumference of the abrasive surface and wherein some portion of the protective enclosure is located opposite the plane of the magnetic guide surface (62) a distance at least 6.35 mm (1/4 inch) from that line defined by the intersection of the plane of the magnetic guide surface with the principal plane of the abrasive surface and extends in a direction perpendicular to the abrasive surface toward the guide plane a distance of more than 0.0254 mm (one thousandth of an inch) and less than 5 percent of the surface diameter beyond the principal plane during sharpening to prevent contact of the face of the knife (48) with the abrasive surface (30).

7. Apparatus according to claim 1, characterized by the fact that the sharpening member is secured to the shaft by means which prevents relative motion betwen the abrasive surface and the shaft.

8. Apparatus according to claim 1, characterized by the fact that the disk-like sharpening member is slidably secured on the shaft, a second disk-like sharpening member being slidably mounted on the shaft, and the biasing means (42) reacting against and urging the disks away from each other.

9. Apparatus according to claim 8, characterized by the fact that each of the front faces of the disks is flat, and the abrasive surface (30) is formed of diamond particles with generally flat surfaces.

10. Apparatus according to claim 8, characterized by guide surfaces outwardly beyond and adjacent each of the front faces for positioning the cutting edge facet (70) at a predetermined angle against a substantial chord of said front face.

11. Apparatus according to claim 1, characterized by a housing (58) having a pre-sharpening section and a honing section, said disk-like sharpening members being in said pre-sharpening section, and a sharpening member being in said honing section, said sharpening member having a flat outer face with abrasive particles mounted thereon, and drive means for orbitally driving said sharpening member.

12. Apparatus according to claim 11, charac-

terized by the fact that the guides for the disk-like sharpening members in the pre-sharpening section are at mirror image angles, the sharpening member in the honing section having a flat outer face on each face thereof with abrasive particles on each of said outer faces, honing section guides being provided for each of said outer faces, and said honing section guides being at mirror image angles different than said mirror image angles of the guides of said pre-sharpening section.

13. Apparatus according to claim 1, characterized by a housing (58) having a pre-sharpening section and a honing section, the disk-like sharpening members being in said pre-sharpening section, a sharpening member in said honing section, said sharpening member having a flat outer face with abrasive particles mounted thereon, and drive means for orbitally driving said sharpening member.

Patentansprüche

1. Messerschärfvorrichtung zum Schärfen eines Messers (68), das eine Fläche hat, die en einer Schneidenfacette (70) endet, mit einem scheibenartigen Schärfglied (30), das eine Schleiffläche besitzt und rechtwinklig auf einer Welle (26) montiert ist, die eine Drehachse besitzt, und mit einem Antrieb, der mit der Welle wirkungsverbunden ist, um der Schleiffläche eine Drehbewegung zu erteilen, gekennzeichnet durch eine magnetische Messerführung (50) mit einer magnetischen Führungsfläche (62) in einer Ebene, die die Schleiffläche unter einem vorherbestimmten Winkel schneidet und mit ihr eine Schnittlinie bildet, und durch Vorbelastungsmittel, die das Schärfglied (30) zu der magnetischen Führungsfläche (62) hin zu bewegen trachten oder die Führungsfläche zu dem Schärfglied hin zu bewegen trachten, wobei die magnetische Führungsfläche zwei ungleichnamige Magnetpole, und zwar einen Nordpol und einen Südpol, besitzt, die so orientiert sind, daß sich jeder von ihnen längs einer zu der Schnittlinie im wesentlichen parallelen Linie erstreckt, wobei der Nord- oder der Südpol längs eines von der Schleiffläche entfernten Teils der magnetischen Führungsfläche (62) angeordnet ist und der Süd- bzw. Nordpol längs eines die Schleiffläche berührenden Teils der magnetischen Führungsfläche berührenden Teils der magnetischen Führungsfläche (62) angeordnet ist, so daß an der Schleiffläche ein Magnetfeld erzeugt wird, das eine Schubkraft ausübt, die die Schneidenfacette (70) mit der Schleiffläche in Berührung bringt, sowie eine Kraft, die die Schneidenfacette mit der Schleiffläche in Berührung hält, während sich die Schleiffläche bewegt.

2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß für die Schneidenfacette (70) ein Paar von Anschlägen (54) vorgesehen sind, die die Schleiffläche (30) berühren und längs des Umfanges derselben im Abstand voneinander angeordnet sind und die Bewegung der Schneidenfacette in der Richtung des Schärfgliedes begrenzen und die Stellung der Schneidenfacette (70) auf der Schleiffläche steuern.

