(54) Title: GRIP ENHANCING MATERIAL HAVING MINIATURIZED SUCTION CUPS AND METHOD AND APPARATUS FOR MAKING THE SAME

(57) Abstract: An enhanced gripping surface is provided by an array of miniature suction cups. The suction cups are formed with a tooling structure having a pair of plates. A first plate includes a plurality of holes and a second plate includes a plurality of pins. When the plates are placed together, small cavities are created between the holes and pins for forming suction cups using a molding or similar process. Alternatively, suction cups can be used for forming a glove form for using in a latex dipping process.
GRIP ENHANCING MATERIAL HAVING MINIATURIZED SUCTION CUPS AND METHOD AND APPARATUS FOR MAKING THE SAME

TECHNICAL FIELD

The present invention relates to a material connected to an objects for improving gripping. More particularly, it relates to a material having miniaturized suction cups on a glove or other object for improved gripping performance.

BACKGROUND ART

Various types of work and athletic gloves are used to increase the gripping strength and control of the user. Some such gloves have friction material at least at locations where the user's hand contacts the object. However, the gripping capacity of the friction material can significantly decrease under certain conditions, such as water or other foreign matter on the glove or the object. Furthermore, friction material provides little increase in gripping capacity for objects with uneven and irregular surfaces.

Several structures on the surface of a glove have been proposed to provide improved gripping strength and control. U.S. Patent No. 6,081,928 discloses a glove with enhanced grip strength through the use of indentations that form a suction. Alternatively, it discloses a glove with suction cups formed on the surface. Similarly, U.S. Patent No. 6,427,248 discloses a grip-enhancing glove with suction cups of various sizes. These structures work best on smooth surfaces. They are unable to provide a enhanced grip for uneven or irregular surfaces.

DISCLOSURE OF INVENTION

According to one aspect of the present invention, a glove has an enhanced gripping surface. The enhanced gripping surface is achieved through the use of extremely small suction cups. The suction cups have a diameter of less than 1/32\textsuperscript{nd} of an inch. According to one aspect of the invention, the suction cup diameter is approximately 1/64\textsuperscript{th} of an inch. According to another aspect of the invention, the suction cups have a density greater than 300 per square inch. According to another aspect of the invention, the suction cups have a density of approximately 600 per square inch. According to another aspect of the invention, the suction cups of the enhanced gripping surface have a conical shape. According to another aspect of the invention, the suction cups have an angle of approximately 120\textdegree. According to another aspect of the invention, the enhanced gripping surface is used on a variety of surfaces. The array of suction cups is formed and attached to the desired surface. Alternatively, the array of suction cups is formed as part of the surface. Surfaces
may include the sole of shoes. Additionally, the enhanced gripping surface may be used on objects.

According to another aspect of the invention, specialized tooling and tooling process is used to form suction cups for the grip enhancing surface. The tooling includes a first plate having a plurality of holes corresponding to the plurality of suction cups. Each hole includes a cylindrical end and a conical shoulder. The tooling includes a second plate having a plurality of small diameter pins. Each of the pins is positioned to fit within a hole in the first plate. Each pin has a conical top surface. When the two plates are engaged, a space remains between the top surface of each pin and the conical shoulder of the corresponding hole.

According to another aspect of the invention, a process for creating the tooling allows the formation of a dense array of small suction cups. The process utilizes the first plate for forming the pins before complete drilling of the first plate holes. A plurality of holes are drilled in the first plate. The shape of the holes corresponds to the shape of the pins. The second plate with the pins is formed through casting in the drilled holes. Once the second plate is removed, the holes are redrilled in the final shape.

**BRIEF DESCRIPTION OF DRAWINGS**

Fig. 1 is a perspective view of a plurality of suction cups of a grip enhancing surface according to an embodiment of the present invention.

Fig. 2 is a cross sectional view of one of the suction cups of Fig. 1.

Fig. 3 is a front view of a first tooling plate according to a first embodiment of the invention.

Fig. 4 is a cross sectional view of the first tooling plate of Fig. 3.

