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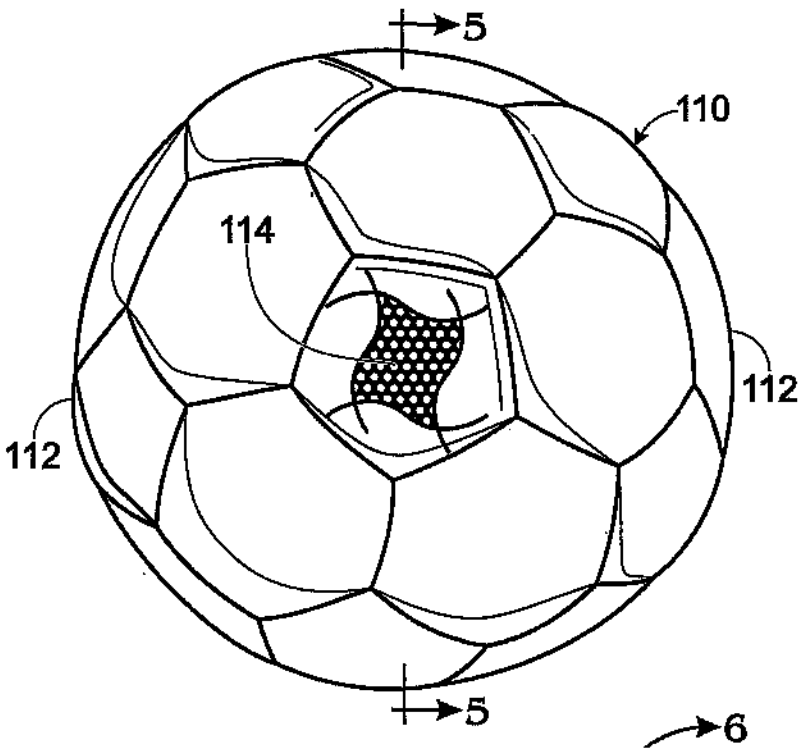
(54) **Title:** DIMPLED INFLATABLE GAME BALLS



(57) **Abstract:** An inflatable game ball with a plurality of air-turbulence-producing depressions (22) distributed over a majority of the outer surface of the skin (16). The depressions produce a preferably circular surface shape, with a breadth of less than about one-quarter inch (6.4 mm) and preferably having a breadth to depth ratio of about 2 to about 6. The game ball of the present invention is preferably a soccer ball (110), or alternatively an American-style football (10), wherein the depressions are distributed substantially uniformly over the majority of the outer surface. A method for providing the game ball with altered aerodynamic performance may include forming depressions by embossing the skin or molding depressions therein.

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DIMPLED INFLATABLE GAME BALLS

This application claims the priority of U.S. Patent Application 10/992,522, filed Nov. 17, 2004.

Field of Invention

This invention relates to altering the aerodynamic behavior of inflatable game balls by providing air-turbulence-generating depressions in the surface thereof.

Background

In sports involving throwing, hitting, kicking or otherwise impelling a game ball, the performance characteristics of the ball can greatly affect the play of the game. Properties of the ball such as the inflation pressure, rigidity, and surface characteristics all influence the speed with which the ball can be projected and the attributes of its flight. Although the size, shape and weight of a particular kind of ball are typically governed by the traditions and rules of the given game, it is possible to modify or improve the performance properties of a ball through altering its surface properties. For instance, tennis balls with differing surface properties of their felt coverings and different rigidities or inflation pressures are well known to be used under different circumstances.

Golf balls, which are of solid construction having an enameled surface covering and a relatively dense resilient core formed of rubber or synthetic plastics, ordinarily are covered by dimples. In the history of development of the golf ball, the surface was originally smooth, but it was discovered from the experience of golfers that a dented ball whose surface had been more or less covered with minute depressions caused by impacts on the ball of hard objects flew further. Golf balls were then deliberately covered with dents or dimples, small depressions in the surface, substantially over their entire surface. This surface texturing provided such a distinct advantage that today all golf balls are covered with such dimpling. The depressions on a typical golf ball are about 1-3 mm (.04-.12 inches) in diameter and about 0.5-1.5 mm (.02-.06 inches) in depth, and are distributed over the surface uniformly. The physical basis underlying the improved flight characteristics of the dimpled golf ball has been explained as resulting from turbulent flow of the air around a dimpled ball which in turn causes less "flow separation" and a

reduced aerodynamic resistance to the ball's travel. Lift may also be generated by a traveling golf ball which has been hit to impart a backspin.

