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Pond

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[54] **CRYSTAL SKETCHING**

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[52] **U.S. Cl.**..... **156/6**, 148/11.5 A, 156/22, 204/29

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[58] **Field of Search** ..... 156/6, 20, 21, 22, 156/23; 148/11.5 A; 204/29

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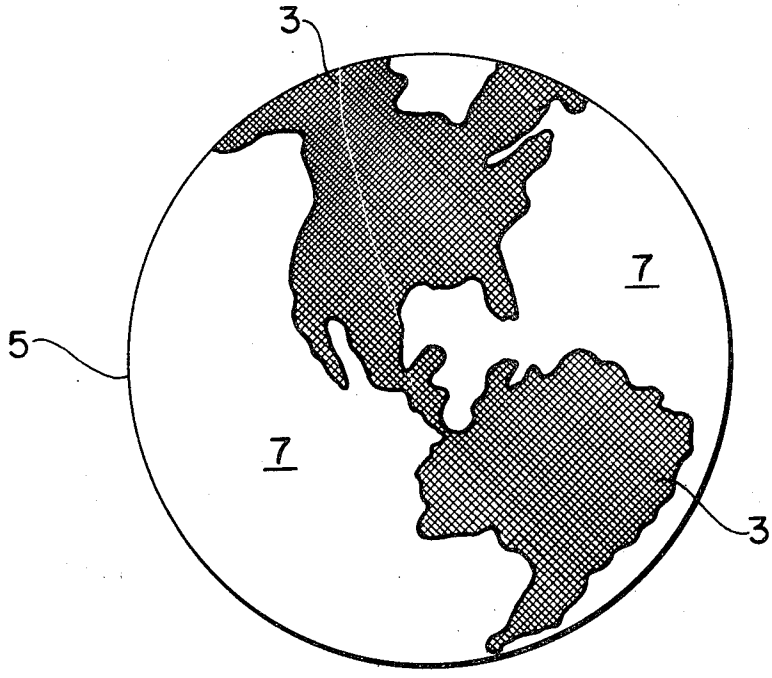
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[57] **ABSTRACT**

Refurbishable works of art are produced on a crystalline metallic surface by forming with plastic deformation an artistic representation, annealing said crystalline surface to relieve the metallic matrix of the imposed energy of plastic deformation in the form of a locally recrystallized surface which is different in crystal grain size and frequently in geometric distribution from the original metallic matrix, and etching said metallic surface to delineate to the eye the pictorial artistic representation composed of crystal grains which are different from those in the contiguous matrix.

