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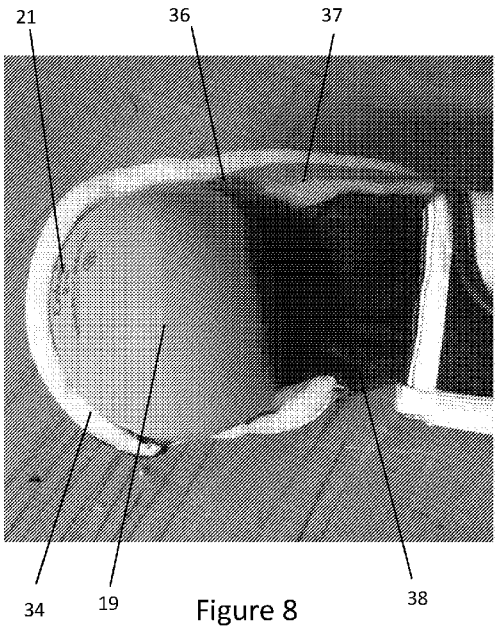


Figure 8

(57) Abstract: Protective equipment, such as a glove for combat sports, with an impact absorbing structure is disclosed. The structure comprises a body defining a space, with the body having at least one opening for the passage of air into and out of the space. The body has an at-rest configuration and a compressed configuration when 5 the body is subjected to an impact force. The structure also comprises a resilient portion that biases the body toward the body's at-rest configuration.

Protective Equipment with Impact Absorbing Structure

Technical Field

The present invention relates generally to protective equipment with an impact absorbing structure.

The present invention relates particularly, although by no means exclusively, to a structure for providing impact force absorption in protective equipment.

The present invention relates particularly, although by no means exclusively, to protective equipment in the form of a glove for combat sports.

Background

In combat sports such as boxing, taekwondo, karate, mixed martial arts and other martial arts, participants commonly wear gloves. The gloves are designed to protect the wearer's hands, in particular their knuckles, from the impact of landing blows on the opponent.

Typically, each glove has a single unitary finger portion that is thickly padded for receiving and protecting all of the wearer's fingers with a separate thumb receiving portion that is of a thinner and more flexible construction. The thumb portion is thinner because, in general, during combat, there is no or very little impact on thumbs. After a person inserts their hands into the glove, they form a fist by clenching their fingers which causes the finger portion of the glove to curl into a fist shape.

There remains however, a need to improve the safety of combat sports, in particular boxing.

More generally, there is a need to improve the safety of a wide range of other protective equipment, including, by way of example only, (a) other sports equipment such as head guards, focus pads, cricket pads, shin pads, chest guards and protective equipment for hockey goalkeepers, and (b) work-related equipment such as construction helmets.

Summary of the Invention

According to an embodiment of the invention, there is provided a glove for combat sports, the glove comprising:

a shell that defines a cavity for receiving a wearer's hand, the shell having a primary impact area at one end of the shell; and

a gas-containing space disposed between the cavity and the primary impact area.

In an embodiment, the cavity is configured to operatively receive the wearer's hand shaped as a fist.

In an embodiment, the glove is formed with a fixed in-use configuration for punching, i.e. it is in a pre-set boxing form prior to the wearer inserting a hand into the cavity.

In an embodiment, the cavity is configured to minimise pre-compression of the gas-containing space when the wearer's hand is received in the cavity.

In an embodiment, the gas-containing space is defined by a body which in one embodiment is in the form of an inflatable bladder.

In an embodiment, the glove comprises a cradle engaging the body to hold the body in position.

In an embodiment, the cradle is integral with a layer of the shell.

In an embodiment, the cradle is in the form of an arcuate member that extends around at least a portion of the body.

In an embodiment, the body is spherical or dome-shaped.

In an embodiment, the body comprises an inflatable bladder.

In an embodiment, the body has at least one opening for the passage of air into and out of the space.

In an embodiment, the opening has a width of 2 – 15mm, typically 2 – 10mm, and preferably 4 – 6mm.

The body may have a plurality of openings.

The opening or openings may be any suitable shape and be in any suitable position.

In an embodiment, the body has an at-rest configuration and a compressed configuration when the body is subjected to an impact force.

In an embodiment, the glove comprises a resilient portion that biases the body toward the body's at rest configuration.

The resilient portion may be formed from any suitable material. By way of example, the resilient portion could be a foam. It could also be any relatively soft material with sufficient resilience to enable it to act as a spring. For example, a coiled or specially configured rubber spring could be used.

In an embodiment, the resilient portion comprises an open cell foam.

In an embodiment, the resilient portion fills the space inside the body.

In an embodiment, the glove comprises an external compressible portion located on the outside of the body, preferably formed of ethylene vinyl acetate (EVA) foam or a visco-elastic polymer or gel.

In an embodiment, the gas-containing space is at a pressure of less than 14kPa, preferably less than 7kPa, more preferably less than 4 kPa, typically less than 2 kPa.

In an embodiment, a portion of the shell around the gas-containing space is adapted to preferentially yield to accommodate deformation of the gas-containing space when a force is received on the primary impact area of the shell.

In an embodiment, a portion of the shell around the gas containing space has one or more pleats.

In an embodiment, the shell has an outer layer and at least one inner layer, the outer layer being configured to slip with respect to one of the inner layers to dissipate forces received to the gloves.

In an embodiment, the outer layer is configured to slip by rotation and/or longitudinally relative to the longitudinal axis of the shell.

In an embodiment, the shell has a slip layer between the outer layer and a resilient inner layer to enable the outer layer to slip with respect to the resilient inner layer.

In an embodiment, the slip layer is provided by talcum powder or silicon or highly elastic rubber.

According to another embodiment of the invention, there is provided a glove for combat sports, the glove comprising a shell that defines a cavity for receiving the wearer's hand, the shell having an outer layer and at least one inner layer, the outer layer configured to slip with respect to one of the inner layers to dissipate forces received to the glove.

In an embodiment, the outer layer is configured to slip by rotation and/or longitudinally relative to the longitudinal axis of the shell.

In an embodiment, the shell has a slip layer between the outer layer and a resilient inner layer to enable the outer layer to slip with respect to the resilient inner layer.

In an embodiment, the slip layer is provided by talcum powder or silicon or highly elastic rubber.

According to another embodiment of the present invention, there is provided a structure for providing impact force absorption in protective equipment, the structure comprising:

a body defining a space, the body having at least one opening for the passage of air into and out of the space, wherein the body has an at rest configuration and a compressed configuration when the body is subjected to an impact force; and

a resilient portion that biases the body toward the body's at rest configuration.

In an embodiment, the body comprises an inflatable bladder.

In an embodiment, the opening has a width of 2 – 15mm, typically 2 – 10mm, and preferably 4 – 6mm.

The body may have a plurality of openings.

The opening or openings may be any suitable shape and be in any suitable position.

The resilient portion may be formed from any suitable material. By way of example, the resilient portion could be a foam. It could also be any relatively soft material with sufficient resilience to enable it to act as a spring. For example, a coiled or specially configured rubber spring could be used.

In an embodiment, the resilient portion comprises an open cell foam.

In an embodiment, the foam fills the space inside the body.

In an embodiment, the structure comprises an external compressible portion located on the outside of the body, preferably formed of ethylene vinyl acetate (EVA) foam.

In an embodiment, when the body is in the at rest configuration, the pressure in the space is atmospheric pressure.

According to another embodiment, there is provided an item of protective equipment incorporating the structure of any one of the above described embodiments.

The item of protective equipment may be a glove, a pad or a guard such as a combat glove, a chest or leg pad or a head guard.

Brief Description of the Drawings

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows components of a glove for combat sports according to an embodiment of the present invention, prior to assembly;

Figures 2 and 3 are top and bottom views of some of the components of Figure 1 assembled into a lower portion of the glove;

Figures 4 and 5 are bottom views of some of the components of Figure 1 assembled into an upper portion of the glove;

Figures 6 and 7 are left and right side views of the assembled glove;

Figure 8 is a cross-sectional side view of the assembled glove of Figures 6 and 7;

Figure 9 is bottom view of the glove of Figures 6 and 7 with the side cut away;

Figure 10 is perspective view of a glove for combat sports according to another embodiment of the present invention;

Figure 11 is another perspective view of the glove shown in Figure 10;

Figure 12 is a perspective view of a bladder of the glove shown in Figures 10 and 11;

Figure 13 shows components of the glove shown in Figures 10 and 11;

Figure 14 is a graph of the impact forces when different glove types were used;

Figure 15 is a graph illustrating the impact force reduction provided by gloves according to embodiments of the present invention;

Figure 16 shows force curves for gloves according to embodiments of the present invention dropped on to a force plate from a height of 3.5m and includes comparison to conventional gloves; and

Figure 17 is another graph illustrating the impact force reduction provided by gloves according to embodiments of the present invention.

Detailed Description of Embodiments

Referring to Figures 1 – 9, there is shown a glove 10 for combat sports in accordance with an embodiment of the invention. The illustrated glove is a left hand glove. In general, gloves are provided and used as a pair of right and left hand gloves. Although only a left hand glove is illustrated, right and left hand gloves of embodiments of the invention are generally of identical construction except for specific shaping to receive respectively right and left hands. For ease of reference, the features of a single glove 10 will be described below and it is to be understood that both right and left hand gloves have the same features. Although the gloves have been specifically designed for boxing, they could be used in taekwondo, karate, mixed martial arts, other martial arts, and other combat sports in which participants wear gloves. It is noted that, whilst the glove 10 is formed to receive an entire hand within the glove cavity, other embodiments of the invention have separate thumb compartments, meaning that the difference in appearance between left and right hand gloves is greater than was previously the case.

As mentioned above, previously gloves have been designed with the aim of reducing impact on the hands of the glove wearer. However, the present invention has been developed from the point of view of reducing the impact on the receiver.

The glove 10 comprises a shell 11 (see Figure 6) which is generally tubular in shape and defines a cavity 12 for receiving the wearer's hand. The shell 11 is formed with a fixed in-use configuration for punching. That is, unlike conventional gloves, the wearer does not curl the glove 10 into a fist shape after putting their hand into the glove cavity 12. Instead the glove 10 is in a pre-set boxing form prior to the wearer inserting a hand into the cavity.

