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PROCESSES FOR SHARPENING RAZOR BLADES

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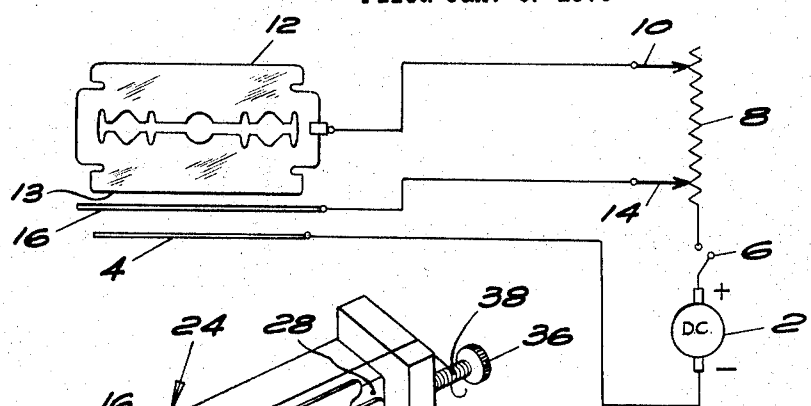

Fig. 1

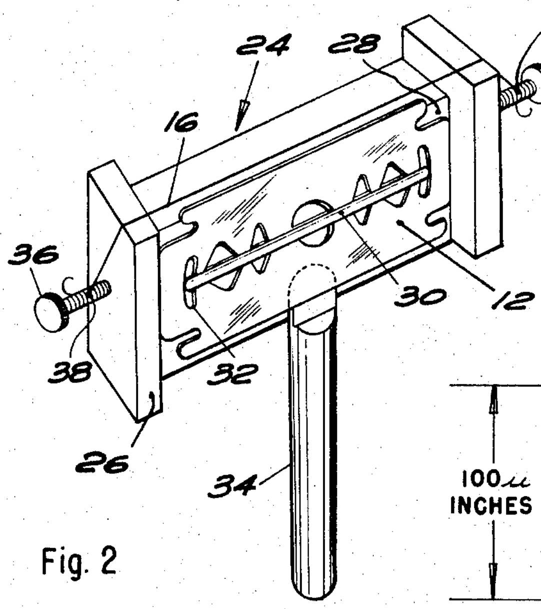

Fig. 2

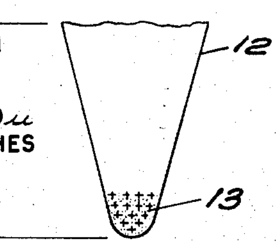

Fig. 3a

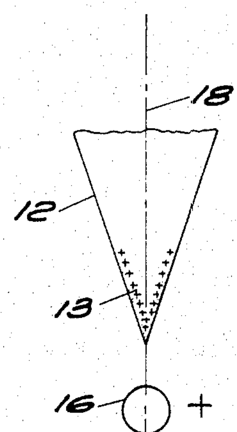

Fig. 3b

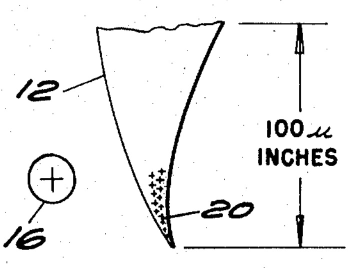

Fig. 4

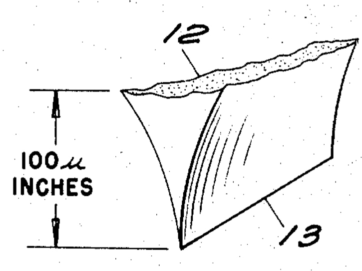

Fig. 5

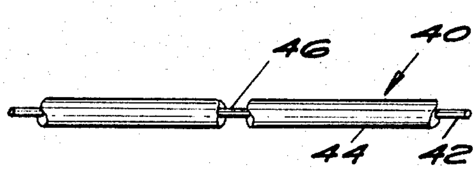

Fig. 6

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PROCESSES FOR SHARPENING RAZOR BLADES

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Continuation-in-part of application Ser. No. 609,862, Jan. 17, 1967. This application Jan. 6, 1970, Ser. No. 1,015

Int. Cl. B23p *1/10*

U.S. Cl. 204—129.55 8 Claims

ABSTRACT OF THE DISCLOSURE

The present invention is concerned with providing improved electrosharpening processes. Generally, the improvements are brought about by positioning an electropositive control electrode adjacent the edge or point being formed. The use of such electrodes enables one to produce sharpened points and edges of especially desirable geometry.

