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THERMALLY TREATING PRECIOUS AND SEMIPRECIOUS STONES

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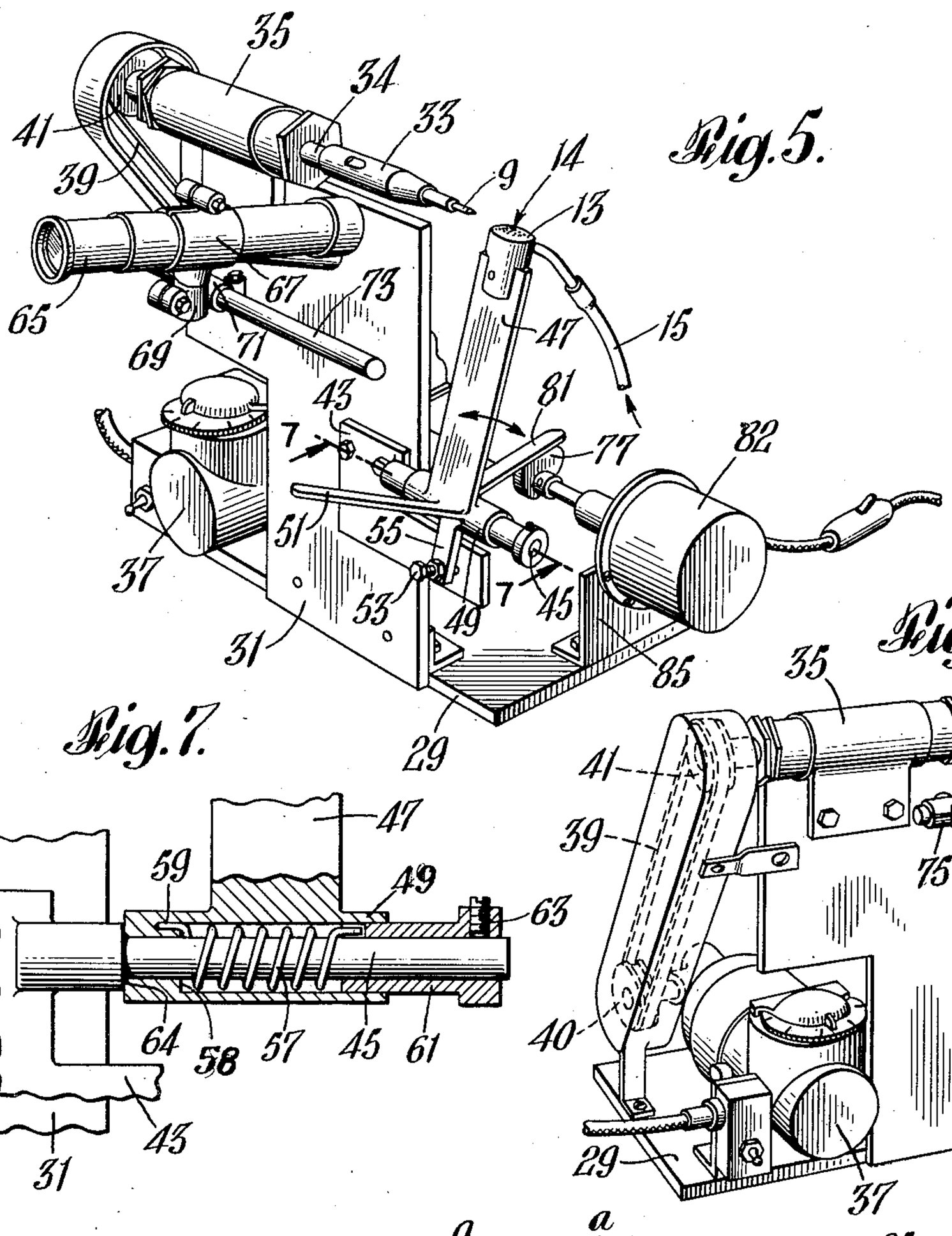

Fig. 5.

Fig. 7.

