Sept. 18, 1945. E. W. ENGLE 2,385,198

METHOD FOR FORMING DRAWING HOLES IN CARBIDE DIE NIBS

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Fig. 1.

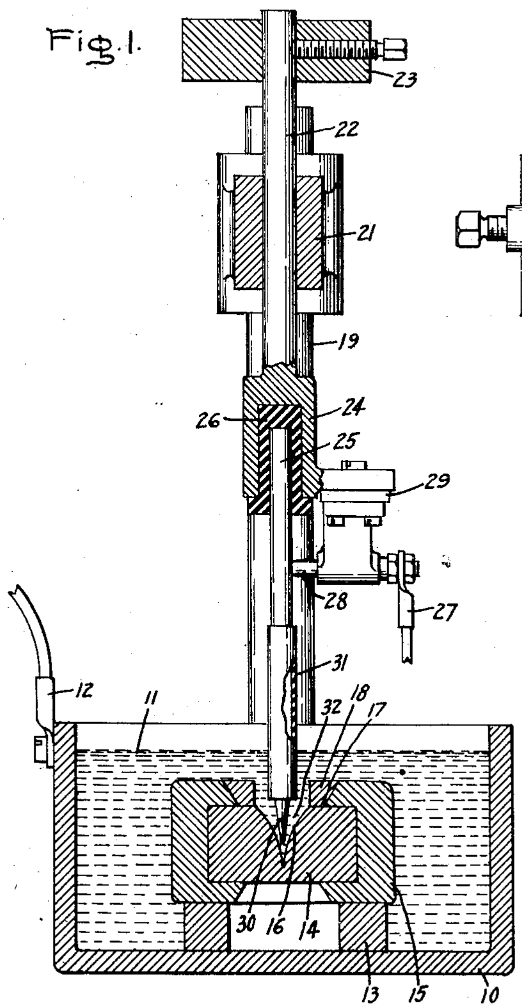

Fig. 2.

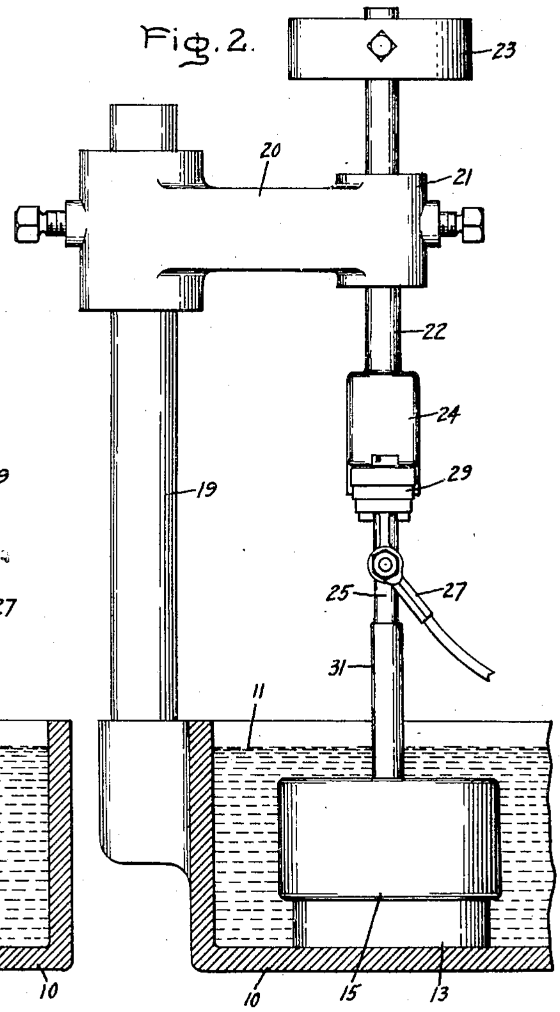

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Fig. 8.

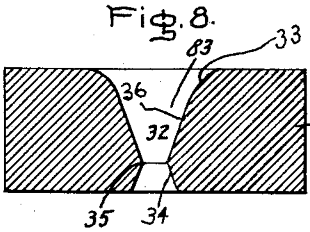

Fig. 7.

