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Bielefeld

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(54) **FLEXIBLE RATCHET MECHANISM FOR THE HEADBAND OF PROTECTIVE HEADGEAR**

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A42B 1/22 (2006.01)

(52) **U.S. Cl.** ..... **2/418**; 2/DIG. 11; 24/68 B

(58) **Field of Classification Search** ..... 2/416, 2/417, 418, 419, 420, 183, DIG. 11; 24/68 B, 24/69 AT, 484
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,500,474 A 3/1970 Austin
4,888,831 A 12/1989 Oleson
4,942,628 A 7/1990 Freund
5,212,838 A * 5/1993 Davidson et al. 132/59
5,412,811 A * 5/1995 Hildenbrand et al. 2/10
5,950,245 A 9/1999 Binduga
6,481,023 B1 11/2002 Wise et al.
6,708,376 B1 * 3/2004 Landry ..... 24/68 R

* cited by examiner

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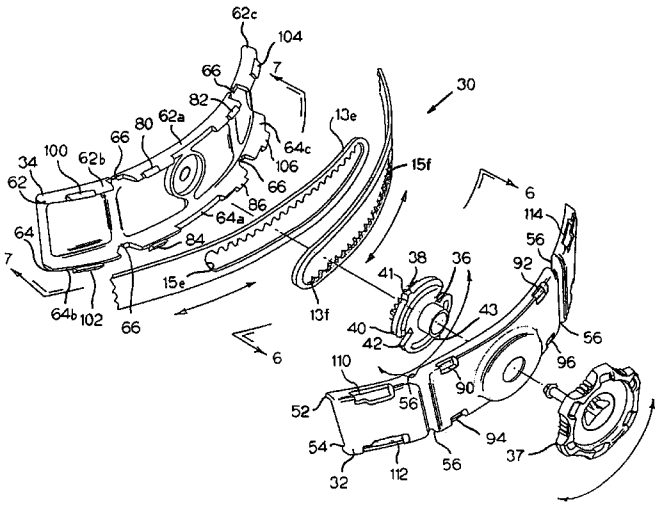
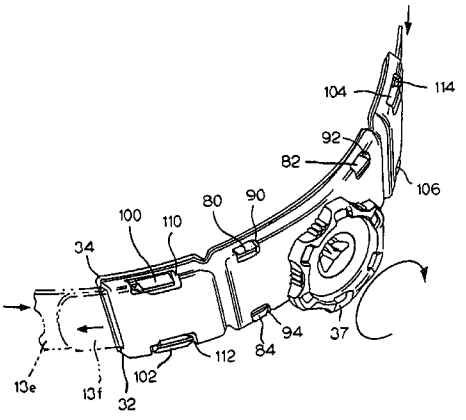
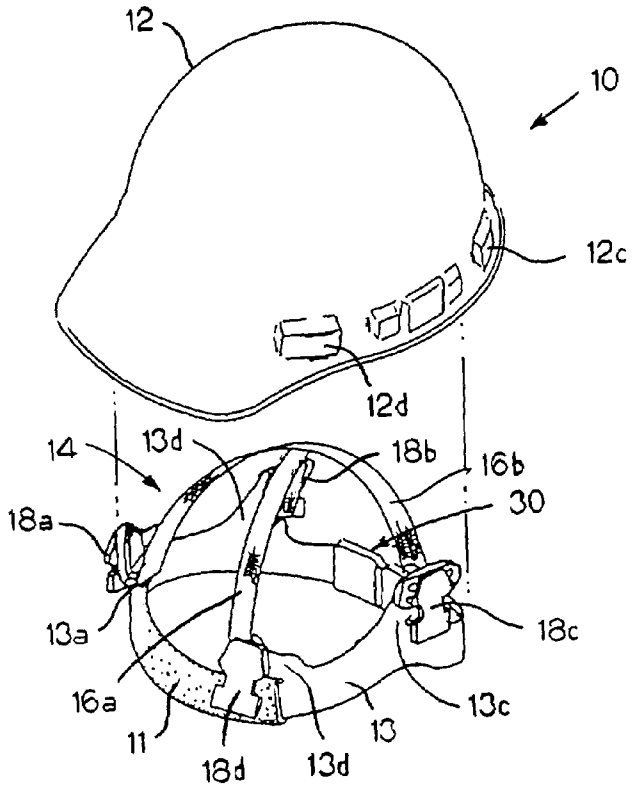
(57) **ABSTRACT**

A ratchet mechanism for the headband of a protective helmet or other headgear allows for adjustment of the size and fit of the headband. The headband has overlapping rear end portions which are enclosed in a housing, which is comprised of an outer substantially arc-shaped housing section joined to a inner substantially arc-shaped housing section. Also contained with the housing sections is an adjustment mechanism adapted to cause lateral movement of the overlapping rear end portions of said headband with respect to one another. The outer and inner housing sections are substantially segmented into multiple discrete portions such that the respective housing sections are flexible along defined boundaries between the discrete portions to provide for a better and more comfortable fit.

17 Claims, 7 Drawing Sheets



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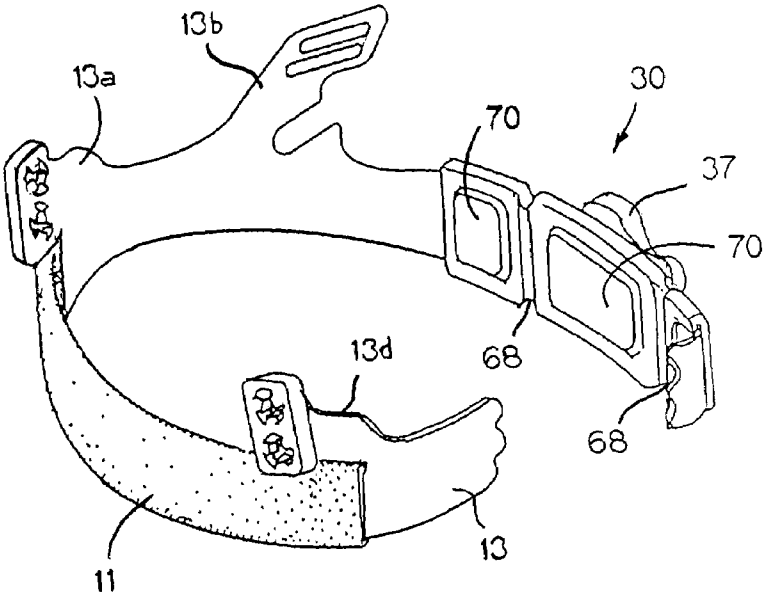
10
12c
12d
14
13d
18b
16b
30
18a
13a
18c
16a
13c
11
13
18d
13d

