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Sullenberger et al.

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(54) **OMNI-DIRECTIONAL SHOULDER ASSEMBLY FOR CRASH TEST DUMMY**

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G09B 23/28 (2006.01)

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

CPC ***G09B 23/288*** (2013.01); ***G09B 23/32*** (2013.01)

(58) **Field of Classification Search**

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USPC 73/866.4
See application file for complete search history.

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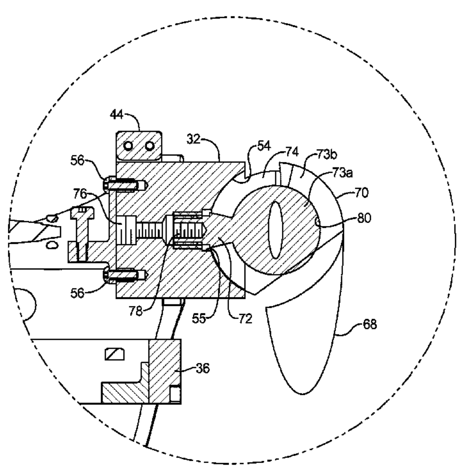
(57) **ABSTRACT**

A shoulder assembly for a crash test dummy includes a movable clavicle adapted for attachment to a spine of the crash test dummy for freedom of movement in three-dimensional space, a scapula non-rigidly adapted mounted for attachment to the spine for freedom of movement in three-dimensional space, a shoulder cup member adapted for attachment to the spine in a plurality of axes for a shoulder joint, and an upper arm assembly having an arm bone made of a plastic material for operative attachment to the shoulder cup member to allow an impact on the shoulder of the dummy to move the shoulder assembly towards the spine.

14 Claims, 13 Drawing Sheets



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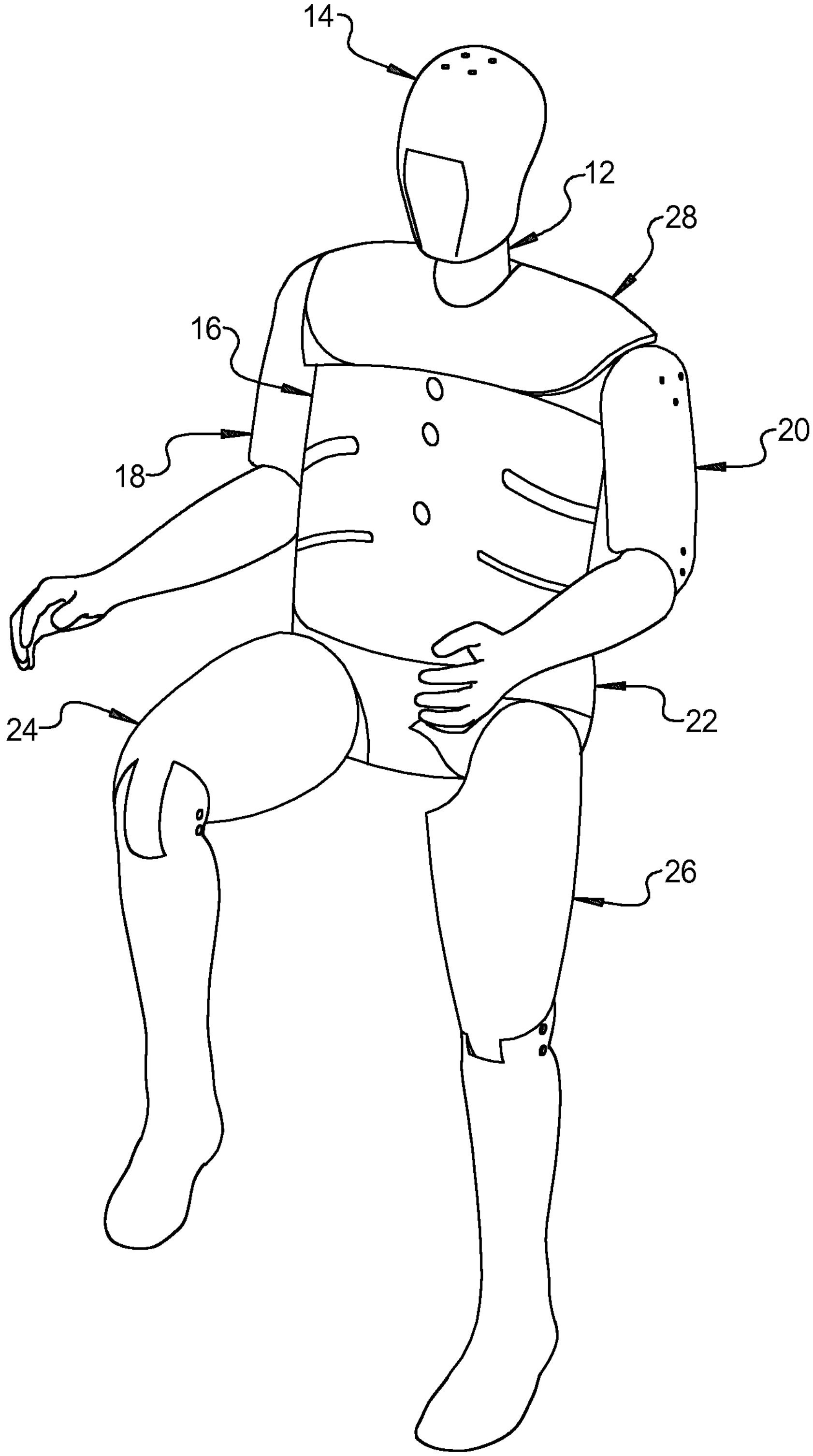