Fig. 5 is a cross sectional view of hole within the first tooling plate and second tooling plate according to the first embodiment of the present invention.

Fig. 6 is a front view of a first tooling plate according to an embodiment of the invention.

Fig. 7 is a cross sectional view of a hole within the first tooling plate and second tooling plate according to a second embodiment of the present invention.

Fig. 8 is a cross sectional view of a hole within the first tooling plate and second tooling plate according to a third embodiment of the present invention.

Fig. 9 is a cross sectional view of a hole within the first tooling plate and second tooling plate according to a fourth embodiment of the present invention.
Fig. 10 is a cross sectional view of a hole within the first tooling plate and second tooling plate according to a fifth embodiment of the present invention.

Fig. 11 is a cross sectional view of a tooling system for formation of a second tooling plate according to an embodiment of the present invention.

Fig. 12 is a front view of a glove form according to an embodiment of the invention.

MODES FOR CARRYING OUT THE INVENTION

The present invention relates to a grip enhancing material. The material can be added to a glove, shoe or other object to provide an improved gripping force. The material includes a plurality of miniaturized suction cups formed in an array. The processes of the present invention allow suction cups to be formed having diameters on the order of 0.05 to 0.03 inches, or less. Such suction cups are smaller than prior art suction cups. Suction cups of this size are not clearly visible to the naked eye as suction cups. The grip enhancing material appears textured. However, the suction cups can provide significant holding power.

A first embodiment of the present invention is illustrated in the perspective view of Fig. 1. The first embodiment 10 includes a plurality of miniaturized suction cups 21, 22, 23, 24 formed on an array. The array may include any number of rows of suction cups and any number of cups per row. Furthermore, the array may have various shapes.

According to an embodiment of the invention, the array of suction cups are positioned on portions of a glove (not shown). Such portions may include any combination of the palm, fingers, thumb, or parts thereof. According to an embodiment of the invention, the suction cups are formed directly in or on the material of the glove, as an integral part thereof. According to another embodiment of the invention, the suction cups are formed on a material which is attached to the glove. The material with the suction cups may be attached by means of glue, stitching, heat sealing, RF Welding, induction sealing, bonding, or any other manner. The invention may also be used on other objects for which enhanced gripping is useful. For example, an array of suction cups may be positioned on soles of shoes.

Fig. 2 is a cross sectional view of a suction cup along the line II-II in Fig. 1. The suction cup 23 is formed upon a base 35 of material. The same material is used for the suction cup 23 and the base 35. Preferably, the suction cup 23 is molded with the base 35. The suction cup 23 includes a stem 31 and a body 32. The body 32 has a conical inner
surface 33 and a conical outer surface 34. According to an embodiment of the invention, the sides of the conical surfaces are at 120°. Of course, other shapes could be used for the body, including concave shapes. The body thickness is approximately 0.005 inches. The stem is cylindrical with a diameter of approximately 0.012 inches and a height of approximately 0.015 inches. Of course, other dimensions could be used. The shape of the suction cup array, number of cups, and the size of the cups can be decreased or increased to control the grip strength. The design would depend on the application and how much grip strength is needed to suit the application.

Fig. 3 illustrates a tool for forming suction cups in accordance with the present invention. The tool is a plate 100 having a plurality of holes 110 through the plate. The holes 110 are spaced apart to form the pattern for the suction cups. As illustrated in Fig. 3, the holes may be approximately 0.043 inches between lines. The lines of holes may be offset as in Fig. 3 or may be aligned. The number and arrangement of the holes 110 depends upon the desired positions of the suction cups. In addition to the plate 100, a second plate (not shown) having a plurality of pins is used in forming the suction cups. The plurality of pins are positioned on the second plate to align with the holes 110 in the first plate. When engaged, the pins of the second plate are disposed within the holes 110 of the first plate 100. The first plate 100 includes a plurality of joining holes 130. Fig. 3 illustrates four joining holes 130 positioned outside the dimensions of the array of holes 110. Similar, aligned holes are present in the second plate. The joining holes 130 are threaded so that a screw or bolt can be screwed through the holes in the second plate into the first plate 100. Thus, the two plates are held tightly together during formation of the suction cups.