FIG. 1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13a
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13
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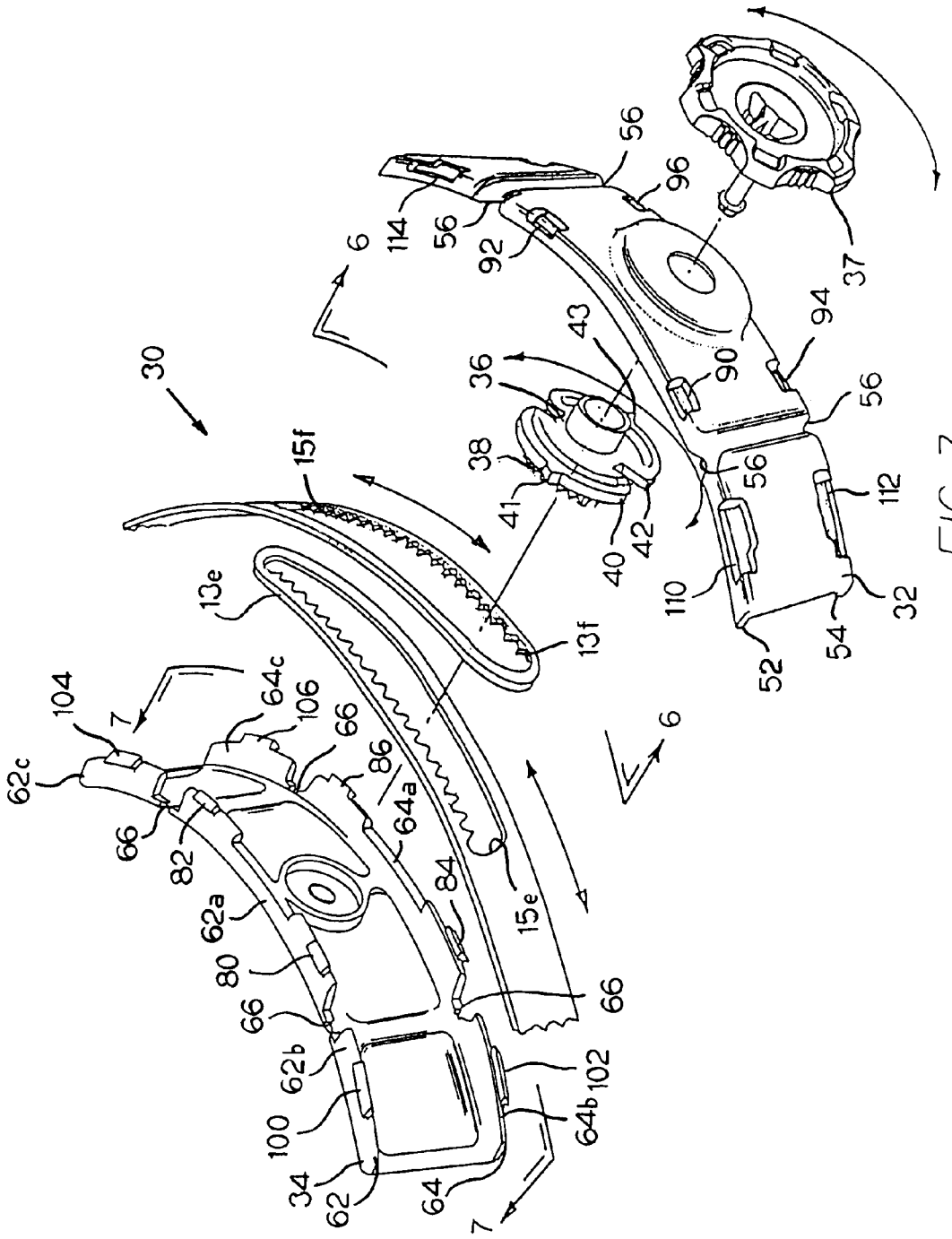
FIG. 2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15f
13e
13f
15e
6
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62c
66
64c
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62b
100
34
62
64
64b
102
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112

FIG. 3

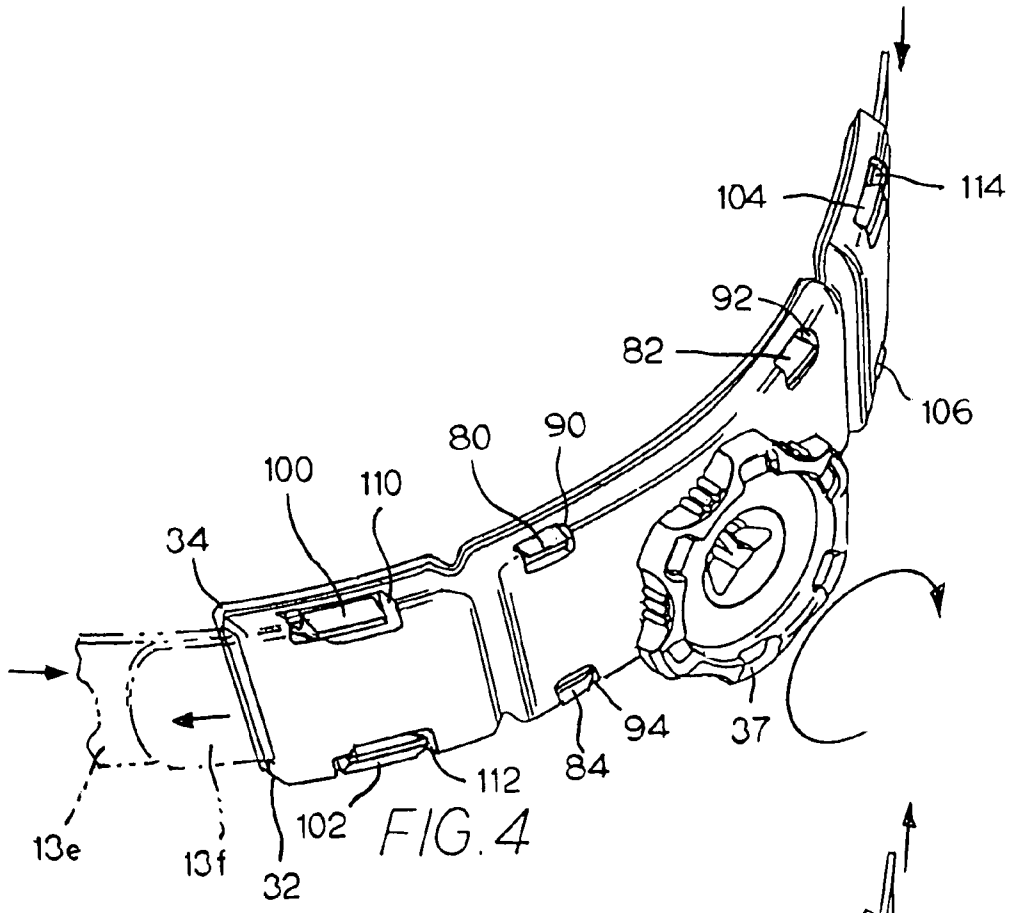
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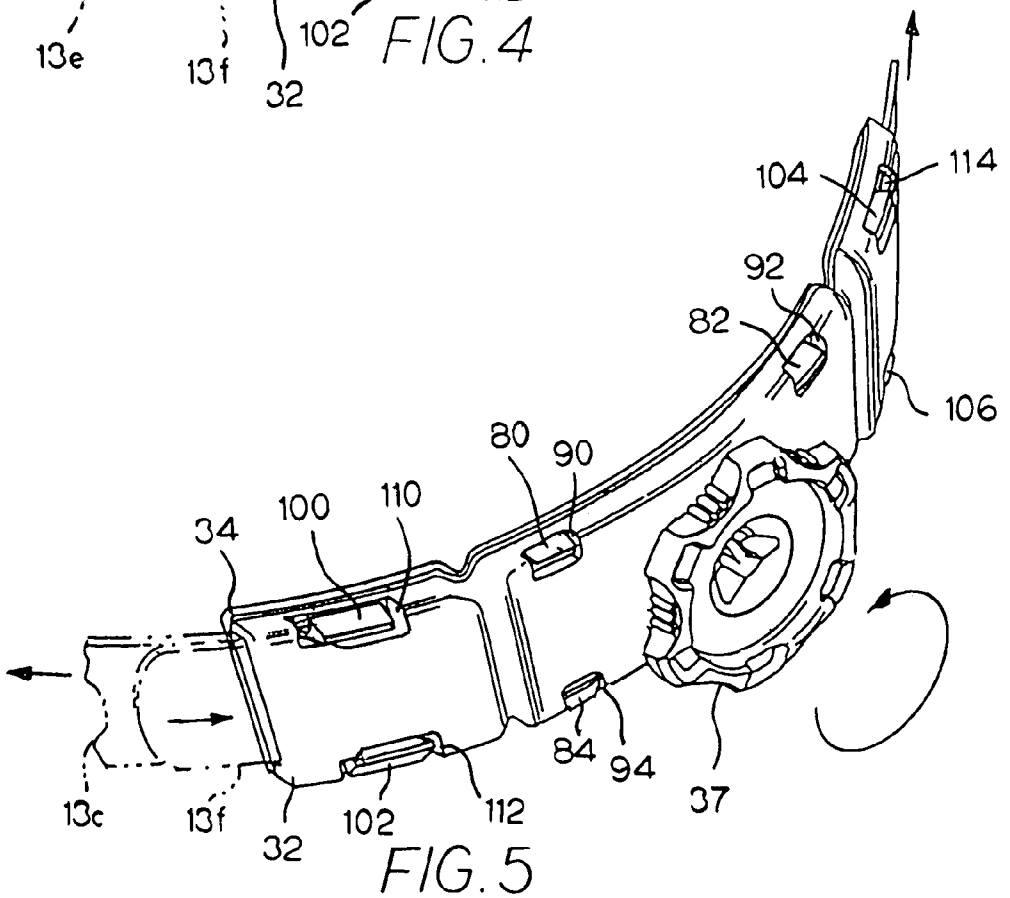
FIG. 4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37
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13c
13f
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FIG. 5