FIG 1

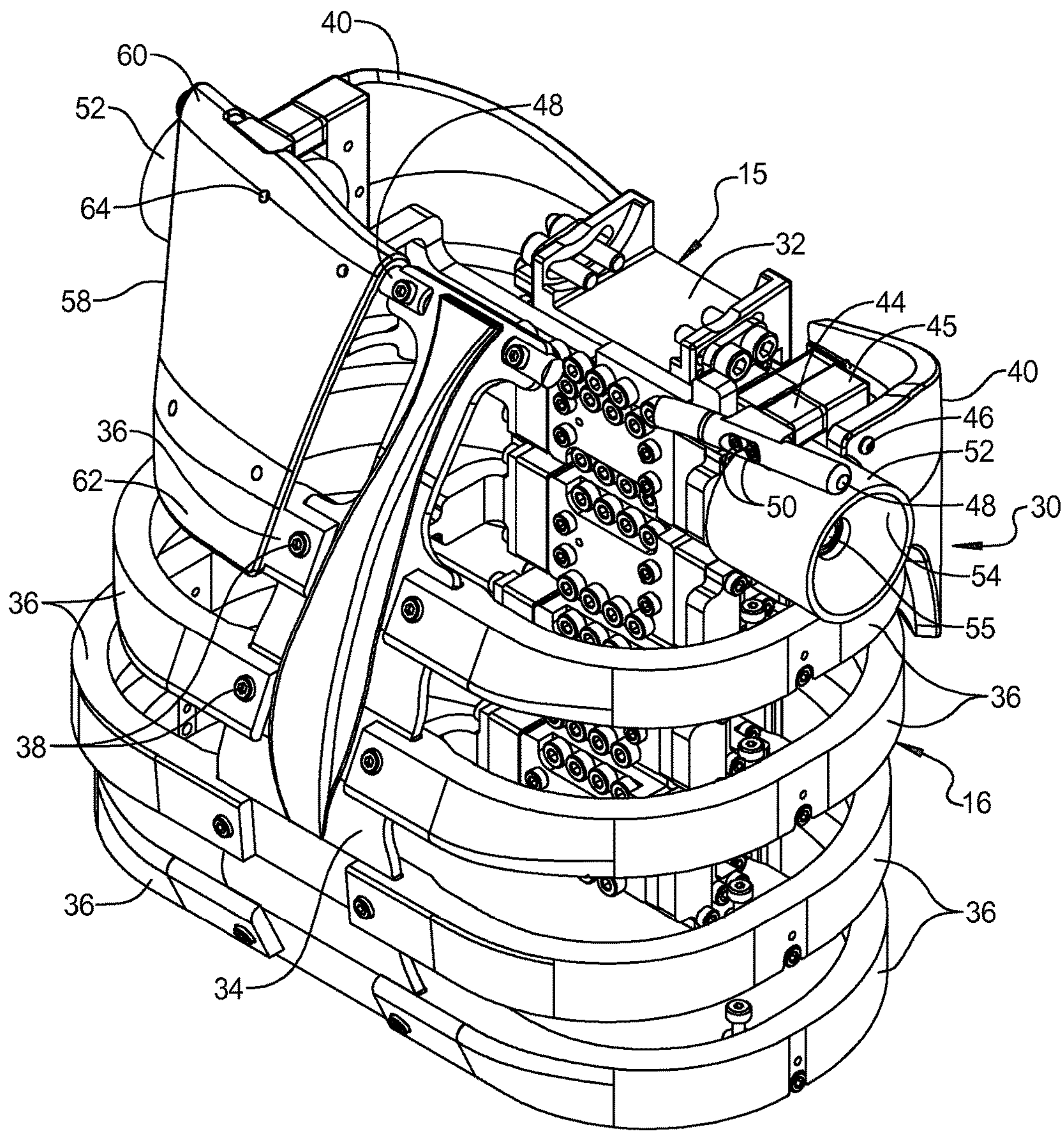
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FIG 2