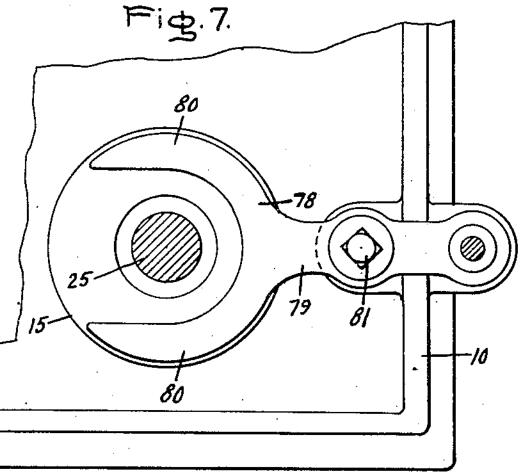

Fig. 6.

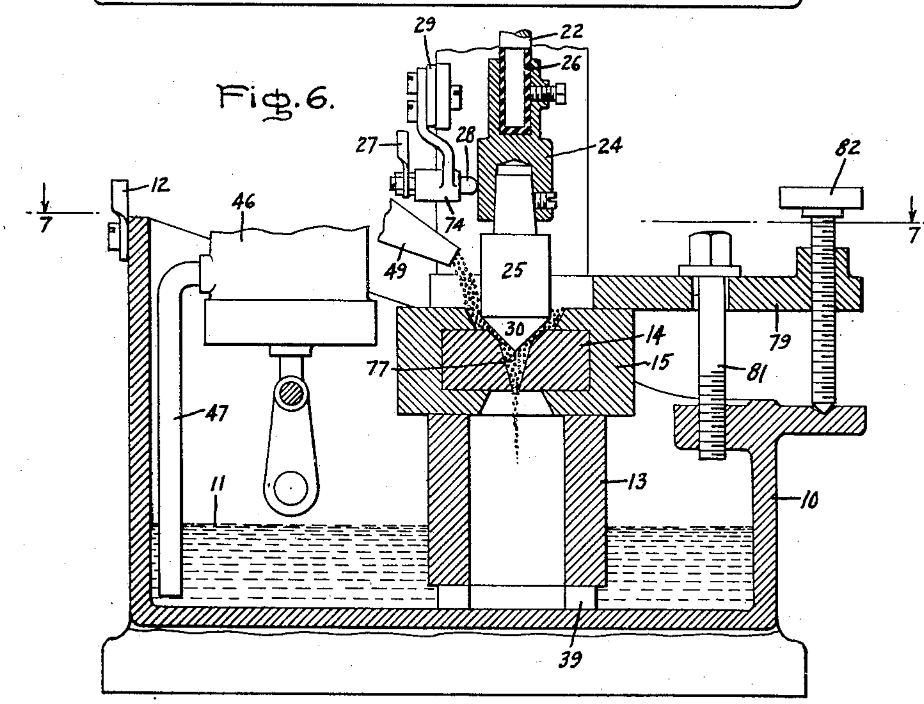

Fig. 3.

