

MULTIPLE IMAGE SURFACEField of Invention

The present invention relates to a surface that contains a plurality of images where each image is viewable individually from a unique angle.

Background

There are known prior art surfaces, for example in coins, in which fragments of images are physically created on the sides walls of elongated grooves. The fragments of a first image are formed as cuts on the sides of the grooves on one side, while the fragments of a second image are cut onto the sides of the grooves on the other side. Thus, when the person looks at the coin surface from one inclined angle, the person sees all the fragments of the first image. The sum total of the fragments combine to enable the person to see the first image. Similarly, when the person looks at the coin surface from another inclined angle, he sees all the fragments of the second image. Since the image fragments are located within the elongated grooves, a problem is that the image has the appearance of a series of lines. Moreover, a limitation of this prior art is that the surface is limited to containing a maximum of two images, due to the fact that the elongated grooves have two side walls on which fragments of two images can be formed.

In order to create more than two images on a surface, another approach taken in the prior art is to manufacture a surface that is provided with a plurality of circular pockets. Each circular pocket has an inner wall surface that is shaped as a hemisphere. Within each hemispherical pocket, fragments of images are formed. The closed perimeter of these circular pockets means that three or more fragments of images can be formed on the circular inner walls of each pocket. Thus, this prior art surface is capable of containing three or more multiple images on the surface, each viewable separately from a different angle. Although this prior art overcomes the two-image limitation, the images produced by these hemispherical pockets are characterised by the appearance of being set against a rather dim backdrop. The images are not clearly distinguishable from the overall surface of the coin.

The prior art discussed above and hereinafter is not admitted as common general knowledge, and is provided merely to illustrate known approaches taken by other developers in the field.

An object of the present invention is to provide an improvement and/or an alternative to the prior art.

Summary of Invention

According to the present invention, there is provided a surface having multiple images each viewable from a different angle, the surface including:

a plurality of pockets each having a closed perimeter and an inner wall surface having a plurality of linear regions,

at least some of the pockets each having a first formation on one of the linear regions thereof, each formation being a fragment of a first image such that all the first formations combine to create the first image which is viewable only from a first angle, and

at least some of said pockets each having further formations on other linear regions of the same pocket, the further formations being fragments of further images each viewable from a different angle.

Preferably, the inner surface includes at least a frusto-conical region.

Preferably, the closed perimeter is a circle which acts as a rim for the frusto-conical region.

Preferably, the end of the frusto-conical region has rounded portions.

The frusto-conical region may have an included angle in the range of eighty to one hundred degrees.

Preferably, the frusto-conical region has an included angle of around ninety degrees. Alternatively, the inner surface may be a perfect cone with an end shaped as a pointed apex.

Preferably, the pockets have a perimeter diameter to height ratio of less than three to one.

Preferably, the pockets have a perimeter diameter to height ratio of around two to one.

Preferably, the formations include recesses that are below the inner wall surface.

Alternatively, or in addition, the formations include protrusions that are above the inner wall surface.

In preferred embodiments, at least some of said pockets each have three or more formations resulting in the surface having three or more images, as the case may be, each viewable from a different angle.

Preferably, the linear regions act as a reflective backdrop for the images created by the formations. The degree of reflectivity need not necessarily be mirror-like, but merely more reflective than the dullness associated with the semi-hemispherical pockets of the abovementioned prior art.

Preferably, the formations of each pocket are positioned closer to the perimeter of the pocket than the end of the pocket.

Preferably, the linear regions are inclined.

Preferably, the surface is formed as a face of a coin.

Preferably, the surface is made of metal.

Preferably, the pockets and formations are made by engraving.

Alternatively, the pockets and formations may be made by stamping.

Preferably, each pocket has a central axis and all points on the perimeter thereof are generally within a limited distance from the axis.

Preferably, all points on the perimeter thereof are equidistant from the axis.

According to another aspect of the present invention, there is provided a method of creating a surface having multiple images each viewable from a different angle, the method including the steps of:

creating on a surface a plurality of pockets each having a closed perimeter and an inner wall surface having a plurality of linear regions,

creating, at least in some of the pockets, a first formation on one of the linear regions thereof, each formation being a fragment of a first image such that all the first formations are able to combine to create the first image which is viewable only from a first angle, and

creating, in at least some of said pockets, further formations on other linear regions of the same pocket, the further formations being fragments of further images each viewable from a different angle.

In the method, preferably the inner surface includes at least a frusto-conical region.