In the illustrated embodiment, the glove 10 has no independent thumb portion (there is a cosmetic thumb patch on the external surface of the shell). Instead the wearer's entire hand is received in the cavity 12 and enclosed by the shell 11. However, in other embodiments there may be a separate thumb cavity internal or external to the shell.

The shell 11 extends along a longitudinal axis between opposed first and second ends 14, 15. At the first end 14 is an opening 16 to the cavity 12 through which the wearer can insert their hand into the cavity 12. The cavity 12 is sufficiently short in length so that a person can only fit their hand in the cavity by clenching their hand into a fist. Advantageously, this prevents inadvertent finger extension and incorrect positioning of the fist of the glove wearer during use of the gloves.

A wrist strap 17 is provided at the first end 14 of the shell to provide wrist support for the glove wearer. The wrist strap 17 is also for securing the glove 10 to the wearer by closing the strap tightly around the wearer's wrist. In the illustrated embodiment, the wrist strap 17 has a Velcro portion for holding the wrist strap in place. However, other securing mechanisms may be used such as loops, press studs or buckles. In other embodiments, instead of a strap, the glove could be secured using laces received through eyelets in the shell.

The second end 15 of the shell 11 is closed to provide a primary impact area 18 at the opposite end of the shell to the opening. The primary impact area 18 is the region of the glove that the wearer aims to use to strike a blow to their opponent. A body in the form of a bladder 19 defines a gas-containing space disposed at the second end 15 of the shell 11 between the cavity 12 and the primary impact area 18. A valve port 20 to the bladder 19 is accessible through the shell 11 from the underside of the glove 10 through which air may be passed to inflate (or deflate) the bladder 19 such as by using needle connected to a conventional bicycle pump. The

bladder 19 is spherical or dome shaped with a curved surface 21 of the bladder facing in the direction of the second end 15 of the shell 11. The dome shape is preferred as it enables the length of the glove to be reduced.

Advantageously, the arrangement of the bladder 19 within the glove means that it is positioned between the wearer's fist and the primary impact area 18. As a result, when the wearer lands a blow on an opponent by striking with the primary impact area, the force of the blow will be cushioned or absorbed by the bladder 19. The applicant has found in test work that, compared to conventional 12 ounce and 16 ounce padded gloves, the impact reduction is substantial at low and moderate impact forces. As a result the potential trauma that can be caused by receiving a blow, in particular to the head, is substantially reduced when the person striking the blow is wearing the glove 10. Furthermore, because the shell 11 of the glove 10 is of a fixed in-use configuration, the wearer's fist is constrained into an alignment with bladder 19 whereby maximum force can only be delivered through the bladder 19 (which is dissipating that force). Also, the shell 11 is configured so that cavity 12 receiving the wearer's hand is entirely located behind the bladder 19 with respect to the primary impact area 18. Thus, the wearer's fist is constrained to a location between the cavity opening 16 and the bladder 19.

Because the bladder 19 can be inflated and deflated, the pressure of the air in the bladder can be adjusted to calibrate the gloves for use in different situations. In general, however, the bladder 19 is configured to be used at low pressure (less than 14kPa, preferably less than 7kPa, more preferably less than 4kP, typically less than 2kP) so that it has sufficient capacity to deform and absorb impact force of a punch. To further enhance this impact absorption, the portion of the shell 11 around the bladder 19 is adapted to readily yield so that the bladder 19 is able to deform, in particular laterally. This is achieved by using a sufficiently flexible material for the shell 11 and/or by providing pleats in the shell.

The relatively short cavity 12, which prevents finger extension as described above, also limits how far a person's fist can be inserted into the glove 10. Advantageously, this limits excessive forward positioning of the fist which could cause pre-compression of the bladder, compromising capacity for further deformation and reducing impact force absorption.

Specific details of the construction of the glove will now be described.

The shell 11 comprises an upper portion 30 and a lower portion 31. The upper and lower portions 30, 31 are stitched together to form the glove shell. Each portion 30, 31 of the shell is formed from at least two layers including an outer layer 32, 33 that is formed from a resilient and durable material such as leather and at least one inner layer. One of the inner layers 34, 35 is formed from a padding material (foam in the illustrated embodiment) to absorb the forces of side impacts on and by the gloves. Even though the intention of the wearer of the glove will be to strike their opponent with the primary impact area 18 of the glove, understandably they will not always be successful in doing so. In some instances this will result in glancing blows to their opponent with the top, bottom or sides of the glove 10. Hence, padding is provided along the length of the glove to absorb the impact of these glancing blows.

The resilient nature of the outer layer material assists in holding the shape of the glove 10 in particular after repeated use. In a non-illustrated embodiment, to further strengthen the shell of the glove, one of the inner layers of the shell may also be formed of a resilient and durable material. This may be the same material from which the outer layer is formed such as leather. This resilient inner layer extends over at least a portion of the bladder to assist in retaining the bladder in position.

Referring in particular to Figures 4 and 8, the glove 10 also comprises a cradle 36 that is provided to support the bladder 19 and hold the bladder in position within the glove. The cradle 36 is an arcuate member that engages and extends around a portion of the bladder 19. The cradle 36 is integral with an inner padding layer 37 of the shell 11 and is formed as an edge of the inner padding layer. Integration of the cradle with the inner padding layer further improves the structural integrity of the glove 10 and mitigates lateral and longitudinal movement of the bladder within the glove. The inventors have found that due to the compressive and shear forces impacting on the bladder during use, without adequate support, the bladder can move laterally and in the longitudinal direction of the glove. With repeated use, this can cause creasing in the glove shell which compromises the integrity of the glove. Advantageously, it is has been found that the cradle (in combination with the resilient outer later and optionally the further resilient inner layer) assists in holding the bladder in position and mitigates creasing of the shell.

Referring in particular to Figure 5, a cloth tube 38 is provided as an inner layer of the upper shell portion 30. When the glove is assembled, the cloth tube 38 forms the inner surface of the cavity 12 in which the wearer's hand is received.

The outer layer 32 of at least the upper portion 30 of the shell 11 is configured to slip with respect to at least one of the inner layers to further dissipate forces received to the glove. In the illustrated embodiment, this is achieved by applying talcum powder between the outside of the cloth tube 38 and the inner padding layers 35, 37. However, in other embodiments a slip layer could be provided between the outer layer 32 and one of the inner layers that is formed from silicon or some other highly elastic material. The outer layer is configured so that it can slip in the longitudinal direction relative to the longitudinal axis of the shell or rotationally about the longitudinal axis of the shell. The advantage of the outer layer of the shell being able to slip with respect to one of the inner layers is that when the person wearing the glove misses their opponent with the primary impact area and instead makes a glancing blow, the shear forces imparted on the glove are dissipated by the slipping of the outer layer with respect to the wearer's fist. This reduces the force impact of the glancing blow on the opponent. It is also to optimise the balance between stiffness and resilience in the glove.

In some embodiments, the glove 10 can include one or more sensors. The sensors provide information for training or competition purposes. For example, a conductive patch may be provided in the region of the primary impact area which is used to indicate when a punch has landed on an electrically active patch provided on a punching bag or garment worn by an opponent. In another example, the conductive patch may be provided in a cover that can be slipped over the glove. In another example, a pressure sensor may be provided in the bladder to determine the force of the blows. In a further example, an accelerometer may be provided in the glove 10 to enable quantification of punch characteristics.

Referring now to Figures 10 and 11, a glove 110 according to another embodiment of the present invention is shown. The glove 110 incorporates a shell 111 and a thumb compartment 121.

The glove 110 of Figures 10 and 11 incorporates a structure for providing impact force absorption. The structure comprises a body in the form of a bladder 119

(see Figures 12 and 13) that defines a space in a similar manner to the glove 10. The bladder 119 has an at-rest configuration and a compressed configuration when the bladder is subjected to an impact force. The bladder also has a plurality of small openings 151 for the passage of air into and out of the space. The openings 151 are in a permanently open configuration to enable free movement of air into and out of the space. The bladder openings 151 have a width of 2 – 15mm, typically 2 – 12mm and in some embodiments 4 – 6mm. In other embodiments, there may be a single opening. When the bladder 119 is in its at rest configuration, the pressure inside the bladder space is identical to ambient atmospheric pressure. The openings 151 in the bladder 119 are also aligned with corresponding openings (not shown) through a shell 111 of the glove so that air can flow into and out of the space from the surrounding atmosphere of the glove. The bladder 119 does not have a valve for controlling the pressure in the bladder as with the glove 10 of the first described embodiment.

The structure also comprises a resilient portion (not shown) that biases the bladder 119 toward the bladder's at-rest configuration. The resilient portion is in the form of an open cell foam that is located inside the bladder 119. The foam may be a medium density, highly resilient open foam of the type often incorporated into cushions or pillows. The foam thickness ranges between 70mm and 100mm. Softer and harder foams may be used. Other options include 'crumbed' foam. The resilient portion foam substantially fills the internal space of the bladder. The use of an open cell foam enables the flow of air into and out of the bladder space. The resilient portion provides a skeleton for the bladder 119 that holds a shape of the bladder when the bladder is not being subjected to any compressive forces. The resilient portion also biases the bladder 119 towards this shape after the bladder has been compressed.

Referring now to Figure 13, the components of the glove 110 include: the top surface of the glove 101 – made from vinyl material – viewed from the underside; glove linings 102, 103, 104 leather or vinyl or cloth; mesh 105 to form the under-surface (or palm surface) of the glove; a reinforcing strip 106 to be positioned between the main section and thumb section of the mesh; vinyl and Velcro strips 107 for the construction of the wrist band of the glove; a strip 108 of an elastic material; a high density, low hardness polyurethane open cell foam cut-out 109; a low density,

medium hardness polyurethane open cell foam cut-out 109a; and a resilient bladder 119.

In use, when a blow is struck with the glove 110, the impact force applies a compressive force to the bladder 119 and increases the pressure of air within the bladder and the pressure differential between the bladder and the ambient atmosphere causes air to move out of the bladder through the opening in the bladder. Because the openings 151 are open to enable the passage of air, the reduction in the volume of the space pushes air out of the bladder through the openings 151. The rate at which this occurs is controlled by the size of the bladder openings 151 and the characteristics of the resilient portion. By enabling air to flow out of the bladder 119 when impact forces are applied to the bladder, the bladder is able to compress to a greater extent, enabling the glove 110 to absorb forces at higher impact forces, as compared to the glove 10 of the first described embodiment.