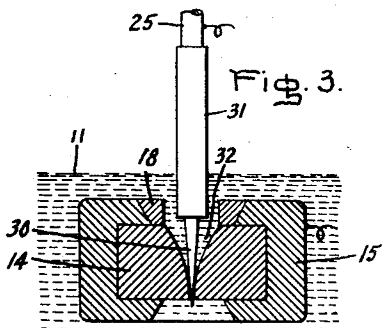

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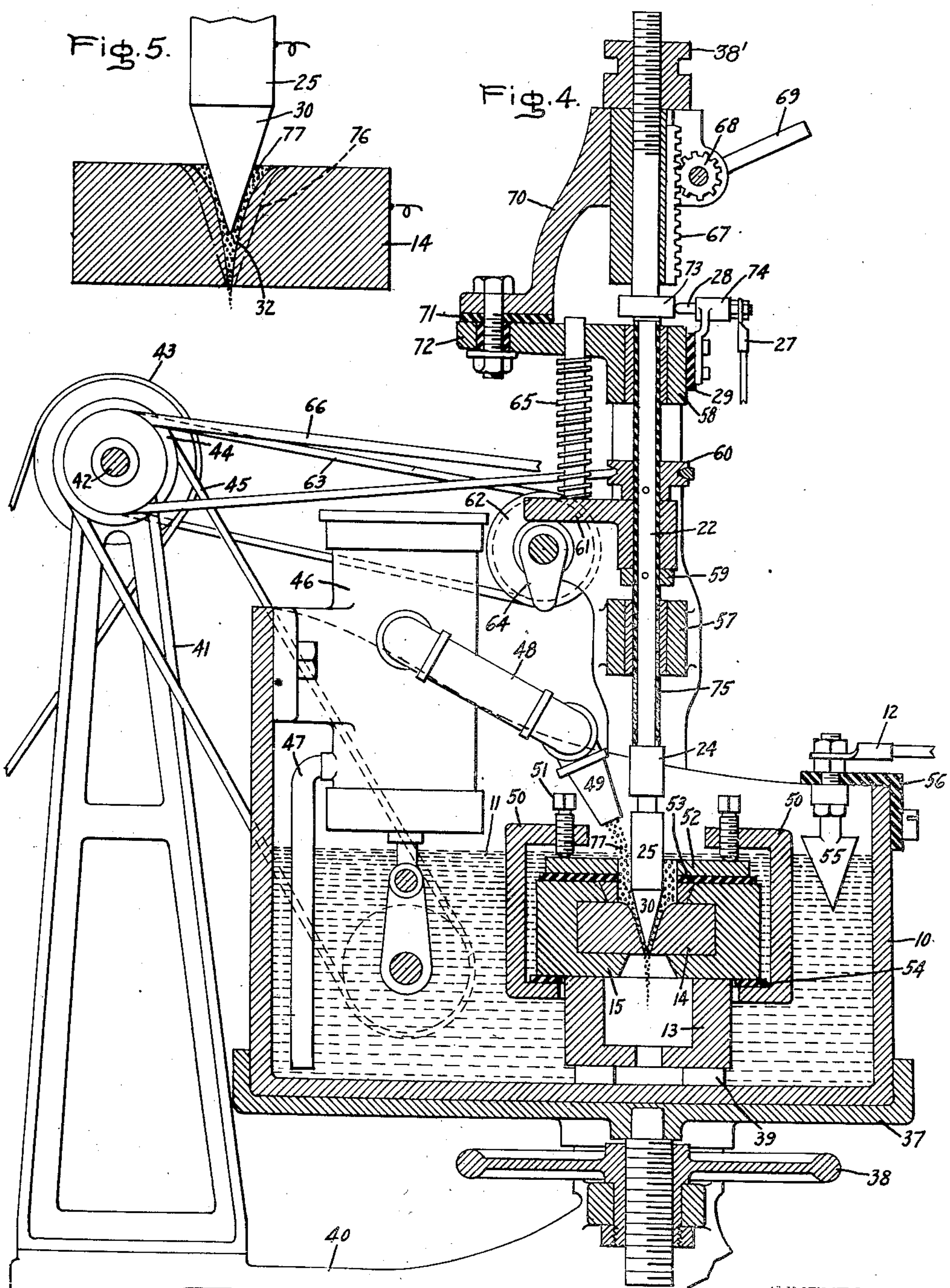
Fig. 5.

Fig. 4.



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2,385,198

METHOD FOR FORMING DRAWING HOLES IN CARBIDE DIE NIBS

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Application February 6, 1942, Serial No. 429,796

9 Claims. (Cl. 204—130)

The present invention relates to a method of and apparatus for forming drawing holes in refractory material such as die nibs. More particularly the invention relates to the making of such holes by removal of material from nibs of hard, metallic, electrically conducting materials, for example, the sintered material known as cemented carbide and described and claimed in Schroter Reissue Patent No. 17,624, March 18, 1930, which by way of example consists of tungsten carbide cemented with cobalt.

In accordance with common practices of the trade die nibs may be made in "blank" or "molded" form. A so-called "blank" nib may be a substantially solid, preferably cylindrical, block of nib material having in one end thereof either a small shallow depression or a flared conical recess extending from about two-thirds to three-quarters through the nib substantially axially thereof. A so-called "molded" nib has a flared passage extending completely through the nib substantially axially thereof. Such nibs are usually encased in materials of high tensile strength such as steel to reinforce them so that they will withstand the forces set up in metal drawing operations. The drawing holes prior to the present invention were usually "formed" in nibs by abrasive action, preferably either with the use of laps having particles of abrasive material distributed in or held on the surface of a suitable binding material, or by other broaching means with the use of free particles of abrasive. When referring to the drawing hole of a nib the word "form" is used herein in the sense of making an initial hole or passage in a blank nib, or shaping or changing the shape of a hole or passage in a molded or a previously finished nib.

Cemented hard metal carbides are characterized by very great hardness and resistance to abrasion. Consequently, the mechanical abrasive methods heretofore employed for forming the passage in die nibs of that character have been somewhat slow and expensive.

A general object of the present invention is the provision of an effective and efficient method of forming drawing holes in hard metal, electrically conducting die nibs which method may be readily carried out in a relatively short time and without the use of excessively costly apparatus and materials. A further object of my invention is the provision of readily made apparatus of simple construction which is capable of efficient and simple use in the practice of the method and which avoids rapid destructive wear of such apparatus.

