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(54) **SAFETY GLOVE**

(52) **U.S. Cl.**

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(57) **ABSTRACT**

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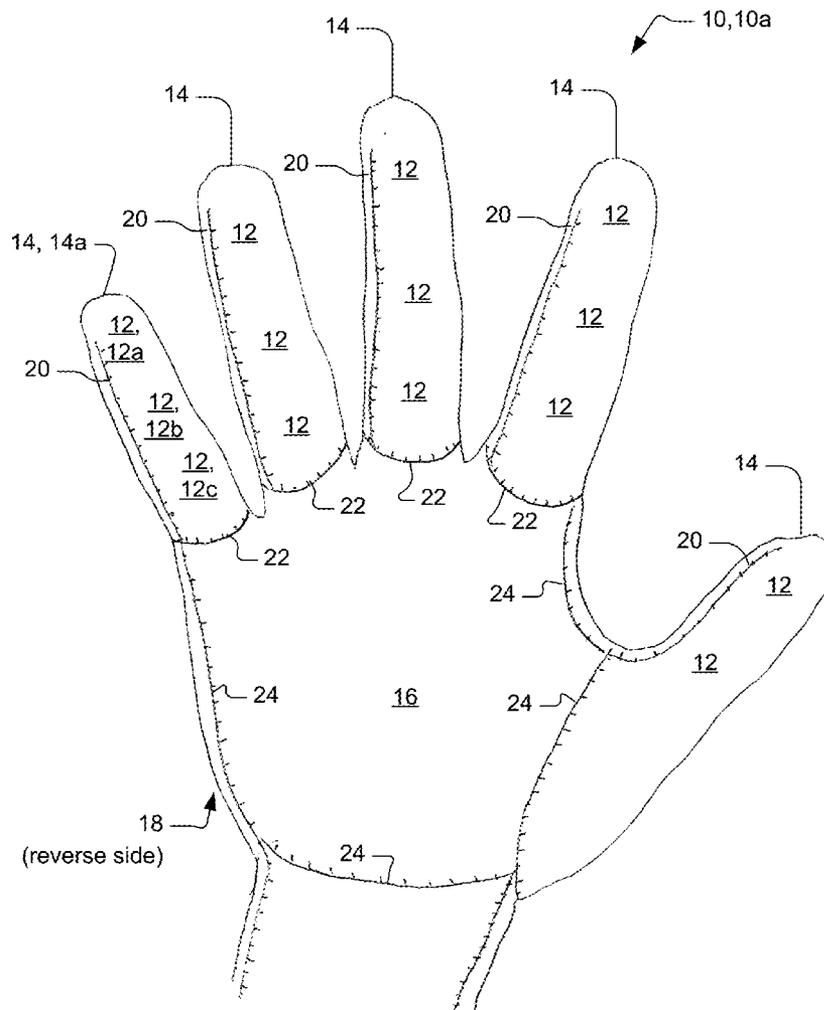
A process for producing a safety glove to be worn on a conventional human hand and where the glove is of a conventional material. A glove is obtained as a unitary construct having glove finger sections to each respectively cover one finger of the hand, a glove palm section to cover the palm, and a glove back section to cover at least part of the backhand. In each glove finger section a separation zone is formed by controllably weakening the material of the glove such that all or part of the respective glove finger section is separable from the rest of the glove, wherein the separation zone retains a discernible thickness throughout.

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**A41D 19/015** (2006.01)



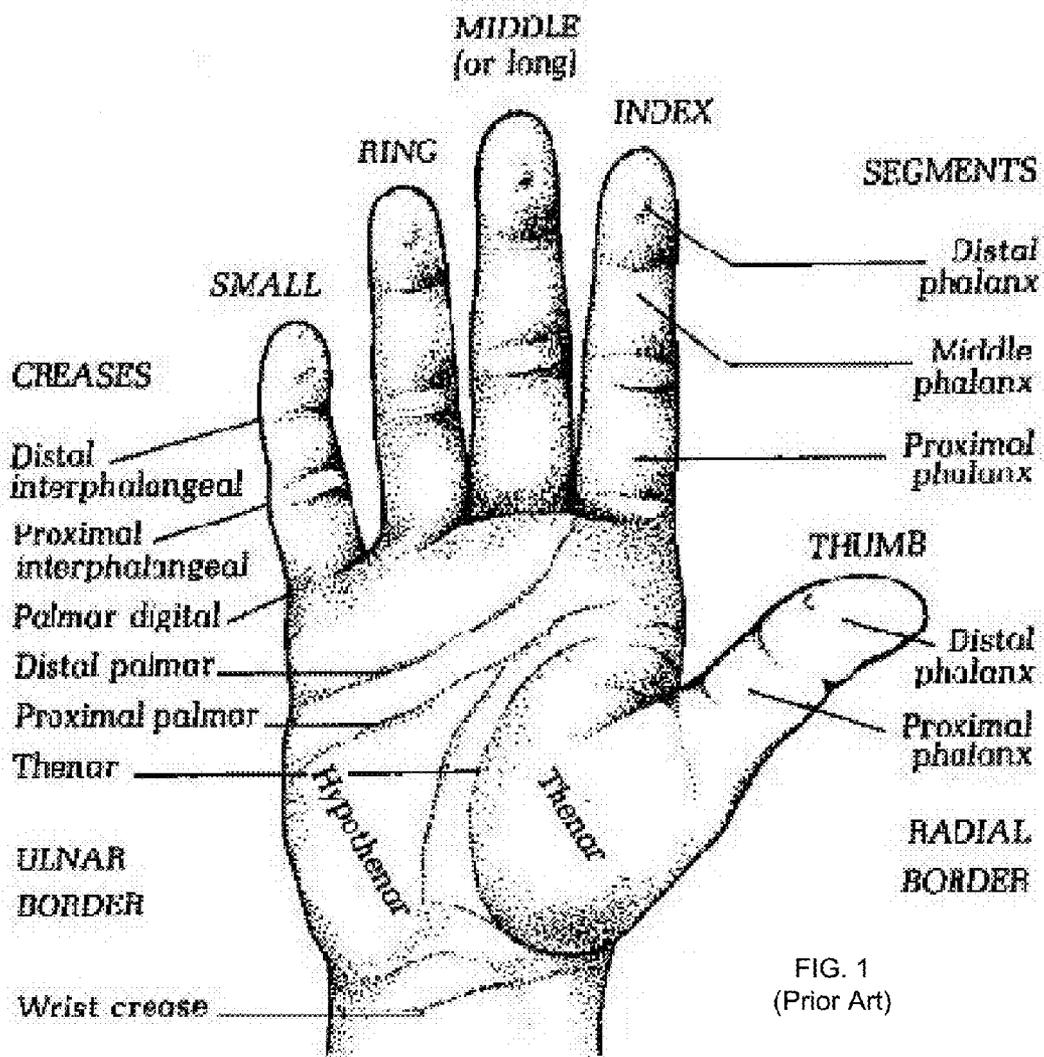


FIG. 1  
(Prior Art)