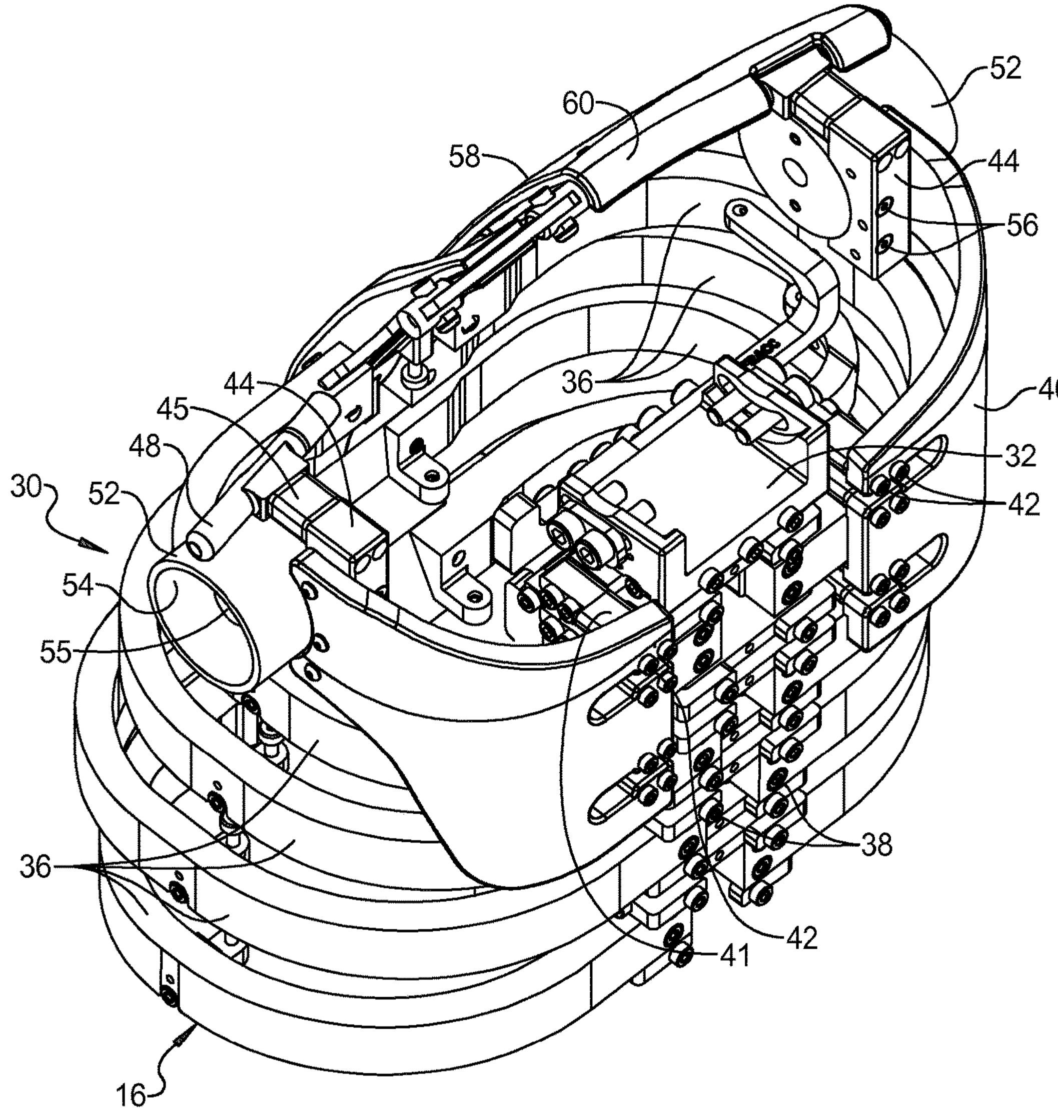