More specific objects of the invention are the provision of an electrolytic method of efficiently and relatively rapidly removing nib material progressively to form a drawing hole in a simple and inexpensive manner characterized by the use of the nib as an anode, a broach or needle as a cathode, and an inexpensive electrolyte of a type which will not unduly attack the hole-forming means and associated structure and which will permit efficient practice of the process.

A further object is the provision of a combined electrolytic and mechanical method of removing nib material to permit efficacious forming of drawing holes, the electrolytic procedure being such as to avoid interference with the mechanical procedure featured by abrasive action of particles of abrasive material, and to permit their simultaneous practice in an efficient manner.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

For a fuller understanding of my invention reference should be had to the following description taken in connection with the accompanying drawings, in which Fig. 1 is a view partly in section and partly in elevation with parts broken away of one embodiment of the apparatus of the present invention showing the relationship between an encased blank nib, a broach or needle, and an electrolyte after the apparatus has been set up for electrolytically making a drawing hole; Fig. 2 is a mirror view of the set-up shown in Fig. 1 with a part in section and broken away; Fig. 3 is a vertical sectional view of the encased nib shown in Figs. 1 and 2 showing a portion of the needle and indicating the approximate shape of the hole formed by electrolytic action; Fig. 4 is a vertical sectional view with parts broken away of a modified form of apparatus suitable for use in carrying out the combined electrolytic and mechanical procedures of the present invention showing an encased nib after the formation of the entrance of a drawing hole; Fig. 5 is an enlarged vertical sectional view of a molded nib showing a portion of a needle in position and particles of abrasive suspended in an electrolyte for the purpose of electrolytically and mechanically forming the entrance of a drawing hole; Fig. 6 is a vertical sectional view with parts broken away of another embodiment of the apparatus which may be used for performing the combined electrolytic and mechanical operations, showing the formation of the bell of the drawing hole in an encased nib with the use thereof; Fig. 7 is a view with parts in section and broken away taken on line 7—7 of Fig. 6; Fig. 8 is an enlarged vertical sectional view of a nib having a finished drawing hole formed therein in accordance with the present invention.

In accordance with the present invention drawing holes are formed in die nibs by a procedure including electrolytic action of a particular type. The practice of the invention is not limited to the formation of drawing holes in die nibs of cemented hard metal carbides. It is particularly suitable for use in connection with any hard, electrically conducting material. A cemented hard metal carbide may comprise particles of hard metal carbide cemented together by a lower melting point metal which will give to the composition certain desired characteristics such as toughness, etc., for example metal of the iron group such as cobalt. As used herein the term "hard metal carbide" means any of the well known carbides or combinations thereof commonly employed as metal cutting tool bits or wire drawing dies. The removal of nib material by electrolytic action is accomplished by supplying a suitable electrolyte to the broach or needle and adjacent portions of the nib and passing electrical current between the nib and the needle. A supply circuit is connected to the nib and needle with the nib serving as an anode and the needle as a cathode so that the oxidizing ions or anions pass to the nib and the reducing ions or cations pass to the needle. These two electrodes may be connected in the supply circuit in a variety of ways as will appear hereinafter. The needle may be of any suitable type and/or shape to meet the requirements of the particular forming operation being practiced. It may be made of any readily electrically conducting material which is not attacked by the electrolytic action, for example various nickel alloys and ferrous alloys such as steel and the like. The action on the needle is cathodic and therefore not generally corrosive to metal.

Although any suitable electrolyte may be employed I prefer an alkaline solution which will not unduly attack the parts of the apparatus and which is capable of dissolving and holding in solution removed nib material. When mechanical removal of nib material is performed in conjunction with the electrolytic procedure the electrolyte should further be of a type that will not unduly affect the mechanical abrasive means and when mechanical abrasive action is not used it should be capable of dissolving oxide compounds of the nib material that form on the nib surfaces being processed. The portions of the nib from which nib material is being removed are kept inundated by the electrolyte during the practice of the electrolytic procedure, i. e., kept submerged or flooded thereby, or the latter is kept flowing over those portions.