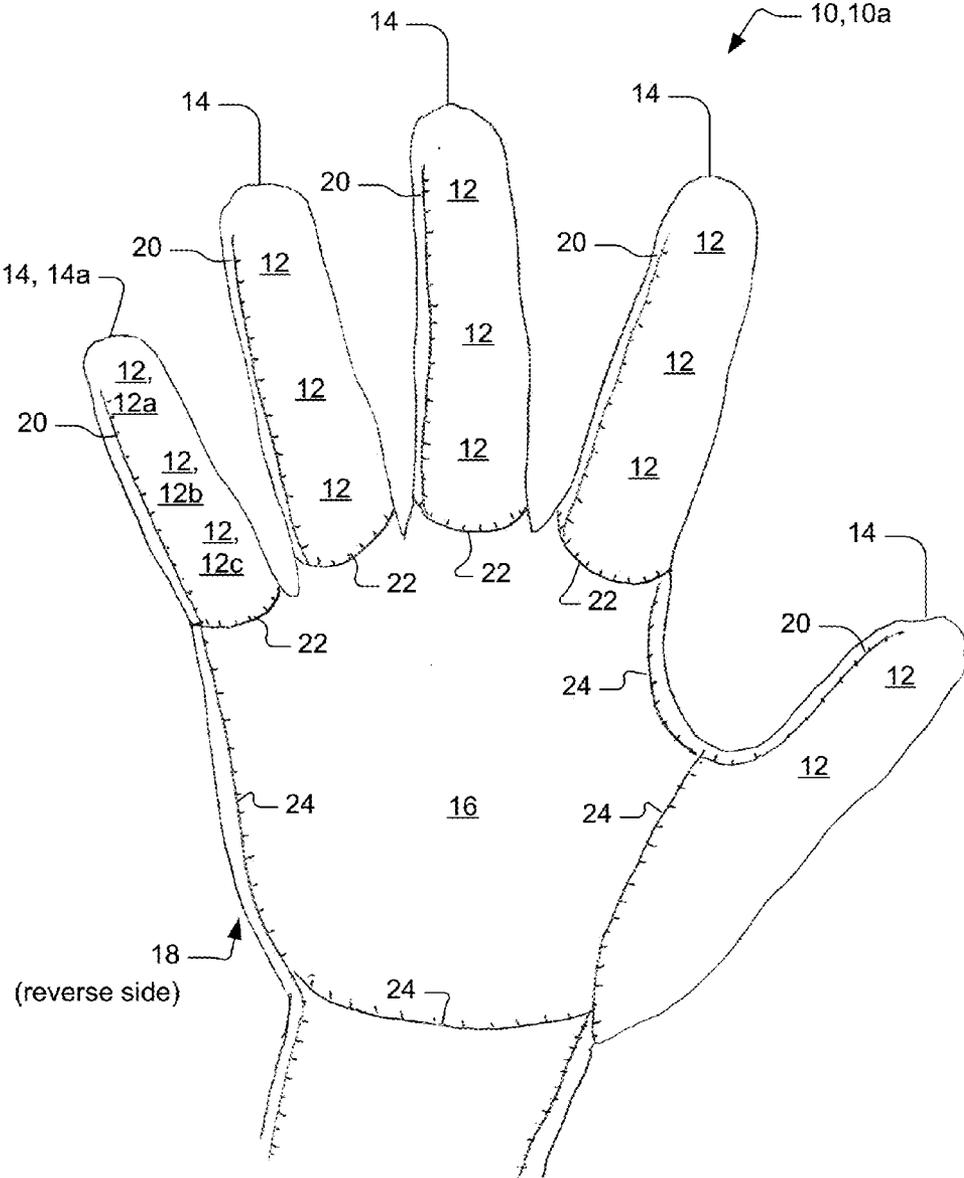


FIG. 2

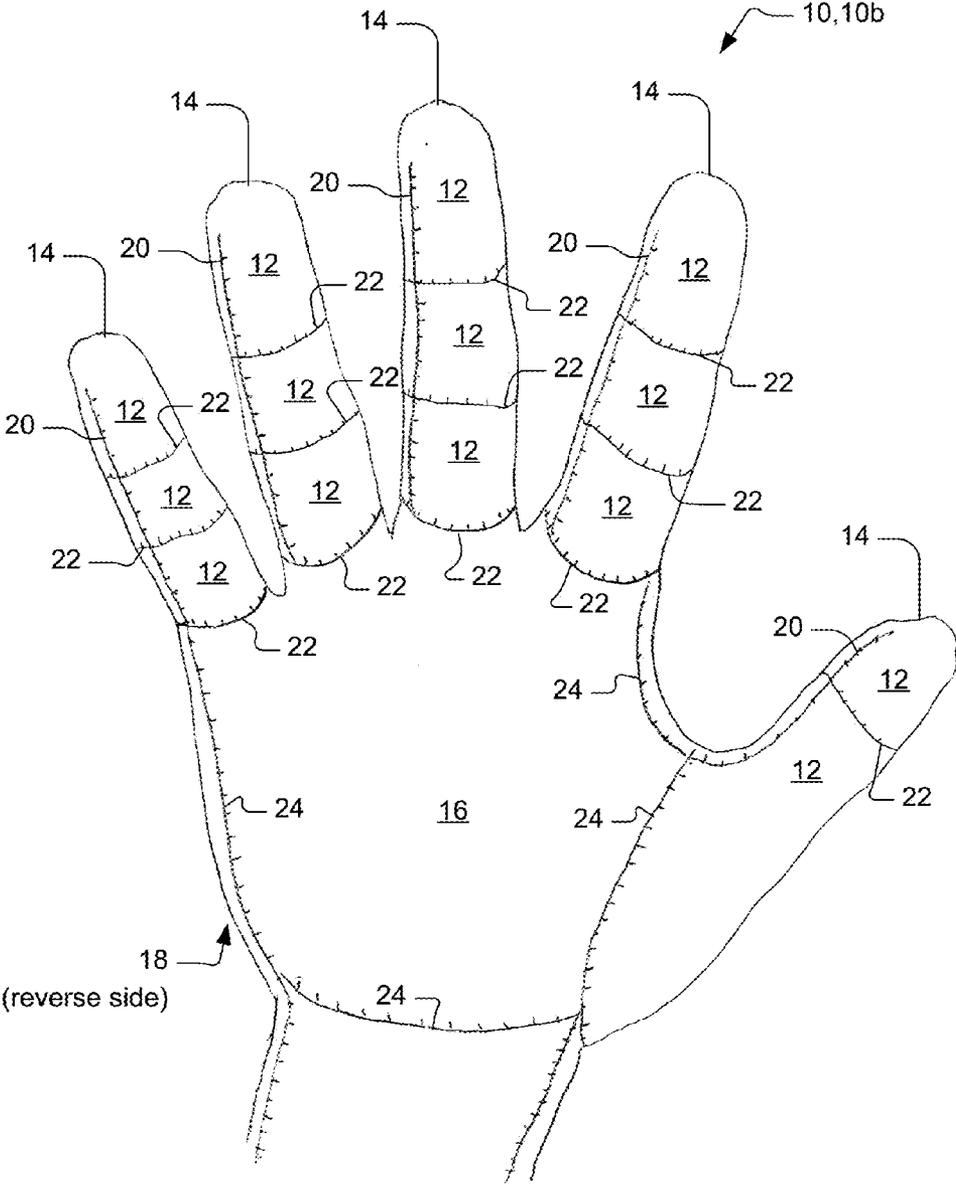


FIG. 3

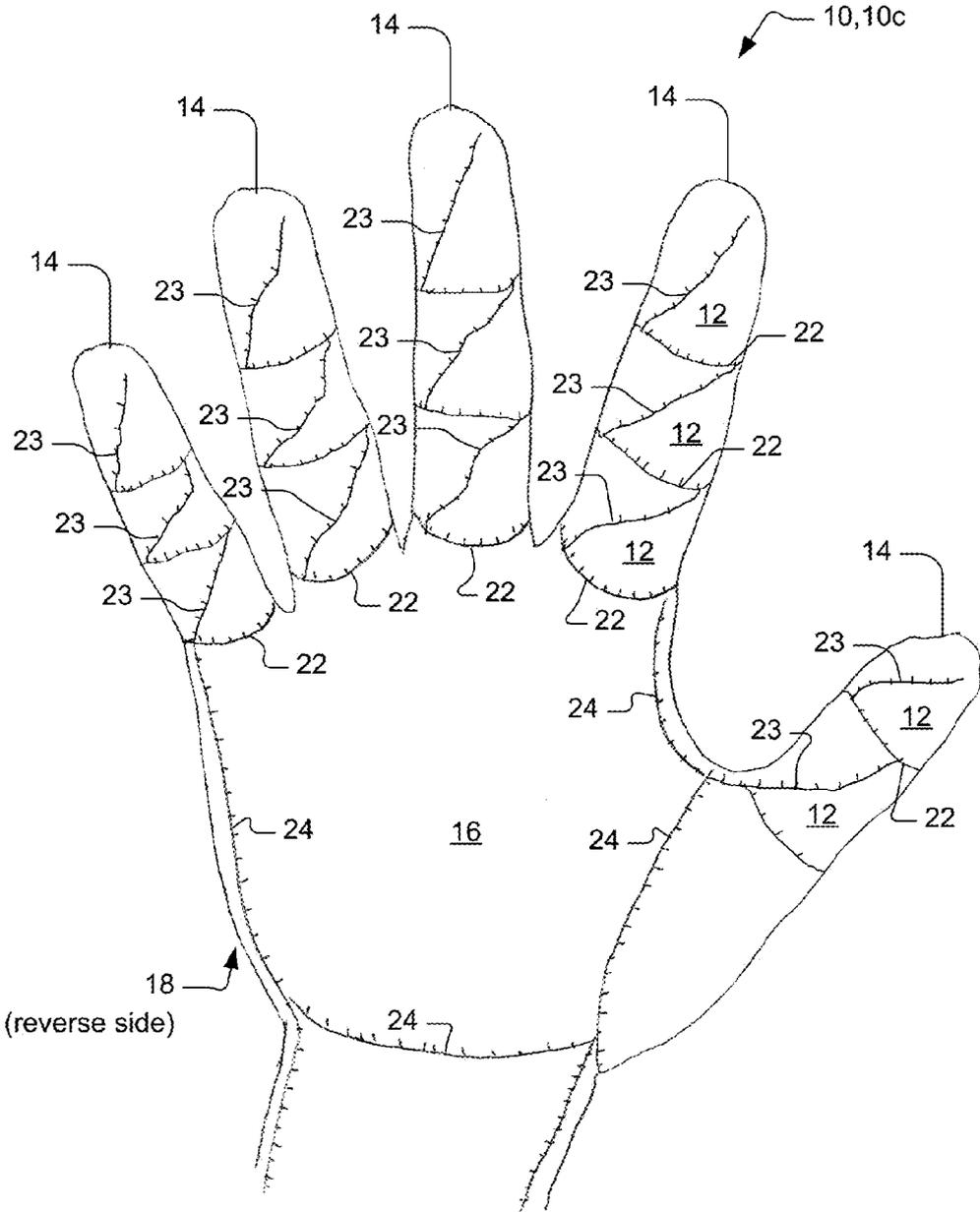


FIG. 4

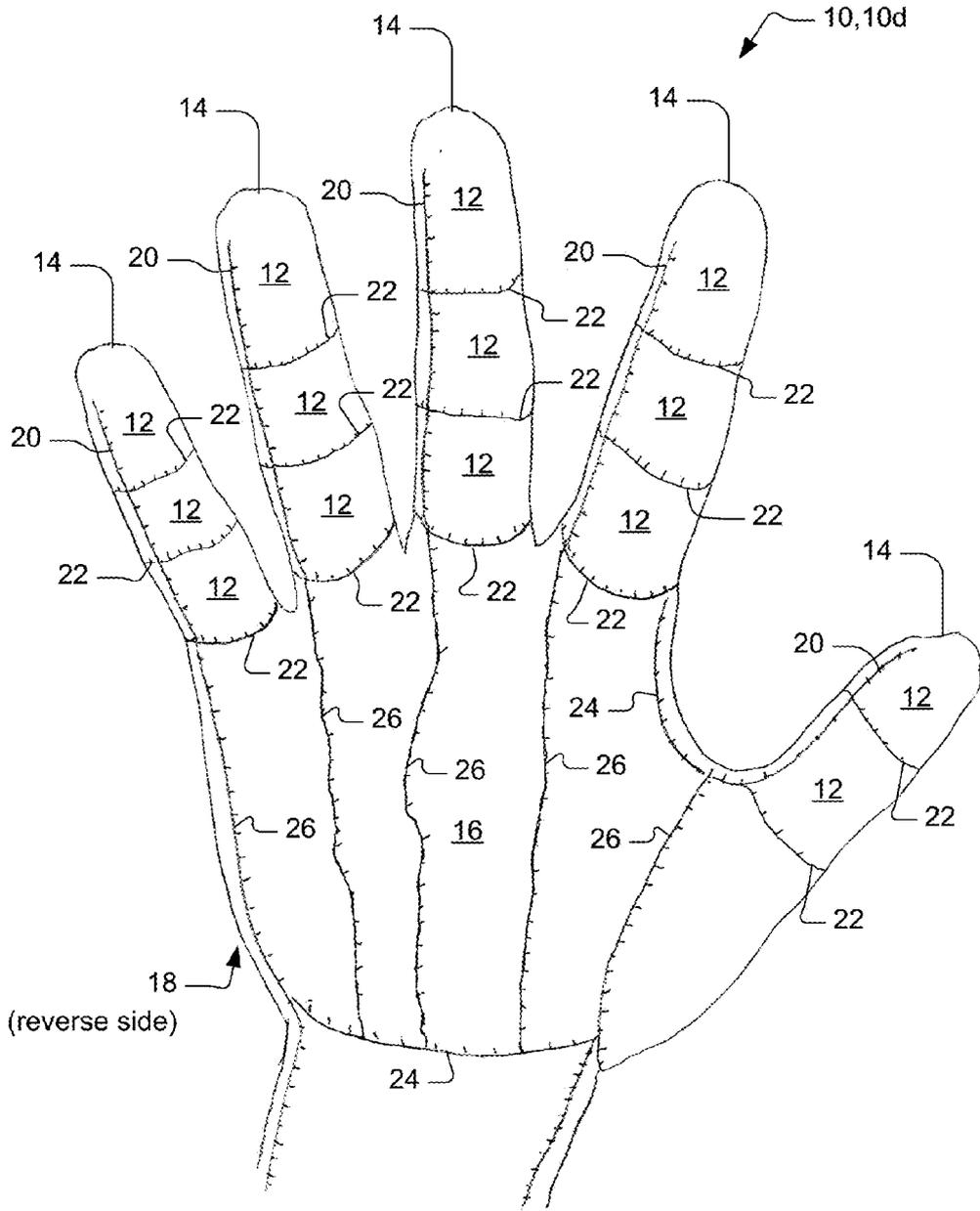