Few other examples of surface texturing designed to affect the aerodynamic performance, as opposed to the grip, of game balls appear to be known. Another solid and not inflatable ball, the baseball, has been modified by covering the surface with depressions of a size similar those found on golf balls. U.S. Patent No. 4,256,304 discloses a baseball suitable for use in an automated pitching machine that is substantially covered with a multiplicity of cup-like or hemispherical depressions. This modification is disclosed to enable the ball to travel greater distances with enhanced accuracy.

Depressions on an inflatable spherical game ball have been disclosed in U.S. Patent No. 5,518,234, although the depressions are much larger than those used on golf balls. The depressions are stated to be for the purpose of improving the player's grip on the ball, a basketball, which is gripped by the player's hand. Each depression is of an approximate size to a fingertip to allow the player to grip a ball having a larger convex surface than is otherwise possible. No disclosure is provided regarding any alteration of aerodynamic properties of this ball. The dimples of this basketball are stated to be in the same proportion to the ball's diameter as the dimples on a golf ball to the golf ball's diameter; thus the basketball of this disclosure visually resembles a greatly oversized golf ball and the depressions are thus much larger than those found on a golf ball.

The type of ball used in the game of American-style football possesses an almost unique shape among the various types of game balls; perhaps only the ball used in the games of rugby and Australian football resemble the elongate American-style football. The term "generally prolate-spheroidal shape" is used herein as a convenient characterization of a ball having, in essence, the shape of an American-style football or a rugby ball, and not in the strict mathematical sense of an ellipse rotated about its major axis. When the term "football" is used herein, it is understood to refer to a ball of the same general shape as an American-style football or a rugby ball, rather than to the spherically shaped "football" or "soccer ball" that much of the world outside the United States usually understands the word to mean.

The unusual shape of the American-style football produces some unique properties of flight when it is thrown, as rotation imparted to the ball such that it rotates about its longitudinal axis produces quite a different resulting flight than does rotation imparted to the ball about any other axis. The football being circular in transverse section but oval shape in longitudinal section, the first kind of rotation produces a "spiraling"

flight in which the ball translates along a path defined by the longitudinal axis of the ball while spinning about that axis, whereas the second kind of rotation results in the ball tumbling end over end. In a spiraling flight, rotation or "spin" of the football about its longitudinal axis provides for lessened aerodynamic resistance to forward travel as the ball is gyroscopically stabilized to translate point first through the air, a configuration that is more streamlined than a tumbling flight produces. The rotation of the ball also provides for a more stable trajectory, similar to the stability of flight imparted to a bullet fired from a rifled gun barrel. Minor imperfections in the surface which would otherwise result in deviation from the planned flight path or unpredictability of position after the ball has traveled some distance, are averaged out by the spinning action, so the flight is more true.

The surface of the football is typically smooth but may be slightly convexly textured to aid in gripping the ball. A common form of surface texturing to aid in gripping the ball on a football is a knobbly texture consisting of small bumps projecting outwardly from a base, covering the exterior of the ball. While regulation footballs also have a laced seam whereby an air bladder is placed inside the outer skin of the ball, which may also be gripped by the player and where the fingertips of someone endeavoring to throw the football are placed in common practice, many footballs such as those molded from plastic do not have a separate air bladder which must be inserted into the shell, but are inflated with a needle and thus do not have laces, or have only simulated laces. Otherwise, apart from the surface texturing, the football typically has a featureless surface except for the seams where the leather segments typically used to form the intact skin are joined together.

A number of examples of texturing of the surface of a football can be found. U.S. Patent No. 2,866,644 discloses a football with a "non-slip" surface for improving the grip of the ball by the player. The surface is covered with ribbing whose main axis is at an angle of about 30 degrees to the longitudinal axis of the football. U.S. Patent No. 4,772,020 discloses a football with helical groove that provides for improved handling. U.S. Patents Nos. 5,851,161 and 5,984,812 disclose a grippable surface for throwable objects including footballs which comprise a mesh panel that fits over the surface of the ball. U.S. Patents Nos. D488,524 and D491,240 show a football with pyramidal pebble texturing of the surface. However, these various texturing features address the handling of the football, rather than the aerodynamic properties of the football.

Summary

The present invention provides an inflatable game ball with a plurality of air-turbulence-producing depressions distributed over a majority of the outer surface of the skin. The depressions are preferably distributed over the majority of the outer surface of the skin and have sufficient depth and breadth to cause air turbulence adjacent the surface of the skin when the ball is moving through the air. The depressions are preferably circular in shape, with a breadth of less than about one-quarter inch and preferably having a breadth to depth ratio equaling about 2 to about 6, and a surface density of about 23 to about 27 depressions per square inch (3.5-4.2 depressions per square centimeter).