3. Vorrichtung nach Anspruch 1, gekennzeichnet durch Vorbelastungsmittel (42), die die Schleiffläche (30) zu der magnetischen Führungsfläche (62) hin zu bewegen trachten und die eine auf das Ende der Welle wirkende Feder aufweisen, wobei die Welle eine Motorwelle ist, die ein genügendes freies Axialspiel hat, um während des Einsetzens des Messers eine ungehinderte Bewegung der Schleiffläche aufnehmen zu können.

4. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Schleiffläche (30) kreisförmig ist und eine konzentrische Nabe (52) mit einem endlichen Durchmesser in einer Größenordnung von 10% des Durchmessers der Schleiffläche hat, wobei die Nabe über die Schleiffläche über mehr als 0,0254 mm und weniger als 5% des Durchmessers der Fläche vorsteht.

5. Vorrichtung nach Anspruch 2, dadurch gekennzeichnet, daß die Anschläge (54) Rollenlager sind.

6. Vorrichtung nach Anspruch 2, dadurch gekennzeichnet, daß die Schleiffläche (30) kreisförmig ist und eine zu der Drehachse der Welle rechtwinklige Hauptebene definiert, daß die Schleiffläche mit einer Schutzumschließung versehen ist, die den Umfang der Schleiffläche berührt und einen der Ebene der magnetischen Führungsfläche (62) entgegengesetzt angeordneten Teil besitzt, der im Abstand von mindestens 6,35 mm von der Schnittlinie zwischen der Ebene der magnetischen Führungsfläche und der Hauptebene der Schleiffläche angeordnet ist und sich beim Schärfen über mehr als 0,0254 mm und weniger als 5% des Durchmessers der Schleiffläche in einer zu der Schleiffläche rechtwinkligen Richtung über die Hauptebene zu der Führungsebene hin erstreckt, um eine Berührung der Fläche des Messers (48) mit der Schleiffläche (30) zu verhindern.

7. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß das Schärfglied an der Welle mit Mitteln befestigt ist, die eine Relativbewegung zwischen der Schleiffläche und der Welle verhindern.

8. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß das scheibenförmige Schärfglied auf der Welle verschiebbar befestigt ist, daß auf der Welle ein zweites scheibenförmiges Schärfglied verschiebbar montiert ist, und daß die Vorbelastungsmittel (42) an den Scheiben angreifen und sie voneinander weg zu bewegen trachten.

9. Vorrichtung nach Anspruch 8, dadurch gekennzeichnet, daß jede der Vorderflächen der Scheiben eben ist und daß die Schleiffläche (30) von Diamantkörnern mit allgemein ebenen Flächen gebildet wird.

10. Vorrichtung nach Anspruch 8, gekennzeichnet durch Führungsflächen, die im Bereich jeder der Vorderflächen auswärts von ihr angeordnet

sind, um die Schneidenfacette (70) unter einem vorherbestimmten Winkel zu einer beträchtlichen Sehne der Vorderfläche zu positionieren.

11. Vorrichtung nach Anspruch 1, gekennzeichnet durch ein Gehäuse (58) mit einem Vorschärfteil und einem Honteil, wobei die scheibenförmigen Schärfglieder in dem Vorschärfteil angeordnet sind und im dem Honteil ein Schärfglied angeordnet ist, das eine ebene Außenfläche mit darauf angeordneten Schleifkörnern besitzt, und ein Antrieb zum Antrieb des genannten Schärfgliedes auf einer Umlaufbahn vorgesehen ist.

12. Vorrichtung nach Anspruch 11, dadurch gekennzeichnet, daß die Führungen für die scheibenförmigen Schärfglieder in dem Vorschärfteil unter spiegelsymmetrischen Winkeln angeordnet sind, daß das in dem Honteil angeordnete Schärfglied auf jeder Fläche eine ebebe Außenfläche mit darauf vorgesehenen Schleifkörnern besitzt, und daß für die Außenflächen in den Honteil Führungen vorgesehen sind, die unter anderen spiegelsymmetrischen Winkeln angeordnet sind als die Führungen in dem Vorschärfteil.

13. Vorrichtung nach Anspruch 1, gekennzeichnet durch ein Gehäuse (58) mit einem Vorschärfteil und einem Honteil, wobei die scheibenförmigen Schärfglieder in dem Vorschärfteil angeordnet sind und in dem Honteil ein Schärfglied angeordnet ist, das eine ebene Außenfläche mit darauf angeordneten Schleifkörnern besitzt, und ein Antrieb zum Antrieb des genannten Schärfgliedes auf einer Umlaufbahn vorgesehen ist.