FIG 3

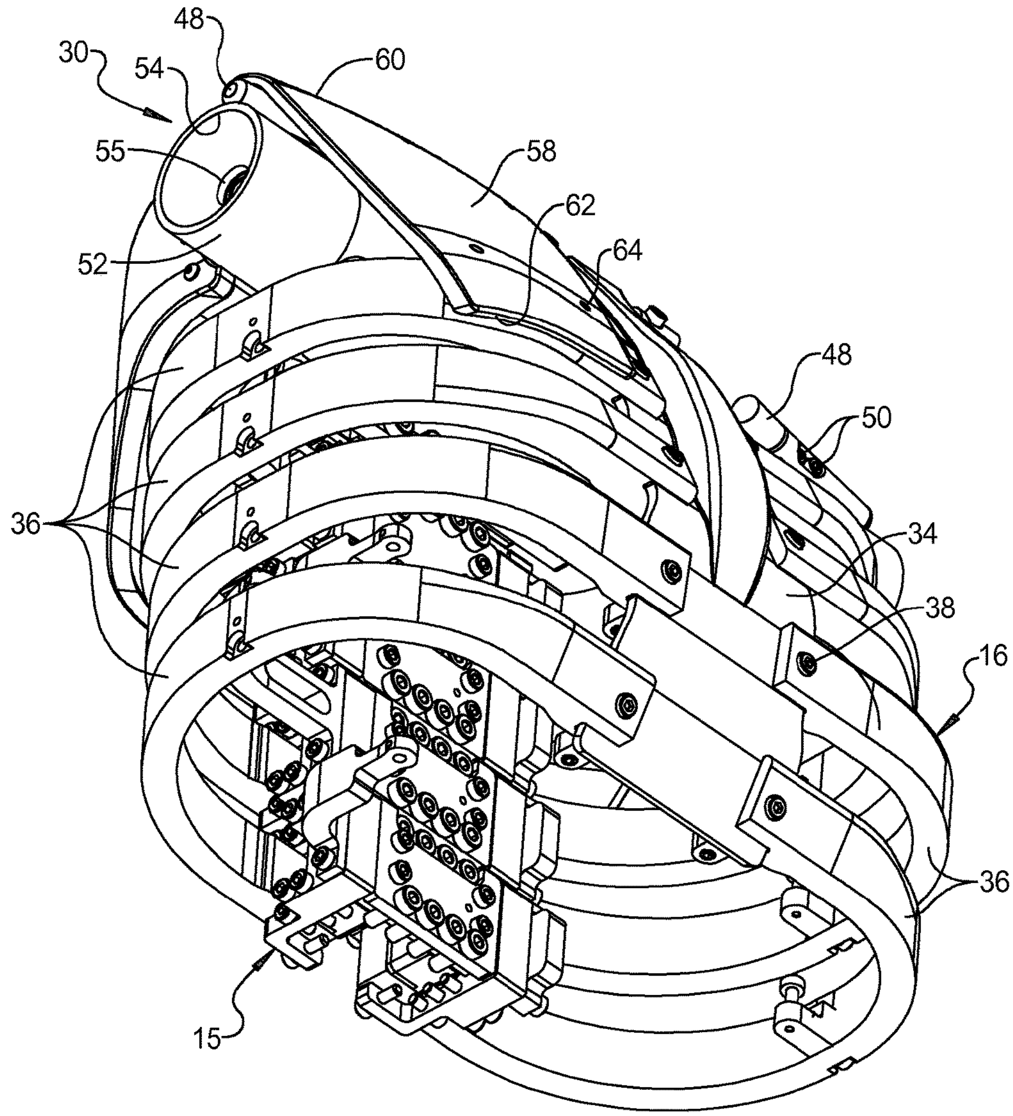
