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ADJUSTABLE, ELASTIC STATIC CONTROL WRISTBANDBackground of the Invention1. Field of the Invention

5 The present invention generally relates to devices for preventing electrostatic discharge, and more particularly to an adjustable, elastic static control wristband.

2. Description of the Prior Art

10 Electrostatic discharge, as well as the mere presence of a static electric field, can be extremely detrimental to sensitive electronic parts. This is particularly true of modern semiconductors and integrated circuits which may be degraded or destroyed by the
15 buildup of static electricity in the workplace. Especially sensitive components can be severely affected by an electrical potential as small as 50 volts, yet the simple act of walking has been known to triboelectrically generate a potential of 30,000 volts or more.

20 The most common tool heretofore used in the battle against electrostatic discharge is a conductive tether which is designed to drain away excess electrostatic charge. One of the earliest grounding tethers is described in U.S. Patent No. 3,015,754 issued
25 to W. Legge, which illustrates a grounding strap for a human leg, with a tether connecting the strap to a conductive tread to be attached to the bottom of a shoe. Later devices incorporated a wristband, and there are several variations of the wristband and/or grounding
30 tether.

 The subject invention relates to an elastic static control wristband which has improved adjustability. Several patents disclose adjustment mechanisms in wrist or body straps. For example, the
35 simplest adjustment device is a conventional buckle, such as that shown in U.S. Patent No. 4,677,521. The primary disadvantage of such a device is that it must be

manipulated each time the wristband is put on or taken off. This is also true for over-center snap type buckles such as that shown in French Patent 2,607,014 (see figure 3 of that patent). Moreover, the extent to which such
5 buckles are adjustable is extremely limited. In other words, several different sizes must be provided for users with different sized wrists. It is also difficult to achieve a proper exact adjustment with these devices, since they provide only discrete adjustment settings.
10 This is critical to the performance of the wristbands, since they must have good contact with the skin, and yet not be so tight to constrict circulation or otherwise be uncomfortable.

There are many alternatives to the standard
15 buckle, such as the prior art clasp depicted in Figure 1, which is also shown in U.S. Patent No. 4,577,256 (see figures 3 and 4 of that patent). This clasp utilizes a gate having a jam which firmly grasps the end of an elastic, conductive strap. The primary problem with this
20 construction is that the loose (conductive) end of the strap which dangles from the clasp may come into contact with an electrical power source, presenting a hazard to the user. This construction is thus somewhat inconsistent with the statement in that patent (at column
25 4, lines 53-59) that the clasp body should be made of an antistatic material in order to avoid such an inadvertent contact with a power source. Of course, the free end of the strap may be cut off, but this creates the highly undesirable potential for unraveling of the material or
30 release of small fibers into the work area which can damage the electronic components being handled. After cutting, it would also be impossible to readjust the wristband to fit a larger wrist. Similar clasp constructions are described in U.S. Patent Nos.
35 4,639,825; 4,662,695; 4,680,668; 4,720,765; 4,755,144; and 4,782,425.

One variation on an adjustable wristband which

overcomes several of the above-noted problems is shown in Figure 2, this variation also being depicted in U.S. Patent No. 4,577,256 (see figure 8 of that patent, and figures 10-11 which show a similar design). In this design, one end of the elastic, conductive strap passes through the clasp and is held loosely against the other portion of the strap by a guide. A gate/jam is still used to fix the effective length of the strap. One significant disadvantage in the design of Figure 2 is that it is incompatible for use with dual-conductor type wristbands (such as that shown in figure 13 of U.S. Patent No. 4,639,825). Furthermore, when this wristband is stretched and then relaxed over the wrist, the inner, overlapping portion may creep out from under the overlying strap, and may similarly create comfort problems when the overlapping portion of the strap curls onto itself.