After the blow has been struck and there is no longer a compressive force being applied to the bladder 119, the bias provided by the resilient portion causes the bladder 119 to reform into its original shape. This causes the volume of the bladder space to increase, the immediate effect of which is to reduce the pressure inside the bladder to below atmospheric pressure. Because the bladder openings 151 are open, the negative pressure in the bladder space causes air to be drawn into the bladder space until it reaches approximately atmospheric pressure.

The structure of the glove 110 of Figures 10 and 11 also comprises an external compressible portion (not shown) located on the outside of the bladder 119. The external compressible portion is formed of ethylene vinyl acetate (EVA) foam or types of foam, a visco-elastic polymer like Sorbothane, or of a thin gel pad. The external compressible portion provides additional force impact absorption.

It is to be appreciated that although the structure is shown and described in relation to its incorporation into a combat glove, it could also be incorporated into various other items of protective equipment. In particular, the structure could be incorporated into any sports equipment that is used to absorb impact forces; for example, head guards, focus pads, cricket pads, shin pads, chest guards and protective equipment for hockey goalkeepers. The structure could also be incorporated into work related protective equipment such as construction helmets.

The structure could also be incorporated into the straps and body-facing section of back-packs to increase comfort. This could be of use to military personnel and people involved in search and rescue operations.

The applicant has found in testwork described below that the glove 10 according to the first described embodiment provided good impact force reduction at low to moderate forces. However, this effect reduced as forces were increased into the range of elite level boxers. It is thought that this effect with the glove 10 is caused by the bladder 19 reaching maximum compressibility at higher impact forces and thus not absorbing much of the impact force. The glove 110 illustrated in Figures 10 and 11 provides impact force reduction at these higher impact forces and also performs very well at low to moderate forces.

Example 1

A trial was conducted in which three people hit a wall mounted force plate covered by a thick foam layer as hard as they could using left and right hands and the following gloves:

- A conventional 10 ounce glove.
- A conventional 16 ounce glove.
- A glove constructed in accordance with the first described embodiment (glove 10) with the bladder 19 inflated to a pressure of 1 and/or 2kPa.

Figure 14 shows the highest single force recorded from 10 attempts. Person 1 in the trial is a national amateur boxing champion. Figure 14 illustrates that the glove according to the first described embodiment reduces impact forces, especially at low to moderate forces.

Example 2

To simulate different punch velocities, a trial was conducted in which gloves with a mechanical fist inside were dropped from various heights up to 5 meters on to a 600 x 400mm force plate. The force plate was covered by a material with a Shore A durometer hardness rating of 35 which is similar to human muscle tissue. When the gloves were dropped from 5 meters, velocities of almost 10m/s were achieved which is close to the maximum velocity reported to be generated by elite boxers.

The following gloves were tested:

- Std 10oz: A conventional 10 ounce glove.
- Std 16oz: A conventional 16 ounce glove.
- LI: A glove constructed in accordance with the first described embodiment (glove 10).
- Mod LI: A glove constructed in accordance with the second described embodiment (glove 110) without an external compressible portion.
- MLIEVA: A glove constructed in accordance with the second described embodiment (glove 110) with an external compressible portion.

Figure 15 shows the highest peak impact force readings for each of the different gloves for various drop heights between 1 and 5 meters. The velocity corresponding to the different drop heights is also given in Figure 15.

As shown in Figure 15, whilst the glove 10 according to the first described embodiment had almost no impact force reduction at velocities above 8.85m/s, the gloves 110 according to the second described embodiment reduced impact forces by 35% at 9.9m/s.

Figure 16 shows typical force curves for different types of gloves dropped from a height of 3.5 meters (velocity = 8.28m/s). Gloves 10, 110 according to both embodiments extend contact times, delay the occurrence of peak force and decrease the magnitude of peak force. However, the glove 110 according to the second embodiment is more effective in all of these measures and this difference has been found to become greater as velocity increases.

Example 3

Further drop tests as described in Example 2 were carried out to evaluate the effect of using different types of foam to form the resilient portions of the bladders 119 in gloves in accordance with the second described embodiment (glove 110) .

The following gloves were tested:

- Std 10oz: A conventional 10 ounce glove.
- Mod LI: A glove constructed in accordance with the second described embodiment (glove 110) with a single piece of medium density, moderate foam as the resilient portion of the bladder 119.

- Soft Foam: A glove constructed in accordance with the second described embodiment (glove 110) with a single piece of low density, soft foam as the resilient portion of the bladder 119.
- Hard Foam: A glove constructed in accordance with the second described embodiment (glove 110) with a single piece of high density, hard foam as the resilient portion of the bladder 119.
- Crumbed Foam: A glove constructed in accordance with the second described embodiment (glove 110) with medium density foam in small pieces as the resilient portion of the bladder 119.

Figure 17 shows the highest peak impact force readings for each of the different gloves for various drop heights between 1 and 5 meters.

Figure 17 shows that each of the gloves in accordance with the second described embodiment (glove 110) performed better than the conventional 10 ounce glove across the entire range of drop heights, with the Mod LI glove being the best performer of all of the gloves. These results mean that the gloves in accordance with the second described embodiment (glove 110) are able to absorb impact forces significantly better than the conventional 10 ounce glove across the whole range of impacts likely to be experienced by boxers.

In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word “comprise” or variations such as “comprises” or “comprising” is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

CLAIMS

1. A glove for combat sports, the glove comprising:

a shell that defines a cavity for receiving the wearer's hand, the shell having a primary impact area at one end of the shell; and

a gas-containing space disposed between the cavity and the primary impact area.

2. A glove as claimed in claim 1, wherein the cavity is configured to operatively receive the wearer's hand shaped as a fist.

3. A glove as claimed in claim 1 or 2, wherein the cavity is configured to mitigate pre-compression of the gas-containing filled space when the wearer's hand is received in the cavity.

4. A glove as claimed in any one of claims 1-3, wherein the gas-containing space is defined by a body.

5. A glove as claimed in claim 4, wherein the glove comprises a cradle engaging the body to hold the body in position.

6. A glove as claimed in claim 5, wherein the cradle is integral with a layer of the shell.

7. A glove as claimed in claim 5 or 6, wherein the cradle is in the form of an arcuate member that extends around at least a portion of the body.

8. A glove as claimed in any one of claims 4 – 7, wherein the body is spherical or dome-shaped.

9. A glove as claimed in any one of claims 4 – 8, wherein the body comprises an inflatable bladder.

10. A glove as claimed in any one of claims 4 – 9, wherein the body has at least one opening for the passage of air into and out of the space.

11. A glove as claimed in claim 10, wherein the opening has a width of 2 – 15mm, typically 2 – 10mm, preferably 4 – 6mm.

12. A glove as claimed in any one of claims 4 – 11, wherein the body has an at rest configuration and a compressed configuration when the body is subjected to an impact force, wherein the glove also comprises a resilient portion that biases the body toward the body's at rest configuration.

13. A glove as claimed in claim 12, wherein the resilient portion comprises foam located inside the body, preferably an open cell foam, or any relatively soft material with sufficient resilience to enable it to act as a spring.

14. A glove as claimed in claim 13, wherein the resilient portion fills the space inside the body.

15. A glove as claimed in any one of claims 4 – 14, wherein the glove comprises an external compressible portion located on the outside of the body, preferably formed of ethylene vinyl acetate (EVA) foam or a visco-elastic polymer or gel.

16. A glove as claimed in any one of claims 1 – 15, wherein the gas-containing space is at a pressure of less than 14kPa, preferably less than 7 kPA, more preferably less than 4 kPa, typically less than 2 kPa.

17. A glove as claimed in any one of claims 1 – 16, wherein a portion of the shell around the gas-containing space is adapted to preferentially yield to accommodate deformation of the gas-containing space when a force is received on the primary impact area of the shell.

18. A glove as claimed in any one of claims 1 – 17, wherein a portion of the shell around the gas-containing space has one or more pleats.

19. A glove as claimed in any one of claims 1 – 18, wherein the shell has an outer layer and at least one inner layer, the outer layer configured to slip with respect to one of the inner layers to dissipate forces received to the glove.

20. A glove as claimed in claim 19, wherein the outer layer is configured to slip by rotation and/or longitudinally relative to the longitudinal axis of the shell.

21. A glove as claimed in claim 19 or 20, wherein the shell has a slip layer between the outer layer and a resilient inner layer to enable the outer layer to slip with respect to the resilient inner layer.

22. A glove as claimed in claim 21, wherein the slip layer is provided by talcum powder or silicon or highly elastic rubber.

23. A glove for combat sports, the glove comprising a shell that defines a cavity for receiving the wearer's hand, the shell having an outer layer and at least one inner layer, the outer layer configured to slip with respect to one of the inner layers to dissipate forces received to the glove.

24. A glove as claimed in claim 23, wherein the outer layer is configured to slip by rotation and/or longitudinally relative to the longitudinal axis of the shell.

25. A glove as claimed in claim 23 or 24, wherein the shell has a slip layer between the outer layer and a resilient inner layer to enable the outer layer to slip with respect to the resilient inner layer.

26. A glove as claimed in claim 25, wherein the slip layer is provided by talcum powder or silicon or highly elastic rubber.

27. A structure for providing impact force absorption in protective equipment, the structure comprising:

a body defining a space, the body having at least one opening for the passage of air into and out of the space, wherein the body has an at-rest configuration and a compressed configuration when the body is subjected to an impact force; and

a resilient portion that biases the body toward the body's at-rest configuration.

28. A structure as claimed in claim 27, wherein the body comprises an inflatable bladder.

29. A structure as claimed in claim 27 or 28, wherein the opening has a width of 2 – 15mm, typically 2 – 10mm, preferably 4 – 6mm.

30. A structure as claimed in any one of claims 27 – 29, wherein the resilient portion comprises foam located inside the body, preferably an open cell foam, or any relatively soft material with sufficient resilience to enable it to act as a spring.

31. A structure as claimed in claim 30, wherein the foam fills the space inside the body.

32. A structure as claimed in any one of claims 27 – 31, wherein the structure comprises an external compressible portion located on the outside of the body, preferably formed of ethylene vinyl acetate (EVA) foam or a visco-elastic polymer or gel.

33. A structure as claimed in any one of claims 27 – 32, wherein, when the body is in the at rest configuration, the pressure in the space is atmospheric pressure.