Revendications

1. Dispositif d'aiguisage de couteaux servant à aiguiser un couteau (48) possédant une face se terminant au niveau d'une facette (70) d'une arête de coupe et comprenant un organe d'aiguisage en forme de disque (30) comportant une surface abrasive, ledit organe d'aiguisage (30) étant monté perpendiculairement à un arbre (26) posédant un axe de rotation, des moyens d'entraînement reccordés de façon opérationnelle audit arbre pour imprimer un mouvement de rotation à ladite surface abrasive, caractérisé par un guide magnétique (50) du couteau possédant une surface (62) située dans un plan faisant un angle prédéterminé par rapport à ladite surface abrasive et recoupant cette dernière suivant une ligne d'intersection, et des moyens de sollicitation servant à repousser l'organe d'aiguisage (30) en direction de la surface (62) du guide magnétique ou à repousser la surface du guide vers l'organe d'aiguisage, ladite surface du guide mangétique comportant deux pôles magnétiques avant des polarités opposées et comportant un pôle nord et un pôle sud orientés de telle sorte que chacun s'étend le long d'une ligne est sensiblement parallèle à ladite ligne d'intersection, ledit pôle nord ou ledit pôle sud étant situés le long d'une partie de ladite surface (32) de ladite bande magnétique, qui est distante de ladite surface abrasive, tandis que l'autre desdits pôles nord et sud est disposé le long d'une partie de ladite surface (62) de guide magnétique, qui est contiguë à ladite surface abrasive de manière à créer, au niveau de cette surface, un champ magnétique possédant une intensité apte à produire une poussée servant à amener la facette (70) de l'arête de coupe en contact avec ladite surface abrasive, et une force servant à maintenir la face intérieure de l'arête de coupe en contact avec ladite surface abrasive alors que cette dernière est en déplacement.

2. Dispositif selon la revendication 1, caractérisé par un couple de butées (54) pour la facette (70) de l'arête de coupe, située dans une position adjacente à la circonférence de la surface abrasive (30), en étant espacées le long de cette circonférence, de manière à limiter le déplacement de la première facette de l'arête de coupe en direction de l'organe d'aiguisage et pour commander la position de la facette (70) de l'arête de coupe sur la surface abrasive.

3. Dispositif selon la revendication 1, caractérisé par des moyens de sollicitation (42) servant à repousser la surface abrasive (30) en direction de la surface (62) du guide magnétique, lesdits moyens de sollicitation (42) comprenant un ressort agissant sur l'extrémité de l'arbre, et ledit arbre étant l'arbre d'un moteur possédant un jeu d'extrémité libre approprié permettant un déplacement non gêné de la surface abrasive pendant l'insertion de la lame.

4. Dispositif selon la revendication 1, caractérisé en ce que la surface abrasive (30) est circulaire et possède un moyen concentrique (52) possédant un diamètre fini de l'ordre de 10 pour cent du diamètre de la surface abrasive et fait saillie audelà de la surface abrasive sur une distance supérieure à 0,0254 mm (un millième de pouce) et inférieur à 5 pour cent du diamètre de la surface.

5. Dispositif selon la revendication 2, caractérisé en ce que les butées (54) sont des roulements à rouleaux.

6. Dispositif selon la revendication 2, caractérisé en ce que la surface abrasive (30) est circulaire et définit un plan principal perpendiculaire à l'axe de rotation de l'arbre, ladite surface abrasive possédant une enceinte de protection contiguë à la circonférence de la surface abrasive, une partie de l'enceinte de protection étant située à l'opposé du plan de la surface (62) du guide magnétique en étant séparée par une distance d'au moins 6,35 mm (1/4 pouce) de la ligne définie par l'intersection du plan de la surface du guide magnétique avec le plan principal de la surface abrasive, et s'étendant perpendiculairement à la surface abrasive en direction du plan du guide, en étant situé à une distance de plus de 0,0254 mm (un millième de pouce) et inférieure à 5 pour cent du diamètre de la surface au-delà du plan principal pendant l'aiguisage de manière è empêcher un contact de la face du couteau (48) avec la surface abrasive (30).

7. Dispositif selon la revendication 1, caractérisé en ce que l'organe d'aiguisage est fixé par des moyens empêchant un déplacement relatif entre la surface abrasive et l'arbre.

8. Dispositif selon la revendication 1, caractérisé

en ce que l'organe d'aiguisage en forme de disque est fixé avec possibilité de glissement sur l'arbre, à un second organe d'aiguisage en forme de disque à l'état monté de manière à pouvoir glisser sur l'arbre, et les moyens de sollicitation (42) réagissant à l'encontre des disques et les écartant l'un de l'autre.