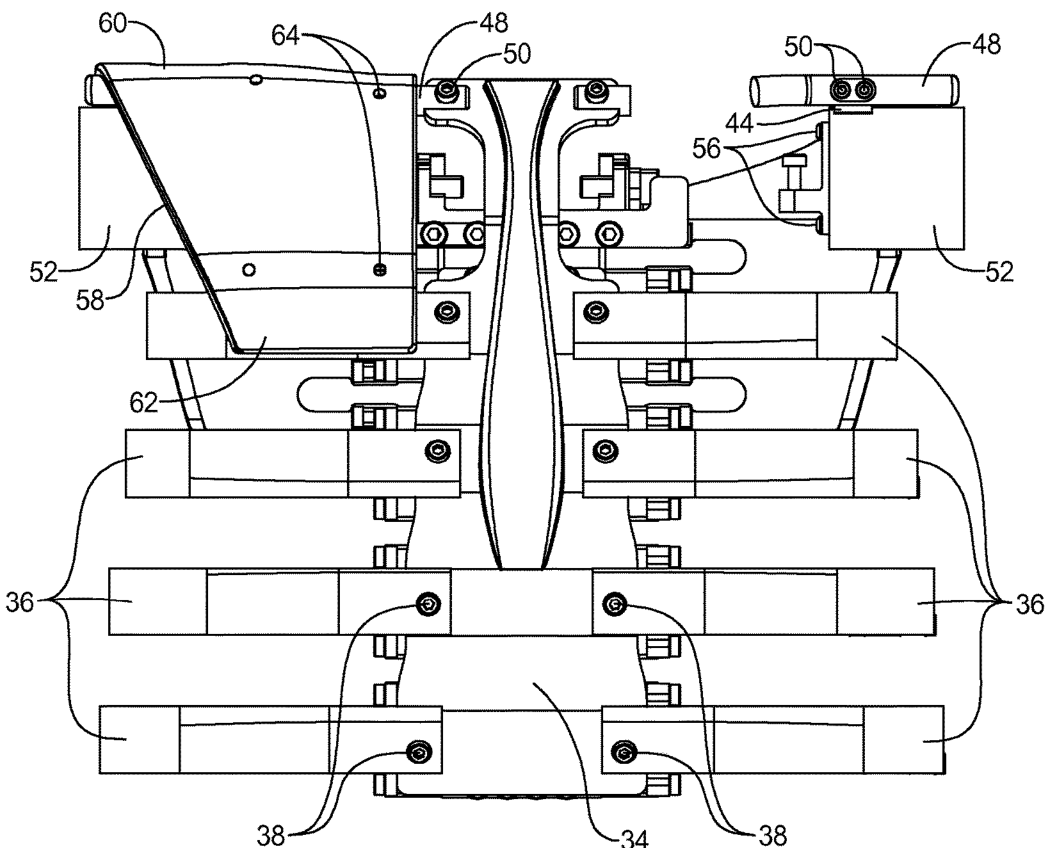