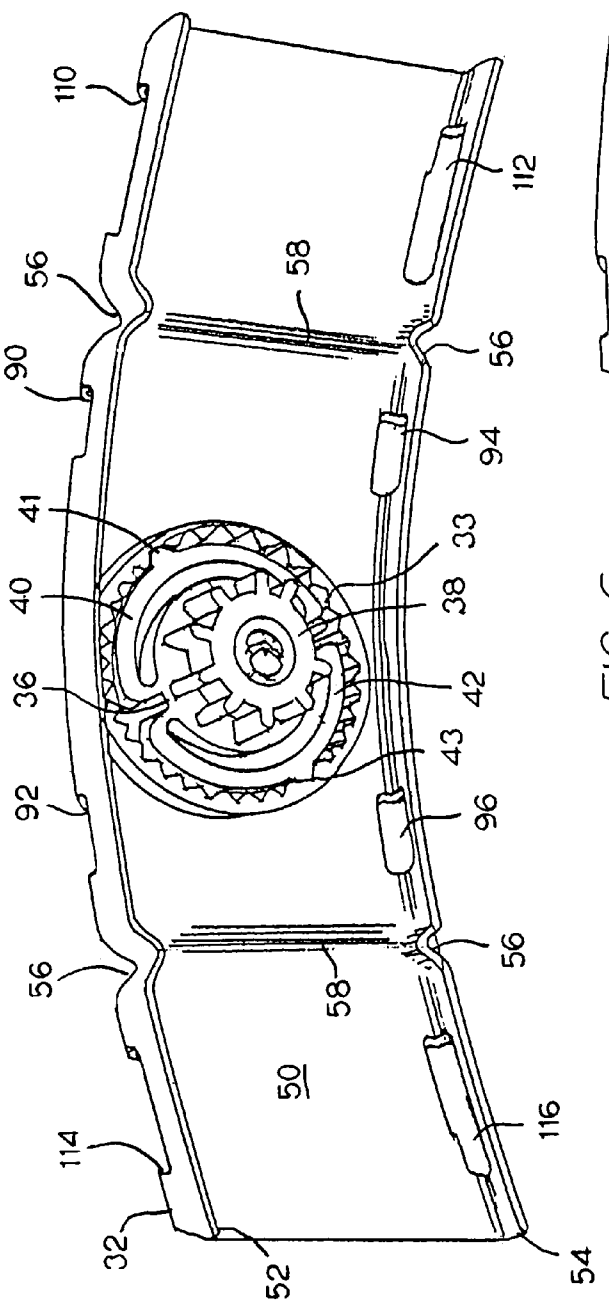
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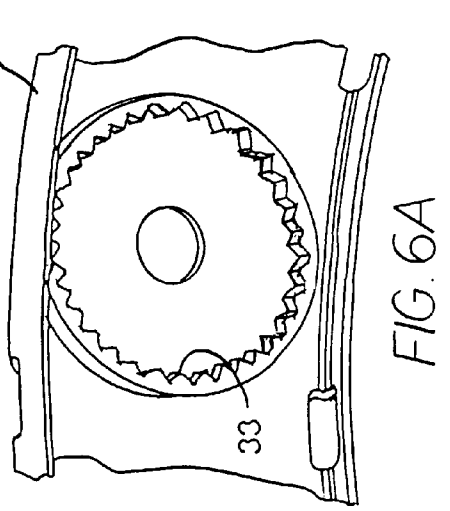
FIG. 6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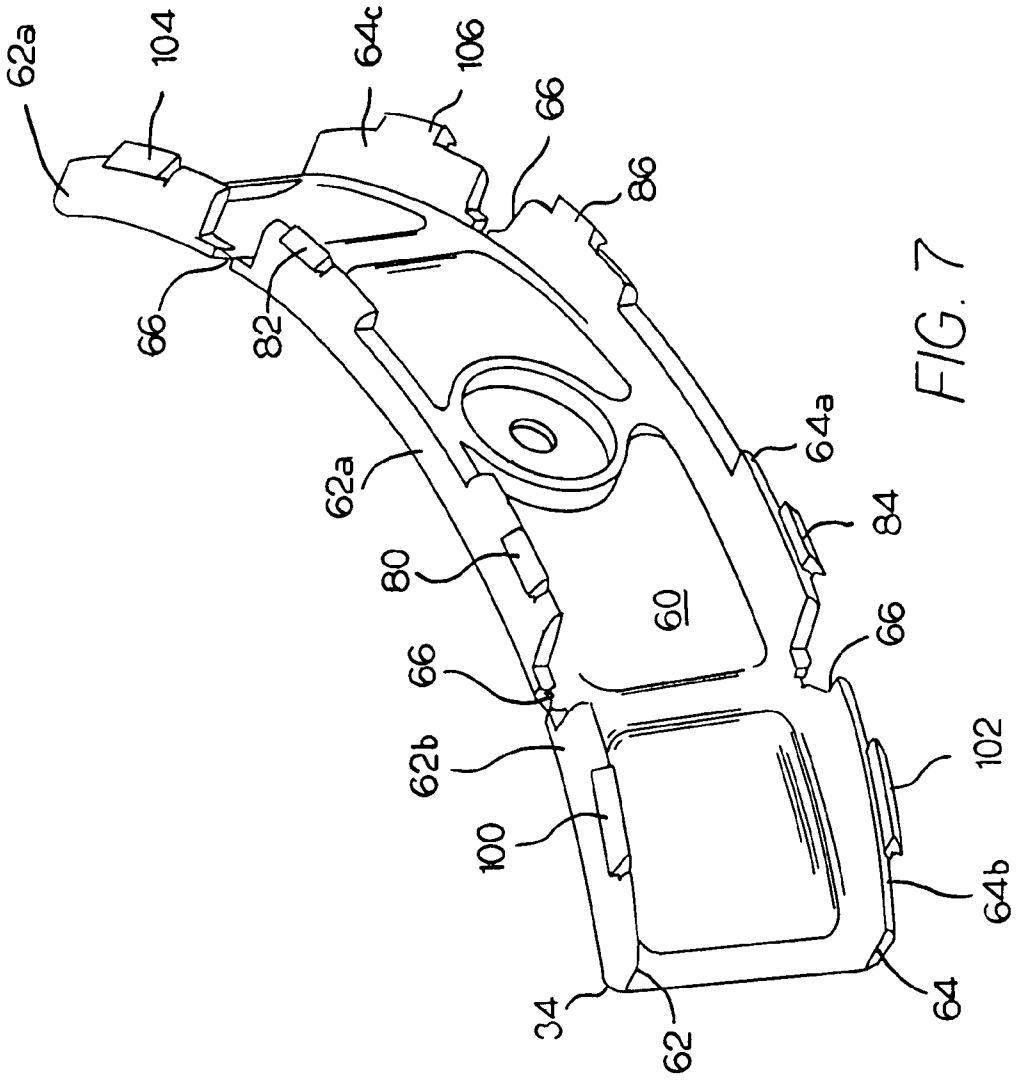
33

FIG. 6A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104
64c
106
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86
66
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62a
64a
84
80
60
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66
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102
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64b
34
62
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FIG. 7