When electrolytic action is used alone for removal of cemented hard metal carbide material such as tungsten carbide cemented with cobalt a suitable electrolyte may be a solution of sodium cyanide preferably of a concentration of about 9 to 14 ounces of sodium cyanide per gallon of water. Such an electrolyte does not unduly attack ferrous metal and effectively dissolves and holds in solution cemented hard metal carbide material and oxides thereof which may be developed. It is particularly effective in dissolving cobalt oxide that is produced on the surface of the drawing hole formed in a tungsten carbide-cobalt nib. Satisfactory results may be obtained by the substitution of one or more of the compounds, sodium carbonate, sodium hydroxide, sodium chloride and the like for a portion of the sodium cyanide.

The invention also contemplates within its scope combined electrolytic and mechanical procedures for removal of nib material. In such a case the broach or needle is of such form and type as to serve as a cathode and additionally as mechanical means to aid in or perform mechanical removal of nib material. Although the broach may be a suitable tool or a lap, it preferably is an elongated member of suitable material which may have its working surfaces cylindrical in shape, or if desired shaped in complement to the shape or surfaces of a finished portion of a drawing hole. With a plain-surfaced broach, such as a steel needle, particles of a suitable abrasive such as silicon carbide or the like are employed. The abrasive particles are supplied between surfaces of the working portion of the needle and adjacent surfaces of the nib and these surfaces are moved relative to each other, such as by rotary and/or reciprocating motion of the needle, to induce abrasion of surfaces of the drawing hole of the nib. In the preferred procedure the abrasive particles are carried by a flow of electrolyte continuously supplied to the needle and nib. The electrolyte need not be of a type which will dissolve oxide compounde of nib material, such as cobalt oxide, developed on the surfaces of the drawing hole being formed since the abrasive action will keep the latter effectively free therefrom. The electrolyte should, however, be of a type which will not destructively affect the abrasive materiay. A solution of sodium carbonate or other similar alkali, as distinguished from sodium cyanide, has been found to be suitable, and a highly concentrated solution is preferred.

The nib may be supported in any desirable manner in a tank or container of suitable construction and material. For example, the tank or container may be made from any natural or artificial stoneware or porcelain material resistant to the electrolyte, such as "Alberene" stone, or iron or steel or alloys thereof.

Direct current of relatively low voltage is employed, e. g. about 4 volts of less. The amperage may be varied with the type of forming operation. By way of example to increase the size of the hole in a tungsten carbide-cobalt nib having a drawing hole of about five-eighths of an inch in diameter at the bearing by combined electrolytic and mechanical removal of nib material a current of about 40 amperes will give satisfactory results. In opening up a very small blank nib with a small needle the current may vary from a few milliamperes to a few tenths of an ampere which, with other conditions properly adjusted, will form a passage at the rate of about an inch in ten hours. The maximum amperage for a given set-up is dictated by the rate of gas evolution, too rapid gas evolution causing arcing. A relatively high rate of gas evolution, however, is of material advantage since the gas evolved at the needle tends to carry away products of electrolysis. The removal of such nib material by the method of the present invention has been found to be of the order of about one gram per ampere hour, a rate of removal much more rapid than is possible by procedures usually practiced prior to the present invention.

The amount of electrolyte to be provided is also largely dependent upon the size of nib being processed, the forming operation being practiced, the amperage of the current and permissible operating temperature. To avoid rapid evaporation of the electrolyte the temperature should not exceed about 170° F., about 150° F. being preferred. For the 40 amperes procedure set forth above about five gallons of electrolyte are sufficient. In opening up a very small nib with a current of a fraction of an ampere an electrolyte container of one pint or less capacity has been found to hold sufficient electrolyte.

Referring to the drawings, like numerals refer to like parts throughout. In Fig. 1 is shown a tank 10 preferably of cast iron having therein a body 11 of suitable electrolyte, such as sodium cyanide solution. A terminal 12 of a suitable external electrical supply circuit is shown connected to the tank 10. A nib support 13, preferably of iron or steel is positioned in the bottom of tank 10. A blank nib 14 encased in a steel casing 15 is located upon the support 13. The blank nib 14 is provided with a flared conical recess 16. The portion 17 of the upper end of the nib which is normally exposed adjacent the entrance of the recess 16 is protected from electrolytic action by a ring 18 of suitable material such as steel. The depth of the body 11 of electrolyte in tank 10 is sufficient to submerge the encased nib as shown. An upright 19 has a bracket arm 20 (Fig. 2) mounted thereon provided with a suitable bearing 21 rigidly secured to shaft 22. The vertical shaft 22 which may be moved vertically by means of the arm 20 is provided with an adjustable collar 23 for regulating the distance between the needle and nib. The lower end of shaft 22 terminates in a chuck 24 adapted to receive the end of a broach or needle 25 suitably insulated therefrom, such as by a layer of insulation 26. A second terminal 27 of the external electrical supply circuit is connected by a suitable contacting means 28 to the shank of the needle 25, supporting means for terminal 27 and contacting means 28 being suitably insulated from its support, such as by insulation 29.