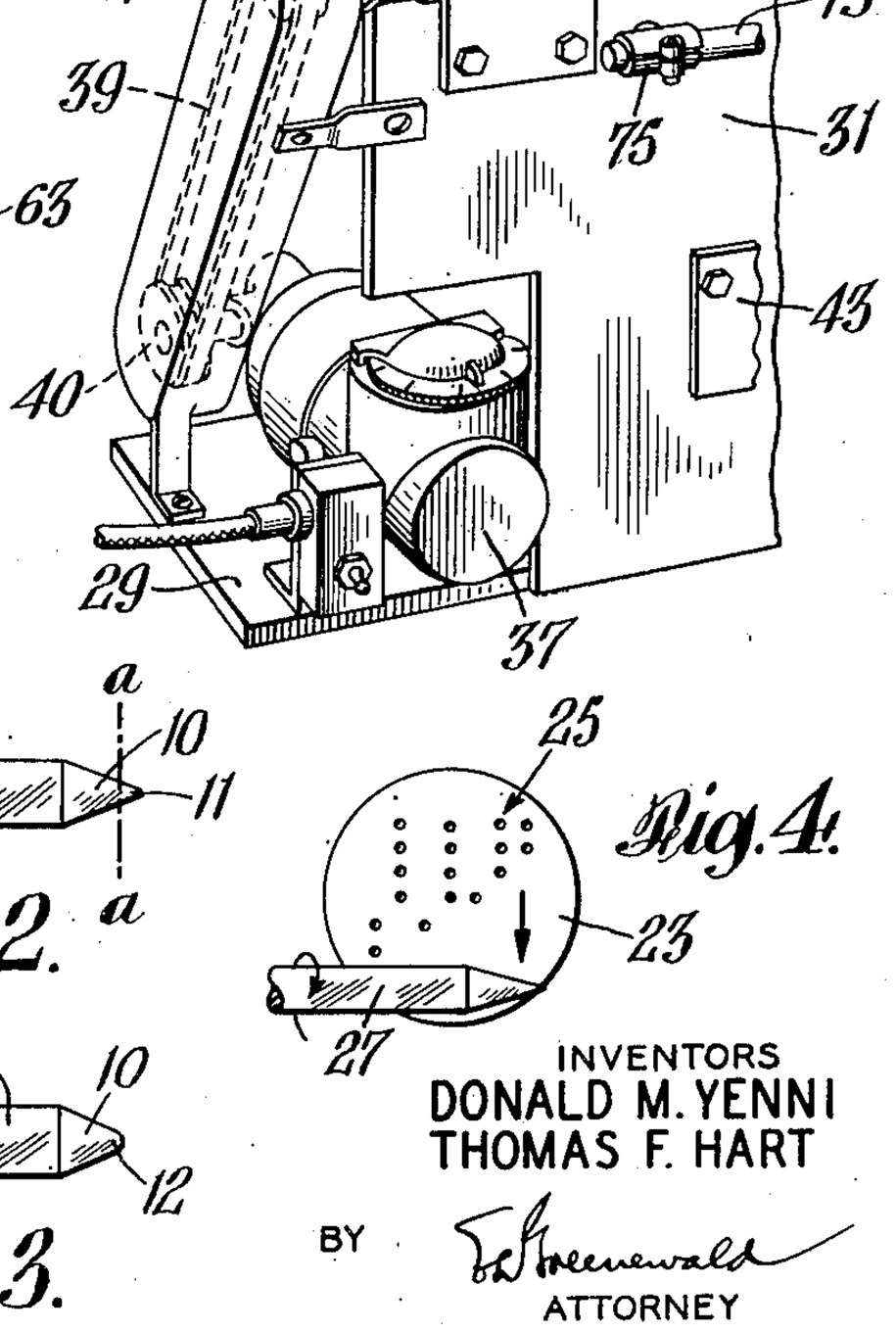

Fig. 6.

Fig. 1.

Fig. 2.

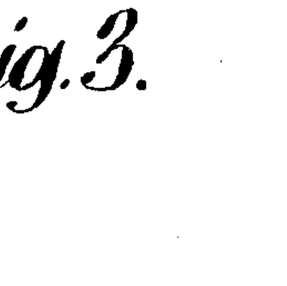

Fig. 3.

Fig. 4.

INVENTORS
DONALD M. YENNI
THOMAS F. HART

BY F. C. Greenewald
ATTORNEY

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THERMALLY TREATING PRECIOUS AND SEMIPRECIOUS STONES

Donald M. Yenni and Thomas F. Hart, Kenmore, N. Y., assignors to The Linde Air Products Company, a corporation of Ohio

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5 Claims. (Cl. 49—77)

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This invention relates to a method for flame shaping or otherwise heating non-combustible precious and semi-precious stones, such as unicrystalline thin rods of natural or synthetic spinel and corundum, e. g., ruby or sapphire. More particularly, the invention concerns a novel method for thermally rounding the pointed end of a stylus-like article, such as a phonograph needle or pivot of corundum or spinel. Furthermore, the invention relates to novel apparatus for carrying out the novel method. Part of the invention described in the present application was originally disclosed in our application Serial No. 567,952, filed December 13, 1944, now abandoned, for improvements in "Thermally Working Precious and Semi-Precious Stones," of which the present application is a continuation-in-part.