34. An item of protective equipment incorporating the structure of any one of claims 27 – 33.

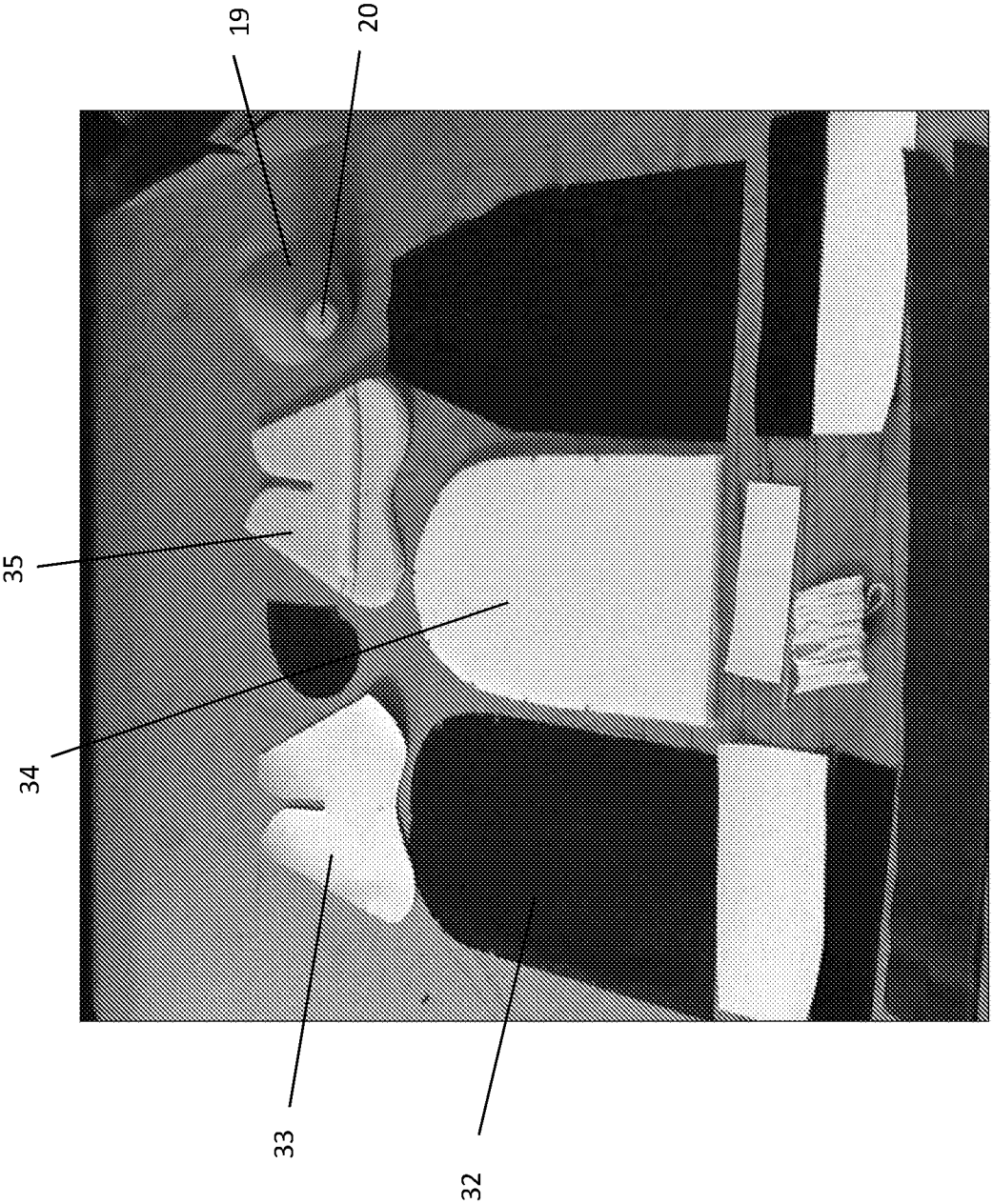


Figure 1

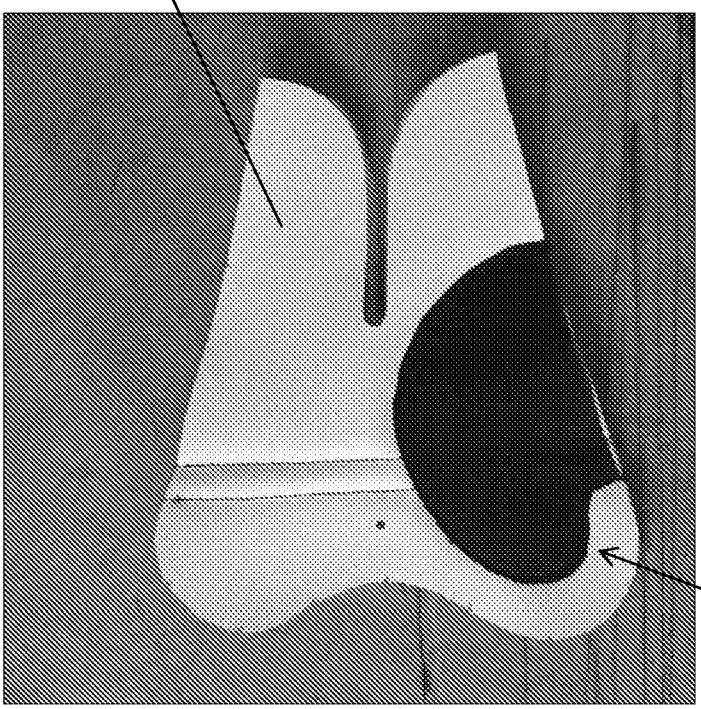


Figure 2

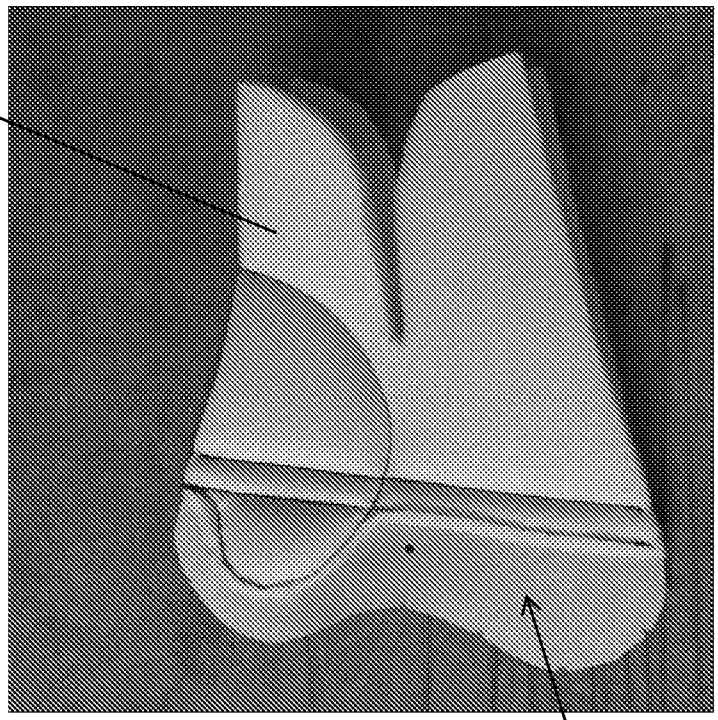