The holes 110 have a specific shape for forming the suction cups. The shape is illustrated in Figs. 4 and 5. The holes 110 are formed of several cylindrical parts, with conical parts connecting the different diameter cylindrical parts. A pin 120 is position within each hole 110. As illustrated in Fig. 5, each hole includes a first portion having a first diameter. The sides 111 of the first portion are substantially perpendicular to the surface of the plate 100. The first portion has a depth of approximately 0.005 inches. A second portion extends from the first portion of the hole 110. The second portion has a conical surface 112 extending from the first portion. A third portion extends from the second portion. The third portion includes a cylindrical side 113. The third portion has a depth of approximately 0.035 inches. Another conical surface 114 forms a fourth portion of
the hole 110. The angle of the fourth portion is the same as for the third portion. A fifth portion has a cylindrical side 115 which extends to the opposing side of the plate 100. The pin 120 has a diameter substantially the same as the fifth portion of the hole. The tip of the pin has a conical surface 121 of the same angle as the second and fourth portions of the hole. When the pin 120 is engaged in the hole 110, the conical surface 121 of the tip abuts the conical surface 114 of the fourth portion of the hole 110. The tip of the pin 120 further extends into the area of the third portion of the hole. The space between the plate 100 and the pin 120 forms the shape of the suction cups.

Fig. 6 illustrates another embodiment of an array of suction cups. It is a front view of a tool plate 150 having a plurality of holes 160 in an array for forming the suction cups. In this embodiment, the array is approximately three inches by three inches. Adjacent rows of holes are approximately 0.043 inches apart and offset from each other. Of course, any other size of array or spacing between rows can be used. Similarly, different sized holes can be used to create different sized suction cups.

The suction cups of the present invention can have different shapes. The structures of the tools 100 having holes 110 and pins 120 can be adjusted to provide different shaped suction cups. Figs. 7-10 illustrate various embodiments of the invention. If Fig. 7, a tool according to a second embodiment of the present invention for forming the suction cup includes a plate 200 has a plurality of holes 210. Each hole 210 includes a first portion with cylindrical sides 211 substantially perpendicular to the surface 205 of the plate 200. A second portion extending from the first portion has a conical surface 212. A third portion, with cylindrical sides 213, extends from the second portion to the opposing surface of the plate. As in the first embodiment, a pin 220 is positioned in each hole 210. The pin 220 has cylindrical sides and a diameter substantially the same as the third portion of the hole 210. The tip of the pin has a conical surface 221. The angle of the conical surface 221 of the pin is approximately the same as the conical surface 212 of the second portion of the hole 210. The pin is positioned so that the tip is spaced apart from the second portion of the hole to provide a space for formation of the suction cups.

Another embodiment, as illustrated in Fig. 8, includes a tool plate 250 having a plurality of holes 260 similar to those of the first embodiment in Fig. 5. Each hole 260 includes a first portion having a first diameter. The sides 261 of the first portion are substantially perpendicular to the surface 255 of the plate 260. The first portion has a depth of approximately 0.005 inches. A second portion extends from the first portion of the hole.
260. The second portion has a conical surface 262 extending from the first portion. A third portion extends from the second portion. The third portion includes a cylindrical surface 263 extending substantially perpendicular to the surface 255 of the tool plate 260. The third portion has a depth of approximately 0.035 inches. A fourth portion forms a flat ring surface 264 substantially parallel to the surface 255 of the tool plate 260. A fifth portion has a cylindrical side 265 which extends to the opposing side of the plate 260. The corresponding pin 270 for this embodiment has a diameter substantially the same as the fifth portion of the hole. The tip of the pin has a flat surface 271 positioned at the center of the hole 260. A second portion of the tip of the pin 270 has a conical surface 272 of the same angle as the second portion of the hole 260. A third portion forms a flat ring 273. When the pin 270 is engaged in the hole 260, the flat ring 273 of the tip of the pin 270 abuts the flat ring 264 of the fourth portion of the hole 260. The tip of the pin 270 further extends into the area of the third portion of the hole. The space between the plate 250 and the pin 270 forms the shape of the suction cups.