8 Claims, 2 Drawing Figures



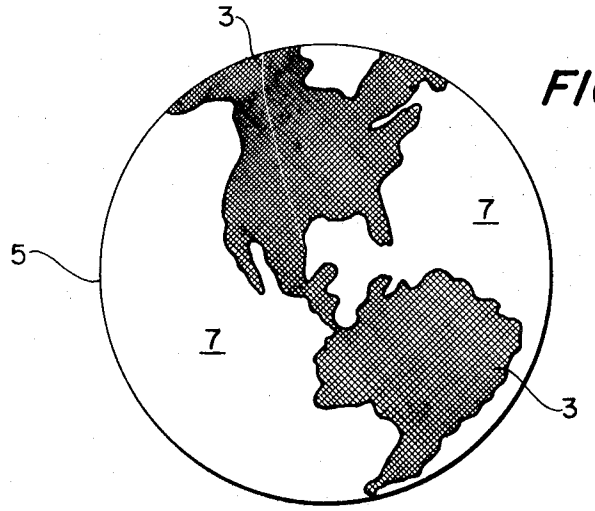


FIG. 1

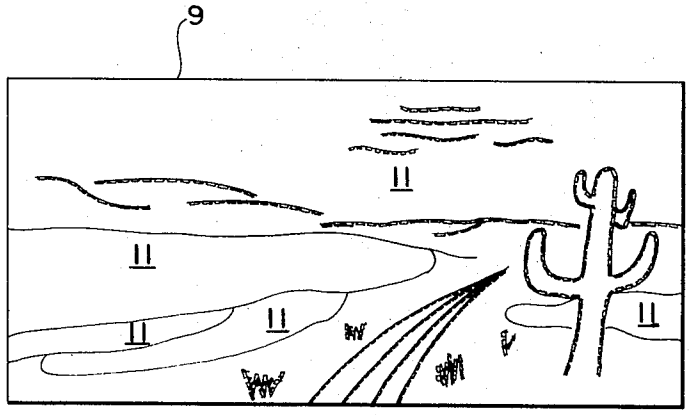


FIG. 2

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CRYSTAL SKETCHING

This invention relates to novel art objects and to a process for producing the same. More particularly, the invention is related to the production of artistic representations embodied in a metal surface.

In the field of art where graphic or pictorial representations are desired, it is customary to use a technique of applying one medium on the substrate of a different medium. The substrate medium is selected with care by the artist and generally consists of such flat articles as canvas, wood, metal, etc. where the primary considerations are durability and compatibility with the drawing medium. Other considerations possibly involved in the selection of the substrate medium include texture, which often influences the applied medium and makes an important contribution to the pictorial effect rendered.

The medium that is applied to the substrate material, on the other hand, is selected from a class which embodies both opaque pigments in vehicles such as oil and soluble pigments in vehicles such as water colors; combinations thereof such as tempera; single opaque material such as charcoal, graphite or ink; and in some popular art forms, small particles of material which are glued to the substrate. In all of these approaches, the delineating is sepatate and not a part of the substrate material. To our knowledge, the only classes of art previously known wherein the delineating material is a part of the substrate material is photography and engraving.

It is an object of the invention to provide a metallic work of art having an intrinsic beauty which if marred or defaced in any manner can be simply refurbished to its original form.

These and other objects of the invention are obtained by forming by plastic deformation in the surface of a crystalline metal matrix, an artistic pictorial representation, said crystalline metal matrix comprising at least one large crystal, the surface area of each crystal being at least equal to or greater than the area of the pictorial representation residing in it, annealing the substrate crystalline metal surface thus deformed to cause recrystallization in said deformed surface areas and form therein crystal grains substantially reduced in size compared to those in the contiguous matrix and etching said annealed crystalline metal matrix to delineate said pictorial artistic representation. Thus, in the concept of recrystallization sketching according to the present invention the delineating material and the substrate are one and the same and yet the delineation is more than complete in that it possesses a quality of apparent translucence, three dimensionality, or directional specularity which causes the rendition to give different effects when viewed from different angles.

The crystalline metallic material or matrix in and a part of which the artistic representation is created in accordance with the invention, may be any metal comprised of one or more large or coarse size crystals visible to the naked eye. Among the suitable metals may be included, for example, aluminum, copper, iron, nickel, titanium, or tantalum, and alloys of these metals. Thus, the crystalline matrix may be either a single crystal or polycrystalline, (i.e., a polycrystal aggregate of large or coarse grain crystals) and may be of any desired shape such as spheroidal or parallelepiped.

It has long been known in the field of metallurgy that the grain or crystal size in polycrystalline aggregates in a wroght material is proportional to the residual strain in the metal prior to recrystallization. This relationship is aptly illustrated in literature as old as "The Metallography and Heat Treatment of Iron and Steel" by Albert Sauveur, The University Press, 1926. The average crystal size of polycrystalline metallic matrixes upon which the artist representations are created will vary not only upon the residual strain in the metal prior to the recrystallization but also on the indication of recrystallization as, for instance, the annealing temperature, the annealing time and the rate of cooling. In general, the higher the full annealing temperature and the slower the cooling rate, the greater the crystal size formation. The number of crystals or grains in a polycrystalline substrate may be as low as two, but most often is much greater in number.