Drawings

In order that the present invention might be more fully understood, embodiments of the invention will be described, by way of example only, with reference to the accompanying drawings, in which:

Figures 1A to 1E show an embodiment of a multi-image surface rendered on the face of a coin, with Figure 1A showing the coin when viewed from directly above, and Figures 1B to 1E showing the same coin when viewed from four different directions;

Figure 2A illustrates four pockets on the surface of the coin of Figure 1A viewed from directly above—three of the pockets have four pits each, while the upper left pocket has no pits;

Figure 2B is a cross-sectional view of two pockets, one of which being the view along line A-A of Figure 2A showing that the pocket has a generally frusto-conical inner wall surface with linear regions;

Figure 2C is a schematic diagram illustrating how a person would see the pits of the pockets in Figures 2A and 2B;

Figure 2D illustrates a schematic view of a person looking at the surface of Figure 1A from at an angle, while Figure 2E illustrates what the person sees when viewing the surface according to the arrangement in Figure 2D;

Figure 3A relates to a further embodiment of a multi-image surface in which the inner surface of the pockets is shaped as an inverted pyramid;

Figure 3B shows a cross-sectional view of the pyramid-shaped pockets of Figure 3A when viewed along line B-B in Figure 3A; and

Figure 3C illustrates a schematic view of a person looking at the surface of Figure 3A from at an angle, while Figure 3D illustrates what the person sees when viewing the surface according to the arrangement in Figure 3C;

In the description and drawings, similar features have been numbered using the same reference numerals merely for the sake of ease of understanding of the specification.

Description of Embodiments

Referring to the drawings, each of Figures 1A to 1E illustrates the same embodiment of a multi-image surface rendered on the face or surface 10 of a coin. The surface 10 of the

coin contains a number of physical images. Each of Figures 1A to 1E shows that different images are visible when the same coin is viewed from different angles. In Figures 1A to E, four images are contained on the surface of the same coin. Each image can only be viewed individually from a unique viewing angle, which means that at any one time, a person can only see one of the four images.

In Figure 1A, the surface of the coin 10 contains a plurality of pockets 20, although, from the scale with which the coin is drawn in Figure 1A, the individual pockets 20 are barely discernable. The embodiment of the coin shown in Figure 1A has over a thousand pockets, but the number of pockets can be increased depending on how fine the images are required to be.

Figure 2A provides an enlarged view of four of the pockets 20. Within three of the four pockets, formations, in the form of pits 30, are engraved on the inner wall surfaces 60 of the pockets 20. The fourth pocket in the upper left of the drawing has no pits, because there are no images on that portion of the surface.

The manner in which one of the four images is contained in the surface 10 of the coin will be described. The other images are contained on the coin face 10 in a similar manner.

The first image, shown in Figure 1B, is contained on the face 10 of the coin in the form of a large number of formations. These formations are distributed throughout the pockets 30B. In Figure 2A, these formations appear as pits in the upper left quadrants. (The other pits in the same pocket relate to other images of Figure 1C to 1E). Thus, each of the pockets 30B contains a fragment of the overall image of Figure 1B. In Figure 2A, when the face 10 of the coin is viewed from a direction Z, the person sees the upper right pits 30B which are contained in some of the pockets 20. Moreover, if the person moves away from the particular angle, he will not be able to see this first image. Thus, the surface structure of the present embodiment is different to that of surface holograms. In the present embodiment, the image is physically fragmented among a large number of pockets, and does not rely on optical light interference for the creation of the image. Moreover, it is not intended that the present invention be able to reproduce the three-dimensional effects that are possible with holograms.

Figure 2C shows how a person 5 will see the pit 30B, when positioned at the appropriate angle and looking in the direction Z of Figure 2A. However, at that angle, the person will not see the closest pit 30D. The other pits 30C, 30E will be side-on to the person, so these pits also will not be seen fully. Therefore, only one of the pits 30B will be clearly

visible from this angle. Thus, the person only sees the first image of Figure 1B that is associated with the upper left pits 30B.

Likewise, for example, in order to view the second image in Figure 1C, the person would be positioned to look at the face 10 of the coin from a direction along arrow Y. From this vantage point, the person sees the detail of upper right pits 30C, but does not see the other pits 30B, 30D, 30E.

Similarly, the image of Figure 1D is seen by looking at the face of the coin along the direction of arrow W.

Likewise, the image of Figure 1E is seen by viewing the coin from the direction of arrow X.

In Figure 2A, the pits 30B, 30C, 30D, 30E are arranged evenly around the periphery of the pocket 20. In the present embodiment, there are four pits 30B-E which correspond to the four separately-viewable physical images.