Figure 3

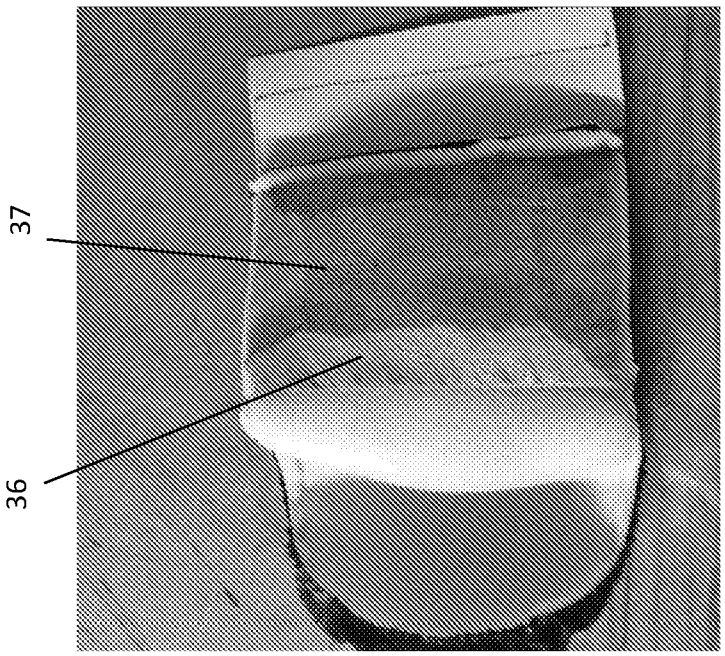


Figure 4

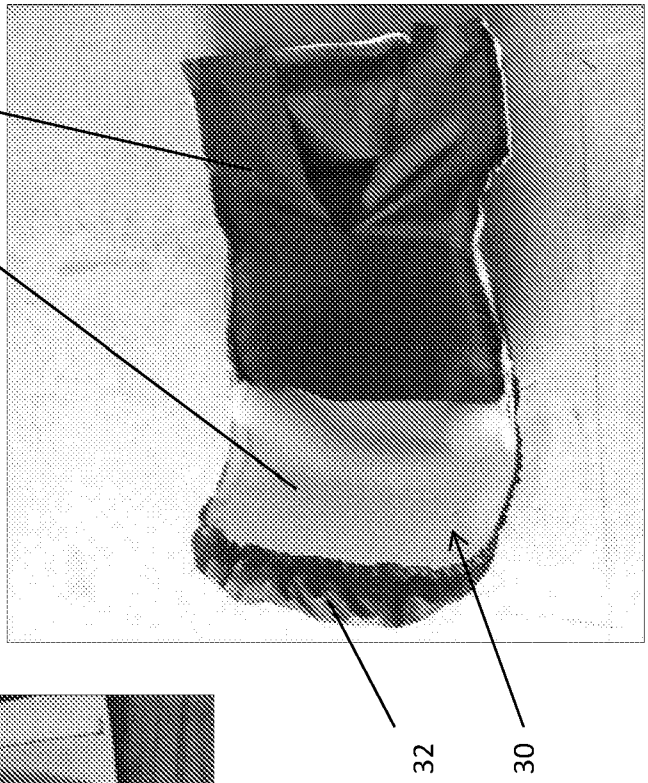


Figure 5

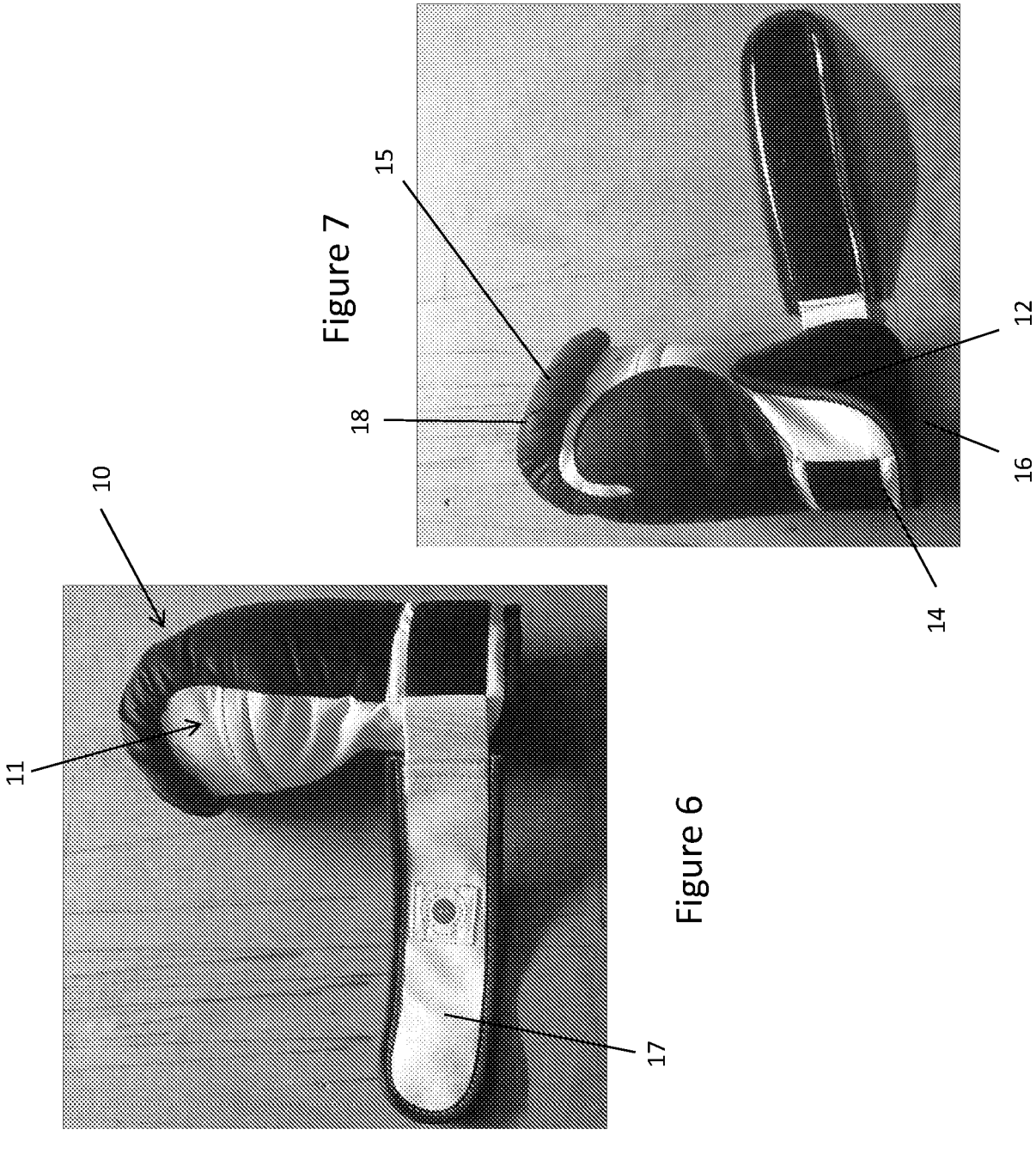


Figure 7

Figure 6

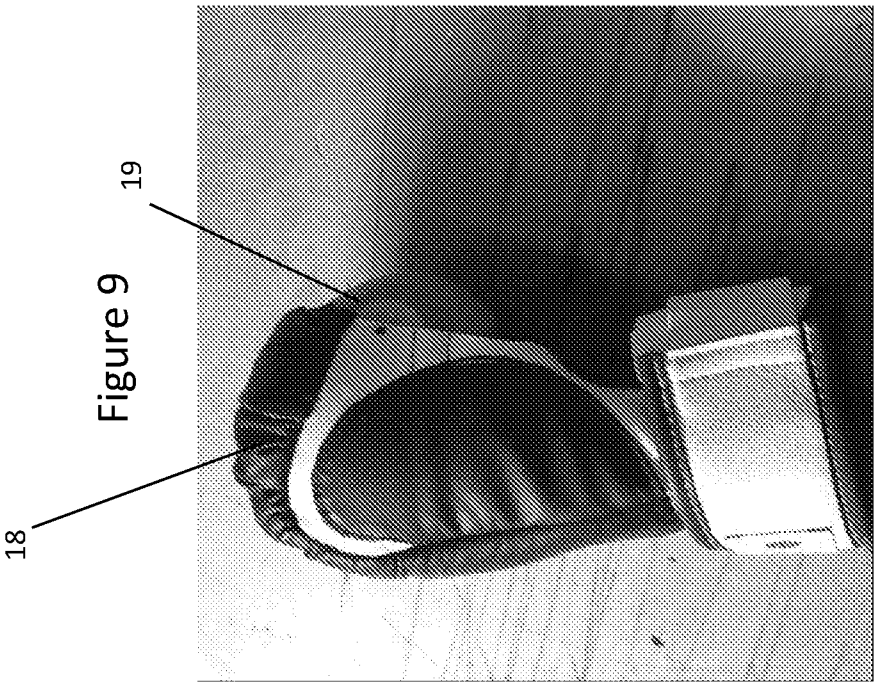


Figure 9