In one embodiment, the inflatable game ball of the present invention is a soccer ball substantially covered by a plurality of the air-turbulence-producing depressions.

In another embodiment, the inflatable game ball of the present invention is a generally prolate-spheroidal game ball such as an American football with a plurality of air-turbulence-producing depressions distributed over a majority of the outer surface of the skin.

Description of the Drawings

Figure 1 shows side view of a preferred embodiment of a dimpled inflatable game ball, a prolate-spheroidal game ball according to the present invention.

Figure 2 shows a cross-sectional view of the football of Figure 1.

Figure 3 shows a detailed cross-sectional view of a portion of the skin of the football of Figure 1.

Figure 4 shows a side view of a preferred embodiment of a dimpled inflatable game ball, a soccer ball according to the present invention.

Figure 5 shows a cross-sectional view of the soccer ball of Figure 4.

Figure 6 shows a detailed cross-sectional view of a portion of the skin of a soccer ball of Figure 4.

Detailed Descriptions of Preferred Embodiments

Referring to Figure 1, a preferred embodiment of a dimpled inflatable game ball according to the present invention comprises an American-style football **10**. As viewed from the side of its elongate axis, the football is substantially elliptical in shape, although the ends **12** are typically blunt rather than smoothly curving as in a perfect ellipse. However, the ends may be smoothly curving as in a rugby ball, rather than blunt, without departing from the principles of the present invention. Elsewhere the outer surface **14** of the football forms a smooth monotonic curve. In the preferred embodiment, the football has a length of about 11 ½ inches (29.2 cm), a diameter of about 6 ½ inches (16.5 cm), and a measurement from end to end over the surface of the football of about 13 ½ inches (34.3 cm). The football **10** is circular in any cross-section taken perpendicular to the elongate axis of the ball. The cross section taken along the mid-point line of Figure 1 in the plane of longitudinal symmetry of the ball has the greatest diameter.

The football **10**, which is hollow and formed of an at least moderately flexible skin **16**, sometimes enclosing an air bladder **18** as is shown in Figure 2, preferably assumes substantially the dimensions stated upon inflation with air or another suitable gas. The skin is preferably formed of leather, rubber, plastic, or similar suitable material that is both at least moderately flexible and is resistant to tearing or puncturing. The preferred air bladder, which may be constructed of any suitable material, pressurizes the skin upon inflation.

Alternatively, the skin of the football may be inflated by a foam material in which the gas pressure in the foam cells and the elasticity of the foam material serves to pressurize the skin of the ball. In this alternative embodiment, the game ball is not hollow in the strict sense of the word, but is filled with the elastic foam which contains many minute individual hollow cells. Thus, the term "inflated" or "inflatable" in the present disclosure are understood to encompass both types of structure.

Regardless of the means of pressurization of the ball, the skin **16** is preferably tough enough to withstand damaging abrasion during handling and play and to protect the air bladder, if any, from puncture and the resulting loss of air pressure.

Typically, the football is inflated to a pressure within a range suitable to confer sufficient elasticity and rigidity to allow it to be firmly grasped, to maintain its shape when subject to acceleration upon being thrown or kicked, but also permitting elastic deformation allowing the football to bounce, or to be kicked substantial distances. Normally a football equipped with an air bladder is filled with air via a port (not shown) in the skin and bladder that allows for insertion of a hollow needle attached to a source of compressed air, the port then closing to seal the air in the bladder when the needle is removed.

If the skin is formed of leather, it typically comprises several segments of elongated shape that are stitched together at their edges and at the ends to form the covering. If the skin is formed of rubber or plastic, it may be molded into shape. During construction of the football, the air bladder is inserted into the interior prior to the final closing of the skin by stitches, adhesives or the like.

Turning to Figures 2 and 3, this prolate-spheroidal preferred embodiment of a dimpled inflatable game ball according to the present invention is provided with depressions **22** on the surface of the ball; the skin is preferably substantially covered by the small depressions. The depressions serve to create air turbulence when the ball is moving relative to the air. The amount of turbulence created is dependent upon a number

of factors including the size, breadth and depth of the depressions **22**, as well as their shape, their density and distribution over the surface, the total proportion of the surface that is covered by the depressions, and the relative velocity of the skin of the ball to the air. Preferably, about 23 to about 27 depressions per square inch (3.5-4.2 depressions per square centimeter) cover the surface of the football **10**. Preferably the depressions on the football **10** are circular in shape, about 3/16 inch (4.8 mm) in diameter, and about 1/16 inch (1.6 mm) deep with a hemispherical profile as shown in Figure 3. They preferably substantially uniformly cover a majority of or substantially the entire surface of the football, such as in a close-packed hexagonal array, but other arrangements may be employed without departing from the principles of the present invention. The preferred size, shape and distribution of the depressions **22** results in a football of the preferred size and shape having a total number of about 3300 depressions.