FIG. 5

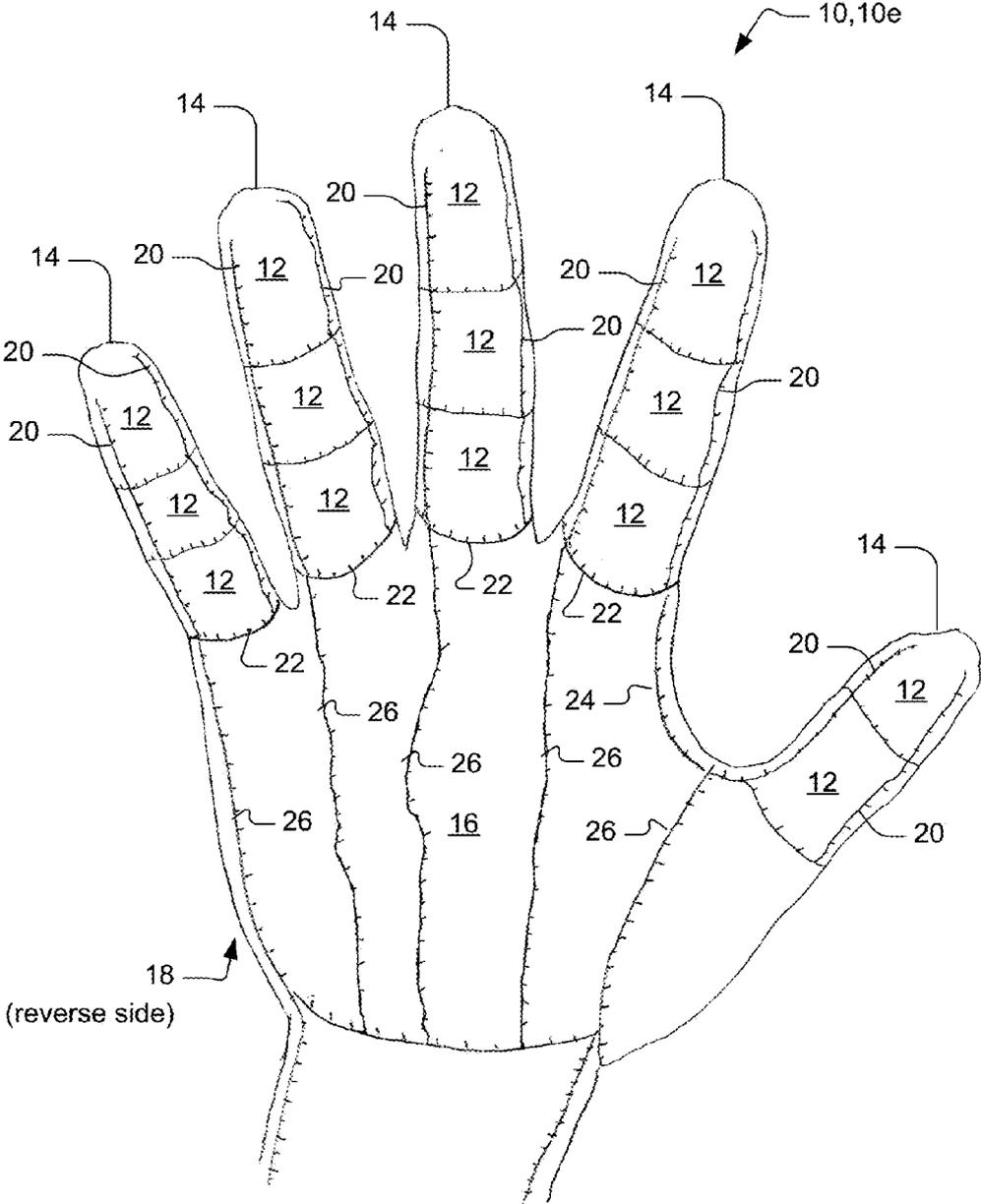


FIG. 6

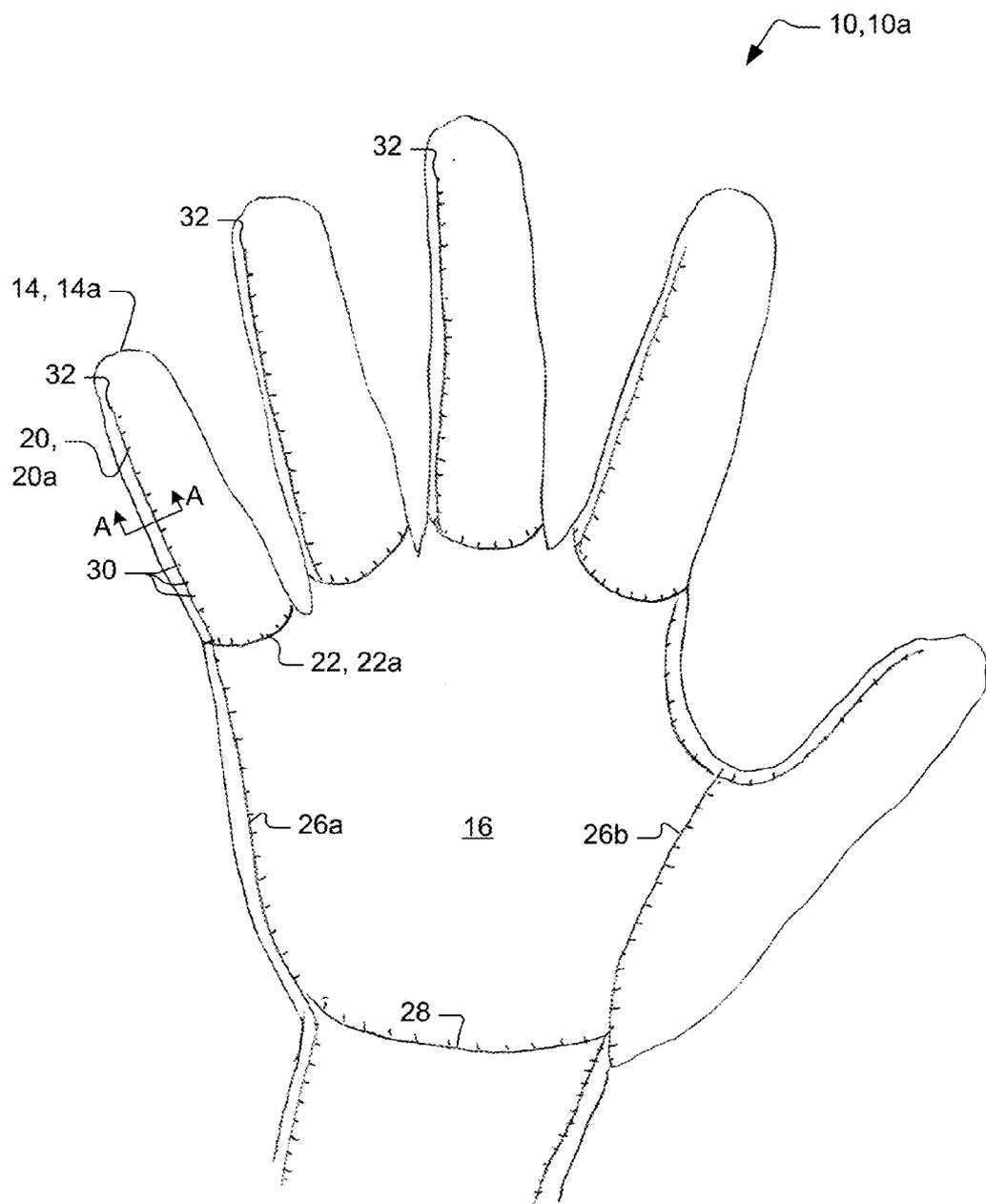
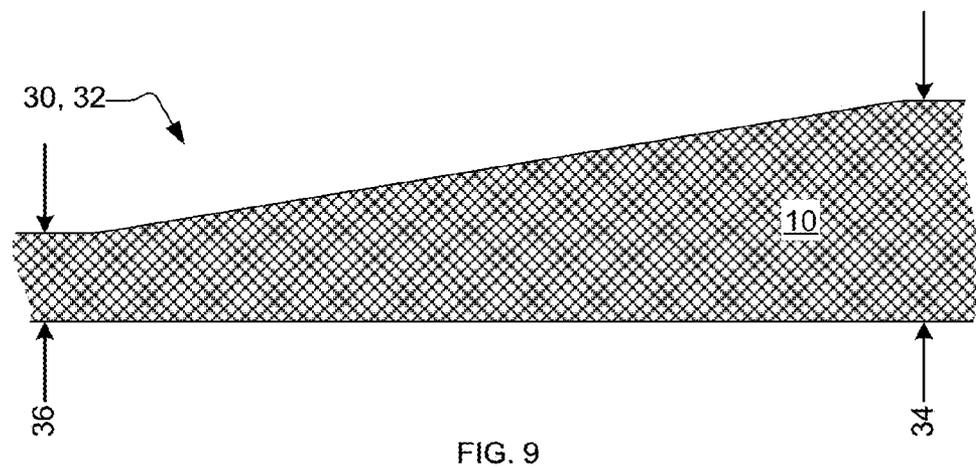
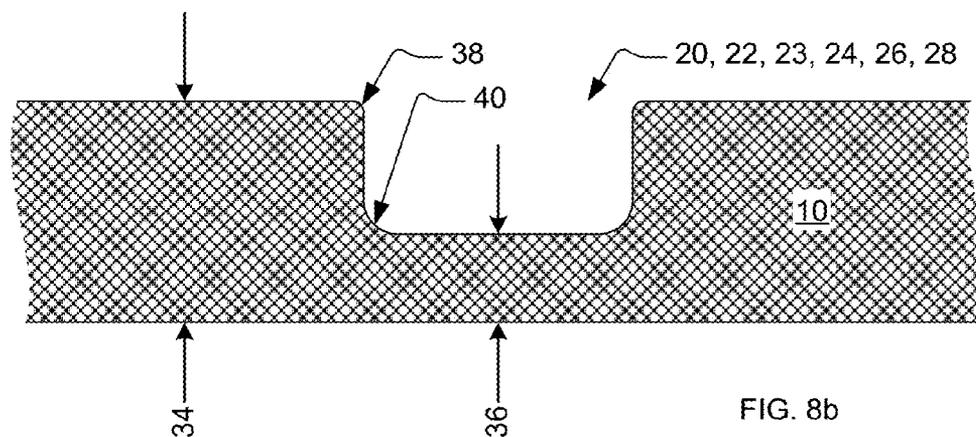