FIG 4



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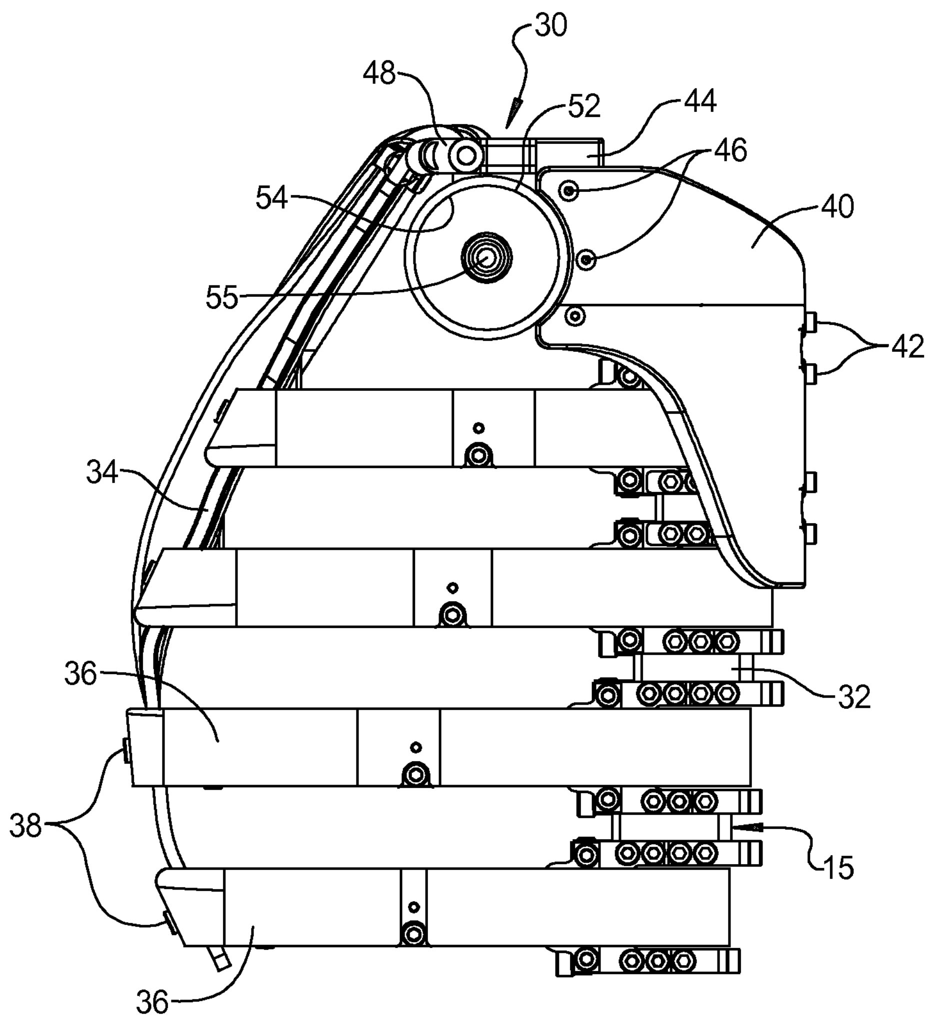

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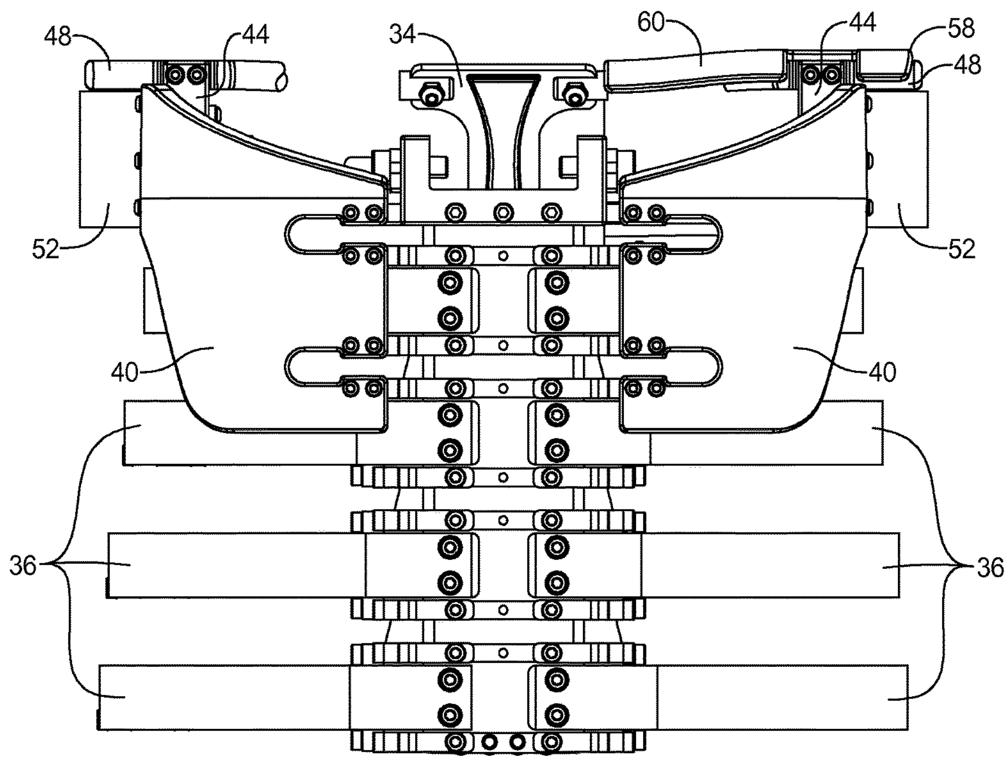