This application is a continuation-in-part of my copending U.S. application, Ser. No. 609,862, filed Jan. 17, 1967, now abandoned.

It is known that objects such as tools, knives, razor blades, needles, electrical contacts, etc. can be sharpened by making such objects the anode in electrolytic baths comprising a cathode and an applied current. Although such processes have provided reasonably good results, the points and sharpened edges produced are often nonuniform and rounded.

The present invention is concerned with providing improvements in such processes whereby more uniform edges and points may be formed and rounding is substantially eliminated. Moreover, the present invention provides processes which are capable of producing concave or hollow-ground edges and points which heretofore could be produced only with considerable difficulty by either electrical or mechanical sharpening methods. Still further, the present invention provides methods for removing nicks, rough spots, burrs, etc. from mechanically sharpened blades without changing the blade angle.

One object of the present invention is to provide improved electrosharpening processes which produce more uniform edges and points.

Another object of the present invention is to provide improved electrosharpening processes in which rounding of the edges and points is substantially eliminated.

Still another object of the present invention is to provide electrosharpening processes which are capable of producing concave or hollow-ground edges and points.

A still further object of the present invention is to provide processes for electrolytically removing burrs, nicks, rough spots, etc. from mechanically sharpened blades without changing the blade angle thereof.

Other objects should be clear from the following description taken together with the accompanying drawings wherein:

FIG. 1 illustrates a circuit for carrying out the processes of the present invention;

FIG. 2 is a perspective view of a blade holder for use in the processes of the present invention;

FIG. 3*a* is a cross-sectional view, normal to the blade edge in exaggeratedly enlarged perspective illustrating the charge density at the ultimate edge of a blade which is being sharpened by a prior art electrosharpening process;

FIG. 3*b* is a cross-sectional view normal to the blade edge in exaggeratedly enlarged perspective illustrating the charge density at the ultimate edge of a blade which is being electrosharpened according to the proceses of the present invention;

FIG. 4 is a cross-sectional view normal to the blade edge illustrating a control electrode positioned adjacent the flank of the electrosharpened rounded-over cutting edge;

FIG. 5 is a view in exaggeratedly enlarged perspective illustrating about the last 100μ inches of a concave blade edge which can be produced by the processes of the present invention; and

FIG. 6 is a perspective view of a point source control electrode for use in the processes of the present invention.

It has been found in the present invention that substantial improvements such as mentioned above may be brought about in electrosharpening processes by positioning an electropositive control electrode in close proximity with the area being sharpened. In the embodiments of this invention which have been found especially useful, the electrode is positioned in such proximity with the area being sharpened as to immediately modify and regulate the charge density in such area without contacting or touching it. Through the use of electrodes in this manner, one is able to selectively regulate the electro-erosion and thereby produce edges and points of especially desirable geometry. The invention has been found especially useful in electrosharpening cutting instruments having elongated cutting edges such as razor blades but it will be readily apparent that it is equally applicable to sharpening other objects such as punches, needles, electrical contacts, etc. The processes of the present invention may be used to form sharpened objects from blanks or they may be used to finish off and improve sharpened objects which have been previously sharpened by other mechanical or electrosharpening processes. It has been found especially useful for the latter.

Usually in carrying out the processes of the present invention, an electrolytic bath comprising a suitable electrolyte is prepared and a circuit such as illustrated in FIG. 1 is made up. In general, the circuit includes a source of D.C. electrical power **2** which is connected through its negative pole to an elongated cathode **4** which is immersed in the electrolyte (not shown). At its positive pole, the source of power **2** is connected through a switch **6** to a variable resistor **8**. A first lead **10** from the resistor **8** is connected to a blade or blade blank **12** whose edge **13** is immersed in the electrolyte for about an ⅛ inch. The immersed blade edge **13** is positioned about ½ inch from the cathode **4** but this distance may be varied to suit particular needs. A second lead **14** from the resistor **8** is connected to an elongated electropositive control electrode **16** which is immersed in the electrolyte, intermediate the cathode **4** and he blade edge **13**. In preferred embodiments, the control electrode **16** is connected to the variable resistor **8** in a manner such that it will be at least as electropositive as the blade or blade blank **12**. Generally, the distance between the control electrode **16** and the immered blade edge **13** will be such that the control electrode **16** will be positioned so as to be able to immediately or directly affect the charge density in the blade edge **13**. As can be appreciated, the particular distance will vary depending upon factors such as the power employed. It has been found that when a current density of about 5 to 20 amps per square cn. is employed, good results may be obtained by positioning the control electrodes **16** about 0.01 to 0.05 inch from the edge or point being formed.