9. Dispositif selon la revendication 8, caractérisé en ce que chacune des faces frontales des disques est plane et que la surface abrasive (30) est formée de particules de diamant possédant des surfaces de forme générale plane.

10. Dispositif selon la revendication 8, caractérisé par des surfaces de guidage situées extérieurement au-delà des faces frontales tout en étant adjacentes à chacune de ces dernières pour le positionnement de la facette (70) de l'arête de coupe sous un angle prédéterminé par rapport à sensiblement une corde de ladite face frontale.

11. Dispositif selon la revendication 1, caractérisé par un boîtier (58) possédant une section de préaiguisage et une section de honage, lesdits organes d'aiguisage en forme de disques étant situés dans ladite section de pré-aiguisage, et un organe d'aiguisage étant situé dans ladite section de honage, lesdits organes de guidage possédant une face extérieure plane sur laquelle sont fixées des particules abrasives, et des moyens d'entraînement servant à entraîner sur un déplacement orbital ledit organe d'aiguisage.

12. Dispositif selon la revendication 11, caractérisé en ce que les guides des organes d'aiguisage en forme de disques situés dans la section de pré-aiguisage sont disposés selon des angles symétriques, l'organe d'aiguisage situé dans la section de honage possédant des surfaces extérieures planes sur lesquelles sont disposées des particules abrasives, des guides situés dans la section de honage étant prévus pour chacune desdites faces extérieures, et étant disposés selon des angles symétriques différents desdits angles symétriques des guides de ladite section de préaiguisage.

13. Dispositif selon la revendication 1, caractérisé par un boîtier (58) possédant une section de préaiguisage et une section de honage, les organes d'aiguisage en forme de disques étant situés dans ladite section de pré-aiguisage, un organe d'aiguisage étant situé dans ladite section de honage et possédant une face extérieure plane sur laquelle sont fixées des particules abrasives, et des moyens d'entraînement pour entraîner selon un déplacement orbital ledit organe d'aiguisage.

Fig.1.

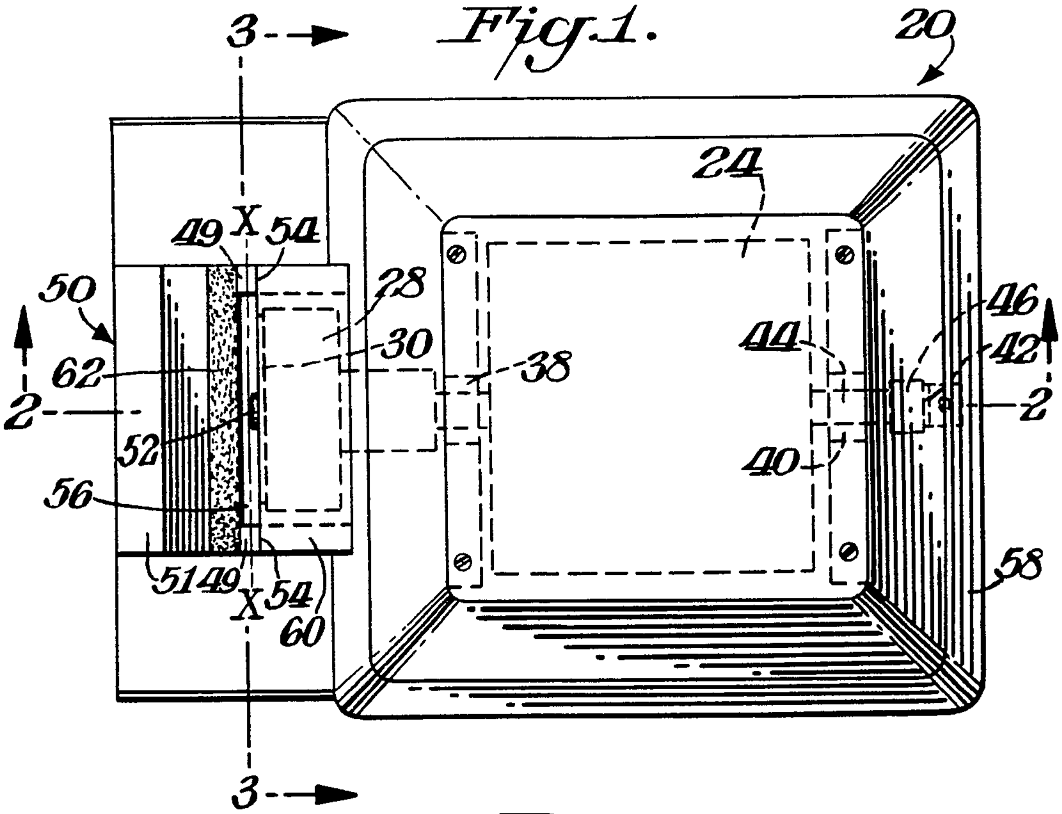
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Fig.2.