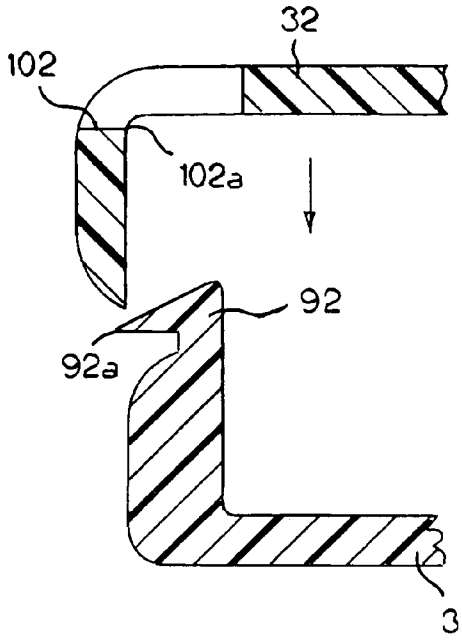

FIG. 8

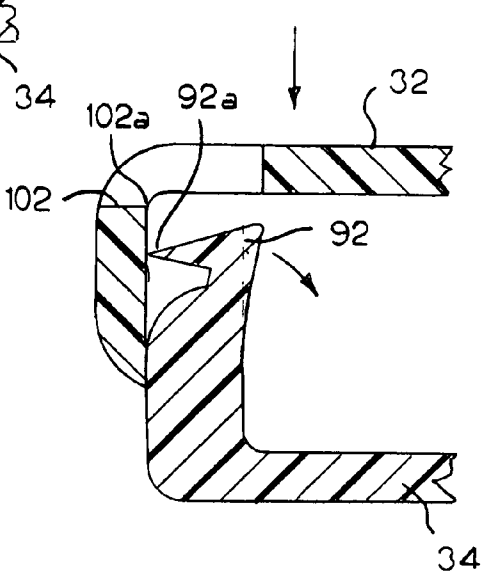

FIG. 9

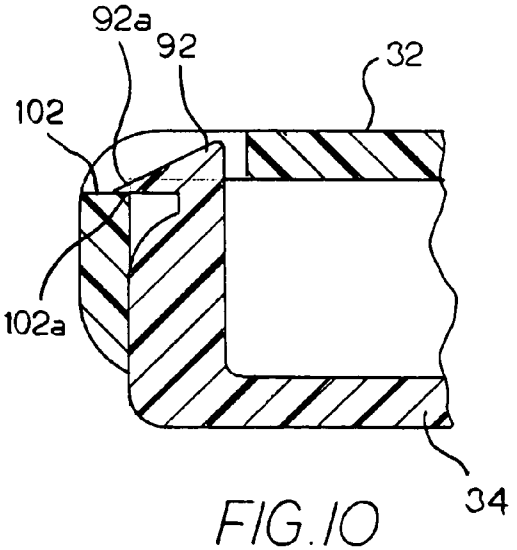

FIG. 10

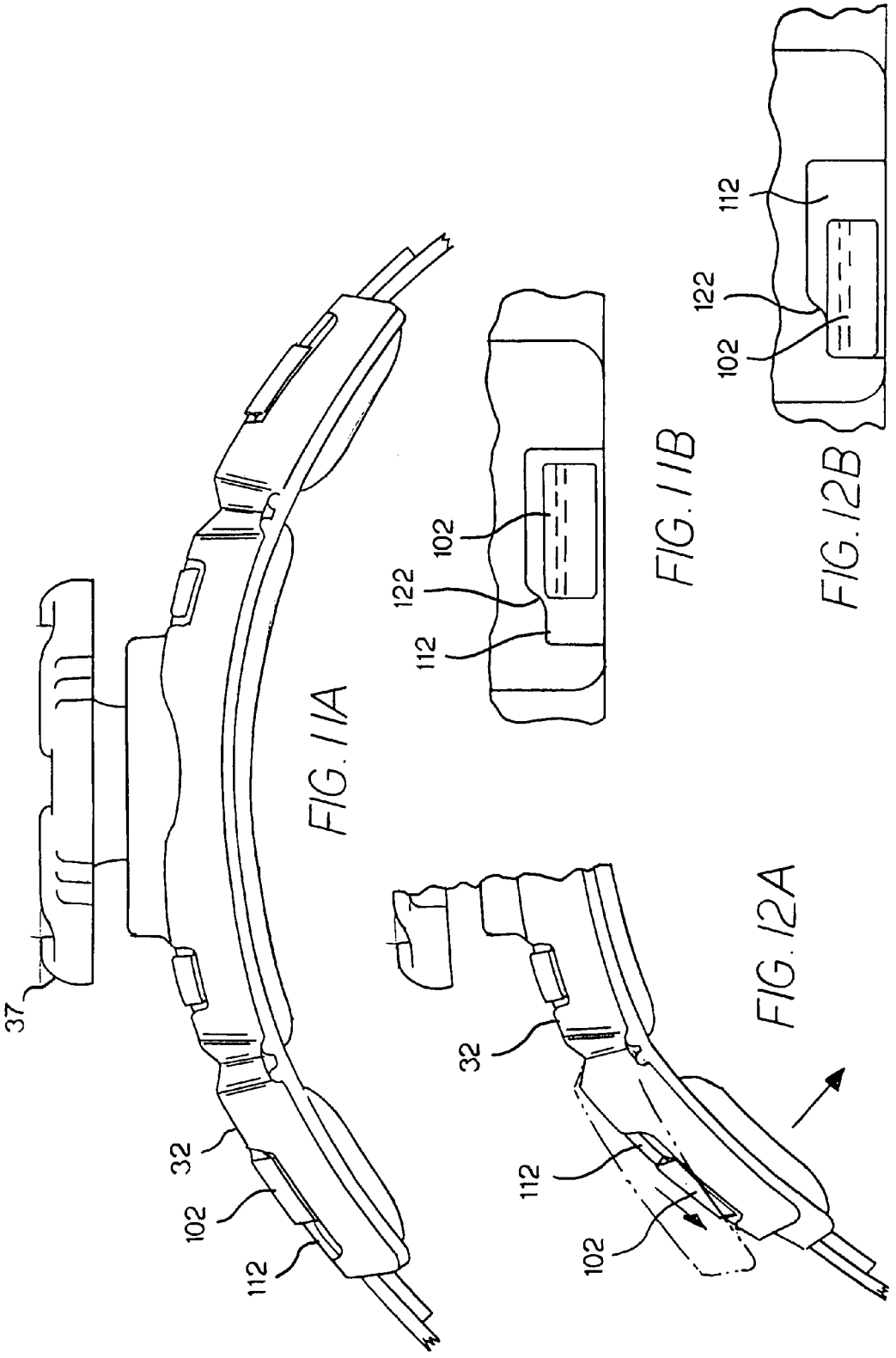

FIG. 11A

FIG. 11B

FIG. 12A

FIG. 12B

FLEXIBLE RATCHET MECHANISM FOR THE HEADBAND OF PROTECTIVE HEADGEAR

BACKGROUND OF THE INVENTION

The present invention relates to a ratchet mechanism for the headband of a protective helmet or similar headgear, a mechanism that allows for adjustment of the size and fit of the headband.

Protective helmets are commonly worn in the industrial workplace to prevent or reduce the likelihood of head injuries. The hard hat is the most common and well-recognized protective helmet. A hard hat consists of three primary components—a shell, a headband, and a suspension system—which cooperate to reduce the potential for injury by attenuating some translational energy of the force of an impact to the helmet.

With respect to the construction and protection afforded by a hard hat, the American National Standards Institute ("ANSI") promulgates minimum performance requirements for protective helmets and further classifies helmets based on their ability to reduce the forces of impact and penetration, as well as their ability to protect against high voltage electric shock. See, for example, ANSI Z89.1-1997 (R1998), American National Standard for Industrial Head Protection.

As mentioned above, a hard hat or similar protective helmet is comprised primarily of: a shell, a headband, and a suspension system. These primary hard hat components cooperate to provide the requisite level of protection. The hard hat shell itself causes any force of impact to be spread across the surface area of the shell. The hard hat suspension separates the wearer's head from the shell such that there is an air gap between the shell and the wearer's head that provides for further attenuation of the force of an impact to the shell. Specifically, when an object strikes the shell of the hard hat, the shell itself flexes inward and the straps of the suspension system will stretch. The air gap accommodates the flexing of the shell and stretching of the straps, but, under normal conditions, prevents the wearer's head from contacting the hard hat shell.

Of course, for a hard hat to provide the appropriate level of protection, it must fit snugly on the wearer's head. In this regard, it is common for the headband of a hard hat to be adjustable to provide for such a snug fit. In this regard, a headband typically has one of two common sizing mechanisms, a pin-lock arrangement or a ratchet mechanism. Regardless of the chosen sizing mechanism, the headband is commonly a flexible, one-piece member that has overlapping rear end portions. With a pin-lock mechanism, a first of the rear end portions of the headband is provided with a pin, and the second of the rear end portions is provided with series of holes at spaced intervals. As such, the pin of the first rear end portion can be inserted through one of the holes of the second rear end portion, thus forming a loop of a selected circumference to fit snugly around the wearer's head. With a ratchet mechanism, lateral movement of the overlapping rear end portions of the headband is effectuated through a rack and pinion arrangement or similar gear arrangement.