For many years it has been customary to shape articles of hard precious and semi-precious stones, such as corundum and spinel, by mechanical abrading procedures employing such hard abrasives as diamond powder. Such procedures are slow, tedious, and expensive. Moreover, they produce minute scratches which tend to reduce the strength of the products, increase their coefficients of friction, and affect their appearance to some extent. Recently it has been found that such hard stones as corundum and spinel can be worked thermally with a flame, but the capabilities of the new thermal method have not yet been fully explored. For instance, the process of flame shaping a stylus with a single flame disclosed in application Serial No. 567,952 is not completely satisfactory when the diameter of the stylus is greater than $\frac{1}{16}$ inch and the included angle of the tapered part of the stylus is less than 40° because the material at the point tends to be drawn toward the base of the tapered part, thus leaving a tip which is too long and fragile for many uses. Also, in flame polishing a rod of corundum or spinel it is difficult to carry the polish to the end of the rod without excessively rounding the end.

The principal object of the present invention is to provide a novel process for thermally working a body of precious or semi-precious stone material in such a way that the shape of the end of the body can be accurately controlled. Another object is to provide such a process for thermally rounding the pointed end of a stylus-like article of precious or semi-precious stone material. Another object is to provide such a process which can be operated with satisfactory results even when the diameter of a stylus is greater than $\frac{1}{16}$ inch and the included angle of its point is less than 40°. Other objects are to provide such a

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thermal process which can be performed by a person not having exceptionally great skill in the art of gem stone working; and which can be mechanized so as substantially to eliminate human error.

Other objects of the invention are to provide novel apparatus which is suitable for performing the novel thermal shaping process; which is simple and compact in construction; and which permits careful control of the progress of a thermal shaping operation.

The above and other objects, and the novel features of the invention, will become apparent from the following description, having reference to the accompanying drawing, wherein:

Fig. 1 is a plan view showing a burner head in position for shaping a stylus by the process of the invention;

Figs. 2 and 3 are side elevational views showing a part of a stylus before and after flame shaping, respectively;

Fig. 4 is a plan view showing a modified form of burner head in position for shaping a stylus;

Fig. 5 is a perspective view of apparatus for performing the novel process of the invention;

Fig. 6 is a perspective view showing a part of the apparatus, as seen from the left in Fig. 5; and

Fig. 7 is a sectional view taken along the line 7—7 in Fig. 5.

In general, our novel process for heating a thin rod of non-combustible precious or semi-precious stone material, such as corundum or spinel, comprises supporting the rod with at least one end in free space, and rotating the rod about its longitudinal axis while effecting relative translational movement between the rod and a special type of heating flame in a direction across the rod axis. The type of flame required is formed by a plurality of individual small flame jets arranged in a pattern such that during the relative movement different flame jets successively are brought into heating relation with successive peripheral zones on the rod, starting with an initial zone remote from the end of the rod and approaching gradually closer to the end. Control of the shape at the end of the rod is best accomplished by ending the direct heating at a terminal zone closer to the end than the initial zone but spaced slightly from the end of the rod. For example, when flame polishing a corundum rod having a sharp end edge, the end edge will be rounded but little if direct heating is terminated just short of the end of the rod, but the flame polish will extend to the end.

Our novel heating procedure is especially ad-

vantageous for flame shaping and flame polishing a stylus-like article having an end which tapers to an apex. A thin rod **9** of stone material, such as corundum, is first tapered at one end in any suitable way, as by grinding, so that the end has a conical shape, as shown at **10** in Fig. 2. If the end of the rod is tapered to a sharp point, it may be desirable to remove the extreme point before proceeding farther, as better control of the radius of curvature can then be obtained in the subsequent flame shaping step. Then relative movement between the tapered rod and the heating flame is effected across the axis of the rod in such a way that different flame jets from a series of ports successively are brought into heating relation with successive peripheral zones starting with an initial zone remote from the apex **11** of the cone **10** and ending with a terminal zone closer to the apex than the initial zone but just short of the apex, as indicated at *a*—*a* in Fig. 2. The material adjacent to and including the apex **11** is in this way gradually brought to a high temperature, melts, and is drawn by surface tension into a rounded shape of the character indicated at **12** in Fig. 3. It is particularly advantageous for the sizes of the ports to be so graduated that the flame jets have successively smaller heating intensity from the initial zone to the terminal zone.