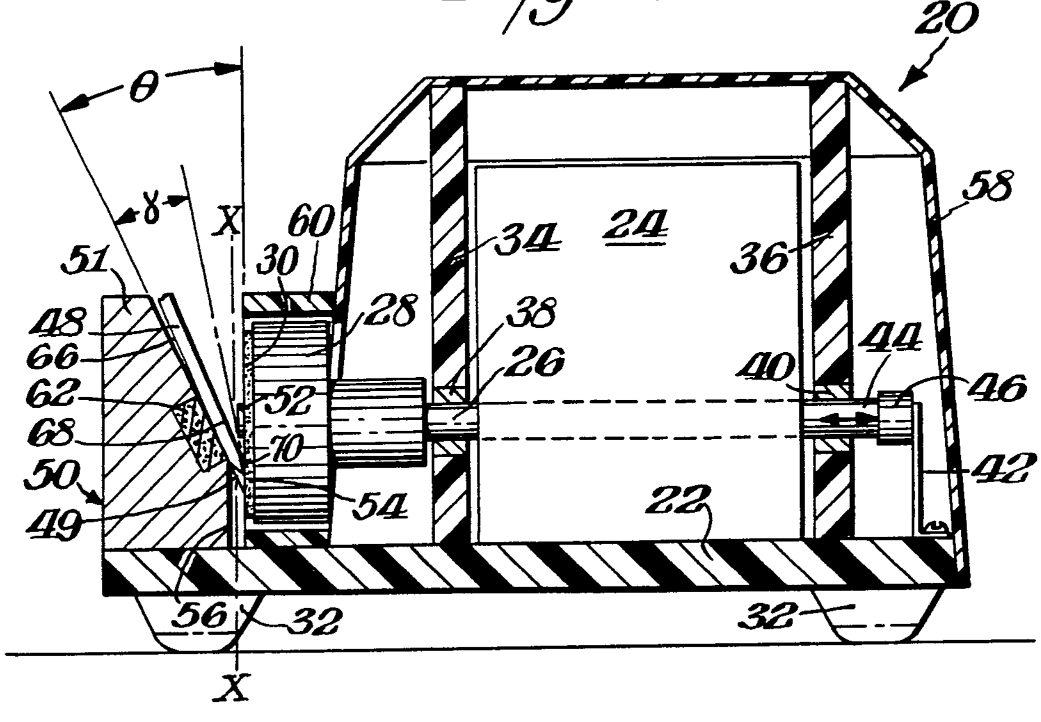
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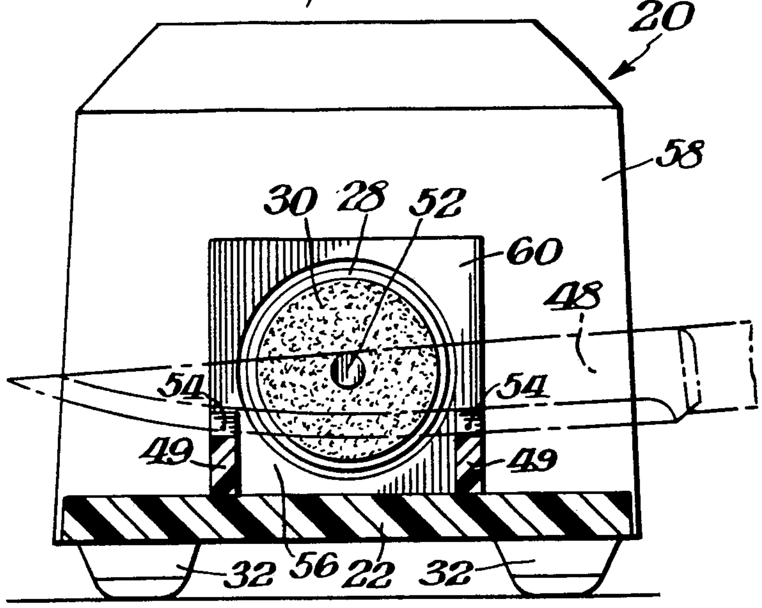
Fig.3.