The pockets 20 have a closed perimeter 50, which indicates that each pocket is a discrete indentation. The pockets are not elongated. In the embodiment of Figure 2A, each pocket 20 has a central axis and all points on the perimeter 50 are generally within a limited distance from the axis. In the present embodiment, all points of the perimeter are the same distance from the axis. In other words, the closed perimeter is a circle which acts as a rim for the inner wall surface. The inner wall surface of the pocket is frusto-conically shaped. This means that each pocket cannot be, for instance, a longitudinal or elongated groove. When a user rotates the surface, or looks at the surface from different angles, each pocket has roughly the same appearance no matter which direction the person looks at the surface. Thus, as the surface is rotated, the person is able to concentrate on the different pits that are visible through the changing angles, rather than being distracted by changes in the inner pocket surfaces. In contrast, if the pockets were to be elongated, the person would perceive that the pockets themselves were changing in orientation when the surface is rotated or viewed from different angles. This is one reason why the embodiment uses pockets, rather than elongated indentations.

Another reason why elongated indentations of the prior art are avoided in the present embodiment is that a substantial part of an elongated indentation consists essentially of two walls, which effectively limits the surface to having only two images. In contrast to the prior art, the surface of the present embodiment is able to contain at least three or four images.

Not all the pockets 20 are required to contain pits 30. For example, in Figure 1B, only a selected number of pockets are required to have pits in the upper left of each pocket 30B. In Figure 2A, one of the pockets does not contain any pits, because that pocket is located on a part of the surface where none of the four images appear.

Figure 2B illustrates a cross-sectional view of the pits 20 viewed along a line A-A of Figure 2A. In the embodiment of Figures 2A and 2B, the pockets 20 are generally frusto-conically shaped. In Figure 2B, the end or bottom of the pocket is generally rounded to retain the frusto-conical shape of the pocket. In other embodiments, the bottom of the pocket may be pointed to create a full cone.

The inner wall surface of each pocket 20 has a plurality of linear regions 60. These linear regions 60 are formed by the linear inclined parts of the faces of the frusto-conical internal shape of each pit 20.

The pits are located on the linear regions. When viewed in Figure 2A, the inner walled surface appears curved, but when viewed in Figure 2B in cross section, it is appreciated that the inner wall surface has a plurality of linear regions. In Figure 2A, the linear regions are found along a line that runs along A-A, or along any radius of the pocket. In this sense, there are numerous linear regions on the frusto-conical inner wall of the pocket.

The reason that the pits are located on linear regions is that the linear regions provide a reflective backdrop for the images. Each image is the sum total of the numerous fragmented pits. Since each pit is on a linear region, those linear regions provide a reflective background or backdrop on which each image appears. This explains why the images are able to appear against a background that is either shiny or at least has a degree of reflectivity. Thus, the present invention is an improvement over the prior art where images appear against comparatively dull backgrounds provided by pockets which have hemispherical surfaces that are devoid of linear regions on the inner walls of the hemispherical pockets.

In Figure 2B, the pits 30 are positioned further up the inner wall, closer to the perimeter of the pocket than the end or bottom of the pocket. If the pits were to be positioned close to the bottom of the pockets, the pits within the same pocket would be closer to one another, and the images created by each pit might be less readily distinguished from the images created by the other pits. Moreover, if the pits were to be closer to the bottom of the pockets, the viewing angle is increased-the person would have to look at the surface from

almost directly above in order to see the pits. Thus, the pits are preferably placed up higher towards the upper rim of the pockets as shown in Figure 2B.

In Figure 2B, the pockets have a diameter to height ratio of less than three to one. Preferably, as shown, the pockets have a diameter to height ratio of around two to one. Preferably, with this ratio, the included angle of the bottom of the pocket is generally ninety degrees (indicated with the word "angle" in the figure). The pockets are preferably of this internal angle. If the internal angle were to be significantly greater than ninety degrees, the pocket would tend to be wider in diameter, which leads to a decrease in the density of pits and pockets per unit surface area. If the internal angle were to be significantly less than ninety degrees, the walls of the pocket would be steeply inclined, which would lead to a very acute low viewing angle for the person to see the images. In alternative embodiments, an acceptable range for the included angle is eighty to one hundred degrees.

The pits 30 are preferably as small as possible, because this enables the pockets to be smaller. An advantage of having the pits and pockets as small as possible is that the density of pits per unit area can be greater. Greater pit density, per unit area, is advantageous because it provides better definition of the images, and also makes it more difficult for the images to be counterfeited. This latter advantage is relevant when embodiments of the surface are used for security purposes.