A fourth embodiment of the suction cup shape, illustrated in Fig. 9, is also similar in shape to the first embodiment. The hole 310 has the same shape as the hole 110 illustrated in Fig. 5. The pin 220 is also similar in shape, but includes a flat tip 321 in the center of the hole 310. Similarly, a fifth embodiment of the suction cup shape, illustrated in Fig. 10 is similar in shape to that of the second embodiment of Fig. 7. The hole 360 is identical to that of the hole 210 of Fig. 7. The pin 370 includes a flat tip 371 at the center of the hole 360.

A unique process is used for manufacturing the tooling used for forming the suction cups of the present invention. The first plate is formed from a block of steel or similar material. A plurality of holes is drilled in the first plate. The holes are positioned according to the desired pattern for the suction cups. The holes are drilled in a multi-step process. First, the holes are drilled in the shape of the pins, as illustrated in Figs. 4, 5, and 7-10. These holes are used to form the array of pins. Fig. 11 illustrates a structure 400 for forming the second plate and pins. The structure 400 is attached to the first plate 100. The structure 400 includes a fill plate 410 and a plurality of spacers 420. The spacers are placed between the first plate 100 and the fill plate 410. A threaded bolt 430 extends through the fill plate 410 and spacer 420 into the first plate 100. The fill plate 410 includes a fill hole 411 in the center.

The pins are cast in the holes in the first plate 100 by forcing material through the fill hole 411. Any material may be used to cast the pins. Preferably, the pins are formed
using a metal material. Once the pins are formed, they are separated from the first plate as an array on the second plate. The spacers 420 create the holes in the second plate for attaching it to the first plate for forming the suction cups.

Following separation, the holes in the first plate are redrilled. The redrilling deepens the holes to form the space for the conical portion of the suction cups. The space for the stems for the suction cups is also formed.

The second plate with the array of formed pins is reinserted into the redrilled holes of the first plate. The spaces formed by the redrilling are used for creating the array of suction cups for the enhanced gripping surface of the present invention. The array of suction cups may be formed within the spaces using any known technique, such as by casting or injection molding. Such techniques may include heating and treating materials during formation under pressure or vacuum. According to an embodiment of the invention, a molding process is used to form the suction cups. Once the material in the molding process has cured, the plates are separated such that the pins are removed from the holes. The material can then be peeled from the first plate. The suction cups are withdrawn from the holes.

The technique used will depend, in part, upon the materials used for the suction cups. Various materials can be used depending upon the desire use of the glove or other object incorporating suction cups of the present invention. For medical gloves, latex, natural rubber, enzyme treated natural rubber, polychloroprene and polyisoprene latex could be used. Of course, these are only examples of materials and the present invention is not limited to the use of any particular material.

In the process discussed above, an array of suction cups is formed in a molding process. The array can be then be attached to a glove or other object. Alternatively, molds could be formed for the glove or other object with shaped holes for the suction cups. Fig. 12 illustrates a mold 500 for use the typical process of forming medical gloves through a dipping process. In order to apply the suction cups to the form, a multiple mold process is used. First, a set of suction cups is formed using the tooling as discussed above. The suction cups are attached to a glove form. A mold is then made of the glove form with the suction cups. A second form 500 is molded within the mold. The second form includes holes 510, 520 for the suction cups to form. Fig. 12 illustrates suction cups on the thumb and forefinger. Of course, suction cups could be placed at any locations on the form and the
resulting glove. A standard latex dipping process is used to create the gloves. When the gloves are formed and inverted, they include suction cups on the desired portions.