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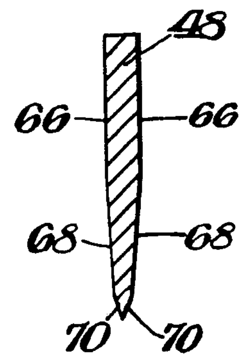

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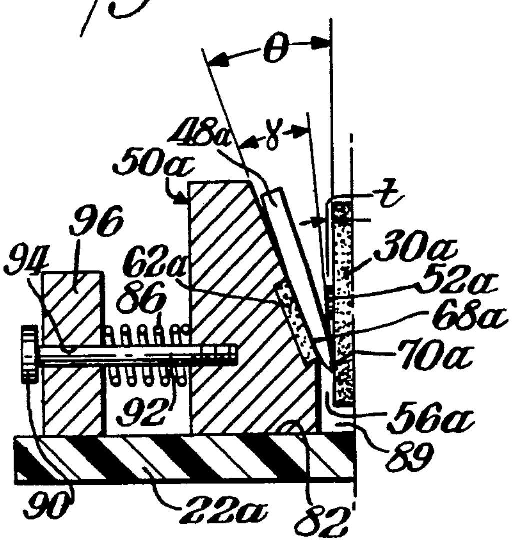
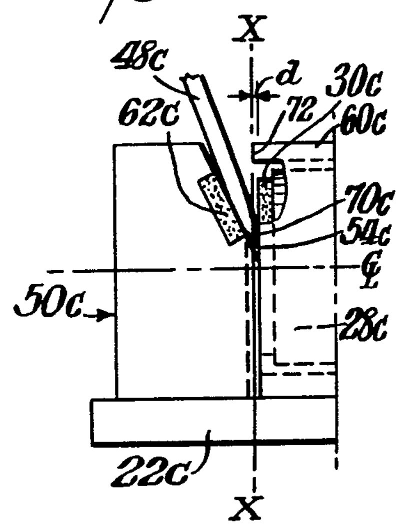


Fig.13.



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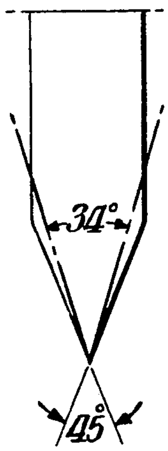
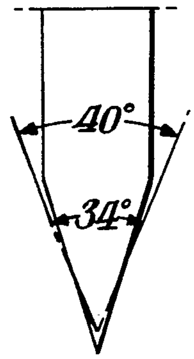


Fig. 7.



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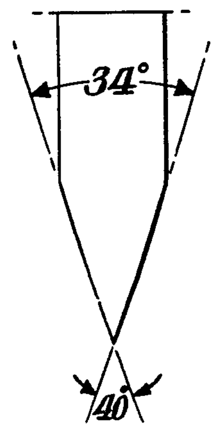

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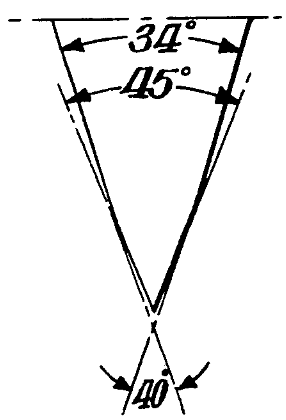

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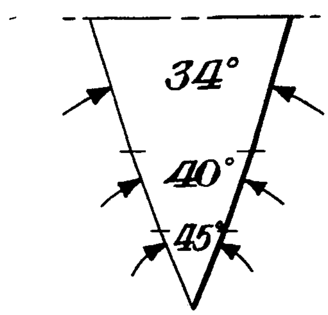