The special type of flame required for performing the process described above advantageously is provided by a unitary burner head **13** of the type shown in Fig. 1 having a plurality of closely spaced individual flame ports **14** arranged in a series of parallel rows of successively greater length such that each row extends beyond one end of the preceding row and an approximately triangular pattern is formed. A combustible gas, such as an oxy-hydrogen or oxy-natural gas mixture, is supplied to the burner head **11** in any conventional manner, as by a hose **15** leading from any suitable source of supply.

In performing our novel process, the burner head **13** is positioned at one side of and below the longitudinal axis *b*—*b* of the tapered rod **9** in such a position that the side or row **19** of the triangular pattern of ports adjacent to the axis *b*—*b* is inclined diagonally away from the axis in the direction of the rod apex **11**. Care must also be taken that the port **14***a* at the far end of the adjacent side **19** will be spaced slightly from the apex **11** when it reaches the rod so that direct heating will not extend beyond the terminal zone *a*—*a*. Then the rod **9** is rotated on its longitudinal axis in any suitable way while the burner head **13** is moved transversely under the rod in a direction normal to the axis *b*—*b* as indicated by the arrow in Fig. 1. Since the burner head is devoid of flame ports between row **19** and the axis, successive peripheral zones starting on the shank **21** and gradually approaching the apex **11** are heated by the impinging flame jets. When the final flame jet from the end port **14***a* is under the rod **9**, the shank **21** is still being heated by the other flame jets in the triangular pattern. After a brief dwell of the burner in heating position to form a small rounded apex smoothly and continuously joined to the tapered surface **10**, as shown in Fig. 3, the burner is removed from heating position. Withdrawal of the burner from heating position desirably is in the opposite direction from the initial movement into heating position so that flame is successively removed from peripheral zones successively farther from the apex of the stylus.

In the burner head **23**, shown in Fig. 4, a somewhat less regular distribution of flame ports **25** is employed, but the general pattern is still approximately that of a triangle which is positioned with respect to a rod **27** in the same manner as described in connection with Fig. 1. With this alternative type of burner head, the manipulative steps of the process are performed in exactly the same way as described in connection with Fig. **1**.

When using a burner head of the type shown in Figs. 1 and 4, the novel process of the invention can be carried out by manually effecting the relative translational movement between the burner head and the rod. However, for practical commercial operation, it is imperative that this process be mechanized as much as possible so that the speed of production will be high, the cost will be low, and spoilage due to the human element will be eliminated as far as possible. Suitable apparatus for carrying out the process is shown in Figs. 5, 6 and 7.

A base plate **29** carries an upright supporting plate **31** upon the top of which is mounted a rotatable horizontal chuck **33** on the end of a shaft **34** which is journaled in a bearing **35** bolted to the support **31**. Chuck **33** is rotated on its longitudinal axis by an electric motor **37** mounted on the base plate **29** and connected to the shaft **34** by a belt **39** running on sheaves **40** and **41**. Chuck **33** may be of any suitable construction for receiving and holding a rod **9** which is to be flame shaped.

A bracket **43** on the upright support **31** some distance below the chuck **33** carries a horizontal shaft or pivot pin **45** which is parallel to the chuck. An arm **47** has a sleeve **49** at its lower end which fits over pivot pin **45** in such a way that the arm can be pivoted back and forth in a direction across the longitudinal axis of rotation of the chuck **33** in a vertical plane normal to the chuck. For heating the rod **9**, a burner head **13** having a bifurcated lower end is mounted on the top of arm **47** and receives a combustible gas mixture from any suitable source (not shown) through conduit **15**.

Movement of the arm **47** is accomplished by manipulating a handle **51** projecting from the sleeve **49**. The proper position of the burner head **13** under the rod **9** is established by adjusting a stop bolt **53** in a tongue **55** which projects downwardly from the sleeve **49**.

The normal position of the burner head **13** is at one side of the axis of rotation of the chuck **33**, as shown in Fig. 5. Return of the burner head to the normal position upon completion of a flame shaping operation is insured by a resilient coil spring **57** surrounding the pivot pin **45** within the sleeve **49**. One end of spring **57** is secured in a hole in a shoulder **58** on the inner end of sleeve **49**, as at **59**. The other end of coil spring **57** is secured in another hole in a hollow bushing **61** which is fixed to the shaft or pivot pin **45** in any suitable way, as by a set screw **63**, and projects at its inner end within the sleeve **49** to act as a bearing for one end of the sleeve. The inward thrust of the spring **57** is arrested by a shoulder **64** on shaft **45**. With this construction, when the handle **51** is depressed by the operator and the burner head **13** is raised into operating position, the coil spring **57** is wound up. When the pressure of the operator's hand is removed from the handle **51**, upon completion of a flame shaping operation, coil spring **57** urges

the arm 47 back to its original position to remove the flame from the rod 9.