As one example of a ratchet mechanism, reference is made to U.S. Pat. No. 4,888,831 issued to Oleson, a patent that is incorporated herein by this reference. As described in the '831 patent, a preferred ratchet mechanism is often a rack and pinion arrangement which operates within elongated overlapping slots defined by the rear end portions of the headband, each of said slots defining a series of teeth of a rack gear. The rack and pinion arrangement and the overlapping rear end portions of the headband are housed between a pair of adjoining arc-shaped housing sections which generally conform to the contour of the wearer's head. The rear end portions of the headband are seated for slidable, lateral movement within the arc-shaped housing sections.

Referring still to the '831 patent, and specifically FIG. 3, one preferred rack and pinion arrangement includes five components: (1) an adjusting knob; (2) a first sprocket that is operably secured to the adjusting knob and engages mating gear teeth defined by the outer housing section, the rearward facing of the two housing sections that enclose the headband; (3) a second sprocket that is operably secured to the first sprocket and engages the teeth of the rack gears of the overlapping rear end portions of the headband; (4) a plate or washer interposed between the first and second sprockets; and (5) a spring or similar biasing member interposed between the first sprocket and the plate so as to bias the first sprocket into engagement with the mating gear teeth defined by the outer housing section. The adjusting knob, first sprocket, and the second sprocket all turn together, with clockwise rotation of the adjusting knob tightening the headband, and counterclockwise rotation of the adjusting knob loosening the headband. The interposed plate and spring bias the first sprocket into engagement with the mating gear teeth defined by the outer housing section so that the rear end portions of the headband do not slide or move without appropriate action by the wearer. In other words, since the interposed plate and spring bias the first sprocket into engagement with the mating gear teeth defined by the outer housing section, the position of the rear end portions of the headband is locked absent manipulation of the adjustment knob by the wearer.

For another example of a rack and pinion arrangement, reference is made to U.S. Pat. No. 5,950,245 issued to Binduga. Again, the headband has overlapping rear end portions. Elongated slots are defined by the rear end portions of the headband, with each of said slots defining a series of teeth of a rack gear. As described in the '245 patent with reference to FIGS. 1 and 2, the rack and pinion arrangement preferably includes (1) an adjustment knob with a first end section for providing a grip member suitable for gripping and turning by the wearer and a second end section that is a generally circular cog, the circular cog engaging the teeth of the rack gears defined by the overlapping rear end portions of the headband; (2) a spring assembly integral with or otherwise secured to the adjustment knob; (3) a housing having outer and inner arc-shaped sections that collectively define an internal cavity; and (4) a ring gear assembly fixed within the housing that cooperates with the spring assembly to provide resistance to rotation of adjustment knob. Thus, in practice, rotation of the adjustment knob causes lateral movement of the overlapping rear end portions of the headband relative to one another. However, because the spring assembly has at least one spring tooth projecting radially and adapted for mating with radially projecting teeth of the ring gear assembly, the position of the rear end portions of the headband is essentially locked absent manipulation of the adjustment knob by the wearer.

Regardless of the specific construction of the ratchet mechanism, the plastic housing that encloses the overlapping rear end portions of a headband typically has a substantially rigid construction. Thus, despite the ability to adjust the circumference of the headband through use of the ratchet mechanism, the fit may still be less than optimal due to the rigidity of the housing, which also may cause discomfort to the wearer.

Furthermore, there are other types of protective headgear that incorporate a similar ratchet mechanism, including but not limited to, faceshields and respirator hoods. As with hard hats or other protective helmets, despite the ability to adjust the circumference of the headband through use of the ratchet mechanism, the fit may still be less than optimal due to the substantially rigid construction of the housing that encloses the overlapping rear end portions of the headband.

It would therefore be desirable to provide an improved construction for a ratchet mechanism for the headband of a protective helmet or other headgear, a mechanism that allows for adjustment of the size and fit of the headband, while also providing increased comfort to the wearer.

SUMMARY OF THE INVENTION

The present invention is a ratchet mechanism for the headband of a protective helmet or other headgear, a mechanism that allows for adjustment of the size and fit of the headband.

For example, a hard hat generally includes: a substantially rigid shell shaped to protect the wearer's head, said shell defining a bottom opening and an internal cavity for receiving the wearer's head; a headband with an absorbent brow pad; and a suspension comprised of two or more intersecting straps with respective keys secured to the distal ends thereof. Thus, to secure the suspension to the shell of the hard hat, the shell includes key sockets spaced about the periphery of the shell, each such key socket being molded into the shell and adapted to receive one of the keys. Furthermore, the headband has a plurality of upwardly extending appendages, each corresponding to a respective key of the suspension, such that the keys can be secured to the headband, completing assembly of the essential components of the hard hat. Example of a preferred construction of the keys **18** and associated key sockets, reference is made to U.S. Pat. No. 6,609,254, which is incorporated herein by reference.

The headband itself has overlapping rear end portions which are enclosed in a housing, which is preferably comprised of an outer substantially arc-shaped housing section joined to a inner substantially arc-shaped housing section, thus defining an internal cavity for receiving the overlapping rear end portions of the headband. Also contained within the internal cavity defined by the housing sections is an adjustment mechanism adapted to cause lateral movement of the overlapping rear end portions of the headband with respect to one another. Specifically, it is preferred that each of the overlapping rear end portions defines an elongated slot and associated rack gear, and the adjustment mechanism includes a rotational element with an associated pinion adapted to mate with and engage the respective rack gears of the overlapping rear end portions of the headband. An adjustment knob extends through the outer housing section to engage the rotational element, such that rotation of the adjustment knob causes rotation of the rotational element, which, because of the mating and engaging of the pinion with the respective rack gears of the overlapping rear end portions, causes lateral movement of the overlapping rear end portions with respect to one another.

However, since prior art constructions of a ratchet mechanism inevitably involve a substantially rigid plastic housing, even though the headband can be adjusted, the fit may still be less than optimal and also may be uncomfortable for the wearer. Thus, the outer housing section of a ratchet mechanism made in accordance with the present invention is substantially segmented into multiple discrete portions such that the outer housing section is flexible along defined boundaries between the discrete portions. Specifically, the outer housing section has a broad wall surface with shorter walls extending from the upper and lower edges of this broad wall surface. These shorter walls are provided with detents at spaced intervals, each detent being formed by angled wall portions that meet at a point, thus creating a precisely located flex point. Then, by connecting each corresponding pair of detents in the upper and lower walls with a channel or groove in the broad wall surface, defined boundaries are created, and the outer housing section is substantially segmented into multiple discrete portions.

Similarly, the inner housing section is also substantially segmented into multiple discrete portions such that it is flexible along defined boundaries between the discrete portions. In this regard, the inner housing section also has a broad wall surface with shorter walls extending from the upper and lower edges of this broad wall surface. These upper and lower walls are designed to mate with the corresponding upper and lower walls of the outer housing section to join the two housing sections together. However, rather than be provided with detents, these walls are broken at spaced intervals that correspond with the position of the detents defined in the upper and lower walls of the outer housing section. Furthermore, notches are defined in the broad wall surface, again to correspond with the position of the detents defined in the upper and lower walls of the outer housing section. By connecting each corresponding pair of notches with a channel or groove in the broad wall surface, defined boundaries are created, substantially segmenting the inner housing section into multiple discrete portions.

To join the outer housing section and the inner housing section together while avoiding interference with the ability of the housing sections of the ratchet mechanism to flex along the defined boundaries, the outside wall segments of the inner housing section are fastened to the corresponding portions of the walls of the outer housing section using a snap-fit relationship, preferably in a manner that for some limited movement of the outside segments of the outer and inner housing sections relative to one another, thus compensating for any shearing motion between the outer and inner housing sections when the housing is flexed.