Turning to Figure 2, a cross-section of the football shows the skin **16** and an air bladder **18** respectively on the outer and inner surfaces thereof. The depressions **22** are preferably hemispherical in contour in the depth dimension. The un-modified skin areas **24** between the depressions **22** form a substantially continuous surface or network over the surface of the football. Depending on the size and spacing and thus the density of the depressions, the un-modified skin areas may constitute a greater or lesser proportion of the total surface area of the football. In the preferred embodiment wherein there are about 23 to about 27 depressions per square inch (3.5-4.2 depressions per square centimeter), each depression being a circle of diameter 3/16 inches (4.8 mm), the skin areas **24** comprise about 30% and the depressions **22** comprise about 70% of the total surface area of the football **10**.

However, the depressions may be of other shapes, sizes and distributions over the outer skin of the ball without departing from the principles of the present invention. For example, the depressions may be polygonal, or even irregularly shaped. For example, the depressions could be hexagonal in form. The depressions may be close packed, or may be substantially separated from each other over the outer skin of the football.

The depressions serve to alter the aerodynamic properties of the football when it is traveling through the air after being thrown or kicked. The aerodynamic properties of a football of this preferred embodiment are altered to a greater or lesser degree depending upon the variables as outlined above. Analogously to the operation of depressions on a golf ball as described previously, the depressions on the football according to the present invention serve to create air turbulence as the ball flies which lessens aerodynamic

resistance by diminishing "separation of the flow." However, due to the asymmetry of a football, compared to the spherical symmetry of a golf ball, the football according to the present invention displays some unique aerodynamic properties.

Particularly when a football is thrown in a "spiral" pass, as discussed above, the depressions according to the invention on the surface of the football **10** alter the aerodynamic properties of the ball and thus the trajectory of the flight. While a football that is kicked generally tumbles end over end in flight, a spiraling pass will cause the football to rotate only on its longitudinal axis as it translates through the air. The special two-fold motion of the spiraling pass, that is, the forward translational motion and the rotational motion on the longitudinal axis, results in the depressions on the ball's skin bringing about desirable aerodynamic effects. In this type of motion especially, the presence of depressions **22** have an effect compared to when the ball is not spinning or is tumbling. The reduced air resistance to translational motion of a ball covered with depressions, due to diminished separation of the flow of the surrounding air, allows a pass thrown with a given force to travel further due to the reduction in air resistance of the ball in flight. In addition, the reduced air resistance to rotation induced by the depressions allows a ball thrown with an initial rotational impetus to continue to rotate longer and at a higher rate, providing for enhanced stability of flight due to gyroscopic stabilization of the ball's flight.

The depressions **22** may be introduced onto the surface of the football **10** using a variety of suitable methods. If the skin **16** is formed of leather, the depressions may be impressed into the surface through the use of a die under pressure. The leather surface may then optionally be coated, hardened or fixed as is known in the art. Alternatively, a flat leather surface may be ablated by suitable means, such as by drilling or grinding out the recesses, particularly in the case of circular depressions. The leather so-treated is then assembled into the intact ball. If the skin is to be formed of rubber the depressions may either be molded in place prior to vulcanization of the rubber, or may be embossed with a die or ground out as in the case of the leather. If the skin is to be formed of plastic, the depressions may similarly be formed in place during the molding operation when the plastic monomer is polymerized in a mold, or may be embossed or ground subsequent to the polymerization operation. In the case of a plastic ball which may be cast or molded in final three-dimensional form in a single operation rather than as a flat structure or set of structures that are assembled by stitching or gluing as in the case of a leather skin, the depressions may be emplaced at the time of formation of the intact football.

Referring to Figure 4, another preferred embodiment according to the present invention is a substantially spherical inflatable game ball such as a soccer ball, or European-style football, **110**. As viewed from the side, the ball is substantially round, the outer surface **112** forming a smooth monotonic curve except for the slight variation caused by the alternating hexagonal and pentagonal patches that preferably make up the skin **116**. In the preferred embodiment, the soccer ball has a circumference of 27-28 inches (68-70 cm) and thus a diameter of 8.6-8.9 inches (21.6-22.3 cm). The soccer ball **110** is circular in any cross-section.