Synthetic corundum rods which are flame shaped into phonograph needles by the method of the invention may have a diameter smaller than $\frac{1}{16}$ of an inch and the radius of curvature desired at the apex of such a phonograph needle may be as small as .0005 inch. Consequently, an optical magnifying device is used to assist the operator in observing carefully, and controlling, the action of the flame. A small telescope 65 is clamped in a sleeve 67 which in turn is adjustably mounted by an upright pivot (not shown) in a second sleeve 69, which in its turn is carried by a third sleeve 71 adjustably mounted for movement lengthwise of chuck 33 on a horizontal rod 73 which is secured by a bracket 75 to the side of the upright support 31. With the construction described, the telescope 65 can be adjusted universally to any selected position for focusing on a workpiece, such as a phonograph needle blank, during the flame shaping operation.

The apparatus described above is manipulated by the handle 51. However, when desired, the burner head 13 can be moved back and forth across the longitudinal axis of the chuck 33 by a motor actuated cam 77 coacting with a cam follower arm 81 on sleeve 49 in such a way that rotation of the cam raises the cam follower 81 until the burner head 13 is in heating position. The cam 77 is so shaped that after a brief dwell of the burner head 13 in its heating position while the cam continues to rotate, further rotation of the cam gradually releases pressure from the cam follower arm 81, and the coil spring 57 urges the burner head 13 back to its normal position at one side of the chuck axis. Cam 77 is rotated by an electric motor 82 supported on an upright bracket 85 which is secured to bed plate 29.

Specific embodiments of the process and apparatus of the invention have been described herein in detail solely to illustrate the principles of the invention. It is to be understood that changes in the mode of operation, and in the construction and relative arrangement of parts of the apparatus can be made by persons skilled in the art within the scope of the invention as defined in the appended claims.

We claim:

1. A process for forming a stylus-like article having a rounded end comprising providing a non-combustible body of precious or semi-precious stone material such as corundum or spinel having a longitudinal axis and a part tapering axially to an apex, supporting said body with said apex in free space, effecting relative movement in a direction across said tapering part between said body and a heating flame comprising a plurality of individual flame jets while rotating said body about said longitudinal axis, during such relative movement impinging different ones of said flame jets successively against successive peripheral zones along said body and said tapering part thereof starting with an initial zone remote from said apex and approaching said apex, and continuing to heat portions of said body preceding said successive peripheral zones by continuing to impinge flame jets against said portions while impinging said different ones of said flame jets against said successive peripheral zones.

2. A process for heating a rod of non-combustible precious or semi-precious stone material such as corundum or spinel adjacent to and including an end thereof which comprises: rotating said rod about its longitudinal axis while effecting relative movement between said rod and a heating flame in a direction across said axis, said flame comprising a plurality of flame jets arranged in an approximately triangular pattern and so positioned that one side of the triangle nearest said rod is inclined away from said rod in the direction of said end.

3. A process for forming a stylus-like article having a rounded end from a non-combustible body of precious or semi-precious stone material such as corundum or spinel having a part tapering to an end, said process comprising: rotating said rod about its longitudinal axis while effecting relative movement between said rod and a heating flame in a direction across said axis, said flame comprising a plurality of flame jets arranged in an approximately triangular pattern and so positioned that one side of the triangle nearest said body is inclined away from said body in the direction of said end toward an apex of said triangle, said relative movement being effected in such a way that the flame jet or jets forming said apex are brought into heating relation with said body on a zone adjacent to but spaced from said end.

4. Flame working apparatus comprising, in combination, a rotatable chuck having a longitudinal axis of rotation; a burner normally positioned at one side of said axis, said burner having a plurality of flame ports arranged in an approximately triangular pattern and so positioned that one side of the triangle nearest said axis is inclined away from said axis and said chuck; and means for effecting relative movement between said burner and said chuck in a direction across said axis in front of said chuck.

5. A process for forming a stylus-like article having a rounded end comprising providing a non-combustible body of precious or semi-precious stone material such as corundum or spinel having a longitudinal axis and a part tapering axially to an end; rotating said body about said longitudinal axis; effecting relative movement between said rotating body and a heating flame in a direction across said axis, said flame comprising a plurality of flame jets arranged in an approximately triangular pattern and so positioned that one side of the triangle nearest said body is inclined away from said body in the direction of said end, said relative movement being effected in such a way that different flame jets impinge successively against successive peripheral zones along said body and said tapering part thereof starting with an initial zone remote from said end and approaching said end.

DONALD M. YENNI.
THOMAS F. HART.

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