

Aug. 18, 1942.

J. BAUMGOLD

2,293,100

ART OF AND MEANS FOR ENGRAVING OR CUTTING SUBSTANTIALLY-INVISIBLE MARKS, OR THE LIKE, IN DIAMONDS AND OTHER ARTICLES

Filed Nov. 2, 1939

2 Sheets-Sheet 1

FIG. 1.

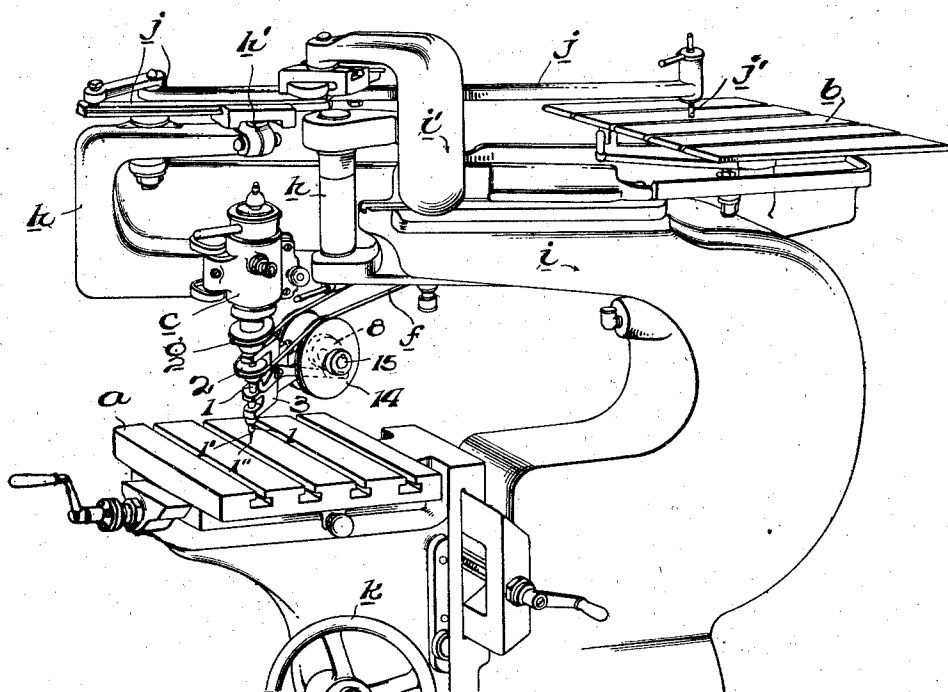
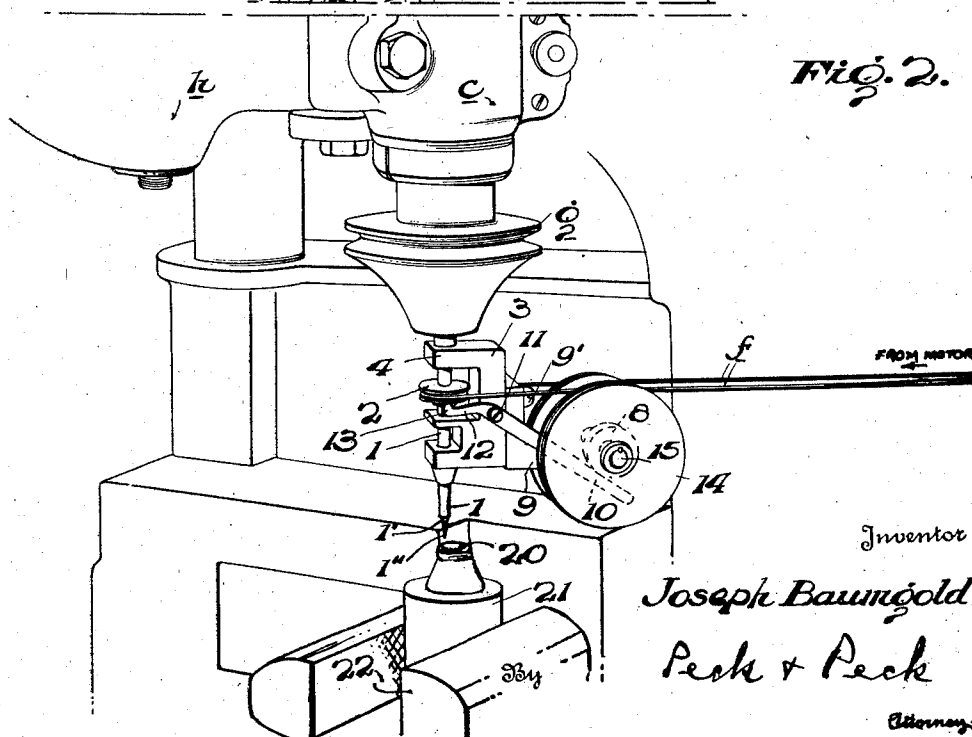


FIG. 2.