Another prior art construction is shown in Figure 3 which utilizes a strap material that has an insulative outer surface and a conductive inner surface. The strap material is folded back and held in place by a figure-8 ring. Such a wristband is produced by Light Year Industrial Co., and is similar to the construction shown in U.S. Patent No. 4,816,964 (see figure 9 of that patent). A simpler version (with a plain conductive fabric strap) is also shown in U.S. Patent No. 3,015,754. This construction is advantageous because it confines the free end of the strap within the loop formed by the rest of the strap. In other words, the free end is held between the strap and the skin of the user, and cannot inadvertently contact a power source. The problem with this construction, however, is that the loop back or folded portion of the strap reduces the effective length of the inner conductive surface. In other words, it is the outer insulative surface which contacts the skin along the folded area of the strap. On small wrists, this folded material can effectively cover all of the

conductive inner surface rendering the fabric element of the wristband useless. Although this problem may be avoided by folding the strap outwardly in an opposite manner, this would then expose the inner conductive surface and re-create the aforementioned safety hazard. Another problem with this construction is that the folded portion will only stretch half as much as the unfolded portion for any given pulling force, meaning that the unfolded portion will undergo greater stresses in use and wear out sooner.

Another exemplary prior art adjustable wristband is shown in Figure 4, which utilizes a D-ring to buckle two inelastic strap portions together. The straps are formed from a fabric which has a conductive portion along the center of the inner surface of the fabric. The free end is secured to the D-ring by a hook-and-loop fastener. Although this construction does not expose any conductive material, it suffers from the same drawbacks as the conventional buckle, i.e., it must be manipulated when put on and taken off, and the user may easily fit it loose for comfort, but resulting in poor skin contact.

Other variations of prior art adjustable wrist straps suffer one or more of the above disadvantages. For example, U.S. Patent No. 4,847,729 discloses a Speidel™-type wristband (a chain of expandable metallic links) for use with static control. The only method of adjusting this kind of wristband, however, is to add a plurality of modified (inelastic) links, which is tedious, reduces the active expansion link percentage, and still only provides discrete expansion settings.

It would, therefore, be desirable and advantageous to design a static control wristband which allows the user to optimize the sizing of the wristband for a comfortable fit, without creating safety concerns or requiring the need of removal of excess conductive strap material. The design should also accommodate dual

conductor wristband variations.

Summary of the Invention

The foregoing objective is achieved in a static
5 control wristband having two straps or strap sections,
one electrically insulative and the other electrically
conductive, and at least one of the two straps or strap
sections being elastic. A connector case is also
necessary to provide the electrical connection between
10 the conductive strap and a grounding tether, and clasp
means are used to adjust the insulative strap.

In one embodiment, a single integral, elastic
strap is divided into two sections, one having a
conductive portion along its inner surface, and the other
15 being completely insulative. The conductive section is
in contact with a metallic snap placed on the connector
case, while the insulative section passes through a
clasp, such as a figure-8 ring. A first variation of
this embodiment allows for an insulative strap separate
20 from the elastic strap (conductive along its inner
surface), but sewn or sonically welded to the conductive
strap. Another variation splits the strap into left and
right segments to accommodate a dual conductor type
wristband. A further variation substitutes a SpeidelTM-
25 type wristband for the elastic fabric strap.

In another embodiment of the invention, an
inelastic strap, conductive at least on its inner
surface, is surrounded by an elastic, insulative strap,
the latter passing through the clasp, and the two straps
30 being aligned by guides. The insulative strap is wider
than the conductive strap in order to prevent exposure of
the conductive strap to a power source. This allows the
use of a cheaper fabric, e.g., one that is inelastic and
is conductive on both its inner and outer surfaces. This
35 embodiment may also be modified by affixing a metallized
film to the inner surface of a nonconductive, inelastic
fabric, or by substituting a non-expanding but flexible

chain of metallic (conductive) links for the conductive fabric, or may further be altered for use as a dual conductor wristband. All of these embodiments provide greater adjustability and comfort without requiring
5 trimming of the excess strap material which is pulled through the clasp, and without otherwise exposing any conductive portions of the wristband, since the excess adjusted material is electrically insulative and thus may be left dangling.