The soccer ball **110**, which is hollow and formed of an at least moderately flexible skin **116**, sometimes enclosing an air bladder **118** as is shown in Figure 5, preferably assumes substantially the dimensions stated upon inflation with air or another suitable gas. The skin is preferably formed of leather, rubber, plastic, or similar suitable material that is both at least moderately flexible and is resistant to tearing or puncturing. The preferred air bladder, which may be constructed of any suitable material, pressurizes the skin upon inflation. The skin of the preferred soccer ball is typically formed by sewing or gluing together alternating hexagonal and pentagonal patches in the pattern of a truncated icosahedron, with the seams disposed inwardly. However the soccer ball may be constructed from patches of other shapes and patterns without departing from the principles of the invention.

The skin **116** is preferably tough enough to withstand damaging abrasion during handling and play, and to protect the air bladder, if any, from puncture and the resulting loss of air pressure.

Typically, the soccer ball is inflated to a pressure within a range suitable to confer sufficient elasticity and rigidity to allow it to be firmly grasped, to maintain its shape when subject to acceleration upon being thrown or kicked, but also permitting elastic deformation allowing the ball to bounce, or to be kicked substantial distances. For a soccer ball meeting official rules, it is preferably inflated to a pressure of about 8.5-15.6 psi (60-110 kPa). Normally, the ball is filled with air via a port (not shown) in the skin and bladder that allows for insertion of a hollow needle attached to a source of compressed air, the port then closing to seal the air in the bladder when the needle is removed. Alternatively, the ball may be filled with an elastic foamed material, preferably a plastic, wherein the gas that is trapped within the cells of the foam provides resiliency. When the term "inflated" or "inflatable" is used herein, it is defined as covering both means of providing internal air pressure to keep the ball elastic.

As shown in Figure 5, the preferred soccer ball according to the present invention is provided with depressions **122** on the surface of the ball; the skin is preferably substantially covered by the small depressions. The depressions have sufficient depth and breadth to cause air turbulence adjacent the surface of the skin when the ball is moving through the air. The amount of turbulence created is dependent upon a number of factors including the size, breadth and depth of the depressions **122**, as well as their shape, their density and distribution over the surface, the total proportion of the surface that is covered by the depressions, and the relative velocity of the skin of the ball to the air. Preferably, about 23 to about 27 depressions per square inch (3.5-4.2 depressions per square centimeter) cover the surface of the ball **110**, and the depressions **122** on the preferred ball **110** are circular in shape, about 3/16 inches (4.8 mm) in diameter, and about 1/16 inch (1.6 mm) deep with a hemispherical profile as shown in Figure 6. They preferably cover a majority of or substantially the entire surface of the ball substantially uniformly, such as in a close-packed hexagonal array, but other arrangements may be employed without departing from the principles of the present invention. The preferred size, shape and distribution of the depressions **122** results in a game ball the size and shape of the preferred soccer ball **110** having a total number of about 6100 depressions, a section of the pattern of the dimpled texturing **114** being shown in Figure 4, although it is understood that this pattern of dimpled texturing covers substantially the entire surface of the ball.

Turning to Figures 5 and 6, a cross-section of the soccer ball's covering shows the skin **116** and an air bladder **118** respectively on the outer and inner surfaces thereof. The depressions **122** are preferably hemispherical in contour in the depth dimension. The un-modified skin areas **124** between the depressions **122** form a substantially continuous surface or network over the surface of the ball. Depending on the size and spacing and thus the density of the depressions, the un-modified skin areas may constitute a greater or lesser proportion of the total surface area of the ball. In the preferred embodiment wherein there are about 23 to about 27 depressions per square inch (3.5-4.2 depressions per square centimeter), each depression being a circle of diameter 3/16 inches (4.8 mm), the skin areas **124** comprise about 30% and the depressions **22** comprise about 70% of the total surface area of the soccer ball **110**.

However, the depressions may be of other shapes, sizes and distributions over the outer skin of the soccer ball without departing from the principles of the present invention. For example, the depressions may be polygonal, or even irregularly shaped.

For example, the depressions could be hexagonal in form. The depressions may be close packed, or may be substantially separated from each other over the outer skin of the soccer ball.

The depressions serve to alter the aerodynamic properties of the game ball when it is traveling through the air after being thrown or kicked. The aerodynamic properties of a game ball according to the invention are altered to a greater or lesser degree depending upon the variables as outlined above. Analogously to the operation of depressions on a golf ball as described above, the depressions on the game ball according to the present invention serve to create air turbulence as the ball flies, which lessens aerodynamic resistance by diminishing "separation of the flow." Thus, the increased distance that can be achieved by a throw or kick of a given force is a desirable aerodynamic results.

In addition to decreasing aerodynamic resistance, the depressions provide greater control over the soccer ball by a soccer player. That is, they increase the frictional engagement between the player's soccer shoe and the ball so that the player can more easily impart controlled spin on the soccer ball. This controlled spin, together with the air turbulence created adjacent the surface of the ball, enables the soccer player to curve the soccer ball in a desired direction more readily. For example, the player is better able to curve the ball around or over a goalie to make a score.