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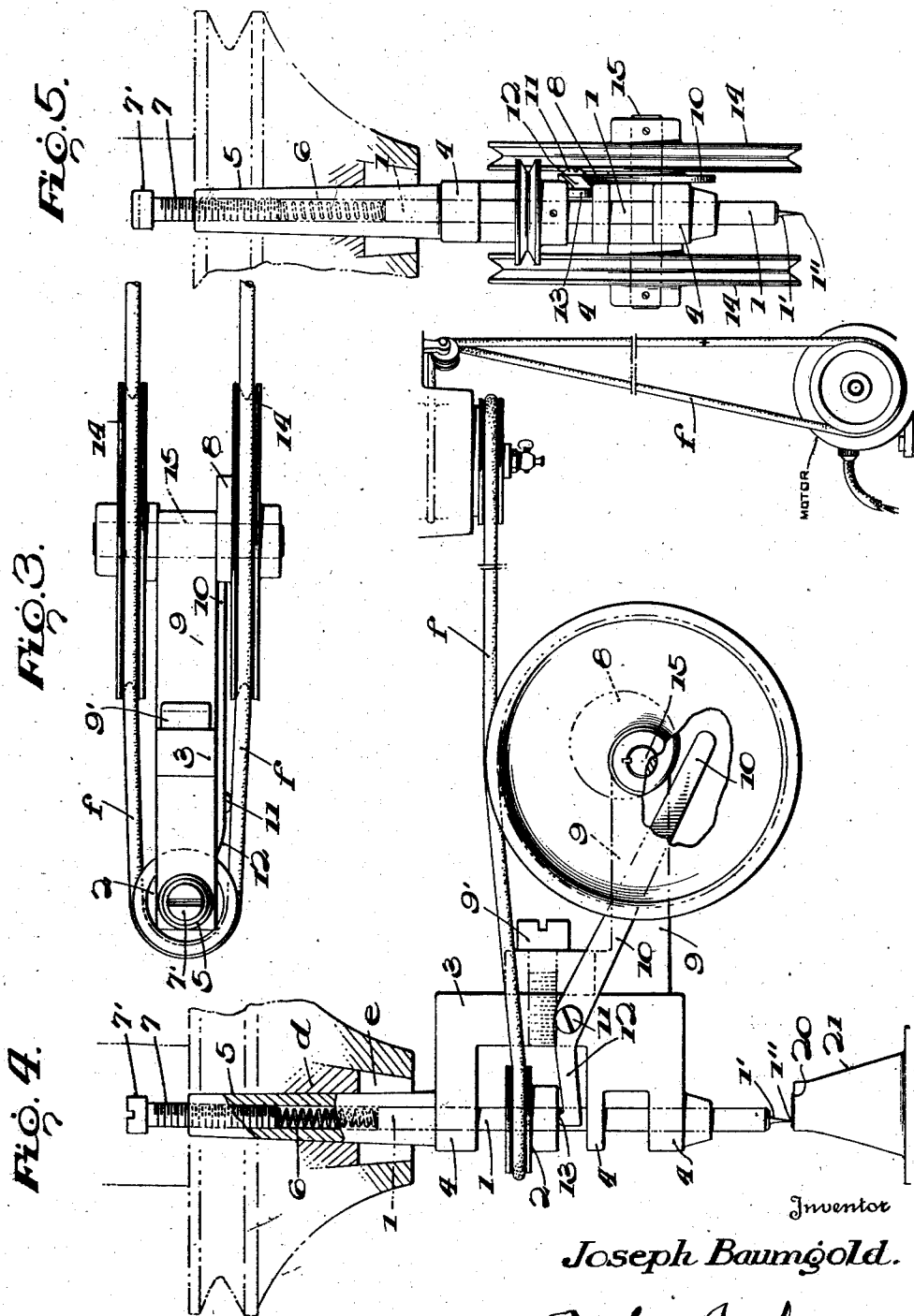
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2 Sheets-Sheet 2



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ART OF AND MEANS FOR ENGRAVING OR
CUTTING SUBSTANTIALLY INVISIBLE
MARKS OR THE LIKE IN DIAMONDS AND
OTHER ARTICLES

Joseph Baumgold, New York, N. Y.

Application November 2, 1939, Serial No. 302,620

15 Claims. (Cl. 125—1)

This invention relates to the art of and means for engraving or cutting substantially invisible marks, or the like, in diamonds and other articles; and the objects and nature of the invention will be understood by those skilled in the art, in the light of the following recitation of the steps and method followed, and explanations of the organization disclosed by the accompanying drawings illustrating what I now believe to be the preferred mechanical expression or embodiment of the invention from among other forms, combinations, or organizations that might be employed or adapted for carrying on the involved method.

It is highly desirable to mark the precious stones and gems of commerce, for instance, diamonds, and substantially like hard stones, with some permanent indicia, such as a so-called "Hall Mark" or the like, to serve the purpose of a trademark in identifying the gem as the product of a particular responsible cutter and polisher or vendor, and such permanent marking will also be of assistance and value in tracing ownership of lost and stolen gems.

At present, the average purchaser is not capable of judging the quality or fineness of a gem, but must accept the statements and assurances of the vendor. If the gem offered for sale has the hall or identifying mark of the producer or vendor permanently cut therein, the vendor of the gem can always thereafter be identified, and held responsible as to the quality of or representations with respect to the gem. Where gems can be and are cut or engraved to carry the hall or identification marks of the cutters and polishers or other vendors thereof, much of the insecurity and feelings of uncertainty on the part of the public in purchasing gems by present methods, will disappear.

Such identification mark on a diamond or other hard stone or gem must be permanent and in no way objectionable or to the slightest degree detracting from the fineness, brilliance or other desirable qualities of the stone, and hence should be substantially invisible, or in other words, practically visible only when viewed through a magnifying glass or the like, and such mark, should be located on a facet of a cut precious stone, preferably on a rear facet.