10

Brief Description of the Drawings

The novel features and scope of the invention are set forth in the appended claims. The invention itself, however, will best be understood by reference to
15 the accompanying drawings, wherein:

Figure 1 is a cross-sectional view of a prior art clasp for a static control wristband;

Figure 2 is a side elevational view of a prior art adjustable, elastic static control wristband, wherein
20 the strap is constructed of a conductive material and the adjustable end is loosely attached to the strap;

Figure 3 is a side elevational view of another prior art adjustable, elastic static control wristband wherein the strap has an outer insulative surface and an
25 inner conductive surface, one end of the strap being folded inwardly;

Figure 4 is a perspective view of a prior art adjustable, inelastic static control wristband;

Figure 5 is a perspective view of one
30 embodiment of the adjustable, elastic static control wristband of the present invention, utilizing a fabric strap having two separate sections;

Figure 6 is a perspective view of another embodiment of the present invention, utilizing an
35 expandable chain of metallic links, having an insulative outer covering, and forming a dual conductor wristband;

Figure 7 is a perspective view of yet another

embodiment of the present invention wherein an insulative, elastic strap surrounds a conductive, inelastic fabric strap;

5 Figure 8 is a perspective view of still another embodiment of the present invention similar to that shown in Figure 7 except that a nonexpandable chain of conductive links has been substituted for the inelastic fabric strap.

10 Description of the Preferred Embodiment

With reference now to the figures, and in particular with reference to Figure 5, there is depicted the simplest embodiment 10 of the adjustable, elastic static control wristband of the present invention.

15 Wristband 10 is generally comprised of a strap 12, a connector case 14 and a clasp 16. In this embodiment, strap 12 is a single piece of elastic fabric which is divided into two sections, 18 and 20. Section 18 has an electrically insulative outer surface, and a conductive

20 portion 22 lying along its inner surface. Section 20 is completely insulative. A stretchweave fabric having this construction is available from Offray, Inc., of Chester, New Jersey. In that particular fabric, when the conductive yarns are not woven into the strap, they lie

25 on the surface thereof and must be cut off. This cutting step may be performed during the manufacture of wristband 10. Strap 12 is typically about 2 centimeters wide, and should be long enough to accommodate a large wrist size, i.e., a total length of about 24 cm. Strap 12 preferably

30 has an elongation of at least 1.5 which allows the wristband to pass around the hand of the user but still retract to fit snugly against the wrist, and also has a low spring rate for comfort, e.g., about 0.12 lbs/in.

Connector case 14, which typically includes a

35 cover 24 and a backplate 26, engages a central portion of strap 12. A conductive (metallic) rivet 28 passes through holes in strap 12 and connector case 14, and

secures a female snap connector 30. Connector 30 thereby makes electrical contact with conductive portion 22 of strap 12. Backplate 26 may also be metallic to enhance conductivity between the skin and connector 30, but cover 24 is preferably formed from an insulative material, e.g., polypropylene or polyethylene. Connector 30 is designed to receive one end of a conductive grounding tether, the other end of which may be electrically connected to ground, i.e., zero electrical potential.

The free end of section 18 of strap 12 is affixed to clasp 16 which may take the form of a figure-8 ring; this end may be affixed to clasp 16 by looping it around the center bar of the figure-8 ring and sewing the end (or sonically welding it) onto itself. The free end 32 of section 20 is then threaded through clasp 16 to form a tight fitting cinch. The length of section 20 may easily be adjusted by feeding more or less material through clasp 16. Regardless of the amount of adjustment, free end 32 never presents a safety hazard inasmuch as it is completely insulative. Both ends of strap 12 are preferably fused to prevent unraveling or release of small fibers.