As a further refinement, it is further contemplated and preferred that the inner housing section be provided with integral "pillows" to increase the comfort to the wearer. Specifically, along the side of the inner housing section that contacts the wearer's head, there are integral and substantially rectangular protrusions extending from the broad wall surface, the so-called pillows.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded perspective view of a hard hat having an exemplary ratchet mechanism made in accordance with the present invention;

FIG. **2** is an enlarged perspective view of a portion of the headband and associated ratchet mechanism of the hard hat of FIG. **1**;

FIG. **3** is an exploded perspective view of the exemplary ratchet mechanism of the hard hat of FIG. **1**;

FIG. **4** is a perspective view of the exemplary ratchet mechanism of FIG. **1**, illustrating movement of the rear end portions of the headband caused by clockwise rotation of an adjustment knob;

FIG. **5** is a perspective view of the exemplary ratchet mechanism of FIG. **1**, illustrating movement of the rear end portions of the headband caused by counterclockwise rotation of the adjustment knob;

FIG. **6** is a perspective view of the outer housing section of the exemplary ratchet mechanism of FIG. **1** taken along line **6**—**6** of FIG. **3**, with the rotating element received in the ring gear;

FIG. **6**A is a perspective view of the outer housing section of the exemplary ratchet mechanism of FIG. **1**, similar to the view of FIG. **6**, but with the rotating element removed to better illustrate the ring gear;

FIG. **7** is a perspective view of the inner housing section of the exemplary ratchet mechanism of FIG. **1** taken along line **7**—**7** of FIG. **3**;

FIGS. **8**–**10** are sectional views of the inner and outer housing sections of the exemplary ratchet mechanism of FIG. **1**, illustrating how the respective housing sections are joined to one another;

FIG. **11**A is a partial perspective view of the exemplary ratchet mechanism of FIG. **1**, illustrating the relationship between an outer tab and a retaining bump when the exemplary ratchet mechanism is in a resting position;

FIG. **11**B is a detailed view of the relationship between the outer tab and the retaining bump when the exemplary ratchet mechanism is in the resting position illustrated in FIG. **11**A;

FIG. **12**A is a partial perspective view of the exemplary ratchet mechanism of FIG. **1**, illustrating the relationship between an outer tab and a retaining bump when the exemplary

FIG. **12**B is a detailed view of the relationship between the outer tab and the retaining bump when the exemplary ratchet mechanism is in the flexed position illustrated in FIG. **12**A.

DESCRIPTION OF THE INVENTION

The present invention is a ratchet mechanism for the headband of a protective helmet or other headgear, a mechanism that allows for adjustment of the size and fit of the headband.

FIG. **1** is an exploded perspective view of an exemplary hard hat **10** that includes a ratchet mechanism made in accordance with the present invention. As shown, this hard hat **10** generally includes: a substantially rigid shell **12** shaped to protect the wearer's head, said shell **12** defining a bottom opening and an internal cavity for receiving the wearer's head; a headband **13** with an absorbent brow pad **11**; and a suspension **14**. In this exemplary embodiment, the hard hat **10** has a 4-point suspension **14** comprising two intersecting straps **16***a*, **16***b*. A key **18***a*, **18***b*, **18***c*, **18***d* is secured to each end of each of the straps **16***a*, **16***b*. Thus, to secure the suspension **14** to the shell **12** of the hard hat **10**, the shell **12** includes four key sockets spaced about the periphery of the shell **12**, each such key socket being molded into the shell **12** and adapted to receive one of the keys (generally and collectively indicated by reference numeral **18**). In this regard, key sockets **12***c* and **12***d* are illustrated and labeled in FIG. **1**. It is contemplated and preferred that the keys **18** be constructed such that they can be "locked" into the key sockets. For further detail regarding one preferred construction of the keys **18** and associated key sockets, reference is made to U.S. Pat. No. 6,609,254, which has been incorporated herein by reference.

As shown in FIGS. **1** and **2**, the headband **13** has a plurality of upwardly extending appendages **13***a*, **13***b*, **13***c*, **13***d*. Each such appendage **13***a*, **13***b*, **13***c*, **13***d* corresponds with a respective key **18***a*, **18***b*, **18***c*, **18***d* of the suspension **14**, such that the keys **18** can be secured to the headband **13**, completing assembly of the essential components of the hard hat **10**.

Nevertheless, the attachment of the headband **13** and suspension straps **16***a*, **16***b* to the shell **12** of the hard hat **10** is not the focus of the present application. Indeed, it is recognized that various attachment means could be employed without departing from the spirit and scope of the present invention. Rather, the present invention relates to a ratchet mechanism for the headband **13** of a hard hat **10** or other protective headgear, as generally indicated by reference numeral **30** in FIGS. **1** and **2**.

Referring now to FIG. **3**, the preferred components of a ratchet mechanism **30** made in accordance with the present invention are illustrated. First, the headband **13** itself has overlapping rear end portions **13***e*, **13***f*. Each of these portions **13***e*, **13***f* preferably defines an elongated slot **15***e*, **15***f* and associated rack gear, the rack gear of one portion **13***e* defined along the upper edge of the slot **15***e*, and the rack gear of the second portion **13***f* defined along the lower edge of the slot **15***f*.

The overlapping rear end portions **13***e*, **13***f* are enclosed in a housing, which is preferably comprised of an outer substantially arc-shaped housing section **32** joined to a inner substantially arc-shaped housing section **34**, thus defining an internal cavity for receiving the overlapping rear end portions **13***e*, **13***f* of the headband **13**. Each of these housing sections **32**, **34** is preferably made of polypropylene or a similar plastic material. Also contained within the internal cavity defined by the housing sections **32**, **34** is a rotational element **36**, which includes a pinion **38**. This pinion **38** is adapted to mate with and engage the respective rack gears of the overlapping rear end portions **13***e*, **13***f* of the headband **13**. An adjustment knob **37** extends through the outer housing section **32** to engage the rotational element **36**, such that rotation of the adjustment knob **37** turns the rotational element **36**, which, because of the mating and engaging of the pinion **38** with the respective rack gears of the overlapping rear end portions **13***e*, **13***f*, causes lateral movement of the overlapping rear end portions **13***e*, **13***f* with respect to one another. Such a mechanism for effectuating the lateral movement of the overlapping rear end portions **13***e*, **13***f* of a headband **13** to accommodate adjustment of the headband **13** is known in the prior art, as described above with reference to U.S. Pat. Nos. 4,888,831 and 5,950,245, each of which has been incorporated herein by reference.

Furthermore, similar to prior art constructions, the rotational element **36** is further provided with an integral spring assembly, which, in this exemplary embodiment, is comprised of two substantially semi-circular arch portions **40**, **42** disposed on opposite sides of the central axis of rotation of the rotational element **36**. A spring tooth **41**, **43** extends from each of the arch portions **40**, **42**. As best shown in FIGS. **6** and **6**A, the outer housing section **32** defines a ring gear **33** that circumscribes the opening through which the adjustment knob **37** passes. Thus, the respective spring teeth **41**, **43** extending from each of the arch portions **40**, **42** of the spring assembly mate with and engage the teeth of the ring gear **33**, locking the position of the rotational element **36**, and thus the rear end portions **13***e*, **13***f* of the headband **13** relative the outer housing section **32**. However, when the adjustment knob **37** and rotational element **36** are manually turned by a wearer, the spring teeth **41**, **43** are forced over the teeth of the ring gear **33** by radially inward compression of the arch portions **40**, **42** of the spring assembly. In other words, by imparting a sufficient torque on the adjustment knob **37** and rotational element **36**, the wearer can overcome the spring

force and effectuate lateral movement of the overlapping rear end portions **13***e*, **13***f* of the headband **13** relative to one another. As shown in FIG. **4**, clockwise rotation of the adjustment knob **37** moves the rear end portions **13***e*, **13***f* of the headband toward one another, decreasing the circumference of the headband **13**. On the other hand, as shown in FIG. **5**, counterclockwise rotation of the adjustment knob **37** moves the rear end portions **13***e*, **13***f* of the headband away one another, increasing the circumference of the headband **13**. Once the wearer ceases rotation of the adjustment knob **37** and rotational element **36**, the spring teeth **41**, **43** are restored to engagement with the teeth of the ring gear **33**, again locking the position of the rear end portions **13***e*, **13***f* of the headband **13**.