In so far as I am informed, the precious stone trade has not heretofore employed or adopted the hereinbefore described conception of marking precious gems by cutting or engraving permanent substantially invisible identification indicia therein, substantially for the reason that it has heretofore not been practicable or commercially

possible to successfully and at comparatively low cost, cut or engrave the required marks in or on the hard gems, for example, diamonds, with the required speed, economy, and uniformity.

5 It is an object of this invention to provide means whereby a series of hard gems or precious stones, for example, can be successfully, and economically marked for identification, by cutting or engraving an identical permanent mark so small in size as to be visible substantially only when viewed through a magnifying glass, on said stones or gems in succession.

A further object of the invention is to provide improved means whereby enlarged identification copy can be reproduced in miniature on hard stones or gems, by a cutting operation under manual control, so small in size as to be substantially visible only through a magnifying glass or the like.

20 A further object of the invention is to produce improved means for producing on a gem or other article, for instance a diamond, a permanent identifying mark of such character and so small in size as not to detract from the desirable characteristics of the diamond or other article, by a cutting or engraving operation under manual control.

A further object of the invention is to provide mechanism of the pantograph reducing type for reproducing enlarged copy in miniature on small articles such as diamonds, for example, by a cutting or engraving operation.

A further object of the invention is to improve the art of cutting comparatively small hard articles, such as precious stones, for example diamonds, with the end in view of producing on such articles permanent identification marks with comparative speed, economy and uniformity, with such marks unobjectionable in size and character.

40 A further object of the invention is to provide, as an accessory for a pantograph reducing engraving or like machine, an attachment for cutting substantially-invisible identification marks in hard gems, for example, diamonds, under the control of the operator, in reproducing a copy or pattern in miniature on each gem.

A further object of the invention is to provide a pantograph reducing engraving or like machine, adapted to reproduce copy in reduced size on work, with a peculiar mechanism controlled by the machine pantograph, for cutting substantially invisible marks on hard gems, for example, diamonds, in reduced reproduction of a pattern carried by such machine.

55 And a further object of the invention is to pro-

vide certain improved organization and part or parts thereof, with the end in view of producing an advantageous and novel mechanism for cutting substantially invisible marks on gems, for example, diamonds, in reduced reproduction of a pattern or copy.

With the foregoing and other objects in view, that will develop hereinafter, my invention consists in certain advantageous method steps, and in various mechanical organizations, combinations, novel features and parts thereof, as more fully described hereinafter, and specified in the accompanying claims.

In the accompanying drawings, forming a part hereof, and illustrating as an example one embodiment of the invention from among others:

Fig. 1 is a perspective view, more or less diagrammatically illustrating a pantograph engraving or like machine including therein, as an example, an embodiment of my instant invention, more or less exaggerated in size, in the form of an accessory removably applied to and operatively included in said machine, without intending to exclude an adaptation wherein an embodiment of my invention is built into a pantograph engraving or substantially like reducing machine.

Fig. 2 is a more or less diagrammatical detail perspective, showing the instant accessory example exaggerated in size applied to the pantograph machine rotary cutter spindle, and also showing in part, means exaggerated in size which can be employed for holding the gem, to be cut and securing the same to the machine work table, the rotary and reciprocatory spindle for operating on the gem being shown at its limit of downward movement, the gem not having been brought up into operative relation to the tip of said last named spindle.

Fig. 3 is a detail top plan of said accessory, exaggerated in size.

Fig. 4 shows said accessory in side elevation, exaggerated in size, the shank thereof being broken away, the pantograph machine cutter spindle in which said shank is clamped being indicated in section by dotted lines, the gem holder and the gem therein being shown in enlarged size, and operatively arranged with respect to the accessory spindle point to intercept the down stroke of the said spindle, and thus stop the upward movement of the long arm of the cam lever, an example of a belt drive being shown.

Fig. 5 shows said accessory in enlarged size, in front elevation.

In Fig. 1, of the drawings, a well known type of pantograph engraving or die sinking machine, is illustrated merely as an example of a reducing machine from among others, in or with which my invention can be employed.

In this machine, the pattern or copy to be reproduced in scaled relation in the work clamped on the work table *a*, is secured on the copy or pattern table or holder *b*, the copy being preferably flat and thus held horizontally on the flat horizontal table *b*, although I do not wish to so limit my invention. The machine is equipped with a vertical cutter head *c*, that carries a vertical rotary cutter spindle *d*, the lower end of which is longitudinally hollow and provided with a suitable chuck or collet *e*, by which the cutter is replaceably clamped in and depending from the spindle for normal operation on the work fixed to work table *a*. The machine is equipped with a belt drive *f*, for driving the cutter spindle

d, through the medium of belt pulley *g*, on said spindle.

The cutter head *c*, is supported for universal lateral movement in all directions over the work, by any suitable horizontal linkage *h*, hung from the machine frame *i*, for horizontal swing on a vertical axis, as is common in the art.

The universal lateral movements of the cutter head over the work, are controlled through the medium of said linkage, by any suitable pantograph mechanism, for instance, the drawings more or less diagrammatically illustrate a horizontal parallelogram type of adjustable pantograph *j*, operatively coupled to said linkage at *h'*, and including a long stylus arm extending over the pattern holder *b*, and carrying the stylus *j'*, for tracing the copy on holder *b*. This pantograph is hung from frame part *i'*, to swing laterally on a vertical axis. The pantograph is set to control and predetermine the reduction ratio between the copy on holder *b*, and the reduced reproduction thereof cut in the work by the cutter carried by the cutter spindle.