In Figure 2B, the end or bottom of the pocket has curved or rounded portions, with a general flat end. However, the actual shape and configuration of the end of the pocket is not critical to the invention since, as mentioned above, it is preferred that the pits are located further up the inner wall, rather than near the bottom of the pocket. Therefore, the bottom of the pocket does not play a major part in the creation of the images. For instance, the end of the pocket can be sharp or pointed, without influencing the images. However, it is preferred that the end of the pocket be rounded, rather than pointed, since a pointed end would itself act as a visible feature that could distract from the actual images.

Nevertheless, other embodiments might use the end of the pocket as an image creation formation. In other words, some pockets might have ends that are rounded, while other pockets might have ends that are sharp. Such differences would be used to create an image that is discernable when the surface of the coin is viewed from directly above.

A further embodiment of the invention is shown in Figures 3A and 3B where the pockets are shaped as inverted pyramids 20. The formations, embodied as pits 30, are

provided on the linear regions of the inner wall surface of each of the pockets. The linear regions are found on the flat inclined surfaces of the inverted pyramid. However, the earlier embodiment of Figures 2A and 2B are preferred over the embodiment of Figures 3A and 3B. First, the sharp edges of the pyramid sides and end of the pyramid act as visible features that can distract from the actual images. Second, in contrast to a conical or frusto-conical inner walled surface, the surfaces of the pyramid-shaped inner wall change visibly when viewed from different angles. Whereas the walls of a conical or frusto-conical inner wall appear relatively similar regardless of the viewing angle.

The image quality is enhanced if there are a greater number of pockets per unit surface area, since this means there would be a greater density of pits per unit area. However, as the number of pockets per unit area increases, the pockets tend to be positioned closer to one another. As seen in Figure 2B, care must be taken to avoid the adjacent pockets being so close together such that the dividing partition 70 between pockets does not become too fragile, which would cause the surface to be less wear resistant.

The embodiments have been described by way of example only, and modifications are possible within the scope of the invention as defined by the appended claims.

The illustrated embodiments have four pits. However, in other embodiments, each pocket 20 can have any number of pits which provide a corresponding number of separately-viewable images. In practice, however, there is an upper limit as to how many unique pits 30 can be positioned around the periphery of each pocket 20 because, as the number of pits 30 increases, it would become increasingly difficult to distinguish each image formed by adjacent pits. In experiments, the pockets have been provided with three or four pits, and conceivably five pits may be attempted.

In the preferred embodiment of Figures 2A and 2B, the inner wall surface of the pocket has a frusto-conical region, but in other embodiments, the inner walled surface can be of a variety of shapes provided that linear regions are present which can act as reflective backgrounds for the images.

In the embodiments, the multi-image surface has been applied to the face of a coin. However, other embodiments may be applied to surfaces on any number of objects, such as identification badges, medallions, rings, to name a few. The multi-image surfaces may be used either for decorative purposes, or for security purposes-since the multi-image surface structure is difficult to reproduce without the appropriate manufacturing equipment.

The coin of the exemplary embodiment is 14 mm in diameter, but other embodiments can be applied to surfaces of larger or smaller size. In the examples, the depth of the pockets is around 0.1 to 0.2 mm.

In the embodiments, the surfaces are engraved directly on metallic surfaces, but other embodiments may be created on other surfaces such as plastic, ceramic and other suitable materials. Embodiments of multi-image surfaces can be created on surfaces such as steel, and alloys like copper-nickel, aluminium-bronze, and other base metals which are commonly used in the coin minting industry. Other production techniques, such as milling or stamping, can also be used.

For instance, a stamping process can be used. In an example of a stamping process, a master tool is created which includes a multi-image surface having conical pockets, for example. From this, a stamping tool is created which has conical protrusions because the intention is for this stamping tool to create the conical pockets when impressed onto a material surface.

The embodiments are made by fine engraving techniques, but conceivably, with suitable technology, the surfaces can be made by casting or other fine manufacturing techniques.

The formations, within the pockets, are embodied as pits. The pits are generally rounded or curved indentations. However, in other embodiments, the formations may be in other shapes and configurations. The pits, for example, can be square or orthogonal. Moreover, the formations of each pocket need not be identical, and the pits within each pocket can be of a variety of shapes.

The width to height ratios described above are preferred dimensions, and other ratios are possible. However, if the width to height ratios become greater than, say, three to one, the pocket would have a shallow slope, in which case the person would tend to look at the coin from directly overhead, causing the person to also see the pits for the other images. The purpose of specifying examples of width to height ratios is to make it clear that the embodiments of the pockets are not elongated grooves. Such elongated grooves, as found in the prior art, are only capable of containing two images. In contrast, the closed perimeter pockets of above embodiments are able to contain three, four or possibly more images. Moreover, the linear regions on the inner wall of the pockets ensure that the images are seen against a reflective background or backdrop.