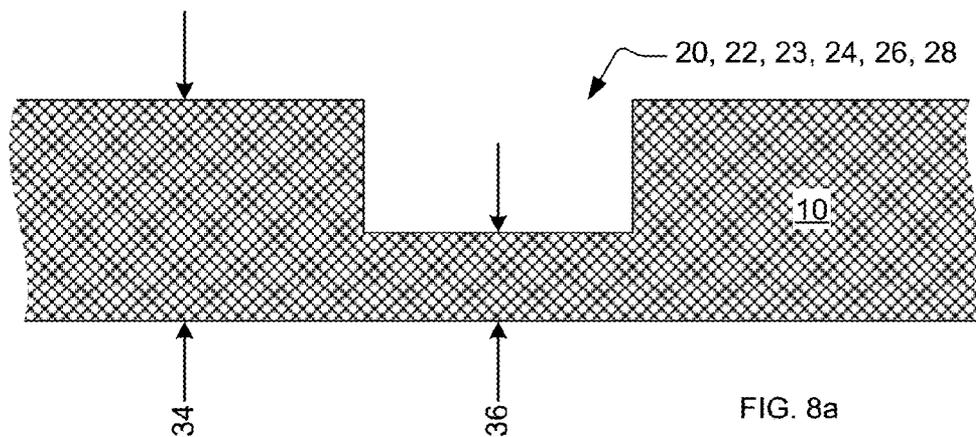
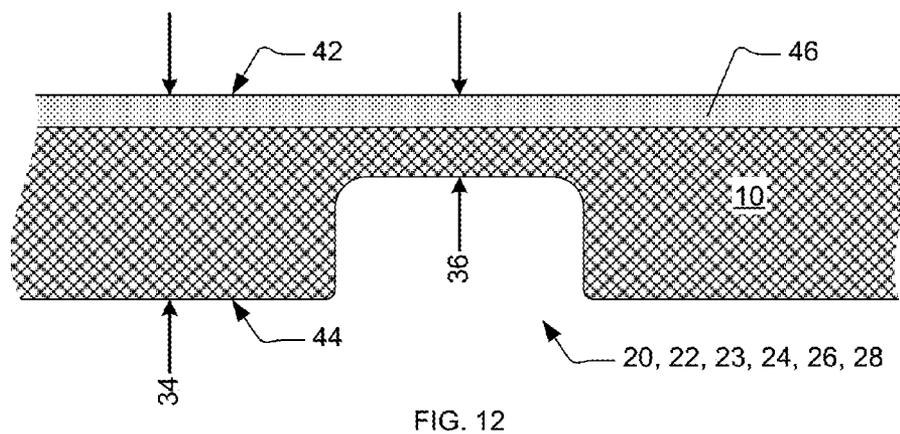
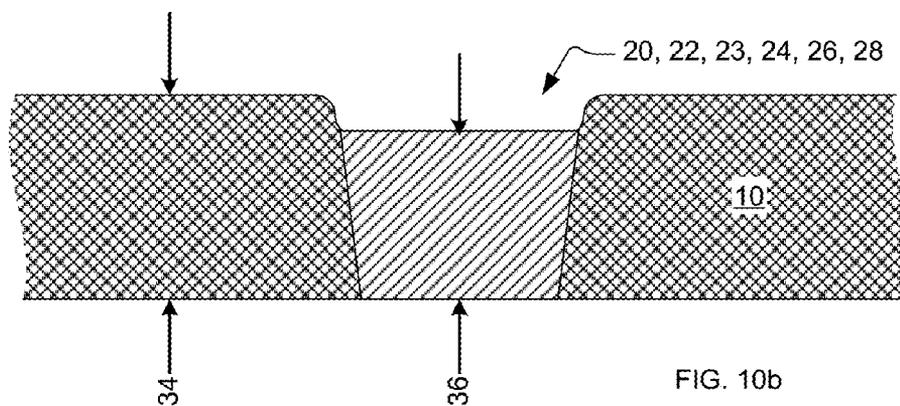
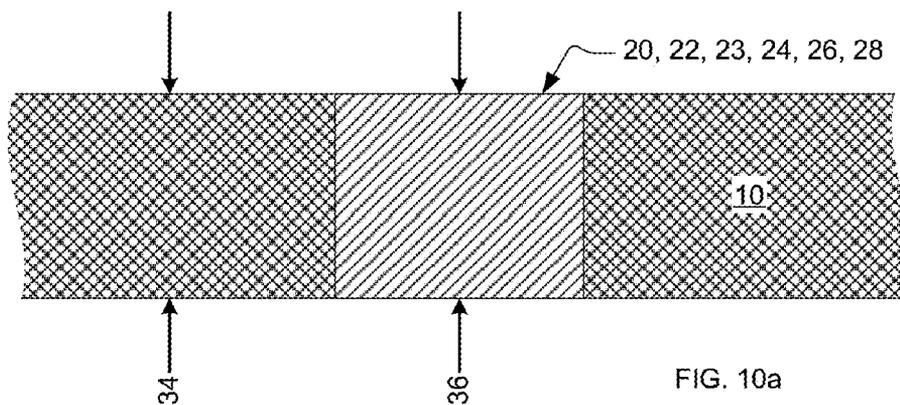