During a reduced reproduction operation, the copy fixed on holder *b*, and the stylus *j'*, are exposed to the view of the operator, who by hand guides the stylus arm of the pantograph laterally in moving the stylus to follow or trace the copy, and the pantograph thus moved laterally causes the cutter head and cutter to precisely follow and duplicate the lateral movements of the stylus in the scaled reducing ratio for which the stylus is set.

The cutters of such pantograph engraving or die sinking machines, are not capable of properly operating on such hard substances as diamonds, for instance, and are not adapted for cutting substantially invisible indicia in such hard substances that are not objectionable. Hence, to solve this problem, I provide the rotary cutter spindle *d*, with an auxiliary cutter spindle *l*, that takes the place of the ordinary engraving cutter heretofore secured to said existing cutter spindle, and mount said spindle *l*, in axial alignment with the spindle *d*, and to rotate therewith as a unit, and also for relative longitudinal movements or reciprocation with respect thereto. This auxiliary spindle *l*, is carried by cutter spindle *d*, but is preferably directly driven by suitable means, for example, belt pulley *2*, fixed to said spindle *l*, and driven by any suitable belt drive, such as the pantograph machine drive *f*, or if desired a separate belt drive can be employed driven by its own small motor, where the spindle *l*, is carried by an accessory for removable application to the pantograph machine in place of ordinary cutter.

In the particular example illustrated, the spindle *l*, is mounted in and carried by a vertically disposed and elongated more or less flattened frame *3*, providing vertically aligned and spaced bearings *4*, for said spindle *l*. This frame *3*, provides a vertically elongated upwardly tapered rigid tubular shank *5*, as a rigid part of the frame and upstanding therefrom. This shank *5*, is in longitudinal alignment with the bearings *4*, and the spindle *l*, mounted in said bearings, and said spindle extends upwardly into said shank and is rotatable and longitudinally reciprocatory or slidable in said shank.

The spindle *l*, is preferably yieldingly pressed downwardly by suitable means for the reasons hereinafter explained. For instance, in this example, I show a coiled expansion spring *6*, located in the tubular shank between the upper

end of spindle 1, and the lower end of a screw threaded spring-tension-adjusting bolt 7, longitudinally screw threaded into the shank 5, and having its actuating head 7', exposed and accessible above the shank. By this bolt 7, the longitudinal downward tension of said spring on said slidable rotary spindle, can be adjusted and determined, as hereinafter pointed out.

The frame 3, and parts carried thereby, are applied to and carried by the cutter spindle *d*, of the pantograph machine, when the ordinary cutter is absent from said spindle, by forcing the tapered shank 5, upwardly into the tubular lower end of spindle *d*, the collet or chuck being in open position, to a tight centered position within the spindle *d*, and said shank 5, is then rigidly secured to spindle *d*, by closing adjustment of the collet or chuck with which said spindle *d*, is provided.

Suitable means are provided for causing longitudinal reciprocation of spindle 1, during the rotation thereof, preferably with a substantially predetermined relation between spindle reciprocations and spindle revolutions, as hereinafter explained. For instance, as an example, I show a vertically rotating eccentric cam 8, driven by the belt, such as *f*, that drives the spindle pulley 2. This cam 8, rotates on a normally fixedly located horizontal axis carried, for instance, by rearwardly extending angle bracket 9, rigid with frame 3. This cam operates on the long arm 10, of a vertically swingable rigid lever fulcrumed at 11, to frame 3, with its short arm 12, arranged beside and out of contact with spindle 1, and at its free end having upstanding nose 13, contacting the flat under face of the hub of pulley 2, rigid with spindle 1. The long lever arm 10, is below cam 8, and is normally yieldingly pressed upwardly against the eccentric circumferential portion of the cam by the constant downward pressure of the pulley 2, on the nose 13, of the lever short arm under the constant downward tension of spring 6, on the longitudinally slidable rotary spindle 1.

Suitable means are provided for driving the cam 8, by the belt drive for spindle 1. For example, I show a pair of rotary idler grooved friction belt wheels 14, carried by the frame 3, 9, and mounted on a common axis 15, arranged transversely of and carried by the bracket arm 9, rigidly secured to frame 3, as by bolt 9', if not formed integral therewith. These wheels 14, are arranged under the two lengths of driving belt *f*, respectively, and are so positioned vertically with respect to said belt plies, that said belt bears down on said wheels under the required tension to drive and rotate the wheels without objectionable slip. The cam 8, is, in this example, arranged at the inner side face of one of said wheels 14, and is fixed thereto, see Figs. 3 and 5. This cam is provided, in this instance, with a continuous cylindrical smooth circumferential surface for normally constant engagement with the top surface of lever arm 10.

In the assembled pantograph reducing engraving or like machine that includes my invention, the rotary and longitudinally movable spindle 1, and the cutter spindle *d*, normally held against longitudinal movements, are maintained in longitudinal alinement, in this particular example, by the tapered shank 5, centered and clamped in and to the spindle *d*, in the same manner that the ordinary engraving machine cutter is centered and clamped in spindle *d*, in axial alinement with said last named spindle.