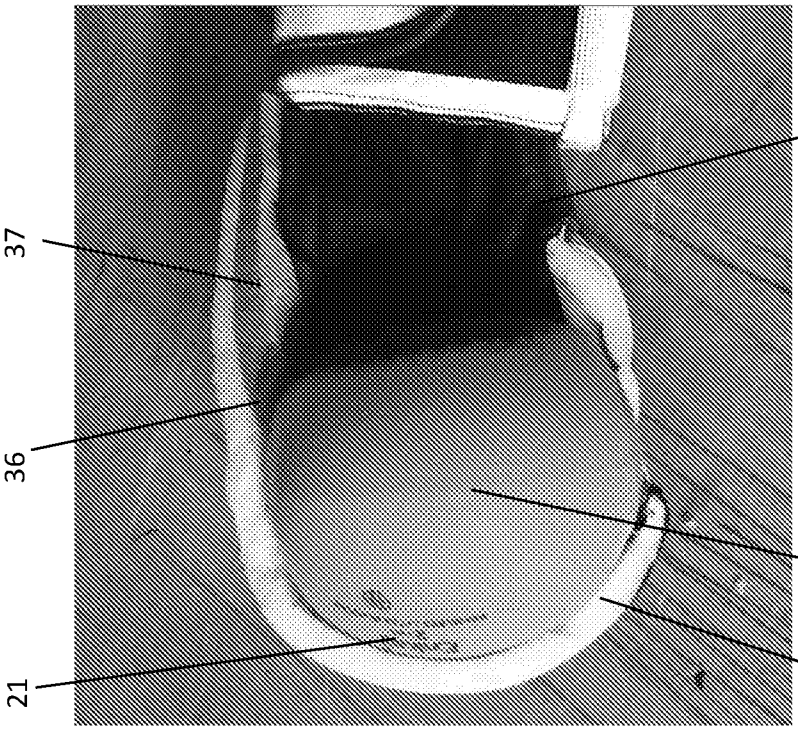


Figure 8

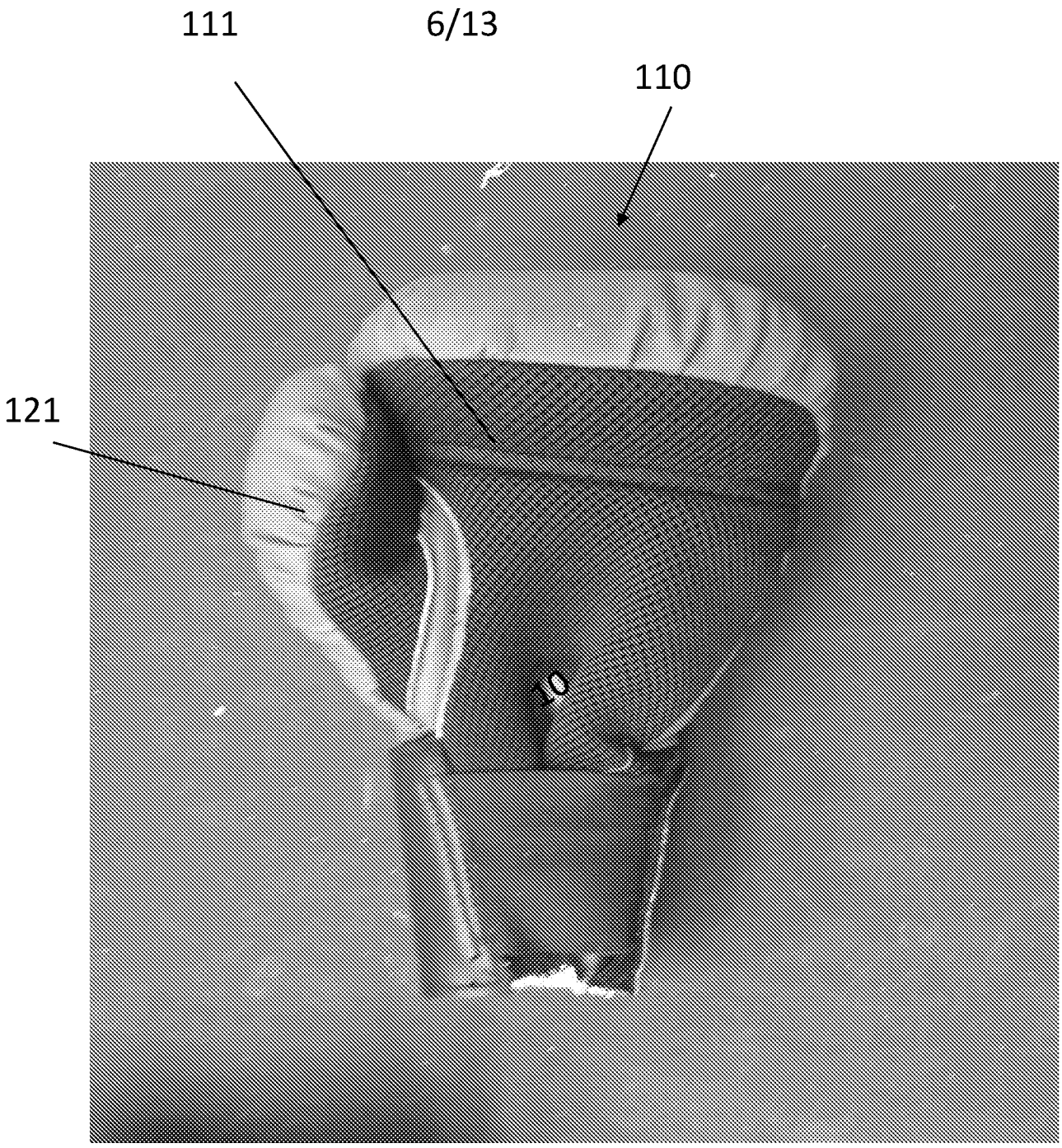


Figure 10

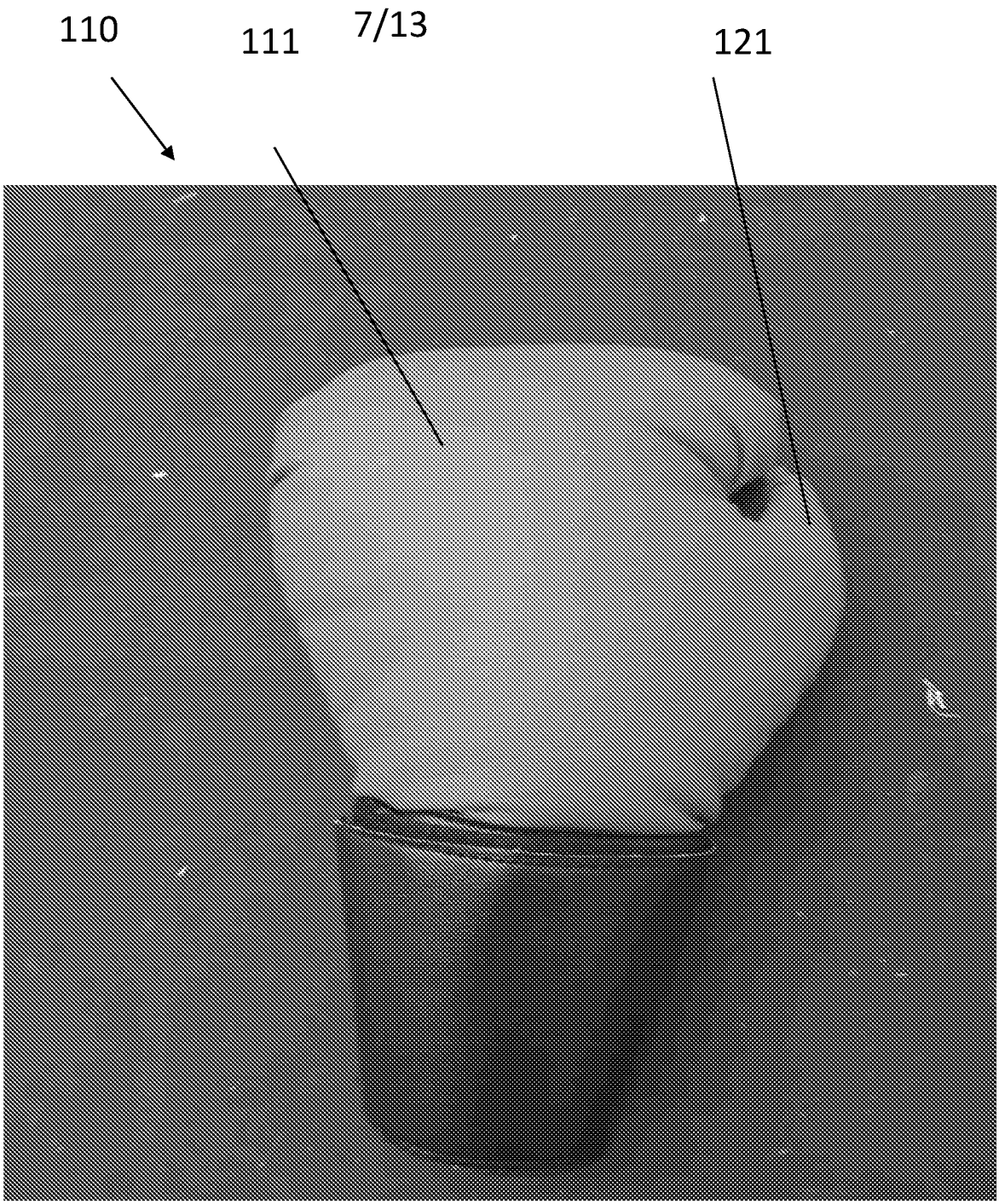


Figure 11

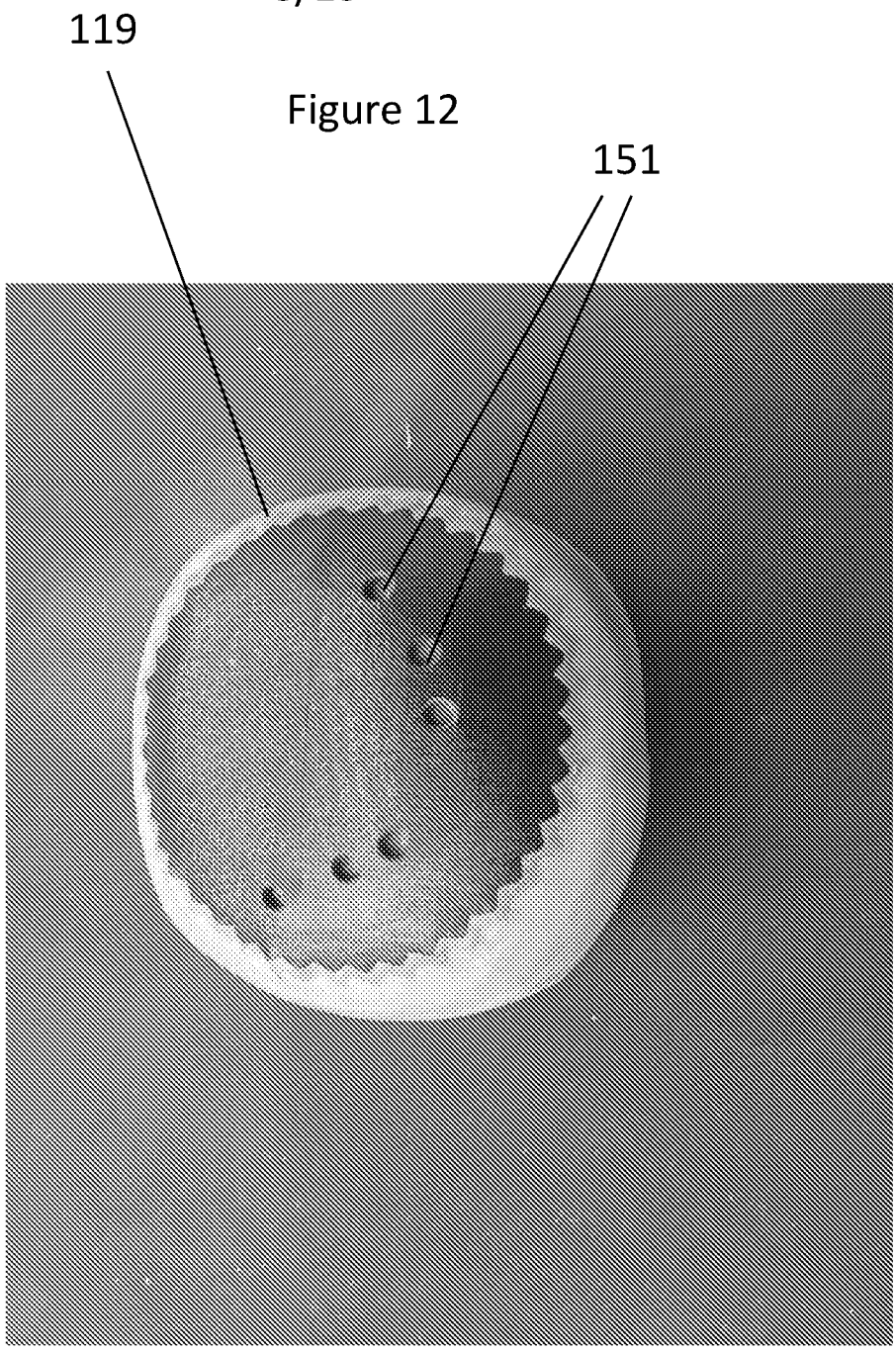
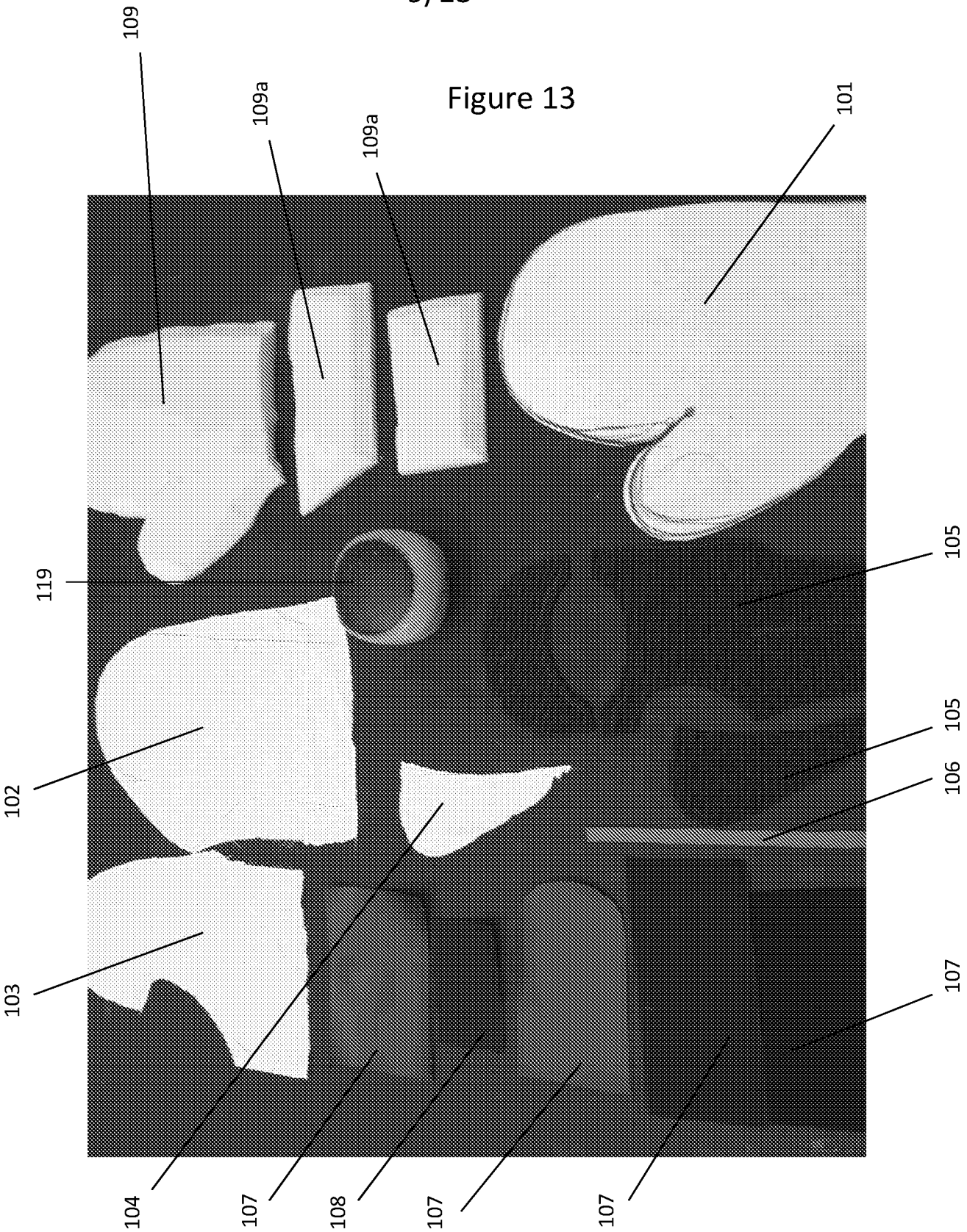