The depressions **122** may be introduced onto the surface of the soccer ball **110** using a variety of suitable methods, the same as are described above in relation to the preferred football.

The terms and expressions which have been employed in the foregoing specification are used therein as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding equivalents of the features shown and described or portions thereof, it being recognized that the scope of the invention is defined and limited only by the claims which follow.

Claims

Claimed:

1. A game ball, comprising:

a flexible, inflatable skin; and

a plurality of depressions formed in the skin, the depressions being distributed over the majority of the outer surface of the skin and having sufficient depth and breadth to cause air turbulence adjacent the surface of the skin when the ball moves through the air.

2. The game ball of claim 1 wherein said ball assumes a generally spherical shape when inflated.

3. The game ball of claim 2, said game ball being a soccer ball.

4. The game ball of claim 1 wherein said ball assumes a generally prolate-spheroidal shape when inflated.

5. The game ball of claim 4, said game ball being an American style football.

6. The game ball of claim 1, wherein the depressions are distributed substantially uniformly over the outer surface of the skin.

7 The game ball of claim 1, wherein the depressions are distributed in a substantially hexagonal array over the outer surface of the skin.

8. The game ball of claim 1, wherein the depressions form substantially circular shapes in the outer surface of the skin.

9. The game ball of claim 8, wherein the depressions have a diameter of less than about one-half inch (12.7 mm).

10. The game ball of claim 8, wherein the depressions have a diameter of less than about one-quarter inch (6.4 mm).

11. The game ball of claim 8, wherein the depressions have a surface diameter to depth ratio of about 2 to about 6.

12. The game ball of claim 8, wherein the depressions comprise a substantially hemi-spherical surface.

13. The game ball of claim 12, wherein the depressions have a surface diameter to depth ratio of about 2 to about 6.

14. The game ball of claim 1, wherein the ratio of the maximum surface breadth to depth of a majority of the depressions is about 2 to about 6.

15. The game ball of claim 1, wherein the surface density of the depressions is about 23 to about 27 depressions per square inch (3.5-4.2 depressions per square centimeter) inclusive.

16. The game ball of claim 1, wherein the depressions have a diameter of less than about one-quarter inch (6.4 mm).

17. The game ball of claim 1, wherein the skin comprises a material selected from among leather, rubber, or plastic.

18. The game ball of claim 1, wherein the skin forms a hollow inflatable interior.

19. The game ball of claim 1, wherein the skin is inflated by an air bladder.

20. The game ball of claim 1, wherein the skin is inflated by an elastic foam material.

21. A method for providing an inflatable game ball with altered aerodynamic performance, comprising

providing a flexible, inflatable skin;

forming a plurality of depressions in the skin, the depressions being distributed over the majority of the outer surface of the skin and having sufficient depth and breadth to cause air turbulence adjacent the surface of the skin when the ball is moving through the air; and

inflating the game ball with a gas.

22. The method of claim 21, wherein the ball assumes a generally spherical shape when inflated.

23. The method of claim 21, wherein the ball assumes a generally prolate-spheroidal shape when inflated.

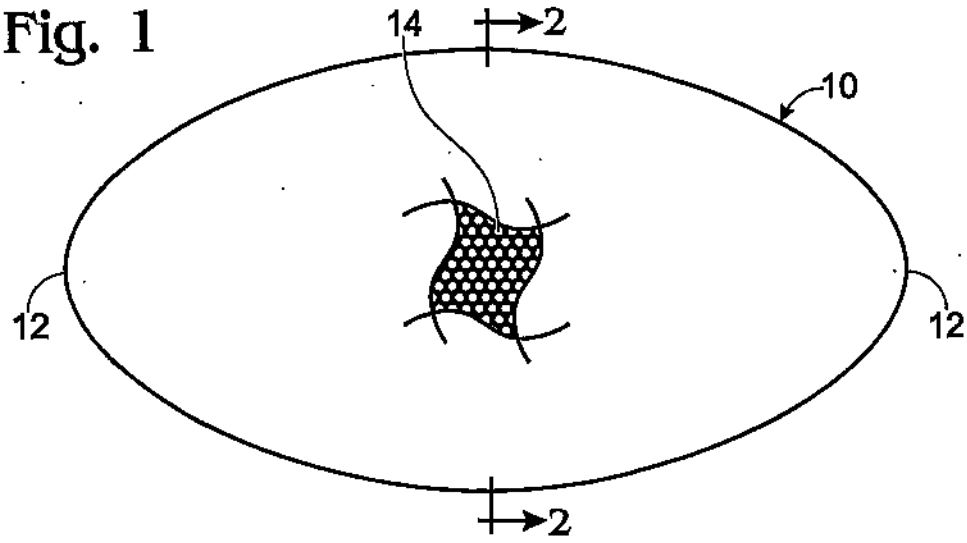
24. The method of claim 21, further comprising distributing the depressions substantially uniformly over the outer surface of the skin.