The instant problem required cutting substantially invisible marks in a rear facet of very hard articles, for example, diamonds, with economy, and without marring or otherwise detracting from the value or desirable characteristics of the gems. So far as I am informed, it is not practicable to provide a cutter having a cutting point of the required hardness to directly by its own action cut or engrave the hard gem to produce therein a substantially invisible mark that will not mar the gem. Hence, I have provided a spindle, the point of which is relatively soft, possessing certain critical peculiarities in formation or structure and operation or action, whereby such spindle can be successfully employed in cooperation with a diamond or substantially like cutting agent, such as diamond dust or the like, to successfully produce the result sought. In carrying out my method, this peculiar spindle does not of itself constitute the diamond cutter, but is of such peculiar formation or structure, as to take up particles of the cutting dust or agent and drive the same against the surface of the diamond and thereby gradually wear and cut the same to form therein the permanent mark or the form or design required by the copy traced by the pantograph stylus. The surface of the mark in the diamond, produced by the cutting dust taken up and driven by said spindle, is smooth and polished and is not of a character to mar the beauty of the diamond or other hard gem.

For instance, as one example from among others that can be employed, the spindle 1, at its lower end is ground to a very fine point 1', in accurate alinement with the longitudinal axis of the spindle, and the tip or end extremity 1'', of this point is accurately ground to a round or semi-spherical form to approximately .0025" diameter more or less. In this particular example, the spindle 1, is cylindrical throughout its length to the point, and of approximately .097" diameter. The point 1', is substantially not more than one-tenth of an inch in length and substantially not more than three degrees taper from base to tip.

In this particular example without intending to so limit my invention, the spindle 1, including its point, is composed of a carbon steel drill rod that has been hardened, with water as a quench and drawn to a dark straw color, and thereafter the end of this relatively soft or not too hard rod or spindle is ground to produce the required described point 1', and its rounded tip.

This spindle is of sufficient hardness to render the point sufficiently resilient laterally to slightly spring or yield laterally under lateral pressure without breaking and to constantly tend to return to its normal central alined position. Also, the point 1, of this spindle is of sufficient softness to permit free particles of the diamond or other cutting dust to become more or less firmly lodged or embedded in the point during the longitudinal vibrations of the rotating spindle and be thereby impelled by the rotating and vertically vibrating point against the surface of the hard gem to cut and wear the same to produce the required permanent design or mark therein. If the spindle point is too hard it will break under lateral thrusts and the impact blows of the vertical vibrations and will not permit the cutting dust particles to become imbedded therein or attached thereto and driven thereby.

In the particular example illustrated, without intending to so limit the invention, I have at-

tained satisfactory results, where the spindle 1, performs a complete vertical vibration or reciprocation for every three revolutions of said spindle. Thus, in this particular example, the cam 8, makes one complete revolution for every three revolutions of the spindle rotating pulley 2, as this ratio represents the differences in diameter between the cam driving idler pulley 14, and the spindle rotating pulley 2.

Where the just mentioned ratio between spindle revolutions and spindle vertical vibrations is substantially as above, and the spindle is rotated at approximately 8000 R. P. M., the spindle will be vibrated approximately 2666 times per minute. However, I do not desire to thus limit my invention, although I have most successfully carried out my disclosed invention at these speeds and ratio, in cutting a permanent mark of one substantially invisible letter or design in diamonds in from six to ten minutes per diamond.

High speed rotation and vertical vibrations of the spindle 1, are necessary to the economical successful production of the substantially invisible marks in hard gems, for instance, diamonds, and the successful method requires both the rotary and longitudinal vertical vibratory abrasive actions of the cutting dust particles embedded in and carried and driven by the spindle point 1', on the transverse and lateral upright surfaces of the portion of the diamond being cut.

While the spindle 1, must rotate and vibrate at high speed, yet successful results can be attained at different speeds and ratios between rotary and vibratory speeds than those hereinbefore given. For instance, I have produced satisfactory results where the spindle 1, vibrates substantially once during substantially two spindle revolutions. I also have attained satisfactory results where the spindle is driven at substantially the rate of 6000 R. P. M.

In the peculiar and exacting work for which my invention is designed, the rapid vertical vibrations of the high speed rotating spindle 1, under the control of adjustable spring tension, perform certain important functions, in that the point of the spindle is thereby caused to rapidly strike the facet of the diamond being operated on with sound-producing more or less forceful impacts, with the sound thereby produced varying in tone according to the force of the impacts. These forceful impacts cause embedding of cutting powder particles in the point 1', or adherence thereof thereto, for movement therewith against the diamond surface. The operator as he becomes experienced in carrying on the instant method, soon becomes skilled or adept in detecting the particular tone or character of the sound of these impacts when the cutting operation is properly progressing, and the change in sound when the vertical position of the work with respect to the point 1', is not what it should be or strokes of the pointer with respect to the diamond surface are not proper.

When the sound produced by the impacts of said point is improper, the operator removes the unit including shank 5, from the machine spindle d, and adjusts screw 7, to attain the desired tension of spring 6, on spindle 1, or else, without disturbing the unit that includes shank 5, slightly raises or lowers the work table that carries the diamond. The screw adjustment 7, controlling the spring tension on spindle 1, performs, in effect, a double function, one of which is to keep the nose 13, of lever 10, 12, in operative engagement with spindle pulley 2, and arm 10, in opera-

tive relation to cam 8, and the other, to vary the spring tension against spindle 1, to obtain and maintain the desired correct impact force of point 1', against the diamond being operated on.