Clasp 16 may take other forms besides a figure-8 ring, such as (i) a clasp having spikes and a hinged cover to capture the fabric, (ii) a wedging gate or jam-type device as shown in Figure 1, or (iii) a D-ring as shown in Figure 4. The clasp should, however, be small and not materially reduce the amount of active expansion of strap 12 and, naturally, be electrically insulative. It will also be understood that, instead of providing a single strap having two integral sections 18 and 20, two separate straps may be provided, one having the conductive inner surface and the other being insulative. The two straps would then be sewn together or sonically welded. Those skilled in the art will further appreciate that the wristband of Figure 5 may easily be modified to a dual conductor wristband (similar to that shown in

Figure 6) by splitting the conductive section 18 of strap 12 into two separate segments, each attached to separate connectors.

Referring now to Figure 6, a dual conductor wristband 40 embodiment of the present invention is shown which employs a plurality of metallic links forming two electrically isolated expandable chain segments 42 and 44. Appropriate chain material is available from Speidel (a division of Textron, Inc., of Providence, Rhode Island) under the brand name "Twist-O-Flex". The chain is conductive, at least along its inner surface, and preferably is insulative along its outer surface, e.g., by providing an insulative coating or affixing durable insulative caps. A connector case 46, similar to connector case 14 of Figure 5, receives both segments 42 and 44. Connector case 46, however, houses two connectors 48 and 50 which are in separate electrical contact with segments 42 and 44, respectively. A dual conductor grounding tether provides separate electrical pathways for each connector 48 and 50.

The free end of chain segment 42 is attached to an electrically insulative strap 52 by means of a clip 54. Strap 52 is essentially identical to section 20 of strap 12, and is thus preferably, but not necessarily, elastic. In the preferred embodiment, chain segment 42 is attached to clip 54 by means of a spring-loaded pin, while strap 52 is attached thereto by looping it around a cross-bar of clip 54 and sewing the end (or sonically welding it) onto itself. Similarly, the free end of chain segment 44 is attached to another (figure-8 type) clasp 56 by a spring-loaded pin, and the free end 58 of strap 52 is then threaded through clasp 56 to form a tight fitting cinch. As with wristband 10, chain segments 42 and 44, together with strap 52, preferably have an elongation of at least 1.5, and a low spring rate. It is understood that the term "elastic" as used herein includes in its meaning the expandable nature of

chain segments 42 and 44 since those segments provide a retracting force.

Another wristband embodiment 60 of the present invention, illustrated in Figure 7, utilizes an elastic, electrically insulative strap 62 and an inelastic, electrically conductive strap 64. Inelastic strap 64 may be formed from a fabric having conductive yarns; alternatively, strap 64 could be constructed by affixing a metallized film (or applying a conductive coating) to the inner surface of a strip of any insulative, durable material. In either case, strap 64 is preferably flexible along its longitudinal direction (length), to conform to contours of the wrist; however, it is preferably rigid along its transverse direction (width), and furthermore should not be easily compressed or rolled along its longitudinal direction. Strap 64 is also preferably relatively hard to inhibit penetration of any pointed object therethrough which might come into contact with the conductive inner surface.

Strap 64 is loosely held against strap 62 by means of two guides (D-rings) 66. The ends of strap 64 are permanently attached to guides 66, but strap 62 is merely threaded through the guides. Strap 62 may be constructed of any elastic, electrically insulative material, including a simple stretchweave fabric. Strap 62 is preferably wider than strap 64 to insure that no conductive portion of strap 64 is exposed. The ends of strap 62 are held in adjustable relationship by another clasp 68. A connector case 70 is again provided, although Figure 7 illustrates the use of a male snap connector 72 rather than a female snap connector.

With further reference to Figure 8, another wristband embodiment 80 of the present invention is depicted which is very similar to the wristband 60 of Figure 7. In fact, wristband 80 is essentially identical to wristband 60 except that flexible chain segments 82 and 84 have been substituted for strap 64. Also, Figure

8 depicts a dual conductor version of the two-strap wristband, i.e., the two chain segments 82 and 84 are separately connected to two male snap connectors. An elastic, insulative strap 86, identical to strap 62, is
5 aligned with chain segments 82 and 84 with guides, as before, and another clasp provides adjustability to strap 86. Although chain segments 82 and 84 may be expandable, they preferably are not, since expanding links, when retracting, may pinch the skin or grab body hair,
10 creating discomfort. The chain segments are, nevertheless, flexible to conform to the shape of the wrist.