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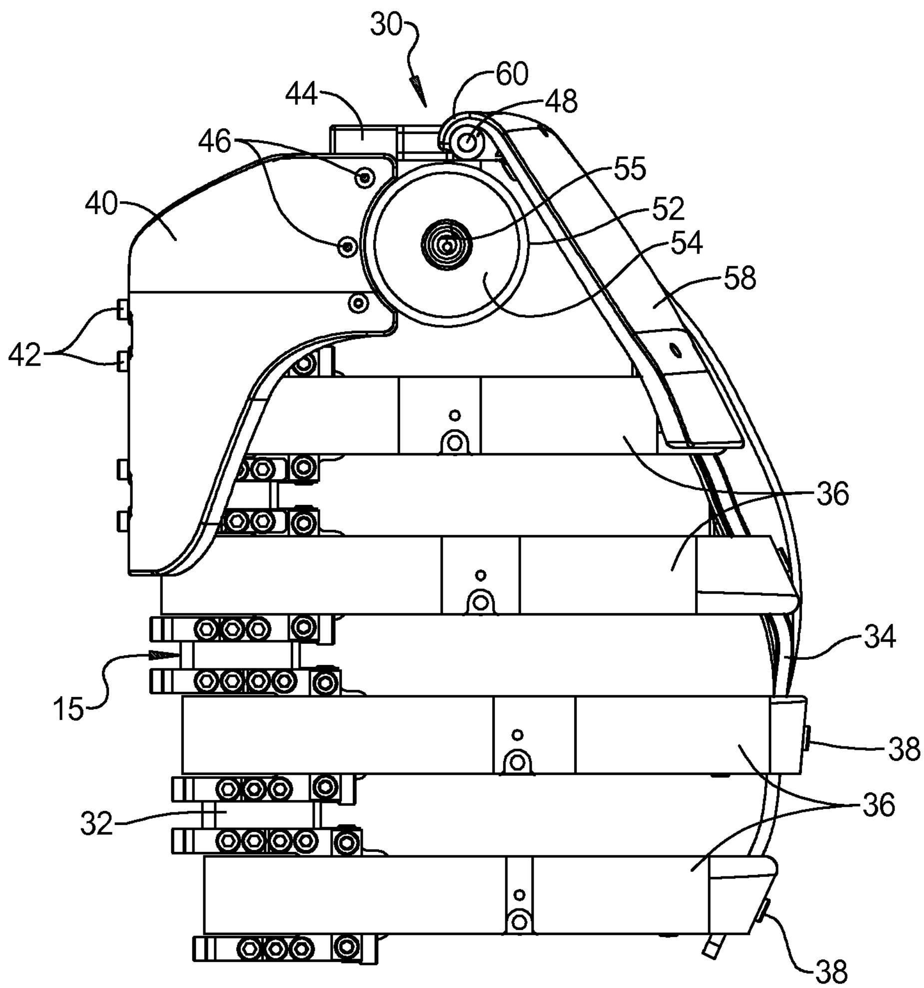