However, as mentioned above, since prior art constructions of a ratchet mechanism inevitably involve a substantially rigid plastic housing, even though the headband can be adjusted, the fit may still be less than optimal and also may be uncomfortable for the wearer. Therefore, it would be desirable to provide a housing for enclosing the ratchet mechanism that is constructed so as to allow for some flexibility.

Referring again to FIG. **6**, the outer housing section **32** of a ratchet mechanism **30** made in accordance with the present invention is substantially segmented into multiple discrete portions such that the outer housing section **32** is flexible along defined boundaries between the discrete portions. Specifically, in this exemplary embodiment, the outer housing section **32** has a broad wall surface **50** with a height that is slightly greater than the width of the rear end portions **13***e*, **13***f* of the headband **13**. Shorter walls **52**, **54** extend from the upper and lower edges of this broad wall surface **50**. In other words, the outer housing section **32** has a substantially C-shaped cross-section. To obtain the desired flexibility, these walls **52**, **54** are provided with detents **56** at spaced intervals. Each detent **56** is formed by angled wall portions that meet at a point. Furthermore, it is preferred that these angled wall portions have a thickness that is less than the nominal thickness of the wall **52**, **54**, creating a weakened area in the walls **52**, **54** that causes "collapse" of the walls at the detent **56**, creating a precisely located flex point. Then, by connecting each corresponding pair of detents **56** in the upper and lower walls **52**, **54** of the outer housing section **32** with a channel or groove **58** in the broad wall surface **50**, defined boundaries are created, and the outer housing section **32** is substantially segmented into multiple discrete portions. Thus, the outer housing section **32** is flexible along the defined boundaries between the discrete portions.

Referring now to FIG. **7**, the inner housing section **34** of a ratchet mechanism **30** made in accordance with the present invention is also substantially segmented into multiple discrete portions such that it is flexible along defined boundaries between the discrete portions. Similar to the outer housing section **32**, the inner housing section **34** has a broad wall surface **60** with shorter walls **62**, **64** that extend from the upper and lower edges of this broad wall surface **60**. These upper and lower walls **62**, **64** are designed to mate with the corresponding upper and lower walls **50**, **52** of the outer housing section **32** to join the two housing sections **32**, **34** together, as is further described below. However, rather than be provided with detents, these walls **62**, **64** are broken at spaced intervals that correspond with the position of the detents **56** defined in the upper and lower walls **52**, **54** of the outer housing section **32**. Furthermore, notches **66** are defined in the broad wall surface **60**, again to correspond with the position of the detents **56** defined in the upper and lower walls **52**, **54** of the outer housing section **32**. By connecting each corresponding pair of notches **66** with a channel or groove **68** (as shown in FIG. **2**) in the broad wall surface **60**, defined boundaries are created, substantially segmenting the inner housing section **34** into multiple discrete portions.

To join the outer housing section **32** and the inner housing section **34**, various techniques could be used with departing from the spirit and scope of the present invention. In this exemplary embodiment, the outer and inner housing sections **32**, **24** are fastened together in a snap-fit relationship with the shorter walls **62**, **64** of the inner housing section **34** fitting inside of and adjacent to the shorter walls **52**, **54** of the outer housing section **32**. Specifically, referring still to FIG. **7**, the center wall segments **62***a*, **64***a* of the inner housing section **34** each include a pair of integral projecting tabs **80**, **82**, **84**, **86**, with each such tab extending from a respective wall segment **62***a*, **64***a* in a substantially parallel relationship to the broad wall surface **60**. Referring again to FIG. **6**, the outer housing section **32** is provided with mating openings **90**, **92**, **94**, **96**. As such, when the housing sections **32**, **34** are pressed together, the projecting tabs **80**, **82**, **84**, **86** of the inner housing section **34** are received and retained by the mating openings **90**, **92**, **94**, **96** of the outer housing section **32**, as generally illustrated in FIGS. **4** and **5**, and as will be described in further detail below with reference to FIGS. **8–10**.

Furthermore, in this exemplary embodiment, each of the outside wall segments **62***b*, **62***c*, **64***b*, **64***c* of the inner housing section **34** are fastened to the corresponding portions of the walls **52**, **54** of the outer housing section **32** using a snap-fit relationship. Specifically, referring again to FIG. **7**, the outside wall segments **62***b*, **62***c*, **64***b*, **64***c* each include an integral projecting tab **100**, **102**, **104**, **106**, with each such tab extending in a substantially parallel relationship to the broad wall surface **60**. Referring again to FIG. **6**, the outer housing section **32** is provided with mating openings **110**, **112**, **114**, **116**. As such, when the housing sections **32**, **34** are pressed together, the projecting tabs **100**, **102**, **104**, **106** of the inner housing section **34** are received and retained by the mating openings **110**, **112**, **114**, **116** of the outer housing section **32**, as generally illustrated in FIGS. **4** and **5**. Unlike the openings **90**, **92**, **94**, **96** defined through the center portion of the outer housing section **32**, however, the outer openings **110**, **112**, **114**, **116** each has a width that is larger than that of the corresponding tab **100**, **102**, **104**, **106**. As such, each tab **100**, **102**, **104**, **106** can "ride" or move within the corresponding openings **110**, **112**, **114**, **116**. As such, when the ratchet mechanism **30** is flexed along the defined boundaries, the openings **110**, **112**, **114**, **116** allow for some limited movement of the outside segments of the outer and inner housing sections **32**, **34** relative to one another, thus compensating for any shearing motion between the outer and inner housing sections **32**, **34** when the housing is flexed.

To further explain the snap-fit relationships described above, FIGS. **8–10** are sectional views that illustrate how one projecting tab **92** of the inner housing section **34** is received and retained by an opening **102** of the outer housing section **32**. As illustrated in FIGS. **8–10**, as the outer section **32** is pressed against the inner housing section **34**, the triangular shape of the projecting tab **92** causes it to flex and rotate inwardly. This continues until the tip **92***a* of the tab **92** clears the lip **102***a* of the opening **102**. Then, the projecting tab **92** returns to its original, upright position with the tip **92***a* of the tab **92** engaging the lip **102***a* of the opening **102**. Each of the other projecting tabs has a similar construction,

creating the snap-fit relationship that joins the inner housing section **34** to the outer housing section **32**.

Finally, as described above, when the ratchet mechanism **30** is flexed inwardly along the defined boundaries, each outer tab **100**, **102**, **104**, **106** will "ride" along the corresponding opening **110**, **112**, **114**, **116** until it reaches the end of that opening **110**, **112**, **114**, **116**. The position of the tabs **100**, **102**, **104**, **106** in relation to the openings **110**, **112**, **114**, **116** at this point defines a yield point for the snap-fit function. If the ratchet mechanism **30** is flexed beyond this yield point, the natural reaction is for the tabs **100**, **102**, **104**, **106** to begin to move away from and disengage the lips of the respective openings **110**, **112**, **114**, **116**, thus reversing the snap-fit motion illustrated in FIGS. **8**–**10**. In short, the snap-fit would fail. Therefore, as a further refinement to control and prevent failure, each of the openings **110**, **112**, **114**, **116** in this exemplary embodiment includes a retaining bump. On such retaining bump **122** is illustrated in FIGS. **11**A, **11**B, **12**A, and **12**B. When the ratchet mechanism **30** is flexed inwardly toward the yield point, the tab **102** will move between the retaining bump **122** and the edge of the opening **112**, as illustrated in FIGS. **12**A and **12**B. If the housing is flexed beyond the yield point, the retaining bump **122** will retain the tab **102** in a locked position relative to the opening **112**. In this regard, it should be recognized that the natural or resting position of the ratchet mechanism **30**, as illustrated in FIGS. **11**A and **11**B, is the suggested position when the ratchet mechanism **30** is assembled. This position allows each outer tab **102** adequate clearance from the retaining bump **122**, so that the tab **102** can momentarily flex and then "snap" or lock onto the opening **112** as described above with reference to FIGS. **8**–**10**.