In the embodiments described above, the formations are formed as pits that are recessed below the surface of the inner wall surface of the pocket. However, the formations can project above the inner walled surface of the pocket. In such modified designs, care must be taken that the person does not see fragments of other images when looking at a particular image to such an extent that the images become indistinct.

In the preferred embodiment of Figures 2A and 2B, the pits are positioned closer to the perimeter and rim of the pocket. Other embodiments, however, can have the formations positioned towards the middle or lower portion inside each pocket, provided that care is taken to ensure that the person does not begin to see an unacceptable amount of the formations of other images at one time.

In the manufacturing process, the pockets are created first, and then the pits are engraved. However, other processes can be used where the pockets and pits are created concurrently. Alternatively, a die can be produced which is adapted to stamp or impress the structure onto a surface.

CLAIMS:

1. A surface having multiple images each viewable from a different angle, the surface including:
 - a plurality of pockets each having a closed perimeter and an inner wall surface having a plurality of linear regions,
 - at least some of the pockets each having a first formation on one of the linear regions thereof, each formation being a fragment of a first image such that all the first formations combine to create the first image which is viewable only from a first angle, and
 - at least some of said pockets each having further formations on other linear regions of the same pocket, the further formations being fragments of further images each viewable from a different angle.
2. A surface according to claim 1 wherein the inner surface includes at least a frusto-conical region.
3. A surface according to claim 2 wherein the closed perimeter is a circle which acts as a rim for the frusto-conical region.
4. A surface according to either claim 2 or 3 wherein the end of the frusto-conical region has rounded portions.
5. A surface according to any one of claims 2 to 4 wherein the frusto-conical region has an included angle in the range of eighty to one hundred degrees.
6. A surface according to claim 5 wherein the frusto-conical region has an included angle of around ninety degrees.
7. A surface according to either claim 2 or 3 wherein the inner surface is a perfect cone with an end shaped as a pointed apex.

8. A surface according to any one of the preceding claims wherein the pockets have a perimeter diameter to height ratio of less than three to one.
9. A surface according to claim 8 wherein the pockets have a perimeter diameter to height ratio of around two to one.
10. A surface according to claim 1 wherein the inner surface includes a region in the form of an inverted pyramid.
11. A surface according to claim 10 wherein the closed perimeter is in the form of the inverted base of the pyramid.
12. A surface according to claim 11 wherein the inverted base of the pyramid has three or four or more sides.
13. A surface according to any one of claims 10 to 12 wherein the pyramid has a base width to height ratio of less than three to one.
14. A surface according to claim 13 wherein the pyramid has a base width to height ratio of around two to one.
15. A surface according to any one of the preceding claims wherein the formations include recesses that are below the inner wall surface.
16. A surface according to any one of claims 1 to 14 wherein the formations include protrusions that are above the inner wall surface.
17. A surface according to any one of the preceding claims wherein at least some of said pockets each having three or more formations resulting in the surface having three or more images, as the case may be, each viewable from a different angle.
18. A surface according to any one of the preceding claims wherein the linear regions act as a reflective backdrop for the images created by the formations.

19. A surface according to any one of the preceding claims wherein the formations of each pocket are positioned closer to the perimeter of the pocket than the end of the pocket.
20. A surface according to any one of the preceding claims wherein the linear regions are inclined.
21. A surface according to any one of the preceding claims wherein the surface is formed as a face of a coin.
22. A surface according to any one of the preceding claims wherein the surface is made of metal.
23. A surface according to any one of the preceding claims wherein the pockets and formations are made by engraving.
24. A surface according to any one of claims 1 to 22 wherein the pockets and formations are made by stamping.
25. A surface according to any one of the preceding claims wherein each pocket has a central axis and all points on the perimeter thereof are generally within a limited distance from the axis.
26. A surface according to claim 25 wherein all points on the perimeter thereof are equidistant from the axis.
27. A surface according to any one of the preceding claims wherein the pockets are non-elongated.
28. A method of creating a surface having multiple images each viewable from a different angle, the method including the steps of:

creating on a surface a plurality of pockets each having a closed perimeter and an inner wall surface having a plurality of linear regions,

creating, at least in some of the pockets, a first formation on one of the linear regions thereof, each formation being a fragment of a first image such that all the first formations are able to combine to create the first image which is viewable only from a first angle, and

creating, in at least some of said pockets, further formations on other linear regions of the same pocket, the further formations being fragments of further images each viewable from a different angle.

29. A method according to claim 28 wherein the inner surface includes at least a frusto-conical region.