The metallic matrixes of the invention which are but single crystals may be prepared by carefully controlling the starting grain size and the residual strain in a given bar of material. The procedure is referred to as a strain-anneal method for growing single crystals and a number of techniques for such growing methods are well known. See, for instance, "Preparation of Metal Single Crystals," A. N. Holden, Transactions of the American Society for Metals, Vol. 42, 1950, p. 319, hereby incorporated by reference. These single crystal growing methods can be successfully applied to all single phase metallic materials which do not twin upon deformation or upon annealing. Illustrative of metals from which single crystals have been grown may include aluminum.

The surface depressions or plastic deformations introduced on the surface of the crystalline metal matrix to form the artistic image or representation generates the plastic strain which induces recrystallization in these areas of depression upon annealing. The surface depressions may be rendered with suitable instruments such as a ballpoint pen, or a metal scribe. It is realized that the residual plastic strain energy of the artist's work can be obtained in a variety of ways, including whole impressions made with a tool on which the desired pictorial representation or a part of the pictorial representation is in relief.

As is readily apparent, the operation requires that the artist visualize what will be incubated from his deformation strokes. Strokes inflicted very close together will not be discernible to the naked eye as separate delineations after the annealing and etching for the network of recrystallized fine grains tend to grow one into the other in an encompassing fashion. In many instances, this gives a desirable effect to the artistic work being represented; in other works, it may not be artistically undesired.

The residual plastic strain energy in the metallic surface which has been placed in accord with the artist's wish is relieved by an annealing operation which causes a recrystallization of the deformed surface matrix to form crystal grains substantially reduced in size compared to those in the contiguous matrix and frequently of different geometric distribution. Recrystallization of a deformed crystalline material upon annealing is a well established phenomenon and it is within the knowledge of those skilled in the art to qualitatively control the crystallization product by variations in the strain energy density in the matrix, and the annealing temperature and time. It is possible, therefore, to achieve a vari-

ety of grain sizes by either varying the intensity of the deforming process or by placing the artistic representation sequential to appropriate annealing steps. An increase in the initial plastic strain, for instance, causes a decrease in grain size, whereas increasing annealing temperature and/or time causes an increase in grain size.

Subsequent to or prior to the annealing treatment the deformation markings may be polished from the surface without losing the recrystallized structure which generally extends to several millimeters beneath the surface. Because of the depth of the grain structure, the art work may be refurbished at this state, if necessary, by repolishing and etching.

The grains in a metallic material are not normally delineated to the eye and must be brought to view by a microetching process after polishing. Microetching is a surface attack which leaves microscopic facets called etch pits on each grain. The etch pits are invariably oriented to the crystal lattice in each grain and in a single grain a myriad of these facets are therefore aligned as microscopic mirrors. Neighboring grains are differently oriented and the general etch pit alignment in each grain is different from the etch pit alignments in neighboring grains. The effect of microetching is to delineate the art work as a pattern of grains different from the surrounding grains, and these grains individually scintillate, alternating in reflected intensity as the relation to the eye changes. Etching can be accomplished by chemical, electro-chemical or thermal means well known in the etching art, although generally there are a few optimal techniques for a given metallic substance; i.e., aluminum is nicely etched by aqua-regia, a solution of hydrochloric and nitric acids.

The finished work of art produced by the process of the invention comprises either a polycrystalline aggregate or a single large crystal in which a part is provided with a pictorial artistic representation delineated by a network of small grain crystals. The completed work of art has an intrinsic beauty and although it gives the appearance of an image in relief, it is surprisingly smooth to the touch and the three-dimensional effect comes apparently from chemical and isotropic characteristics. Moreover, the finished work possesses an advantage over other art works such as normal oil paintings and the like in that if it is scratched or otherwise marred, re-etching will cause the original image to spring forth as a fresh work since the delineating medium is a part of the substrate. This peculiar "memory" effect will make the device useful for a variety of art works in that after wear, thay can be refurbished to their original form by simple etching.