Thus, the ratchet mechanism **30** of the present invention allows for adjustment of the size and fit of the protective helmet **10** or other headgear, and because of the flexibility of the outer and inner housing sections **32**, **34**, a better and more comfortable fit can be obtained. As mentioned above, although the exemplary ratchet mechanism described herein is incorporated into a hard hat, the ratchet mechanism of the present invention can certainly be incorporated into other types of headgear that have an adjustable headband, such as faceshields and respirator hoods, without departing from the spirit and scope of the present invention.

As a further refinement, and as illustrated in FIGS. **1** and **2**, it is further contemplated and preferred that the inner housing section **34** be provided with integral "pillows" to increase the comfort to the wearer. Specifically, along the side of the inner housing section **34** that contacts the wearer's head, there are integral and substantially rectangular protrusions extending from the broad wall surface **60**, the so-called pillows **70**. These pillows **70** are preferably integrally molded into the inner housing section **32** with a thickness that is less than the nominal thickness of the broad wall surface **60**. Furthermore, the pillows **70** are preferably offset from the edges of the inner housing section **34** and the defined boundaries between the discrete segments of the housing section **34** so as to avoid stiffening or deformation of the pillows **70**.

It will be obvious to those skilled in the art that further modifications may be made to the embodiments described herein without departing from the spirit and scope of the present invention.

What is claimed is:

1. A ratchet mechanism for a headband that has overlapping rear end portions, comprising:

a housing including an outer substantially arc-shaped housing section joined to a inner substantially arc-shaped housing section, thus defining an internal cavity for receiving the overlapping rear end portions of said headband;

an adjustment mechanism substantially contained within the internal cavity defined by said housing sections and adapted to cause lateral movement of the overlapping rear end portions of said headband with respect to one another; and

wherein the outer housing section is substantially segmented into multiple discrete portions such that the outer housing section is flexible along defined boundaries between such discrete portions, and wherein the inner housing section is similarly and substantially segmented into corresponding discrete portions such that the inner housing section is also flexible along defined boundaries between such discrete portions, such that, when the outer and inner housing sections are joined, the housing of the ratchet mechanism has a flexibility that allows it to conform to the head shape of a wearer.

2. The ratchet mechanism as recited in claim **1**,

wherein the overlapping rear end portions of said headband each define an elongated slot and associated rack gear; and

wherein said adjustment mechanism includes

a rotational element contained within the internal cavity defined by said housing sections, said rotational element including a pinion which is adapted to mate with and engage the respective rack gears of the overlapping rear end portions of said headband, and further including a spring assembly adapted to engage a portion of one of said housing sections to resist rotation of the rotational element relative to said housing sections, and

an adjustment knob secured to said rotational element such that rotation of the adjustment knob results in rotation of the rotational element, the pinion of the rotational element engaging the respective rack gears of the overlapping rear end portions of said headband and causing lateral movement of the overlapping rear end portions of said headband with respect to one another.

3. The ratchet mechanism as recited in claim **1**, wherein the outer housing section has a broad wall surface with shorter walls extending from upper and lower edges of the broad wall surface, said shorter walls being provided with detents at spaced intervals, each corresponding pair of detents in the shorter walls being connected by a channel in the broad wall surface, thus providing the outer housing section with the desired flexibility.

4. The ratchet mechanism as recited in claim **3**, wherein the inner housing section has a broad wall surface with shorter walls extending from upper and lower edges of the broad wall surface, said shorter walls being broken at spaced intervals that correspond with the position of the detents defined in the shorter walls of the outer housing section.

5. The ratchet mechanism as recited in claim **4**, wherein notches are defined in the broad wall surface of the inner housing section to correspond with the position of the detents defined in the shorter walls of the outer housing section, each corresponding pair of notches being connected by a channel in the broad wall surface, thus providing the inner housing section with the desired flexibility.

6. The ratchet mechanism as recited in claim **5**, wherein portions of the shorter walls of one of said housing sections are provided with projecting tabs that extend from the shorter walls in a substantially parallel relationship to the

broad wall surface, and wherein corresponding openings are defined through the shorter walls of the other of said housing sections, such that, when the outer and inner housing sections are joined together, the projecting tabs are received and retained in the openings to fasten the outer and inner housing sections together, while still allowing for limited movement of the housing sections with respect to one another.

7. The ratchet mechanism as recited in claim **1**, in which a side of the inner housing section that contacts a wearer's head is provided with integral pillows to increase comfort to the wearer.

8. The ratchet mechanism as recited in claim **7**, in which said pillows are molded into the inner housing section and are offset from edges of the inner housing section and the defined boundaries between the discrete segments of the inner housing section.

9. The ratchet mechanism as recited in claim **1**, wherein the outer housing section has a broad wall surface with shorter walls extending from upper and lower edges of the broad wall surface, said shorter walls being provided with detents at spaced intervals, each corresponding pair of detents in the shorter walls being connected by a channel in the broad wall surface, thus providing the outer housing section with the desired flexibility.

10. The ratchet mechanism as recited in claim **9**, wherein the inner housing section has a broad wall surface with shorter walls extending from upper and lower edges of the broad wall surface, said shorter walls being broken at spaced intervals that correspond with the position of the detents defined in the shorter walls of the outer housing section.

11. The ratchet mechanism as recited in claim **10**, wherein notches are defined in the broad wall surface of the inner housing section to correspond with the position of the detents defined in the shorter walls of the outer housing section, each corresponding pair of notches being connected by a channel in the broad wall surface, thus providing the inner housing section with the desired flexibility.

12. The ratchet mechanism as recited in claim **11**, wherein portions of the shorter walls of one of said housing sections are provided with projecting tabs that extend from the shorter walls in a substantially parallel relationship to the broad wall surface, and wherein corresponding openings are defined through the shorter walls of the other of said housing sections, such that, when the outer and inner housing sections are joined together, the projecting tabs are received and retained in the openings to fasten the outer and inner housing sections together, while still allowing for limited movement of the housing sections with respect to one another.

13. The ratchet mechanism as recited in claim **2**, wherein the rotational element of said adjustment mechanism is provided with an integral spring assembly comprised of two substantially semi-circular arch portions, with a spring tooth extending from each of said arch portions and adapted to engage the teeth of a ring gear defined by the outer housing section, thus locking the position of the rotational element unless a wearer imparts a sufficient torque on the adjustment knob and the rotational element.

14. The ratchet mechanism as recited in claim **2**, in which a broad wall surface of said inner housing section is provided with integral pillows to increase comfort to the wearer.

15. The ratchet mechanism as recited in claim **14**, in which said pillows have a thickness that is less than a nominal thickness of the broad wall surface of said inner housing section, and in which said pillows are offset from edges of the inner housing section and the defined boundaries between the discrete segments of the inner housing section.

16. In combination with an article of protective headgear with an internal suspension, a ratchet mechanism for an adjustable headband, comprising:

a housing including an outer substantially arc-shaped housing section joined to a inner substantially arc-shaped housing section, thus defining an interrut cavity for receiving overlapping rear end portions of said headband and allowing for lateral movement of the overlapping rear end portions of said headband with respect to one another within said internal cavity; and

a means for selectively adjusting and maintaining a desired overlap of the overlapping rear end portions of said headband;

wherein the outer housing section is substantially segmented into multiple discrete portions such that the outer housing section is flexible along defined boundaries between such discrete portions, and wherein the inner housing section is similarly and substantially segmented into corresponding discrete portions such that the inner housing section is also flexible along defined boundaries between such discrete portions, such that, when the outer and inner housing sections are joined, the housing of the ratchet mechanism has a flexibility that allows it to conform to the head shape of a wearer.

17. The ratchet mechanism for an adjustable headband as recited in claim **16**, wherein the overlapping rear end portions of said headband each define an elongated slot and associated rack gear, and wherein said means for selectively adjusting and maintaining a desired overlap of the overlapping rear end portions of said headband comprises:

a rotational element contained within the internal cavity defined by said housing sections, said rotational element including a pinion which is adapted to mate with and engage the respective rack gears of the overlapping rear end portions of said headband, and further including a spring assembly adapted to engage a portion of one of said housing sections to resist rotation of the rotational element relative to said housing sections, and

an adjustment knob secured to said rotational element such that rotation of the adjustment knob results in rotation of the rotational element, the pinion of the rotational element engaging the respective rack gears of the overlapping rear end portions of said headband and causing lateral movement of the overlapping rear end portions of said headband with respect to one another.

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