In this connection, it is to be noted that when the diamond facet to be worked on is in the correct vertical operating position with respect to the working tip 1'', of the spindle point, said facet stops the downward movement of said tip, to properly receive the impact thereof, before the pulley 2, and lever end 12, reach their normal limits of downward movement as when no diamond or work is present in the downward path of spindle tip 1''. In other words, the surface of the diamond when fixed in position for being cut by the spindle point tip, reduces the length of downward vibration of the spindle, and hence said surface of the diamond interrupts and stops the down moving spindle and receives the full downward thrust and impact of the tip 1'', of the spindle point.

In carrying out my instant method, any suitable means or device is employed to rigidly hold the diamond 20, or other hard gem, in a facet or surface of which the substantially invisible mark is to be cut, with said facet or face horizontally arranged and exposed below the rotary spindle point. The means 21, 22, holding the diamond, is rigidly clamped on the vertically adjustable work table in operative relation to said spindle point. The diamond 20, can be rigidly secured by solder, shellac, or otherwise in a suitable holder 21, which can be placed in a clamp or vise 22, and be secured in proper position on the work table.

When the diamond has been fixed on the work table a, with the diamond facet to be cut, properly located under the spindle point, the operator adjusts the work table a, upwardly to bring the horizontal exposed facet of the diamond to the required elevation with respect to the spindle point tip, Fig. 4, as hereinbefore explained. This initial positioning of the diamond, approximately carries the diamond facet into a horizontal plane that intercepts the vertical downward path of the spindle tip vertical vibrations. As before explained, the proper vertical positioning of the diamond is determined by the operator by the sound of the impacts of the spindle point against the diamond. Where the marks to be cut are substantially invisible, the depth of cut will be only a fraction of a thousandth of an inch, hence the necessity of most accurately determining the necessary vertical adjustment, and the success of the solution of determining proper adjustment by sound. The rotary spindle d, of the pantograph, when combined with my spindle 1, and associated parts, is freely rotatable but is maintained in a normally fixed horizontal plane against vertical movements, and hence the pantograph machine spindle feeds and depth stop mechanism, are not employed where the spindle 1, is used.

Before, or as the cutting operation progresses, any suitable cutting agent is applied to the gem facet being or to be operated on. For instance, I have had satisfactory results with powdered or finely crushed industrial diamonds rendered plastic by the addition of suitable oil. For instance, grade No. 2 diamond dust with enough olive oil added to make a thick paste, or one carat of crushed industrial diamond plus three to forty drops of oil more or less. However, my invention is not so limited.

The flat copy or pattern of the letter or de-

sign, constituting the trade or hall mark to be cut into a series of diamonds one by one, in such miniature reproduction as to be substantially invisible, is clamped down in horizontal form on the pattern table of the pantograph machine. This copy should disclose the trade or hall mark in such large size as to be clearly legible to the pantograph machine operator, and the pantograph of the engraving machine should be adjusted and set to the required quite large reduction ratio to require reproduction of the copy on the work by the machine through spindle 1, in such reduced scale as to be visible substantially only through a magnifying glass or the like. For instance, the diamonds have been successfully provided with such substantially invisible permanent marks, by the use of my instant invention, where the pantograph reduction was 18 to 1, the letter of the copy or pattern fixed on the pattern table was $\frac{3}{4}$ " high, and the resulting letter cut in the diamond was .008" high. Other instances can be referred to where the reduction ratios are different than that above mentioned to permit use of larger, more clearly visible, copy or designs for reduced reproduction in substantially invisible form of the above or different sizes, in the diamonds.

When the small hard gem to be operated on has been properly located and fixed on the machine work table with respect to the point 1' of the spindle, said table is adjusted upwardly to bring the horizontal facet of the gem to a horizontal plane that intercepts the straight vertical line path of movement of the tip of spindle point 1', for instance, merely as an example, to a horizontal plane that is .008", more or less, above the horizontal plane of the normal limit of downward movement of said tip of spindle point 1. Then, during operation of the machine, the operator, by hand manipulation, moves the pantograph stylus in tracing the copy on table b, causing corresponding scaled lateral movements of the machine cutter head c, and spindle 1, and its point 1', with slight lateral movement of said point with respect to the gem and lateral pressure of said point against lateral surfaces of the cut being formed in the gem, all while said point is rotating and vibrating at comparatively high speed. It will be noted from the foregoing explanations, that during the operation of the rotating and vibrating spindle point on the facet of the hard gem located in an elevated horizontal plane to interrupt the downward strokes of said spindle point, the rotating spring-down-pressed spindle point will at each down stroke momentarily be stopped against vertical movement while tightly pressed and rotating against the then stop-forming transverse surface of the gem.

The operator closely watches the operation of the spindle point on the hard gem being cut and can, if so desired, be provided with a magnifying glass for this purpose. By manual control, the operator constantly maintains the surface of the gem being operated on at the proper vertical elevation with respect to the tip of the spindle point to attain the desired results. These adjustments are often substantially less than a thousandth of an inch, and hence measuring and scale means are useless where quick correcting adjustments are required. I have discovered that the experienced operator can quickly make correcting adjustments to bring the facet of the diamond being operated on into the proper vertical location with respect to the spindle pointer,

by reason of his skill and experience in the observation of the action of the spindle pointer on the diamond and his familiarity with the tone or characteristic of the sound generated by the impacts of the pointer on the diamond when the diamond is in the proper vertical adjustment so that when the sound is off-tone, the operator is thereby advised to make the necessary correcting adjustment.