The working portion of the needle 25 consists of a tapered point 30 which is positioned closely adjacent to the surfaces of the recess 16 in the nib 14 when the apparatus is set up for operation as shown. The shank of the needle 25 is preferably provided with a protective or insulating coating 31, such as a section of rubber tubing, an electrolytically deposited layer of rubber, a heat vulcanized coating of rubber, or a coating of sulphur applied in a molten state for the purpose of limiting contact between the electrolyte and the needle to the portion at the tip which will be opposed to the surfaces of the drawing hole being formed in the nib. When the external supply circuit is closed current will flow from the terminal 12 through the iron tank 10, the steel support 13, the steel casing 15 to the nib 14, from the nib 14 through the electrolyte to the working portion 30 of the needle 25, and from the needle to the terminal 27. As a result, nib material is progressively removed by electrolytic action forming a passage 32 in the nib 14 as shown in Fig. 3. The casing 15 and the ring 18 protect the outer surfaces of the nib from electrolytic action. Ferrous material such as iron or steel are not deleteriously affected by the electrolyte or electrolytic action. Since the electrolyte, however, may build up an insulating oxide coating on ferrous material, it may be desirable to apply pressure to the encased nib to insure good conductivity between the tank 10 and the nib 14 and to avoid the formation of insulating oxides between the contacting surfaces of the tank 10, support 13 and the nib casing 15.

Passage 32 so formed will be tapered somewhat as shown in Fig. 3 with the major portion of the walls thereof disposed at an angle of about 15° to the axis of the nib. As previously pointed out a molded nib has a similarly shaped passage provided therein during the construction thereof. To finish a molded nib or a blank nib provided with a passage in the above manner, the passage designated as a whole by numeral 32 must be provided with a bell 33, a back relief 34, a bearing 35 and have the surface of the approach portion 36 smoothly ground or finished as indicated in Fig. 8.

In Fig. 4 is shown an apparatus in operation for forming or finishing the approach 36 (Fig. 8) of the drawing hole. The tank 10, which may be of iron, or some non-conducting material such as natural or artificial stoneware or porcelain if electrical current is to be conducted to the nib 14 by means other than the tank as hereinafter described, is suitably supported on a platform 37 provided with suitable means, if desired, for raising and lowering the tank 10 and for imparting lateral motion thereto. It may be desirable to provide manual means such as a hand-wheel 38 for raising the tank 10 to bring the surfaces of the passage 32 (Fig. 8) in the nib 14 adjacent to the working portion 30 of the broach 25. If relative reciprocatory movement between the nib and needle is desired it may be obtained by raising or lowering tank 10 either by such manual means or automatic mechanical means such as a driven sprocket or gear and suitable associated structure, although movement of the needle for this purpose is preferred. The encased nib 14 is mounted on a support 13 which may be a cup-shaped steel member. Provision may be made for conducting current to the nib 14 by means other than the tank 10. For example the support 13 may be positioned upon suitably spaced apart insulating blocks 39 in the bottom of the tank, the blocks being spaced apart to permit free circulation of the electrolyte. A threaded nut 38' provides a fine adjustment between the nib 14 and the working portion 30 of the needle 25.

The tank and supporting means are mounted upon a suitable frame 40 provided with uprights 41 in which are journaled a rotatable shaft 42 driven by suitable means such as a belt 43 and an electric motor (not shown). Upon the shaft 42 is keyed a pulley 44 driving a belt 45 for operating a pump 46 having an intake pipe 47 extending to within a short distance of the bottom of the tank 10 and a discharge pipe 48 terminating in a nozzle 49 adapted to direct a flow of electrolyte to the working portion 30 of the needle 25 and the passage through the nib 14. As is indicated, particles of a suitable abrasive, preferably silicon carbide, are distributed in the electrolyte and circulated therewith. The circulation of the electrolyte prevents the particles of abrasive from entirely settling out and insures a constant supply thereof between the working surfaces of the needle 25 and the adjacent surfaces of the passage in the nib 14.