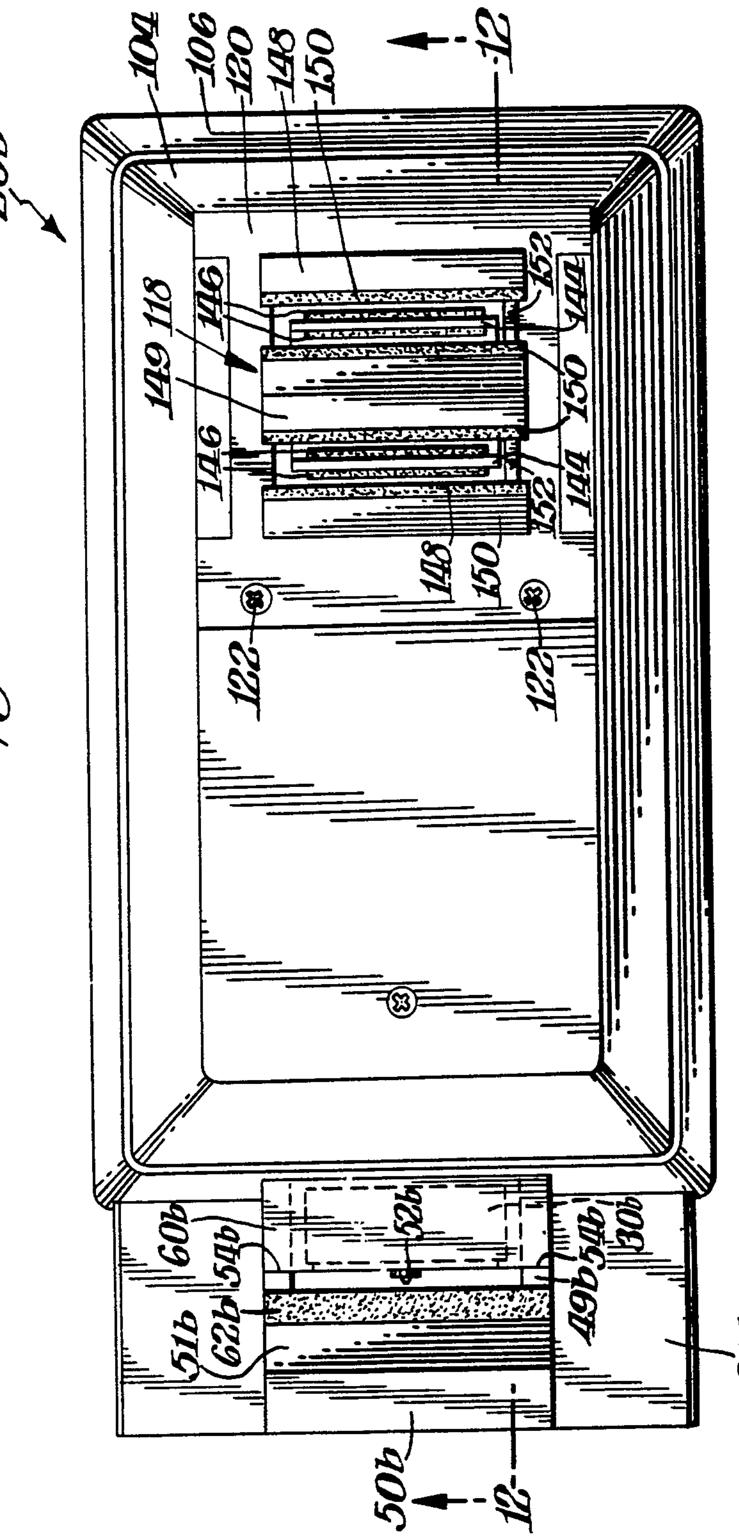
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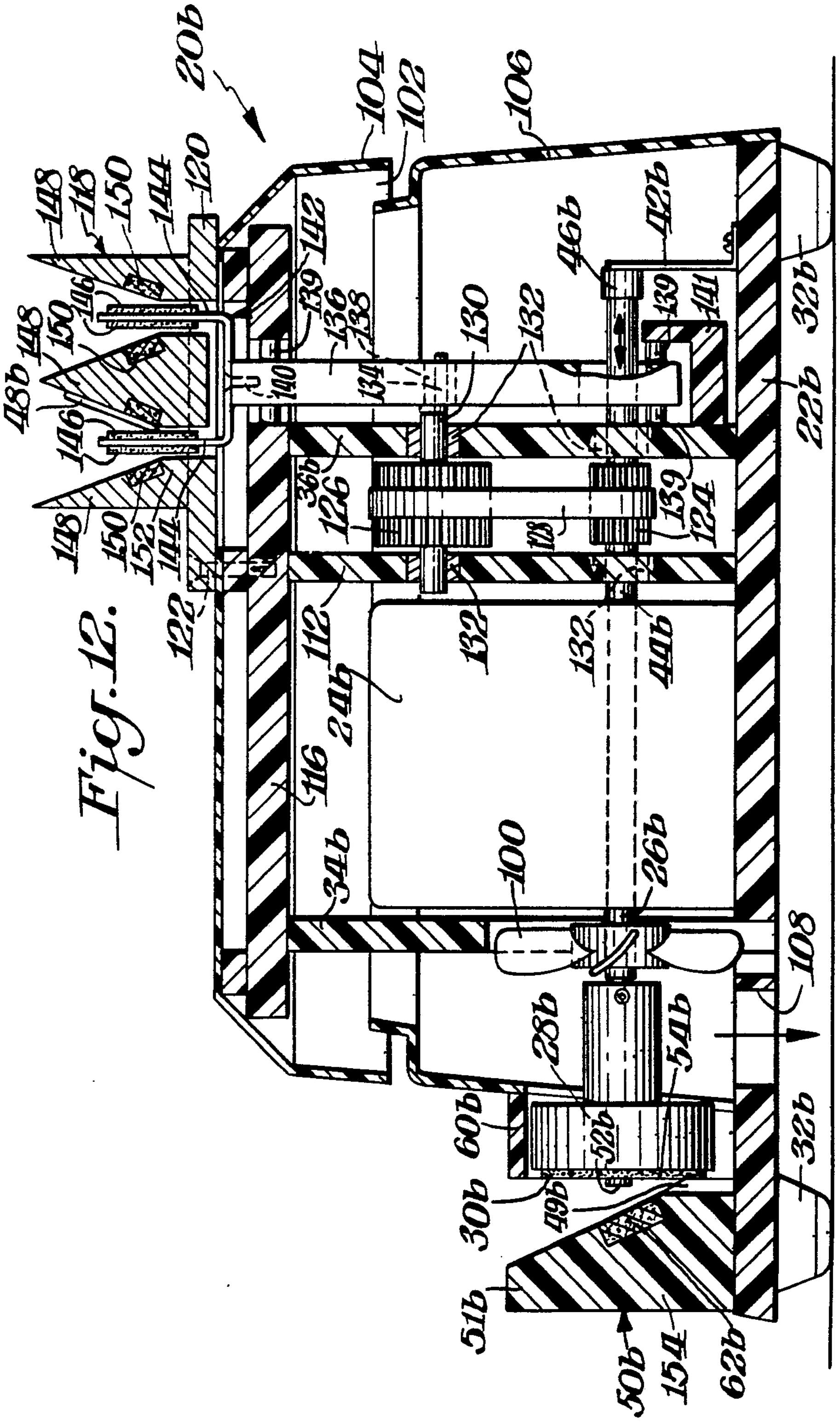
30b
22b