FIG. 7





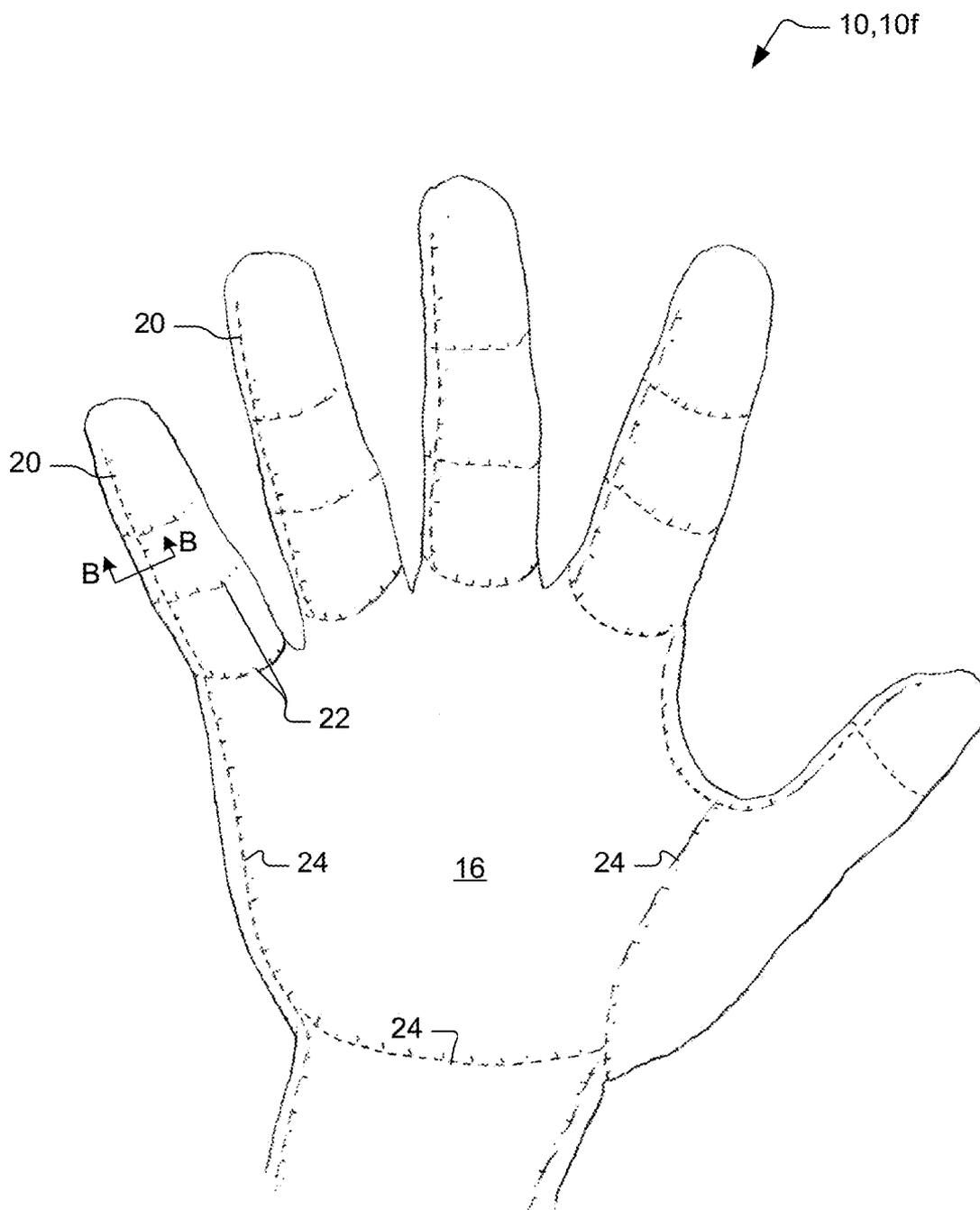


FIG. 11

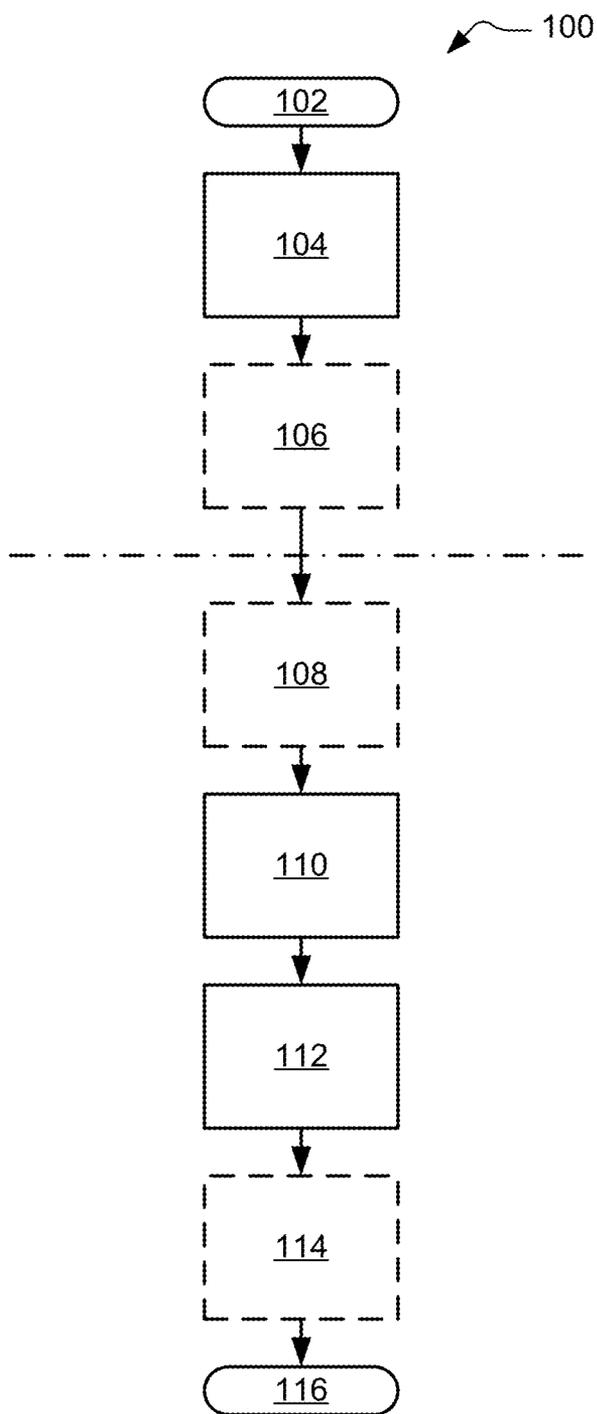


FIG. 13

**SAFETY GLOVE**

**CROSS-REFERENCE TO RELATED APPLICATIONS**

[0001] Not applicable.

**STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT**

[0002] Not applicable.

**THE NAMES OF THE PARTIES TO A JOINT RESEARCH AGREEMENT**

[0003] Not applicable.

**INCORPORATION-BY-REFERENCE OF MATERIAL SUBMITTED ON A COMPACT DISC**

[0004] Not applicable.

**BACKGROUND OF THE INVENTION**

[0005] 1. Technical Field

[0006] The present invention relates generally to apparel, and more particularly to a work glove type hand covering specially configured to protect the hand of a worker in an occupational environment.

[0007] 2. Background Art

[0008] Work gloves are a hand covering that are desirable or necessary in many endeavors today. For instance, they are widely used to prevent skin abrasion, exposure to sharp edges, splinters, and contact with caustic and unhygienic materials. For straightforward reasons, work gloves are often outright necessary in fields using chemicals, electricity, and extremes of heat and cold.

[0009] Of particular present interest, work gloves are worn when working around many types of moving machinery, such as lathes, mills, drills, presses, conveyor belts, etc. Here wearing work gloves may be desirable because of concerns related to the work materials, such as those noted in the last paragraph, as well as for protection from the moving machinery.

[0010] Unfortunately, accidents involving work gloves are common. Let us consider one example. An operator of a drill press may wear work gloves to reduce abrasion and splinters from material shavings, burns from material or tooling headed by the drilling process, cuts from the flutes of sharp drill bits, etc. Work gloves in this scenario, however, can themselves become snagged on the work material, on a rotating drill bit, or elsewhere on the drill press. The result then can be a fright, injury, or even death as the snagged work glove immobilizes the worker's hand or contributes to pulling their hand or even their whole body into danger. The phrase "glove-caused accident" has been used to describe such accidents as a class.

[0011] To discuss work gloves an understanding of the basic anatomy of the hand is useful. FIG. 1 (prior art; based on "Essentials of Hand Surgery," American Society for Surgery of the Hand, 2009) shows a typical human right hand with many of the accepted labels for the various parts of the hand. As can be seen, "proximal" and "distal" are defined by being nearer or further away from the wrist, and thus the rest of the body. The hand has four fingers and a thumb, but for present purposes the thumb can effectively be treated as a fifth finger (albeit, one lacking a middle phalanx). FIG. 1 shows the palm of the hand (also known as the volar), including the heel of the

hand (also known as and here labeled the thenar). FIG. 1 does not show the corresponding posterior part of the hand, called the opisthenar area (or dorsal), that is, the back or the top of the hand.

[0012] There have been many attempts to solve work glove problems. One such approach has been to armor the glove. U.S. Pat. No. 2,686,316 to Linn, U.S. Pat. No. 2,923,946 to Nielson, U.S. Pat. No. 3,290,695 to Burtoff, U.S. Pat. No. 3,184,756 to DeLuca, Jr., U.S. Pat. No. 3,386,104 to Casey, and U.S. Pat. No. 3,732,575 to Pakulak are all examples of this. Unfortunately, this approach has clear limits. While it may work well to prevent injuries when a worker stacks lumber, for example, the use of an armored glove would not help the drill press operator in the above example. Indeed, the added material, the reduced mobility, etc. might significantly increase the likelihood of a glove-caused accident. The added awkwardness of such gloves might also motivate the worker to not bother wearing them.

[0013] Another set of solutions to work glove problems has been an "anti-armor" approach, to intentionally make work gloves fragile so they easily separate into pieces, wherein such a piece of the glove may be immobilized or pulled into danger but the rest of the glove and the worker's hand can be pulled to safety.

[0014] U.S. Pat. No. 4,131,952 by Brenning, Jr. provides a detailed discussion of a piece-wise glove assembly approach. Here a safety glove for a work person is taught that has fingerless body sections for covering the palm and top of the hand, and finger and thumb sections are attached but remain easily separable. In the event a section is snagged or caught in a machine the work person, with a reflex action, can pull their hand in an opposite direction. Brenning, Jr. terms the mechanism used to connect its sections "rupturable joints" and provides examples including a ring or bead that is pressed into a cooperating channel or groove, an O-ring or beaded joint variation of this, or sections attached using a low tensile strength band or low strength connecting thread or a network of woven threads to provide a weakened tear line at the junction. Disadvantages here are that the joints are awkward, making some embodiments of the gloves hard to wear, and generally making the gloves complex and expensive to manufacture.

[0015] German Pat. No. DE 10 2007 015 961 by Kipp teaches a perforation zone approach. The work glove here is perforated at crucial points to provide predetermined breaking zones. The crucial points for perforation are at the knuckles of each finger as well as across major portions of the palm of the hand.

[0016] The use of perforations beneficially permits easy and economical manufacture of a single piece glove, but also results in a glove that may be less durable and that is unsuitable for some uses. Perforations are small holes, and therein lie some problems. If work glove material between two perforations wears away or is broken, a bigger hole results. As this process progresses, small holes become much bigger holes, with large edge regions. In theory, as partial separation along perforations occurs a worker should discard such a glove for a new one. In practice, however, this may not occur promptly or at all. Workshop owners frown on frequent replacement and workers, mindful of shop owner concerns or due simply to their own unwillingness to take time, may delay putting on a replacement glove. A worn glove with one or more holes with large edge regions can then itself undermine safety by providing an increased likelihood of snagging.