Preferably the encased nib is clamped upon its support 13 in a suitable position such as by clamps 50, 50 which may be anchored to a suitable portion of the frame or the tank. Each of the clamps 50, 50 is provided with a set screw 51 for the purpose of clamping a top plate 52 of suitable material, such as iron or steel, against the top of the casing 15 and a nib-protecting ring 18 for maintaining the latter in position, with, if desired, a layer 53 of insulating material interposed therebetween. Another layer of insulating material 54 is also preferably interposed between the bottom of the casing 15 and each clamp 50 for completely insulating the encased nib from the apparatus. However, if it is desired to conduct electricity to the nib through the casing 15 and the clamps 50, 50 either one or both of the layers of insulating material 53 and 54 may be omitted. Electricity is conducted to nib 14 preferably through the casing 15 and the body 11 of electrolyte from a contact element 55 connected to the conductor 12 and supported on tank 10 by a suitable insulating member 56. The contact member 55 preferably is pointed and may be a triangularly-shaped steel sheet mounted for vertical adjustment on the support 56 so that the contact area between member 55 and the electrolyte may be varied at will to act as a liquid rheostat for controlling the amount of current.

The shank of the needle 25 is mounted by means of the chuck 24 on the end of the shaft 22 suitably supported in journal boxes 57 and 58 mounted on the frame 40. Upon shaft 22 is mounted a lift arm or cam follower 61 between a collar 59 and pulley 60. A pulley 62 driven by a belt 63 from the shaft 42 rotates a lifting arm or cam 64 periodically to lift the needle 25. A compression spring 65 may be used to cooperate with the force of gravity in lowering the needle 25 after it has been lifted by lift arm 61 for reciprocating the working portion 30 of the needle relative to the surfaces of the passage in the nib 14. The pulley 60, pinned or keyed to shaft 22, is driven by a belt 66 on shaft 42 for rotating the needle 25.

The shaft 22 may be provided with a rack 67 in mesh with a pinion 68 rotatable by a hand lever 69 and supported by a bracket arm 70 suitably insulated by means 71 from a support 72 mounted on the frame 40, so that the needle may be lifted and lowered manually if desired. The other terminal 27 of the external electrical supply circuit is connected to the brush 28 adapted to ride on the surface of a ring 73 mounted on the shaft 22. Brush 28 is supported by means of a bracket 74 suitably mounted on the frame 40 such as by the journal box 58 in an insulated manner such as by means 29. Shaft 22 is insulated from the journal boxes 57 and 58, collar 59, pulley 60 and the lift arm 61 by suitable means such as a sleeve of insulation 75.

In removing nib material from a passage 32 in a nib to form the passage 76 indicated by dot-dash lines in Fig. 5, the electrolyte carrying particles 77 of abrasive material, such as silicon carbide, is continuously circulated by the pump to the nib, the working portion 30 of the needle 25, through the nib passage 32 and the support 13, and between the spaced apart blocks 39. to insure continuously a proper supply of abrasive particles between the working portion 30 of the needle 25 and the surfaces of the nib passage 32. Current regulated by the adjustment of the liquid rheostat including member 55 is passed through the body 11 of electrolyte and the nib casing 15 to nib 14, from the nib 14 through the electrolyte to the needle 25, and through the shaft 22, ring 73 and brush 28 to the terminal 27. As a consequence nib material will be removed by combined electrolytic and mechanical action. the abrasive particles 77 keeping the surfaces of the nib passage free from metal oxides and properly finishing the surfaces of the entrance.

Figs. 6 and 7 show an apparatus equipped with a needle adapted for the formation of the bell of a drawing hole, and the relative positions of the broach and nib during the formation thereof. The tank 10 of this apparatus is not of a depth sufficient to permit submersion of the encased nib 14 when supported by the support 13. However, the supply of electrolyte carrying abrasive particles maintained at the working portion 30 of the needle 25 by the pump 46 is adequate to keep the surfaces of the passage in the nib inundated. In this modified form of the apparatus the spaced apart blocks 39—39 are made of suitable conducting material such as iron or steel and good contact between tank 10, blocks 39—39, support 13 and casing 15 is maintained by a clamp 78 comprising an arm 79 having spaced apart members 80, 80 adapted to engage the top of the casing 15 on opposite sides of the broach 25 as shown. The arm 79 is mounted on the frame or tank by a bolt 81 and a set screw 82 cooperates therewith to apply desired pressure to the assembly. In this apparatus the shaft 22 is not insulated from the frame. The chuck 24, however, is suitably insulated from the shaft 22 by insulating means 26 and brush 28 connected to the terminal 27 rides upon the circumferential surface of the chuck. Suitable mechanism similar to that described in connection with Fig. 4 is provided for reciprocating and/or rotating the broach 25. The drawing hole 83 shown in Fig. 8, may be finished by forming the back relief 34 by a similar procedure with the use of suitable apparatus such as that shown in Fig. 4 or 6.