25. The method of claim 21, wherein the skin provided is comprised of one of rubber or leather, and the depressions are formed in the skin by embossing the skin with a die.

26. The method of claim 25, wherein the skin is first formed as one or more substantially flat sections, all or a portion of the sections are embossed with the depressions, and the one or more sections are thereafter stitched into the hollow, inflatable form.

27. The method of claim 21, wherein the skin provided is comprised of plastic, and the depressions are formed by molding them into the plastic.

Fig. 1



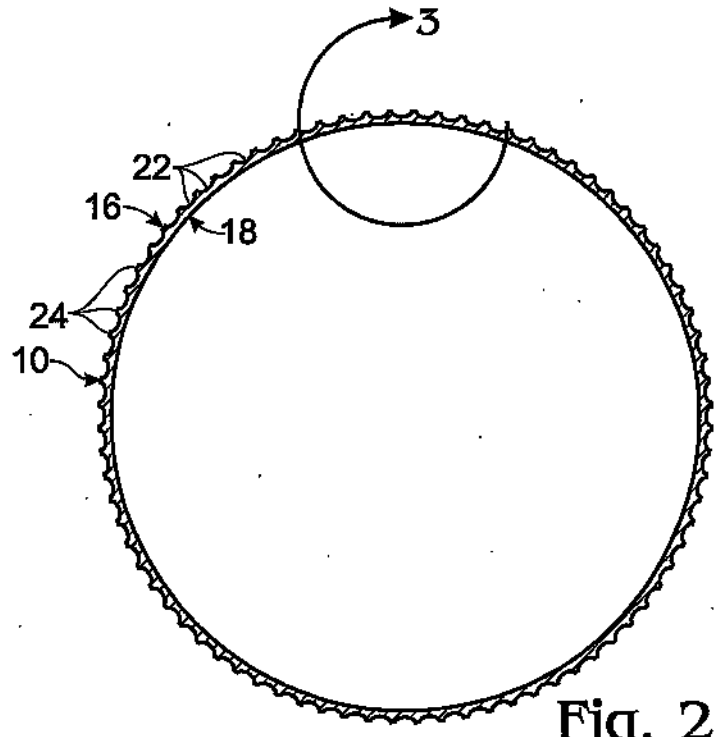


Fig. 2

Fig. 3

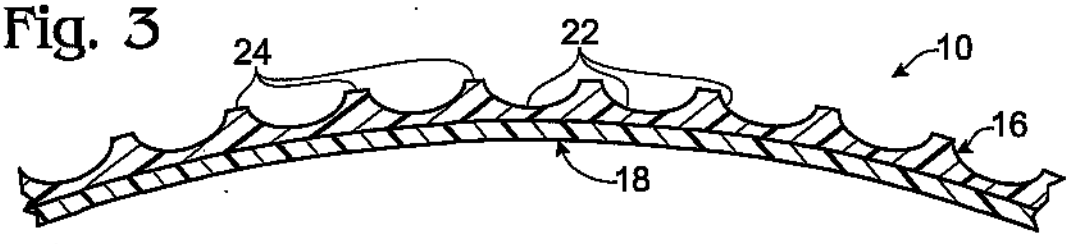
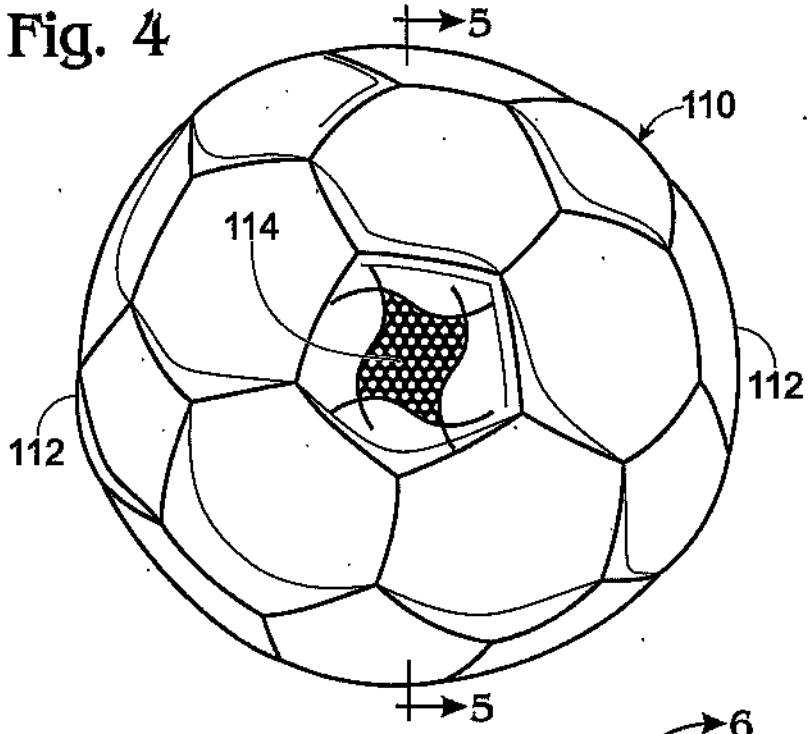