Having disclosed at least one embodiment of the present invention, various adaptations, modifications, additions, and improvements will be readily apparent to those of ordinary skill in the art. Such adaptations, modifications, additions and improvements are considered part of the invention which is only limited by the several claims attached hereto.
CLAIMS

1. A grip enhancing material comprising:
   a flexible base material; and
   a plurality of suction cups extending from the base material, the suction cups having
   a diameter less than 0.06 inches.
2. The grip enhancing material according to claim 1, wherein the plurality of suction
   cups is formed jointly with the flexible base material.
3. The grip enhancing material according to claim 1, wherein each of the suction cups
   include:
   a stem extending from the base material; and
   a concave cup extending from the stem opposite the base.
4. The grip enhancing material according to claim 3, wherein the concave cup includes:
   a convex conical surface facing the base material having a first angle relative to the
   base material;
   a concave conical surface, having a second angle relative to the base material,
   wherein the first angle and second angle are substantially the same; and
   a side wall extending cylindrically between the convex conical surface and the
   concave conical surface.
5. The grip enhancing material according to claim 4, wherein the concave conical
   surface extends substantially to a point.
6. The grip enhancing material according to claim 4, wherein the concave cup includes
   a flat, circular surface in the center of the concave conical surface.
7. The grip enhancing material according to claim 4, wherein the concave cup includes
   a flat, ring surface between the side wall and the concave conical surface.
8. The grip enhancing material according to claim 1 further comprising an attachable
   surface on the base material opposite the suction cups for attaching the grip enhancing
   material to an object.
9. The grip enhancing material according to claim 8, wherein the attachable surface
   allows attachment to a glove.
10. A tooling system for creating at least one suction cup, the tooling system
   comprising:
       a first plate having at least one hole therethrough; and
       a second plate, attachable to the first plate, having at least one pin extending
therefrom positioned to be disposed within the at least one hole when the second plate is attached to the first plate.

11. The tooling system according to claim 10, wherein when the at least one hole and at least one pin are sized such that a suction cup shaped space is formed when the second plate is attached to the first plate.

12. The tooling system according to claim 11, wherein at least one hole includes a first portion of a first diameter and a second portion of a second diameter less than the first diameter, and wherein the at least one pin is has a diameter of the first diameter and is positioned within the first portion of the at least one hole when the second plate is attached to the first plate.

13. The tooling system of claim 10, wherein the at least one hole includes a plurality of holes and wherein the at least one pin includes a plurality of pins.

14. The tooling system according to claim 13, wherein the plurality of holes are arranged in an array and the plurality of pins are arranged in an array.

15. A method for forming a tooling system for forming at least one suction cup, the method comprising the steps of:

- forming at least one hole in a first plate, the at least one hole not extending completely through the first plate;
- casting a second plate on the first plate such that at least one pin is formed in the at least one hole;
- removing the second plate from the first plate; and
- extending the at least one hole through the first plate such that when the at least one pin of the second plate is inserted in the at least one hole of the first plate, a suction cup shaped cavity remains within the at least one hole.

16. A method for forming suction cups using a tooling system having a first plate with holes therethrough and a second plate with pins thereon, the first and second plates being attachable such that the pins extend within a portion of the holes and leave suction cup shaped cavities within a portion of the holes, the method comprising the steps of:

- attaching the second plate to the first plate such that the pins are disposed within the holes;
- depositing a viscous material on a surface of the first plate opposite the second plate so that a portion of the material passes within the suction cup shaped cavities and a portion of the material remains on a surface of the first plate;
curing the material to solidify the material;
removing the second plate from the first plate; and
removing the cured material from the first plate. 17. A method for forming a glove
having a plurality of suction cups on a portion therefore, the method comprising the steps
of:
creating a glove form;
adding a plurality of suction cup shaped cavities to the glove form at the portions
thereof;
creating a mold of the glove form and suction cup shaped cavities;
creating a second glove form from the mold; and
forming a glove with the second glove form using a dipping process.
Fig. 1

Fig. 2

SUBSTITUTE SHEET (RULE 26)
Fig. 3

Fig. 4

Fig. 5

SUBSTITUTE SHEET (RULE 26)