Alternately, perforations as holes provide openings for ingress into a glove of undesirable materials. Work material shavings that are too large to penetrate a normal woven fabric can easily work into perforation holes to irritate or penetrate underlying skin.

[0017] In passing, it can be appreciated that the approaches exemplified by Brenning, Jr. and Kipp can be used with a variety of glove materials. For example, rubber, plastic, leather, and woven fabrics can all be used (although applying perforations to woven fabric can reduce durability). The following examples employ woven fabrics, albeit ones that can be coated. These thread-based approaches generally include weaving a small denier thread into the area where the glove finger attaches to the glove palm.

[0018] European Patent Office application EP 2 572 598 by Kim teaches a weakened material approach. Similar to Brenning, Jr.; Kipp; and presently discussed Becker et al., Kim's is a separable sections approach. The English language disclosure in Kim confusingly uses the phrase "cut-off section" where the phrase "separable section" is more descriptive, since the sections of Kim's glove would typically be torn off rather than cut off. Rather than use perforations to define where the cut-off or separable sections of its glove are, Kim teaches zones where the material of its glove is "woven thin." Kim also teaches that its glove can be coated over the fabric, including over the woven thin portion. This approach avoids the problems noted above with respect to perforations. Kim's woven thin portions are shown as being quite localized, to precisely define its cut-off or separable sections. This tends to complicate manufacturing and increase end product cost.

[0019] U.S. Pub. No. 2013/0139295 by Becker, et al. teaches an alternate weakened threads approach. Here, rather use a thin weave, a predetermined tearing zone is provided close to the proximal end of the fingers, that is, close to the transitions to the palm of the protective glove. In this tearing zone a first yarn component is provided continuously and a second yarn component is left out. Becker, et al. teaches that this glove is coated over substantially all of its fabric, and that its separable sections are quite localized and precisely defined. This as well tends to complicate manufacturing and increase end product cost.

[0020] Summarizing, the prior art approaches have not completely solved the problems with work gloves. Armor style safety gloves are often impractical, or can increase the chances of injury, and/or simply may not be worn. Other styles of safety gloves have employed separable sections. Multi-piece safety gloves tend to also be awkward to wear, as well as complicated to manufacture and therefore high in cost. Single-piece safety gloves use precise localized failure zones. Perforations are one approach to defining the separable sections, but have glove durability issues and permit the entry of material through the perforations. The other approach to defining separable sections has been to alter the weave at failure zones, which is accordingly limited to use with woven fabrics. Single-piece safety gloves tend to be easier to manufacture but particular attention must be directed to defining the failure zones and providing glove durability. Moreover, it has been the present inventors' experience that section-wise separation in existing safety gloves is not always reliable. Accordingly, there remains a need for improved designs and manufacturing processes for safety gloves.

BRIEF SUMMARY OF THE INVENTION

[0021] Accordingly, it is an object of the present invention to provide an improved safety glove.

[0022] Briefly, one preferred embodiment of the present invention is a process for producing a safety glove of a conventional material that can be worn on a conventional human hand having fingers, a palm, and a backhand. The glove first is obtained as a unitary construct having glove finger sections to each respectively cover one finger of the hand, a glove palm section to cover the palm, and a glove back section to cover at least part of the backhand. For each glove finger section a separation zone is formed in the glove by controllably weakening the material of the glove such that all or part of the respective glove finger section is separable from the rest of the glove. The separation zone, however, retains a discernible thickness throughout.

[0023] Briefly, another preferred embodiment of the present invention is a safety glove of a conventional material to wear on a human hand, wherein the hand has a palm, a backhand, and a plurality of fingers comprising at least two phalanxes. The glove is obtained as a unitary construct wherein glove finger sections each connect to a glove palm section and to a glove back section at a palmar digital crease. A separation zone is formed in each glove finger section by controllably weakening the material of the glove such that all or part of the respective glove finger section is separable from the rest of the glove, yet where the separation zone retains a discernible thickness throughout.

[0024] And briefly, another preferred embodiment of the present invention is an improved safety glove to be worn on a conventional human hand having fingers, a palm, and a backhand. The glove of the type fabricated as a unitary construct of a conventional glove material that is a member of a set of consisting fabrics, synthetics, hides, and composites of these. The glove is also of the type that includes glove finger sections to each respectively cover one finger of the hand, a glove palm section to cover the palm, and a glove back section to cover at least part of the backhand. The improvement comprises each glove finger section further having a separation zone made by controllably weakening the material of the glove such that all or part of the respective glove finger section is separable from the rest of the glove, yet where the separation zone retains a discernible thickness throughout.

[0025] These and other objects and advantages of the present invention will become clear to those skilled in the art in view of the description of the best presently known mode of carrying out the invention and the industrial applicability of the preferred embodiment as described herein and as illustrated in the figures of the drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

[0026] The purposes and advantages of the present invention will be apparent from the following detailed description in conjunction with the appended figures of drawings in which:

[0027] FIG. 1 (prior art) shows a typical human right hand with many of the accepted labels for the parts of the hand;

[0028] FIG. 2 shows a human right hand wearing a glove in accord with the present invention, wherein the glove fingers have an axial and a radial separation zone;

[0029] FIG. 3 shows a human hand wearing an embodiment of a glove in accord with the present invention, wherein the glove fingers have multiple radial separation zones;

[0030] FIG. 4 shows a human hand wearing an embodiment of a glove in accord with the present invention, wherein the glove fingers have multiple radial and non-radial (diagonal) separation zones;

[0031] FIG. 5 shows a human hand wearing an embodiment of a glove in accord with the present invention, wherein the glove palm has multiple axial separation zones;

[0032] FIG. 6 shows a human hand wearing an embodiment of a glove in accord with the present invention, wherein the glove fingers have multiple axial separation zones;

[0033] FIG. 7 shows a hand wearing the glove of FIG. 2, to facilitate a discussion of applicable safety principles;

[0034] FIGS. 8a-b show alternate versions of detail along the section A-A of FIG. 7;

[0035] FIG. 9 shows detail of the cross regions and tip regions in FIG. 7;

[0036] FIGS. 10a-b show other alternate versions of detail along the section A-A of FIG. 7;

[0037] FIG. 11 shows a human hand wearing an embodiment of a glove in accord with the present invention, wherein separation zones are on the glove interior;

[0038] FIG. 12 shows detail along the section B-B of FIG. 11; and

[0039] FIG. 13 is a flowchart showing a method suitable for manufacturing gloves in accord with the present invention.

[0040] In the various figures of the drawings, like references are used to denote like or similar elements or steps.

#### DETAILED DESCRIPTION OF THE INVENTION

[0041] A preferred embodiment of the present invention is a safety glove. As illustrated in the various drawings herein, and particularly in the views of FIGS. 2-6 and 11, wherein embodiments of the invention are depicted by the general reference character 10. [The references in the figures generally are numeric only for generic reference and numeric-alpha for specific reference. For example, “glove 10” refers to a generic instance of a glove and “glove 10a” refers to a specific embodiment of a glove. Similarly, “glove phalanx sections 12” refer to generic instances, e.g., of the fourteen possible for a glove used on a human hand, and “glove phalanx sections 12a-c” refer to three specific such sections.]

[0042] Briefly, the present inventors have observed that glove separation is needed in the event of a snag or catch but that reliance only on separable sections or zones made with present methods is misguided. Additionally, the present inventors have observed that reliance only on radial separation is not always adequate. For example, when pulling on a finger of the glove, zones or the threads that run the length of the finger often are what need to break for the finger portion of the glove to best detach from the palm section of the glove.

[0043] FIG. 2 shows a human right hand wearing a glove 10, 10a in accord with the present invention. The glove 10a here has separable sections made using one or more of novel methods, described in detail presently, and the glove 10a here has non-radial separation features. The glove 10a includes glove phalanx sections 12 that form glove finger sections 14 to accept the fingers and thumb of the hand. The glove phalanx sections 12 of each glove finger section 14 here are integral, as contrasted with other embodiments of the inventive glove 10 discussed presently. For example, glove finger section 14a comprises glove phalanx sections 12a-c, where

the glove phalanx sections 12 are demarcated by the underlying interphalangeal creases of the hand (see FIG. 1 (Prior Art)). The glove 10a in FIG. 2 further includes a glove palm section 16 and a glove back section 18.

[0044] The glove finger sections 14 here are each particularly distinguished by having an axial separation zone 20 that runs lengthwise, that is, proximal to distal along the length of the finger. As can be seen, the axial separation zones 20 each inherently also run lengthwise along the glove phalanx sections 12 of each respective glove finger section 14.

[0045] The glove 10a in FIG. 2 also has circumference-like or radial separation zones 22 corresponding with the palmar digitals of the fingers. Finally, the glove 10a has other separation zones 24. Note, the axial separation zones 20 common to a glove finger section 14 align across the respective glove phalanx sections 12. This is not a requirement and another alignment may be used. In general, however, alignment tends to facilitate separation of a glove 10 in a more severe accident.

[0046] The use of radial separation features that circle a finger is known, as already discussed in the Background Art section herein. The prior art methods of making those features have disadvantages, however, and again, improved methods are discussed in detail below. In contrast, the use of non-radial separation features is novel. The axial separation zones 20 in FIG. 2 are an example of a non-radial separation feature taken to a logical extreme.

[0047] Turning now to FIG. 3, it shows a hand wearing an alternate glove 10, 10b embodiment. Here the glove phalanx sections 12 are each respectively defined by additional radial separation zones 22 that correspond with the underlying interphalangeal creases of the hand.

[0048] FIG. 4 shows a hand wearing another alternate glove 10, 10c embodiment. Here an alternate type of non-radial separation feature is used, diagonal separation zones 23. These may be preferable over axial separation zones 20 in some applications.