Fig. 4



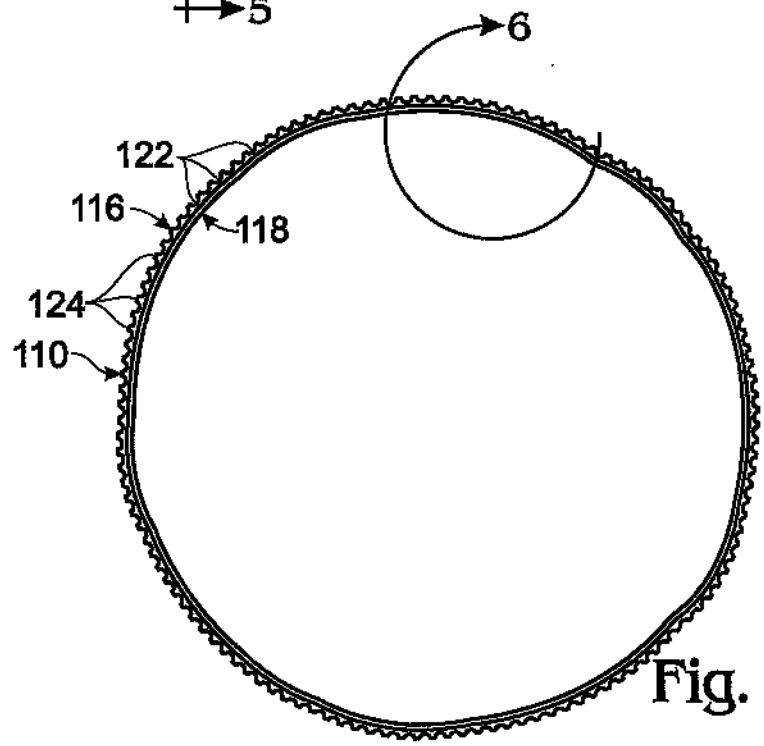
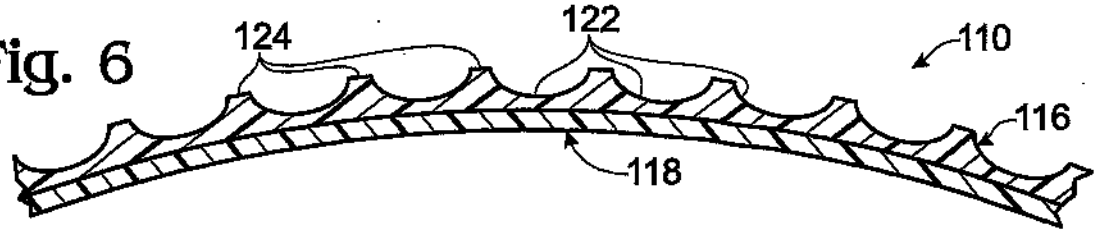


Fig. 5

Fig. 6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US05/41833

A. CLASSIFICATION OF SUBJECT MATTER
IPC: **A63B 41/08**(2006.01)

USPC: 473/599,603,604
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 473/596, 597, 603, 604, 605, 613, 614

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,928,962 A (FINLEY) 29 May 1990 (29.05.1990), see entire document.	1, 4-8, 17-19, 21, 23, 24 --- 2, 3, 9-16, 20,22,25-27
Y	US 5,984,812 A (SASSAK) 16 November 1999 (16.11.1999), see entire document.	9, 10, 16
Y	US 5,228,687 A (LUECKE et al.) 20 July 1993 (20.07.1993), see entire document.	20
Y	US 6,500,082 B1 (OU) 31 December 2002 (31.12.2002), see entire document.	26

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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28 February 2006 (28.02.2006)

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