It will be appreciated as well that the art works prepared in accordance with the process of the invention may be subjected to other decorative processing known to the art. For instance, there often exists techniques for coloring metals as in the color anodizing of aluminum and such techniques could easily be employed in conjunction with recrystallization art work.

The following examples are included to further demonstrate the present invention and will be described with reference to the attached drawing wherein FIG. 1 is a perspective view of a completed work of art on a single crystal of aluminum and FIG. 2 is a perspective view of a completed work of art on a polycrystalline aluminum plate matrix of a plurality of crystals.

EXAMPLE I

Referring to FIG. 1, land masses 3 of the earth are outlined with soft crayon on a spherical single crystal 5 of pure aluminum having a diameter of 2½ inches. These outlines are then indented using a ballpoint pen. The total land mass area is then indented using the ball point pen in a scribbing or cross-latching manner. If the indentions produced are very small, the recrystallized grains will be large but shallow. If the indentations are severe, the recrystallized grains will be smaller but will permeate the globe deeper. After all the indentations are completed, the sphere is annealed by placing it in a furnace at 1,115° F for 15 minutes. It is then removed and rapidly cooled. Upon inspection it looks just like it did before it was placed in the furnace. After lightly sanding away the indentations, it looks exactly like it did before the outlines were imposed. When the sanded object is placed in aqua-regia for approximately 15 minutes, the crystals develop etch pits which allow one crystal to be distinguished from another and it is found that all of the land masses 3 are composed of small crystals and all of the oceanic masses 7 are the same single crystal 5. Despite this, the surface of the globe is smooth to the touch. If the resulting work of art is scratched or similarly marred, it can be easily refurbished by merely re-etching it since the delineating material is part of and yet permeates the matrix material.

EXAMPLE II

Referring to FIG. 2, a 3 inch × 6 inch plate 9 of polycrystalline aluminum having four or five large crystals 11 in it is etched to more readily delineate the crystals. It is found that as the etched plate is tipped to various angles the different crystals will change in the amount of light they reflect so that one crystal may become light as another becomes dark. Upon studying such a display, the artist begins to see a scene, e.g., a nature scene. With a ballpoint pen he sketches by deformation the minimum number of lines to compose the subjects that comprise his scene. The plate is then annealed, cooled, sanded and etched as described in Example I. In the resulting plate, the artist finds that the scene he saw in his mind's eye superimposed on the big crystals is now present and everyone sees the same scene. Not only is the same scene committed permanently, but will have taken on a three dimensionality for as the plate is tipped to various angles (due to variation in reflectance of the crystals) the day scene becomes a night scene or the summer scene a winter scene, or the background becomes highlighted over the foreground, etc.

It is claimed:

1. A process for the production of a refurbishable work of art which comprises impressing an artistic pictorial representation in the surface of a crystalline metal matrix comprised of at least one large crystal the surface area of each being at least equal to or greater than the area of the pictorial representation residing in it by plastic deformation, annealing the crystalline metal surface thus deformed to cause recrystallization in the deformed surface areas of said artistic pictorial representation and the formation of small grain crystals substantially reduced in size compared to those in the contiguous matrix, and etching said annealed crystalline metal matrix to delineate said artistic pictorial representation as a network of small grain crystals.

2. The process of claim 1 wherein the crystalline metal matrix is on aluminum.

3. The process of claim 2 wherein the crystalline metal matrix is a single crystal.

4. The process of claim 3 wherein the single crystal is in the shape of a spheroid.

5. The process of claim 1 wherein the crystalline metal matrix is comprised of a plurality of crystals.

6. The process of claim 5 wherein the crystalline metal is in the shape of a parallelepiped.

7. The process of claim 5 wherein at least part of the plastic deformation is along the boundary of at least one crystal.

8. The process of claim 2 wherein the etching is effected by immersion in a bath of aqua-regia.

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