[0049] FIG. 5 shows a hand wearing yet another alternate glove 10, 10d embodiment. The glove palm section 16 here includes multiple palm axial separation zones 26. These palm axial separation zones 26 each align with a respective axial separation zone 20 of a glove finger section 14. This is not a requirement and another alignment may also be used, of fewer or more palm axial separation zones 26 may also be used. In general, however, alignment here as well tends to facilitate separation of a glove 10 in a more severe accident.

[0050] FIG. 6 shows a hand wearing still another alternate glove 10, 10e embodiment. Here each glove finger section 14 and each glove phalanx section 12 has multiple axial separation zones 20 that run lengthwise.

[0051] Collectively, FIGS. 2-6 show various embodiments of gloves 10 in accord with the present invention. We turn now to a discussion of how the gloves 10 operate to promote safety.

[0052] FIG. 7 shows the hand wearing the glove 10, 10a of FIG. 2. In the event the glove 10a becomes snagged or caught on the glove finger section 14a (the small finger) it is desirable that this glove finger section 14a of this glove 10a detach at the radial separation zone 22a, as shown. That is, close to the palmar digital of the small finger. It has been the present inventors' observation that this occurs more safely if the glove 10a can separate at both the axial separation zone 20a and the radial separation zone 22a.

[0053] To appreciate why the present approach is often safer, consider the alternate and the prior art approach wherein a safety glove has an equivalent to a radial separation

zone but no equivalent to an axial or other non-radial separation zone. When a finger section of a glove with only a radial separation zone is snagged or caught, an effect similar to that in the children's toy known as a Chinese finger trap can occur, trapping the finger in the glove finger section even despite the glove having separated at the radial separation zone for that glove finger section. Injury to the wearer of such a glove is therefore much more likely, and such an injury effectively becomes a "glove-caused accident" regardless of how the accident initially began.

[0054] Continuing with FIG. 7, the axial separation zone 20a there is a finger axial separation zone. This figure also shows two palm axial separation zones 26a-b and wrist radial separation zone 28 that provide similar safety benefits.

[0055] FIG. 7 also shows optional cross regions 30 which can be a feature of all the types of separation zones 20, 22, 23, 24, 26, 28. Such cross regions 30 may be desirable to better control the separation action along a separation zone 20, 22, 23, 24, 26, 28.

[0056] Returning briefly to FIG. 6, here the benefits of multiple finger/phalanx axial separation zones 20 and multiple palm axial separation zones 26 can now be appreciated. The glove finger sections 14 each have three axial separation zones 20 (or two for the thumb). Moreover, these are for each phalanx and thus define smaller sections. This additionally reduces the possibility of any compressive trapping (i.e., the Chinese finger trap effect). Nonetheless, this does not appreciably weaken the glove 10 or reduce its durability.

[0057] Summarizing, the structure of gloves 10 having separation zones 20, 22, 23, 24, 26, 28 has been covered above, including the points of novelty of finger/phalanx diagonal separation zones 23 (non-radial separation zones) and axial separation zones 20. With respect to the separation zones 20, 22, 23, 24, 26, 28, they typically correspond with features of the hand. For example, axial separation zones 20 will usually run all or substantially the entire axial length of a hand feature like a finger or the palm. Radial separation zones 22 will usually run the circumference of a feature like a finger or the wrist and they will correspond with an interphalangeal crease, a palmar digital crease or the wrist crease. Key points about the separation zones 20, 22, 23, 24, 26, 28 is that their quantity, placement, and dimensions should correspond with where sections of the glove 10 should desirably separate. The separation zones 20, 22, 23, 24, 26, 28 are weakened areas in the glove 10, so that separation can occur.

[0058] What remains to be covered is the present inventors' method to manufacture the separation zones 20, 22, 23, 24, 26, 28 in gloves 10 and the additional points of novelty here. As discussed in the Background Art section herein, the prior art like U.S. Pat. No. 4,131,952 by Brenning, Jr.; EPO application EP 2 572 598 by Kim; and U.S. Pub. No. 2013/0139295 by Becker, et al. principally teach manufacturing separable features concurrent with the manufacture of a glove as a whole. This approach is unduly complex and uneconomical. A noted exception to is German Pat. No. DE 10 2007 015 961 by Kipp, which teaches adding perforations to form perforation zones as a separable feature. This approach is less complex and more economical, but produces a glove that has disadvantages and that may be unsuitable in some work environments or for use with some work materials.

[0059] The inventors urge that principal manufacture of a glove should be performed first, with a controlled weakening

of the material of the glove then performed later to create the desired separation zones 20, 22, 23, 24, 26, 28 and thus to form the complete glove 10.

[0060] Mindful of the above considerations and that it is desirable to extend the safety principle of the present invention to gloves of knit and woven fabrics, synthetics (e.g., rubbers, plastics, etc.), hides (e.g., leathers and other animal skins), and composites of these, the inventors have developed multiple approaches for manufacturing the gloves 10.

[0061] FIGS. 8a-b show alternate versions of detail along the section A-A of FIG. 7 that are in accord with the present inventors' method of manufacturing the glove 10. Here controlled weakening is performed by removing material of the glove 10 at the desired separation zones 20, 22, 23, 24, 26, 28. Usable approaches here are to use a chemical or abrasive processes for material removal. The inventors' preferred approach, however, is to optically apply light energy to create the pattern of separation zones 20, 22, 23, 24, 26, 28. This approach, especially using a modern light source such as a laser with computerized numerical control (CNC), can be used to very precisely, rapidly, and consistently remove material and has the added benefit of being very flexible to change between glove 10 types, sizes, and materials. For instance, laser energy can partially melt, re-plasticize, or vaporize the material.

[0062] In FIG. 8a the glove 10 generally has material of a general thickness 34, and material is controllably removed at the separation zones 20, 22, 23, 24, 26, 28 to a zone thickness 36. The general thickness 34 typically is uniform throughout the glove 10, but this is not a requirement. The zone thickness 36 may be uniform throughout the separation zones 20, 22, 23, 24, 26, 28 but this may intentionally be varied to control the force needed for separation along the various separation zones 20, 22, 23, 24, 26, 28. It should be noted that the zone thickness 36 throughout the separation zones 20, 22, 23, 24, 26, 28 has a discernible thickness. That is, there are no holes completely through the material of the gloves 10 that are added in the separation zones 20, 22, 23, 24, 26, 28 (of course, if the glove is made of woven or knitted fabric and is not coated, there will still be natural openings between threads).

[0063] In FIG. 8b the glove 10 again has the general thickness 34 and the zone thickness 36 but the separation zones 20, 22, 23, 24, 26, 28 have a top bevel 38 and a bottom bevel 40. The top bevel 38 and the bottom bevel 40 are optional, but may be desirable since they can make the glove 10 more durable. In particular, using laser removal of material permits including the top bevel 38 and the bottom bevel 40, and making them dimensionally different as shown here.

[0064] FIG. 9 shows optional detail at the cross regions 30 and tip regions 32 in FIG. 7. The separation zones 20, 22, 23, 24, 26, 28 can simply end abruptly at an end point, but by transitioning from the zone thickness 36 to the general thickness 34 the glove 10 can again be more durable.

[0065] FIGS. 8a-b, 9 show material having been removed to achieve controlled weakening. It should be noted that a separation zone 20, 22, 23, 24, 26, 28 as a whole is weakened, and that the zone thickness 36 throughout the separation zone 20, 22, 23, 24, 26, 28 retains a discernible thickness. This is distinguishable from perforating a glove, which is not encompassed by the inventors' approach.

[0066] FIGS. 10a-b show other alternate versions of detail along the section A-A of FIG. 7 that are also in accord with the present inventors' method of manufacturing the glove 10. Here controlled weakening is performed by altering the mate-

rial of the glove **10** at the desired separation zones **20, 22, 23, 24, 26, 28**. Chemical, thermal, and optical approaches can be used to altering the material in a manner that weakens it. In some cases this can be by altering the chemical composition in the separation zones **20, 22, 23, 24, 26, 28**, say, for instance, by breaking down long molecules in a plastic or rubber type material. In other cases this can be by altering fabric or thread fiber structure, say, for instance, to make it brittle or more easily separable.

[0067] In FIG. **10a** the glove **10** has the general thickness **34** and the zone thickness **36** but they are essentially equal. This has the pragmatic advantage that there is now dimensional transition across the separation zones **20, 22, 23, 24, 26, 28** so they do not separate easily in the course of normal wear. To appreciate this, compare FIG. **8a** with FIG. **10a** and note that with all else being equal the accumulated wear from friction across the separation zones **20, 22, 23, 24, 26, 28** in FIG. **8a** will make the glove **10** there less durable.

[0068] In FIG. **10b** the glove **10** has the general thickness **34** and the zone thickness **36** are not quite equal, which represents the typical case when material alteration is employed. In addition to the material being weakened in the separation zones **20, 22, 23, 24, 26, 28** there typically is also some nominal dimensional change. Of course, an approach where material removal and material weakening both occur may also be suitable. Say, where a laser beam is used to remove exposed material and heat as a result of this alters and thus weakens underlying material.

[0069] Digressing, it has been noted that the inventors prefer optical and particularly laser based approaches to forming separation zones **20, 22, 23, 24, 26, 28**. Lasers are widely used in the textile and garment industries, but not in the manner the inventors use here. Lasers have been employed to cut clear through fabric, and frequently to cut clear through multiple stacked pieces at once. In contrast, the present inventors propose using a laser to controllably and very precisely surface treat materials, including knit and woven fabrics. The inventors' approach can use less powerful, thus less expensive and safer lasers than are commonly used for textile and garment material cutting. A tradeoff in this, however, is that the inventors' approach processes one glove **10** at a time, which is opposite general textile and garment industry practice.