The positioning of the control electrode **16** relative to the edge or point being formed may also be varied depending upon the particular edge or point geometry desired. In especially useful embodiments, the control electrode is positioned adjacent the apex of the edge or point being formed. FIG. 3*b*, which is a cross-sectional view normal to the edge, illustrates one such embodiment.

As can be noted, the electrode **16** is positioned with its length along the apex in a manner such that a plane **18** equidistant from and parallel to the flat surfaces of the blade **12** will pass through the electrode **16** along its length. The positioning of the electrode **16** in this manner causes the current to be more evenly distributed along the surfaces of the edge being formed and prevents it from building up in the tip, as illustrated in FIG. 3*a*, which causes rounding. By means, of this embodiment, the production of blades having edge radii of less than 10μ inches is made possible. The positioning of the electrode in this manner also permits one to remove burrs, nicks, etc. from mechanically sharpened blades without changing the blade angle.

A different positioning of the control electrode **16** relative to the blade edge is illustrated in FIG. 4. As shown therein, the electrode is positioned with its length adjacent to the flank or side of the edge being formed so as to produce a rolled-over edge **20**. As can be noted, the electrode **16** is positioned along the flank or side opposite to the one in which it is desired to form the rolled edge **20**. Positioning the electrode **16** in this manner promotes the build up of current density on the opposite side and brings about the formation of the rolled edge **20** on such side.

Although FIGS. 3*a* and 4 illustrate only two modes of positioning the control electrode, it should be clear that it can be positioned in any number of positions adjacent the edges or points being formed so as to control the electroerosion rates in predetermined areas and thereby produce sharpened edges and points of any desired geometry. As can be appreciated, when desired, more than one electrode may be employed at one time to achieve the desired geometry.

The electrolytes for use in the processes of the present invention may be selected from any of those which have been found useful in the electropolishing or electrosharpening art. As examples of useful solutions, mention may be made of (A) a 50–50, by volume, solution of concentrated nitric acid and acetic anhydride, (B) a concentrated phosphoric acid solution which is saturated with chromium trioxide and (C) a solution containing by volume 50% ethanol, 40% concentrated phosphoric acid and 10% concentrated hydrochloric acid. Especially useful results were obtained using a chromium trioxide saturated solution of 20% concentrated sulfuric acid and 80% concentrated phosphoric acid. In general, it was found that the temperature of the electrolyte could be varied to suit particular needs. Quite satisfactory results were obtained by running the process at 20° C. and using a cooling coil to maintain the temperature constant.

Generally, the steels which are used in the electrosharpening processes of the present invention should be free from carbides and impurities which are not electroerosible. Satisfactory results have been obtained using 18–8 stainless steels and 6.25 Cr-0.88% C steels which have been heat treated to dissolve the carbides.

In carrying out the processes on individual blades, the blade **12** may be held in a blade holder **24**, such as shown in FIG. 2. In general, the blade holder **24** includes a base portion **26** which is formed from a non-conductive, inert material such as Teflon. Within the base portion **26**, there is provided an elongated channel **28** which is adapted to receive a blade or blade blank **12**. The blade **12** is properly positioned within the channel by an elongated projection **30** which is adapted to extend into the elongated slot **32** of the blade **12**. When the blade is positioned in the channel **28**, a portion of it will contact the conductor **34** which is attached to the channel **28** and serves as a connector for tying the blade **12** into the circuit. In each of the end walls there is positioned a screw member **36** having an orifice **38** therein. The orifices **38** are adapted to receive the ends of the control electrode **16** which extends from one side of the holder **24** to the other along and just above the edge of the blade **12**. During use, one of the screw members **36** may be used as a connector to tie the control electrode **16** into the circuit.

Generally, a length of narrow wire will serve as an elongated control electrode. The wire may be of ordinary stainless steel if replacing it is not a problem. Otherwise, it should be formed from platinum. Usually, the diameter of the wire may be varied. Best results have been obtained in electrosharpening razor blades using a platinum wire having a diameter of 0.01 inch.

FIG. 6 illustrates a point source control electrode **40** which is especially useful in sharpening points such as on needles, electrical contacts, etc. In general, the electrode **40** comprises a piece of wire **42** covered by a thick insulating jacket **44** and having a small bared portion **46**. When the bared portion **46** is positioned for example just above the apex of the point being formed, rounding can be substantially reduced.