Fig. 11.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34b
100
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50b
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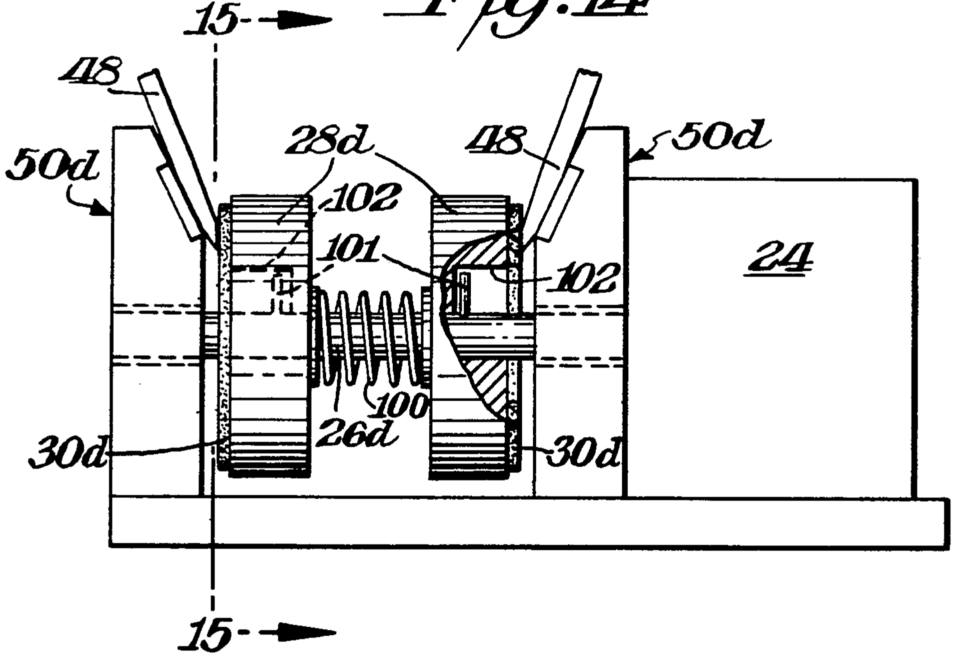
62b

Fig. 12.

Fig. 14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100
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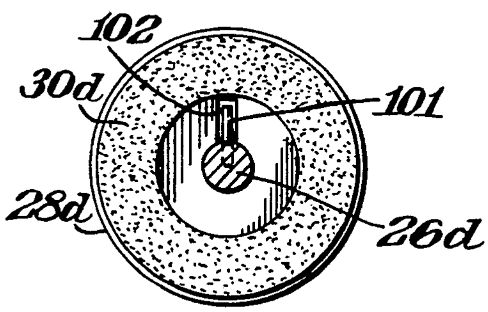
30d
30d
15

Fig. 15.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