Figure 12

Figure 13


109
109a
109a
101
119
105
102
105
106
103
107
104
107
108
107
107

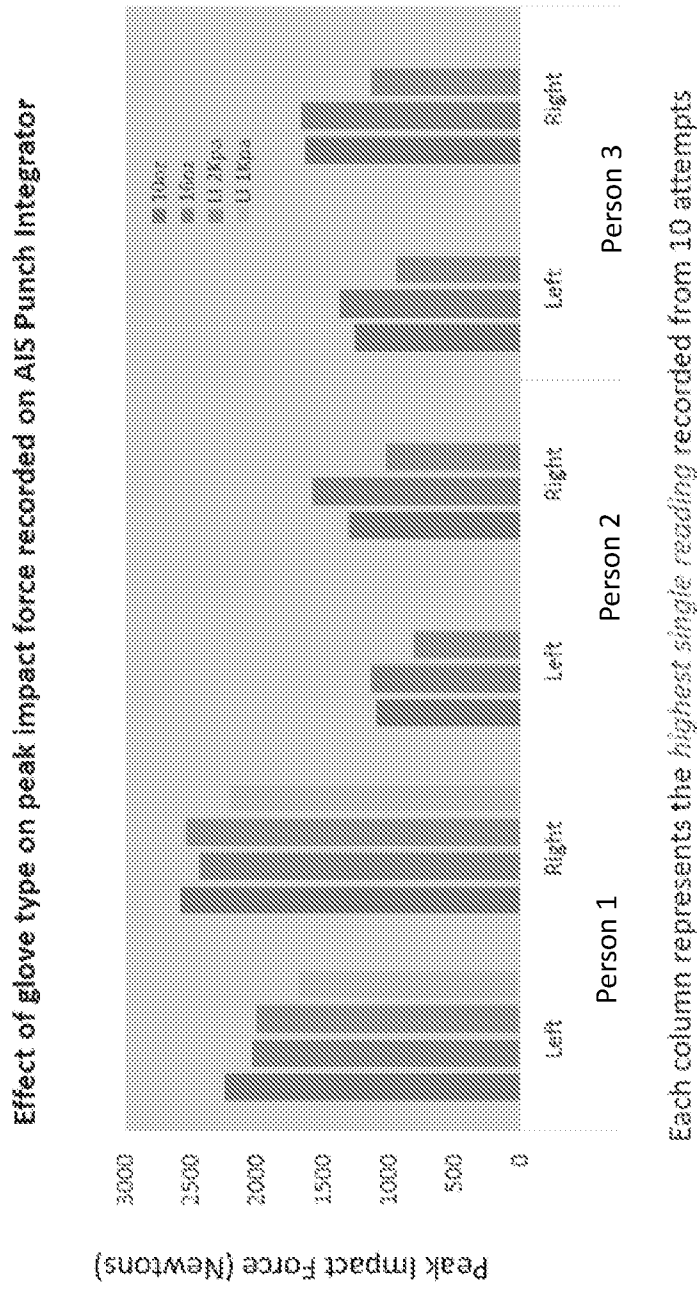

Effect of glove type on peak impact force recorded on AIS Punch Integrator
Peak Impact Force (Newtons)
3000
2500
2000
1500
1000
500
0
Left
Right
Left
Right
Left
Right
Person 1
Person 2
Person 3
Each column represents the highest single reading recorded from 10 attempts

Figure 14

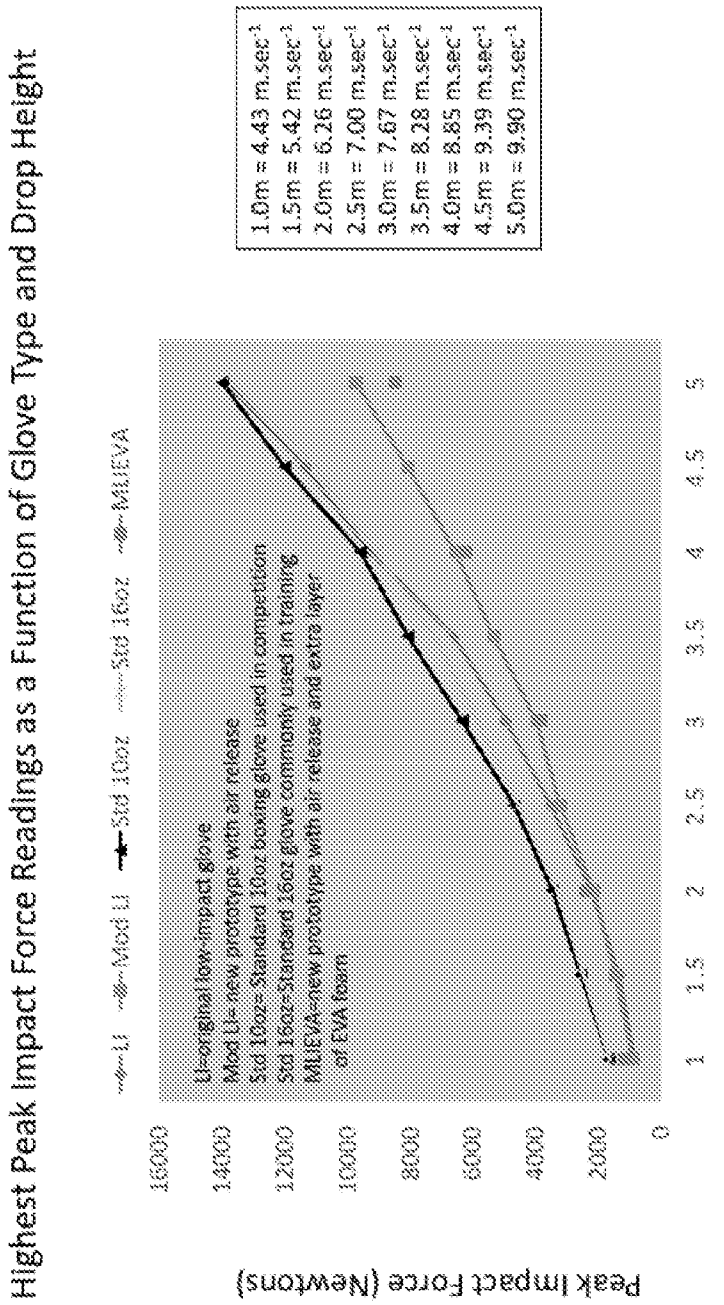

Highest Peak Impact Force Readings as a Function of Glove Type and Drop Height
Peak Impact Force (Newtons)
Drop Height (metres)
0
2000
4000
6000
8000
10000
12000
14000
16000
1
1.5
2
2.5
3
3.5
4
4.5
5
LI
Mod LI
Std 10oz
Std 16oz
MLEVA
LI=original low-impact glove
Mod LI= new prototype with air release
Std 10oz= Standard 10oz boxing glove used in competition
Std 16oz=Standard 16oz glove commonly used in training
MLEVA=new prototype with air release and extra layer of EVA foam
1.0m = 4.43 m.sec-1
1.5m = 5.42 m.sec-1
2.0m = 6.26 m.sec-1
2.5m = 7.00 m.sec-1
3.0m = 7.67 m.sec-1
3.5m = 8.28 m.sec-1
4.0m = 8.85 m.sec-1
4.5m = 9.39 m.sec-1
5.0m = 9.90 m.sec-1