The advantages attained by providing a machine of the pantograph reducing reproduction type, capable of reproducing copy with uniformity on hard gems, for example, diamonds, in such small size as to be substantially invisible, with comparative speed and economy, will be readily appreciated. In so far as I am informed, I am the first to provide such an organization. The merchant or producer of cut hard gems, for example, diamonds, can, by the use of such pantograph machine, with comparative speed and economy, apply his hall or trade mark in non-objectionable substantially invisible size and with uniformity to any number of gems, one by one, in accurate scaled reproduction of the one copy.

The pantograph machine, herein referred to, for cutting in the work reduced reproductions of the copy, is provided with a vertically adjustable support or knee for the work table a, actuated and controlled by accurate vertical feed means, in this example, represented by and propelled by the manually actuated handle k.

While the particular embodiment of my invention disclosed as one example, is in the form of an accessory for removable attachment to the pantograph engraving machine of the general type disclosed in the place of the usual engraving cutter, it will be understood that the pantograph copy reproducing machine of the required type or types, can include an embodiment of the essential characteristics of my said invention built therein as a more or less permanent part thereof, to function substantially as hereinbefore described on articles, for example, diamonds.

Where my invention is embodied in the form of an accessory for removable attachment to the pantograph machine, it is, in this example, capable of easy and quick application to and removal from the machine, as a unit, for driving by the machine belt drive, or by a separate belt drive and its small motor, or otherwise, in either event, the machine cutter spindle not being driven by its own belt drive.

The foregoing disclosure is for purposes of explanation of an example embodiment, and not for purposes of limitation, as various possible modifications, changes, omissions, and substitutions fall within the scope of the following claims.

What I claim is:

1. The art of reproducing copy in hard gems, for example diamonds, in reduced, substantially microscopic size; that comprises cutting the substantially microscopic copy reproduction in a hard gem surface by the cooperating action between particles of hard cutting powder on said surface and a substantially microscopic tip of a rapidly and unidirectionally rotating, laterally cutting spindle point periodically vibrating longitudinally to impart impacting blows against said surface and the powder thereon, manually controlling the relative positioning between the gem surface and said point to maintain said surface in position to receive said blows, and manually controlling and propelling said spindle laterally

pantographically with respect to the gem surface being cut.

2. The art of reproducing relatively large copy in hard gems, for example diamonds, in size visible substantially only through a magnifying glass or the like; that comprises cutting the substantially microscopic copy reproduction in the hard gem surface by the cooperating action of the substantially microscopic approximately smooth-surfaced tip of a rapidly and unidirectionally rotating spindle point with fine particles of hard cutting powder, such as diamond dust, on the gem surface; periodically projecting said rotating spindle forcibly longitudinally to project said tip with force against said gem surface and powder particles thereon; manually controlling the operative relative positioning between the gem surface and said point tip to maintain said surface within the striking range of said tip, and manually controlling and propelling said rotating vibratory spindle laterally with respect to said surface of the gem for lateral cutting thereof.

3. The art of reproducing copy in hard gems, for example diamonds, in reduced, substantially microscopic size; that comprises cutting the substantially microscopic copy reproduction in the hard gem surface by the cooperating action of particles of a hard cutting powder on said surface, with the non-cutting substantially microscopic tip of a rapidly and unidirectionally rotating spindle point periodically vibrated longitudinally to strike the gem surface and particles thereon; maintaining substantially the entire spindle-tip, end surface, which surface is perpendicular to the spindle axis, against the gem while the spindle and surface and the gem are in contact; and manually, during the cutting of the gem, controlling the relative vertical positioning between the gem surface and said point tip to maintain said surface at a plane intercepting the longitudinal straight-line path of spindle point tip movements.

4. The art of reproducing copy in hard gems, for example diamonds, in reduced, substantially microscopic size; comprising cutting the substantially microscopic copy reproduction in a hard gem surface by the cooperating action of particles of hard cutting powder on the gem surface with the non-cutting surface of a substantially microscopic tip of a rapidly and unidirectionally rotating spindle point, periodically and forcibly spring pressed longitudinally to strike said tip against the gem surface and powder thereon, manually controlling the relative positioning between the gem surface and said point to maintain said surface at a plane intercepting the longitudinal straight-line path of movements of said rotating spindle point, and producing lateral cutting of the gem surface by manually controlling and propelling said rotating vibratory spindle and its point bodily and laterally with respect to the gem surface being cut.

5. In the method of reproducing copy in hard gems, for example diamonds, in reduced, substantially microscopic size, those steps comprising cutting the substantially microscopic copy reproduction in the hard gem surface by the cooperating action between hard cutting powder particles on the gem surface and the surface of a substantially microscopic tip of a rapidly and unidirectionally rotating spindle point, said point tip being relatively soft with respect to said powder particles and the gem surface to take up and propel such particles, manually control-

ling the relative vertical positioning between said gem surface and said tip to maintain the same in operative gem cutting relation, and producing lateral cutting by manually propelling said spindle and its point laterally with respect to said surface of said gem and controlling the lateral positioning thereof.

6. In the method of reproducing copy in hard gems, for example diamonds, in reduced, substantially microscopic size, those steps which comprise cutting the substantially microscopic reproduction in a hard gem surface by the cooperating action between the particles of a hard cutting powder on the gem surface and the surface of a substantially microscopic tip of a rapidly and unidirectionally rotating spindle point vibrating longitudinally to and from the gem surface, said tip surface being relatively soft with respect to the powder and gem surface, manually controlling the relative positioning between the gem surface and said tip to maintain the operative relation between the tip and gem surface, and producing lateral cutting by manually and pantographically controlling the lateral positioning of the spindle and its point with respect to the gem.