In carrying out the processes of the present invention, the electropositiveness of the control electrode may be varied to achieve the particular geometry desired, e.g. concave edges, ultimate edge angle, etc. In preferred embodiments, as pointed out above, the control electrode is made at least as electropositive as the edge or point being formed. In especially useful embodiments, the control electrode is more electropositive. When the control electrode is positioned at the apex and it is made more electropositive than the point or edge being formed, the electroerosion along the sides of the edges and points is increased and concave edges and points are formed. A blade having a concave edge is illustrated in FIG. 5. Up until now, it has been difficult to produce such edges with the best available mechanical or electrical sharpening processes.

Particularly good results have been obtained using a current density of about 5 to 20 amps/cm.^{2} at 50 to 100 volts between the cathode and blade edge. Under such conditions, the time necessary to sharpen a blade from a blank will vary depending on factors such as the thickness of the blank, the electrolyte employed, the distance between the cathode and blade edge, etc. Generally, using a stainless steel blank having a thickness of about 0.004 inch, sharpening will be accomplished in about 100 to 140 seconds. If it is desirable to use the process to finish previously sharpened blades, this can usually be accomplished in about 1.4 seconds. For any particular system, instruments such as the electron microscope may be used to determine the optimum process time.

The following nonlimiting example illustrates the processes of the present invention.

EXAMPLE I

An electrolytic bath consisting of concentrated phosphoric acid saturated with CrO_3 was prepared and the edge of a 0.004 inch thick blade blank of 17 Cr-7 Ni, cold rolled stainless steel was immersed into it for about an ⅛ inch. The blank was connected through a 7 ohm resistor to the positive pole of a D.C. power source. A control electrode was connected directly to the positive pole of the power source and positioned in the electrolyte about 0.03 inch from the edge of the blank in a manner such that it would lie along the apex of the sharpened edge which was to be formed. A cathode consisting of a circular stainless steel disk about 1½ inches in diameter was connected to the negative pole of the power source and placed in the bath about a ¼ of an inch from the control electrode. The cathode was positioned in a manner such that its flat surface was perpendicular to and bisected by a plane which was equidistant from and parallel to the flat surfaces of the blank. The blank was electrosharpened for 120 seconds at 50 volts and 5 amps to provide a sharpened edge having a concave configuration over the last 15μ inch.

Although the present invention was described above in terms of a noncontinuous process, it should be apparent that it is readily adaptable to a continuous process by using a continuous strip of razor blade steel and passing it through an extended zone comprising an electrolyte, an elongated control electrode and the cathode.

Having thus described my invention, what is claimed is:

1. In a process of forming an elongated cutting edge on a cutting instrument by electrosharpening wherein the cutting instrument is the anode in an electrolytic bath comprising an electrolyte, a cathode and an applied D.C. current, the improvement characterized by positioning an elongated, narrow wire electropositive control electrode with its length adjacent and parallel to the elongated cutting edge being formed, said control electrode being at least as electropositive as the cutting instrument and being in such proximity with said edge being formed, without touching said edge, as to immediately modify and regulate the charge density in said edge.

2. A process as defined in claim **1** wherein said control electrode is more electropositive than the cutting instrument.

3. A process as defined in claim **1** wherein the elongated electropositive control electrode is positioned along the flank of the cutting edge being formed to provide a rolled-over edge.

4. A process as defined in claim **3** wherein the control electrode is more electropositive than the cutting instrument.

5. A process as defined in claim **1** wherein the control electrode is positioned along the apex of the cutting edge being formed, intermediate the cathode and said apex.

6. A process as defined in claim **5** wherein said control electrode is more electropositive than the cutting instrument.

7. In a process of electrosharpening razor blades wherein the blade to be sharpened is the anode in an electrolytic bath comprising an electrolyte, a cathode and an applied D.C. current, the improvement characterized by positioning an elongated, narrow wire electropositive control electrode along the apex of the edge being formed so that a plane equidistant to and parallel to the flat surfaces of the blade will pass through the length of said electrode, said electrode being at least as electropositive as the blade and being in such proximity with said edge being formed, without touching said edge, as to immediately modify and regulate the charge density in said edge.

8. A process as defined in claim **7** wherein said control electrode is more electropositive than said blade so as to produce a concave edge.

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U.S. Cl. X.R.

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