Figure 15

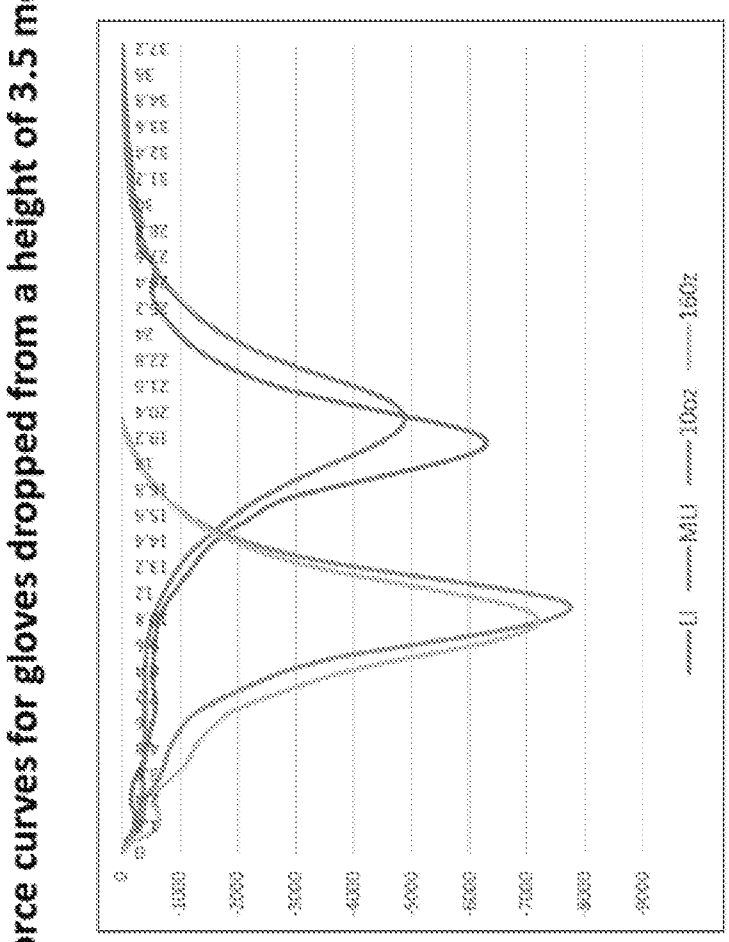
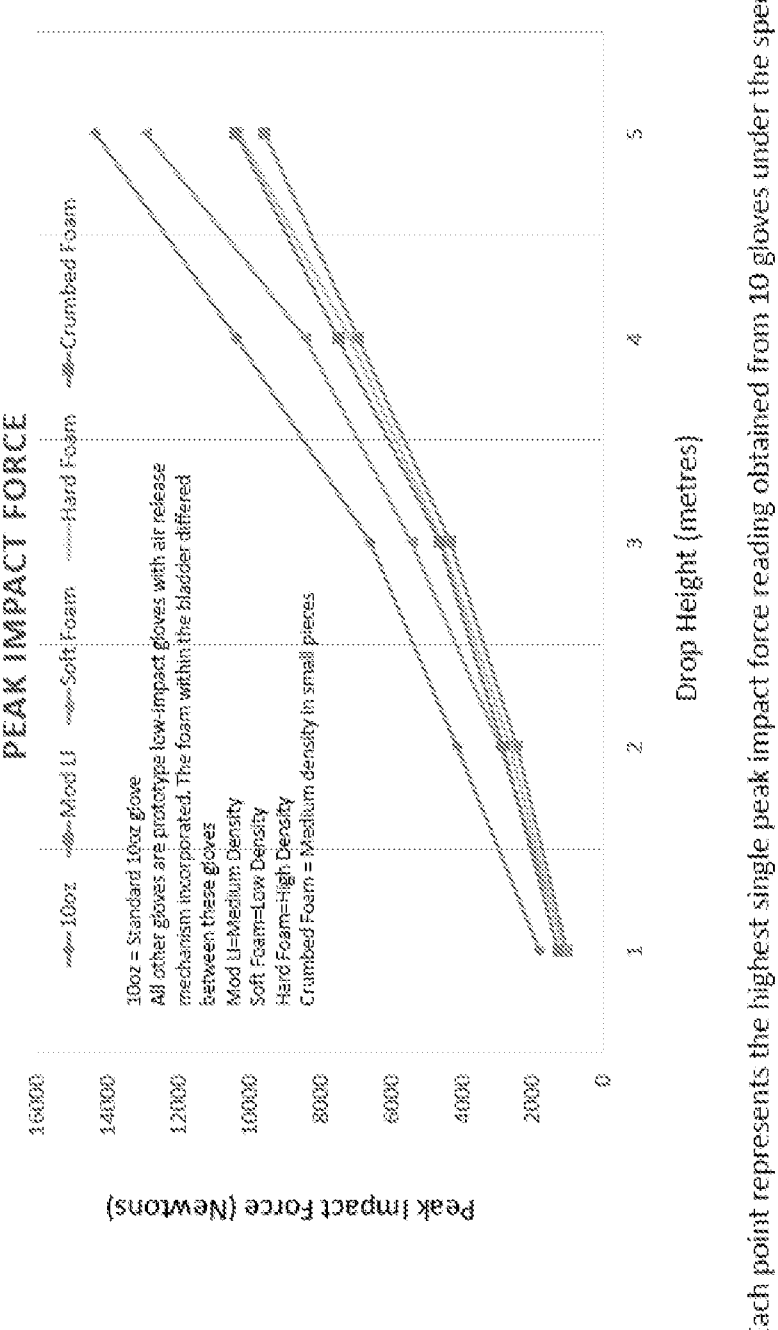

Typical force curves for gloves dropped from a height of 3.5 metres
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
LL
MU
10oz
16oz

Figure 16



Each point represents the highest single peak impact force reading obtained from 10 gloves under the specified condition

Gloves were dropped on to a force plate covered by a floor tile and 27mm thick mat with Shore A hardness of 35

Figure 17

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2016/051060

A. CLASSIFICATION OF SUBJECT MATTER

A63B 71/14 (2006.01) A41D 19/015 (2006.01)

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)

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)

EPODOC: /IC/CN (OR A41D13/10, A63B71/08+, A63B71/14+, Y10S2/03, A41D19/015+), /IC (OR A41D19/00, A63B71/14, A41D13/10, A63B71/08, A41D19/015) & Keywords in ALL English language Databases (Bladder, Sphere, Cell, Air, Inflatable, Pneumatic, Boxing, Combat, Glove, Mitt) and similar terms and/or combinations; EPODOC; WPIAP: /IC/CN OR A41D13/10, A63B71/08+, A63B71/14+, Y10S2/03, A41D19/015+, A41D19/00, A63B71/14, A41D13/10, A63B71/08, A41D19/015, A63B71/14&Z, A41D19/015&610Z, A63B71/08&Z, A41D19/015&130Z & Keywords (Glove, Mitt, Boxing, Martial Arts, Gas, Filled, Inflated, Pneumatic, Bladder, Sac, Dome, Semi Circle) and similar terms and/or combinations; Google Patent & Keywords (Boxing, Impact, Hit, Slip Layer, Glance) and similar terms and/or combinations; and Applicant/Inventor searched using both internal (provided by IP Australia) and external (Google Patent, Espacenet, AUSPAT, EPODOC, WPIAP) databases - Perkins, Paul; Hahn, Allan; & Keywords (Glove, Boxing) and similar terms and/or combinations.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 February 2017	02 February 2017
Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au	Roger Small AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0399359630

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2016/051060

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:

because they relate to subject matter not required to be searched by this Authority, namely:

the subject matter listed in Rule 39 on which, under Article 17(2)(a)(i), an international search is not required to be carried out, including

2. ☐ Claims Nos.:

because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos:

because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box for Details

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-22

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/AU2016/051060**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 925669 A (BOON) 08 May 1963 See: figs. 1 and 2; pg. 1, lines 49-57 and 69-74; pg. 1, line 88 to pg. 2, line 30; and pg. 2, lines 58-63.	1-4, 8-13, 16-20
X	GB 504904 A (SUTHERLAND) 02 May 1939 See: figs. 1 to 5; pg. 1, lines 7-11; pg. 2, lines 19-27 and 64-66.	1-2, 4-12, 15-18
X	US 2275206 A (SUTHERLAND) 03 March 1942 See: figs. 1 to 5; pg. 1, lines 6-9 and 29-34.	1-13, 15-18
X	US 1554807 A (GATELY et al.) 22 September 1925 See: figs. 1 to 3; pg. 1, lines 45-47 and 59-70.	1-13, 16-18
A	US 2012/0208032 A1 (FADEN et al.) 16 August 2012 See: abstract.	21-22

INTERNATIONAL SEARCH REPORT	International application No. PCT/AU2016/051060

Supplemental Box

Continuation of: **Box III**

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

- Claims 1-22 are directed to a glove for combat sports comprising a shell that defines a cavity for receiving the wearer's hand. The feature of a gas-containing space disposed between the cavity and the primary impact area is specific to this group of claims.

- Claims 23 to 26 are directed to a glove for combat sports comprising a shell that defines a cavity for receiving the wearer's hand. The feature of the shell having an outer layer and at least one inner layer, the outer layer configured to slip with respect to one of the inner layers to dissipate forces received to the glove is specific to this group of claims.

- Claims 27 to 34 are directed to a structure for providing impact force absorption in protective equipment comprising a body defining a space, the body having at least one opening for the passage of air into and out of the space.. The feature of the body having an at-rest configuration and a compressed configuration when the body is subjected to an impact force and a resilient portion that biases the body towards the body's at-rest configuration is specific to this group of claims.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied *a priori*.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2016/051060**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		**Patent Family Member/s**	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
GB 925669 A	08 May 1963	GB 925669 A	08 May 1963
GB 504904 A	02 May 1939	GB 504904 A	02 May 1939
US 2275206 A	03 March 1942	US 2275206 A	03 Mar 1942
US 1554807 A	22 September 1925	US 1554807 A	22 Sep 1925
US 2012/0208032 A1	16 August 2012	US 2012208032 A1	16 Aug 2012
		US 2012207964 A1	16 Aug 2012
		US 8927088 B2	06 Jan 2015
		US 2016113348 A1	28 Apr 2016
		US 9462847 B2	11 Oct 2016
		US 2012204327 A1	16 Aug 2012
		US 2012204329 A1	16 Aug 2012
		US 2014109298 A1	24 Apr 2014
		US 2015125663 A1	07 May 2015
		US 2016227867 A1	11 Aug 2016
		WO 2012112554 A2	23 Aug 2012

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.