[0070] By using laser material removal and/or alteration the force required for failure can be controllably varied between different separation zones **20, 22, 23, 24, 26, 28**. Indeed, it can even be controllably varied within a single separation zone **20, 22, 23, 24, 26, 28**. The present inventors have found that the force required to cause separation at a separation zone **20, 22, 23, 24, 26, 28** can be reduced by 10% to 80% or more than what would cause separation in a comparable glove with no separation zones. Additionally, repeatability in actual manufacturing can probably be maintained in the range of +/-10% or better.

[0071] Digressing further, it has been noted that the inventive gloves **10** may be of knit and woven fabrics. The inventors have devoted particular attention to working with such fabrics. For instance, one approach here has been to work with radial separation zones **22** to "thin" threads in both directions, 1 to 5 threads in the circumference or radial direction, and at least 85% of the threads in the length or axial direction. By thinning the threads that run in the length or axial direction where the threads fail can be controlled, and thus what amount of force applied at a glove finger section **14** will "rip" it from the glove palm section **16** of the glove **10**. This can be

contrasted with prior art approaches, wherein regions are woven thin or a second yarn component is left out but this only effects one dimension. The present inventors' approach performs "thinning" in both directions. Because these the threads in separation zones **20, 22, 23, 24, 26, 28** are not necessarily straight line features, the number of threads that will be "thinned" will vary somewhat but both directions will be thinned even for extremely small features like fine threads.

[0072] For example, each glove finger section **14** may have a different number of lengthwise threads, which is a controlling feature of the force required for failure. By varying the depth of thinning, each glove finger section **14** can be rip at roughly the same force. To the same point, by keeping the same depth of thinning, different failure forces for individual glove finger sections **14** can be provided. For instance, simplified here to convey the principle, picture a middle glove finger section **14** that may have 100 lengthwise threads and require 50 lbs of force to fail, and a little glove finger section **14** that may have only 80 lengthwise threads and require only 40 lbs of force to fail (force required for failure is proportional to the number of lengthwise threads). If all threads are thinned by the same amount, the force reduction required for failure would still remain proportional, and the force required for failure would still vary by finger. If the middle finger threads were thinned half way through, and the little finger threads were thinned in the range of 30 to 40 percent of the way through, an approximate equivalent failure force for both glove finger sections **14** can be attained.

[0073] As another example, for non-radial features that run down the length of each finger, such as the axial separation zones **20** and the diagonal separation zones **23**, it may be desirable that ripping require a lower force closer to the finger tip. For instance, picture a glove finger section **14** snagged near the finger tip, with the direction of force being across the glove finger section **14**. This would be a worst case scenario for this type of snag, as it exerts proportionally more force on the joint or phalange the further down the finger the force is applied. By progressively increasing the depth of thinning further away from the palm, the force required for failure along the entire feature can be varied, from highest force near the knuckle, and progressively decreasing to the lowest force near the finger tip.

[0074] FIG. **11** shows a hand wearing another alternate glove **10, 10f**; and FIG. **12** shows detail along the section B-B of FIG. **11**. The separation zones **20, 22, 24** in FIG. **11** are shown in ghost outline to represent that they are formed on the interior of the glove **10f**. FIG. **11** shows how the glove **10f** has an exterior surface **42**, an interior surface **44**, and coating **46** on the exterior surface **42**. Here material is weakened from the inside of the glove **10f**. This will prevent creating edges on the outside of a glove **10**, such as can be seen in FIGS. **8a-b** and to lesser extent in FIG. **10b**, that can shorten the life of a glove **10**. FIG. **12** shows the general thickness **34** and the zone thickness **36** being appreciably different, suggesting that material removal is used for weakening. This is not necessarily the case, however, and even material alteration in the manner shown in FIG. **10a** (general thickness **34** and zone thickness **36** are equal) may benefit from the weakening being applied from the inside of the glove **10f**. If the process were performed on the outside of a glove **10** with a coating **46**, the weakening would affect the coating **46**, by thinning it rather than the main glove material, or by cutting through the coating **46** to reach the main glove material.

[0075] FIG. 13 is a flowchart showing a method 100 suitable for manufacturing gloves 10 in accord with the present invention. The method 100 starts in a step 102, where any desired initialization can be performed. Next, in a step 104 a basic glove is fabricated. Optionally (as reflected by the use in this figure of ghost outline), in a step 106 the glove can be coated. If weakening for separation zones is to be formed on the interior surface of the glove, in a step 108 the glove is turned inside out. In a step 110 the glove is prepared for separation zone creation. In general, this will entail positioning and holding the glove in manners suitable for it to receive the controlled material weakening of the particular type being employed. In a step 112 the desired separation zones 20, 22, 23, 24, 26, 28 are created. At this point the glove 10 in accord with the present invention is essentially finished. If the glove 10 was turned inside out in step 108, in a step 114 it is turned outside out. And the method 100 ends in a step 116, where any desired wrap-up can be performed.

[0076] In FIG. 13 a line separates step 106 and step 108. This is to emphasize a potential demarcation between parties and times in performing the steps. Under one manufacturing scenario, one party performs all of the steps in a relatively brief period and then typically sells or uses the gloves 10. Under another manufacturing scenario, one party performs all of the steps but they pause after step 106. This party may then sell or use some of the gloves, which will not be gloves in accord with the present invention because they will not have any separation zones. The gloves that this party does not sell or use are stocked, and when this party has a need (for sale or use), it resumes the method 100 at step 108 or step 110 and finishes manufacturing gloves 10 in accord with its need. Note, in this particular manner, for example, this party can flexibly use stock to manufacture type gloves 10a today and to manufacture type gloves 10f tomorrow. Under yet another manufacturing scenario, a first party performs steps 102-106 and provides the result (e.g., sell the basic gloves) to a second party that then performs the rest of the method 100 and completes manufacture of the gloves 10 in accord with the present invention. Note, in similar manner, the second party can procure and stock basic gloves to flexibly manufacture different types of the gloves 10, 10a-f as desired.

[0077] While various embodiments have been described above, it should be understood that they have been presented by way of example only, and that the breadth and scope of the invention should not be limited by any of the above described exemplary embodiments, but should instead be defined only in accordance with the following claims and their equivalents.

What is claimed is:

1. A process for producing a safety glove that can be worn on a conventional human hand having fingers, a palm, and a backhand, wherein the glove is of a conventional material, the process comprising:

obtaining the glove as a unitary construct having glove finger sections to each respectively cover one finger of the hand, a glove palm section to cover the palm, and a glove back section to cover at least part of the backhand; and

for each said glove finger section:

forming a separation zone in the glove by controllably weakening the material of the glove such that all or part of respective said glove finger section is separable from the rest of the glove, wherein said separation zone retains a discernible thickness throughout.

2. The process of claim 1, wherein:  
said separation zones are optically formed in the material.

3. The process of claim 2, wherein:  
said separation zones are formed with a laser.

4. The process of claim 1, wherein:  
the glove is fabricated from a material that is a member of a set of consisting fabrics, synthetics, hides, and composites of these; and  
said separation zones are formed by heat at least partially melting, re-plasticizing, vaporizing, or altering the molecular structure of the material.

5. The process of claim 1, further comprising:  
turning the glove inside out; and  
performing said forming on the material of the interior of the glove.

6. The process of claim 1, wherein:  
said separation zones are first radial separation zones each corresponding with a palmar digital crease of the hand; and  
the process further comprising, for each said glove finger section:  
forming a second radial separation zone corresponding with an interphalangeal crease of the respective finger.

7. The process of claim 1, wherein:  
said separation zones are radial separation zones; and  
the process further comprising, for each said glove finger section:  
forming a non-radial separation zone.

8. The process of claim 1, wherein:  
said non-radial separation zones are axial separation zones.

9. A safety glove to wear on a human hand, wherein the hand conventionally has a palm, a backhand, and a plurality of fingers comprising at least two phalanxes, and wherein the glove is of a conventional material, the glove comprising:

a unitary construct wherein said plurality of said glove finger sections each connect to said glove palm section and to said glove back section at a palmar digital crease; and

a separation zone in each glove finger section of the glove made by controllably weakening the material of the glove such that all or part of respective said glove finger section is separable from the rest of the glove, wherein said separation zone retains a discernible thickness throughout.

10. The glove of claim 9, wherein the glove has a general thickness, said separation zones have a zone thickness and wherein:

said zone thickness is less than said general thickness.

11. The glove of claim 9, wherein:  
said separation zones are formed by altering the material with an optical process.

12. The glove of claim 11, wherein:  
said optical process uses a laser.

13. The glove of claim 11, wherein the glove has an interior surface and an exterior surface, and wherein:  
said separation zones are formed on said interior surface.

14. The glove of claim 11, wherein said separation zone in each glove finger section of the glove is a finger first separation zone, and further comprising:

a finger second separation zone in each glove finger section of the glove.

15. The glove of claim 14, wherein:  
said finger first separation zone is a radial separation zone; and

said finger second separation zone is a non-radial separation zone.

**16.** An improved safety glove to be worn on a conventional human hand having fingers, a palm, and a backhand, the glove of the type in which:

the glove is fabricated as a unitary construct of a conventional glove material that is a member of a set of consisting fabrics, synthetics, hides, and composites of these; and

the glove includes glove finger sections to each respectively cover one finger of the hand, a glove palm section to cover the palm, and a glove back section to cover at least part of the backhand; and

the improvement comprising:

each said glove finger section further has a separation zone made by controllably weakening the material of the glove such that all or part of respective said glove finger

section is separable from the rest of the glove, wherein said separation zone retains a discernible thickness throughout.

**17.** The glove of claim **16**, wherein:

said separation zones are formed by at least partially melting, re-plasticizing, vaporizing, or altering the molecular structure of the material.

**18.** The glove of claim **17**, wherein:

said separation zones being formed with a laser.

**19.** The glove of claim **16**, wherein the glove has an interior surface and an exterior surface, and wherein:

said separation zones are formed on said interior surface.

**20.** The glove of claim **16**, wherein said separation zone is a finger first separation zone, and the improvement further comprising:

each said glove finger section further having a finger second separation zone.

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