7. In the method of reproducing copy in hard gems, for example diamonds, in reduced, substantially microscopic size, those steps which comprise cutting the substantially microscopic reproduction in a hard gem surface by the cooperating action of the particles of a hard cutting powder on the gem surface with the surface of a substantially microscopic tip of a rapidly and unidirectionally rotating spindle, said tip surface being relatively soft with respect to the powder and gem surface, and manually, and during the cutting of the gem controlling the relative positioning between the gem surface and said tip to maintain the operative relation between the tip and gem surface.

8. In the method of reproducing copy in hard gems, for instance diamonds, in reduced, substantially minute size, those steps including locating and manually maintaining the gem with a facet in operative relation to the substantially minute tip of the point of a rapidly and unidirectionally rotating spindle; supplying said gem facet with fine particles of hard cutting dust; periodically impelling said rotating spindle in a predetermined ratio to spindle revolutions, longitudinally to impact forcibly said tip against said gem facet and cutting dust thereon with an audible sound generating stroke, and momentarily maintaining the rotating tip against said facet and the dust particles after each such stroke; and cutting the substantially minute reproduction in said gem facet by the cooperating action of said dust particles with said rotating tip and the dust particles impelled by said rotating tip against the gem surface, and controlling the distance through which the spindle is impelled by the sound generated by the stroke.

9. In a pantograph machine for reproducing copy in reduced size in work, wherein the cutter head and its vertical rotary cutter spindle are moved laterally in a normally fixed plane by the manually actuated pantograph mechanism in tracing the work; a unidirectionally rotary driven spindle axially aligned with and depending from and carried laterally with said cutter spindle and longitudinally reciprocatory with respect to said cutter spindle, and provided with an aligned fine short laterally-resilient depending point having a minute tip of a character to grind fine particles

of a hard cutting dust against the hard surface to be cut; means for rotating said pointed spindle at substantially high speed; and means for periodically and forcibly projecting said rotating spindle to carry its tip against the surface being cut and the dust thereon with an impacting blow, and for thereafter momentarily holding said rotating tip pressed against said surface and dust particles.

10. In a pantograph machine for reproducing copy in reduced size on work and having a cutter head controlled and impelled in its lateral movements by the pantograph; a unidirectionally rotary and longitudinally vibratory spindle carried by and movable laterally with said head, and having a longitudinally alined metal point with a minute tip, characterized by its capacity to grind particles of cutting powder and thereby to cut minute marks in hard gems, for instance, diamonds; means for rotating said spindle at substantially high speed; and means for longitudinally vibrating said rotating spindle at a predetermined ratio of spindle vibrations to spindle revolutions for projecting said tip against the gem and the powder thereon.

11. Means for cutting substantially invisible reduced reproductions of copy in gems, for example, diamonds, when operatively associated with the cutter head and its rotary cutter spindle of a pantograph machine for reduced reproduction of copy in the work, where said cutter head is controlled and propelled in its lateral movements by the pantograph stylus in tracing the copy; said means including a spindle longitudinally alined and rotatable with said cutter head spindle, said spindle being longitudinally vibratable, and having a longitudinally alined point with a minute tip to grind particles of hard cutting powder against the diamond or other hard surface being cut; means for rapidly and unidirectionally rotating said spindle; and means for longitudinally vibrating said rotating spindle including mechanism for propelling said spindle downwardly to strike the pointer tip thereof with impacting force against the gem surface and powder thereon, and for momentarily holding the rotating pointer tip against the same.

12. An accessory for removable attachment to and operative association with the rotary cutter spindle of a pantograph reducing machine in

place of the engraving cutter usually clamped by the chuck of said cutter spindle, where said cutter-spindle is moved laterally in a fixed plane by the pantograph mechanism as the pantograph stylus traces the copy to be reproduced in scaled relation in the work; said accessory including a frame having a rigid shank for clamping to said cutter spindle, a rotary spindle mounted and longitudinally vibratable in said frame and provided with a fine, short, laterally resistant point having a minute tip of a character to grind fine particles of a cutting powder against a hard gem surface for cutting therein the copy reproduction in microscopic size; means for rotating said vibratory spindle; and means for periodically propelling said spindle longitudinally.

13. A machine for cutting minute designs in the surface of a gem, said machine comprising a rotatable tool having a minute laterally resistant point, pantograph means for moving said point in a path which makes a minute design corresponding to a predetermined large design, and means for unidirectionally rotating said tool at a high speed, and means for impelling said tool axially and with a predetermined frequency while rotating.

14. A method of cutting a minute design in the surface of a gem comprising grinding a hard powder between the gem and the minute end surface and the lateral surface of a laterally resistant tool while constantly rotating the tool unidirectionally and at high speed, so utilizing all of the end surface which is perpendicular to the axis of rotation, pantographically moving said tool laterally with respect to that axis and in a path over a minute area, and simultaneously reciprocating said tool in an axial direction.

15. A method of cutting a minute design in the surface of a gem comprising grinding a hard powder between the gem and the minute end surface and the lateral surface of a laterally resistant tool while constantly rotating the tool unidirectionally and at high speed, so utilizing all of the end surface which is perpendicular to the axis of rotation, and pantographically moving said tool laterally with respect to that axis and in a path over a minute area, and manually controlling the position of the tool along the axis thereof during the cutting of the gem.

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