Each of the foregoing embodiments presents a wristband which allows a wide degree of adjustment for
15 comfort and yet, due to the elasticity of at least one of the straps, insures proper electrical contact with the skin of the user. Furthermore, this is accomplished without exposing any conductive portion of the straps and without the necessity of trimming the loose end of any
20 strap.

Although the invention has been described with reference to specific embodiments, this description is not meant to be construed in a limiting sense. Various
25 modifications of the disclosed embodiment, as well as alternative embodiments of the invention, will become apparent to persons skilled in the art upon reference to the description of the invention. It is therefore contemplated that the appended claims will cover such
30 modifications that fall within the true scope of the invention.



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I claim:

1. A device for electrically connecting an individual to a conductive grounding tether, comprising:
a first strap having an electrically conductive
5 portion for contacting a limb of the individual;
a second strap which is electrically insulative, attached to said first strap;
one of said first and second straps being elastic;

10 a connector case attached to said first strap, and having connector means for electrically connecting said conductive portion of said first strap to the tether;

15 clasp means for adjusting the effective length of said second strap; and

said first and second straps, connector case and clasp means defining a closed loop for encircling the limb of the individual.

2. The device of Claim 1 wherein said first and
20 second straps are integrally formed together, and both of said straps are elastic.

3. The device of Claim 1 wherein said first strap has outer and inner surfaces, said outer surface thereof being electrically insulative and said inner
25 surface thereof having an electrically conductive portion.

4. The device of Claim 1 wherein said first strap is constructed from an elastic fabric having conductive yarns.

30 5. The device of Claim 1 wherein said first strap is constructed from a chain of electrically conductive, expandable links.

6. The device of Claim 1 wherein:
said first strap is divided into first and
35 second electrically isolated segments; and

said connector means comprises first and second connectors, said first connector being in electrical





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contact with said first segment of said first strap, and said second connector being in electrical contact with said second segment of said first strap.

7. The device of Claim 1 wherein:

5 said second strap, connector case and clasp means define a closed loop which surrounds said first strap; and

 said first strap is flexible but inelastic.

8. A device for eliminating the buildup of an electrostatic charge on an individual, comprising:

10 first strap means for contacting a limb of the individual, said first strap means having an electrically conductive portion;

 a connector case attached to said first strap means and having connector means for electrically connecting said conductive portion of said strap means to an electrically conductive tether;

15 second strap means attached to said first strap means, said second strap means being electrically insulative;

20 one of said first and second strap means being elastic;

 clasp means for adjusting the effective length of said second strap means, said first and second strap means, connector case and clasp means defining a closed loop for encircling the limb of the individual.

9. The device of Claim 8 wherein:

 said first and second strap means comprise a single integrally formed strap having first and second sections, said first section corresponding to said first strap means and said second section corresponding to said second strap means;

30 said first strap section has outer and inner surfaces, said outer surface thereof being electrically insulative and said inner surface thereof containing said electrically conductive portion; and

 said strap is constructed from an elastic





fabric having conductive yarns.

10. The device of Claim 8 wherein said first strap means comprises a chain of electrically conductive, expandable links; and

5 said second strap means comprises an electrically insulative, elastic fabric.

11. The device of Claim 8 wherein:

 said first strap means comprises an inelastic but flexible fabric having electrically conductive yarns;

10 said second strap means comprises an electrically insulative, elastic fabric; and

 said second strap means, connector case and clasp means define a closed loop which surrounds said first strap means, and further comprising guide means for
15 aligning said second strap means with said first strap means.

12. The device of Claim 8 wherein:

 said first strap means comprises a nonexpandable but flexible chain of conductive links;

20 said second strap means comprises an electrically insulative, elastic fabric; and

 said second strap means, connector case and clasp means define a closed loop which surrounds said first strap means, and further comprising guide means for
25 aligning said second strap means with said first strap means.