Although I have illustrated my invention in connection with a pointed needle other forms of needle may be employed, for example, those having a cylindrical, hexagonal or other cross-sectional area. If a cylindrical needle is employed it will tend to form a tapered hole due to the fact that the electrolytic action takes place for a longer period of time at the upper portion than at the lower portion of the surface of the hole through the die. If a needle having a uniform cross-sectional area of a shape other than cylindrical, for example hexagonal, is employed it also will tend to form a tapered hole through the die but the hole will conform to the cross-sectional shape of the needle.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. The method of forming a hole in a refractory metal body which comprises applying force to an electrically conductive needle to press it against abrasive particles between the surface of said refractory metal body and said needle, causing relative movement between a working portion of the needle and adjacent surfaces of the refractory metal body to induce abrasion of the latter and supplying an alkaline electrolyte to the needle and adjacent portions of the refractory metal body while anodically treating said body in said electrolyte.

2. The method of forming a drawing hole in a die nib which comprises electrolytically and mechanically removing material from a sintered carbide nib by simultaneously forcing an electrically conductive needle against abrasive particles between the needle and nib, moving the surfaces of a working portion of the needle relative to adjacent surfaces of the nib to induce abrasion of the latter, and maintaining a supply of an alkaline electrolyte at the adjacent portions of the needle and nib while anodically treating said nib in said electrolyte.

3. The method of forming a drawing hole in

a die nib which comprises electrolytically and mechanically removing material from a cemented hard metal carbide nib by simultaneously forcing an electrically conductive needle against abrasive particles between the needle and nib, imparting motion to the needle to induce abrasion of surfaces of the nib adjacent thereto, and maintaining a supply of an alkaline electrolyte at the adjacent portions of the needle and nib while anodically treating said nib in said electrolyte.

4. The method of forming a drawing hole in a die nib which comprises electrolytically and mechanically removing material from a cemented hard metal carbide nib by simultaneously forcing an electrically conductive needle against abrasive particles in an alkaline electrolyte between the needle and nib, and imparting motion to the needle to induce abrasion of surfaces of the nib adjacent portions of the needle and nib while anodically treating said nib in said electrolyte.

5. The method of forming a drawing hole in a die nib which comprises electrolytically and mechanically removing material from a cemented hard metal carbide nib by simultaneously forcing an electrically conductive needle against abrasive particles between the needle and nib, imparting rotary motion to the needle to induce abrasion of surfaces of the nib adjacent thereto, and maintaining a supply of an alkaline electrolyte at the adjacent portions of the needle and nib while anodically treating said nib in said electrolyte.

6. The method of forming a drawing hole in a die nib which comprises electrolytically and mechanically removing material from a cemented hard metal carbide nib by simultaneously forcing an electrically conductive needle against abrasive particles between the needle and nib, imparting reciprocative and rotary motion to the needle to induce abrasion of surfaces of the nib adjacent thereto, and maintaining a supply of an alkaline electrolyte at the adjacent portions of the needle and nib while anodically treating said nib in said electrolyte.

7. The method of forming a drawing hole in a refractory metal die nib having a passage therethrough comprising positioning an electrically conductive needle in the nib passage, circulating an alkaline electrolyte carrying abrasive particles between the needle and nib and through the nib passage and causing relative movement between surfaces of a working portion of the needle and adjacent surfaces of the nib passage to induce abrasion of the latter while anodically treating said nib in said electrolyte.

8. The method of forming a drawing hole in a cemented hard metal carbide nib having a passage therethrough comprising positioning an electrically conductive needle in the nib passage, circulating between the needle and nib and through the passage an alkaline electrolyte carrying particles of silicon carbide and causing relative movement between surfaces of a working portion of the needle and adjacent surfaces of the passage to induce abrasion of the latter while anodically treating said nib in said electrolyte.

9. The method of forming a drawing hole in a cemented hard metal carbide nib having a passage therethrough which comprises positioning an electrically conductive needle in the nib passage, circulating between the needle and nib and through the nib passage a substantially saturated solution of sodium carbonate carrying abrasive particles and causing relative movement between surfaces of a working portion of the needle and adjacent surfaces of the passage to induce abrasion of the latter while anodically treating said nib in said solution.

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