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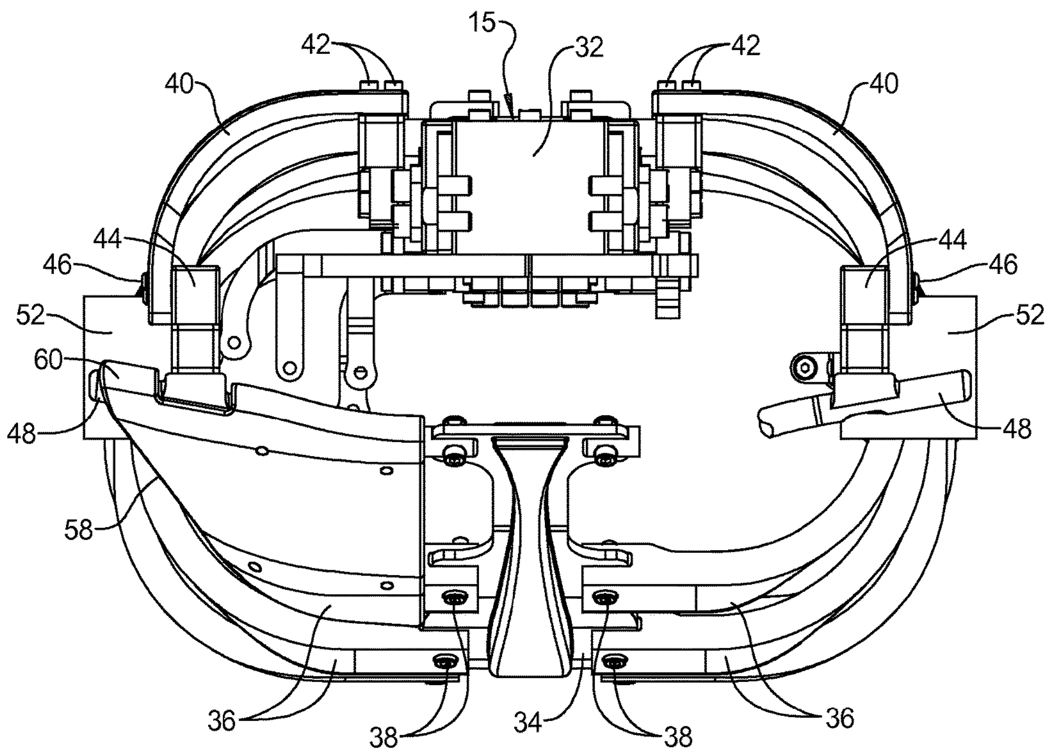

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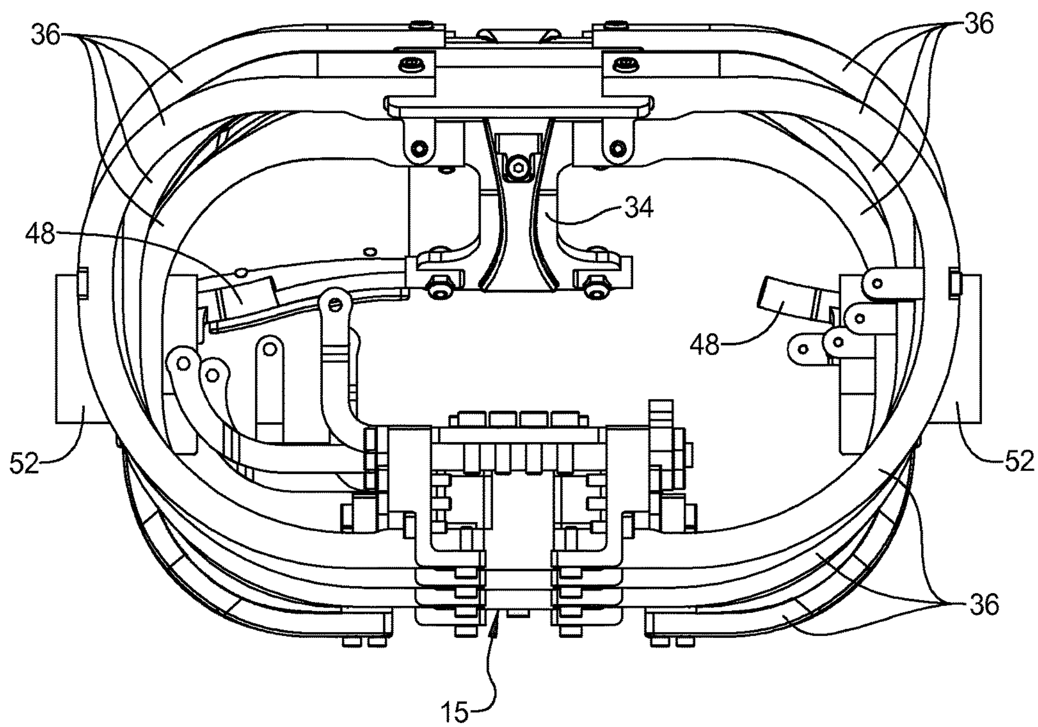

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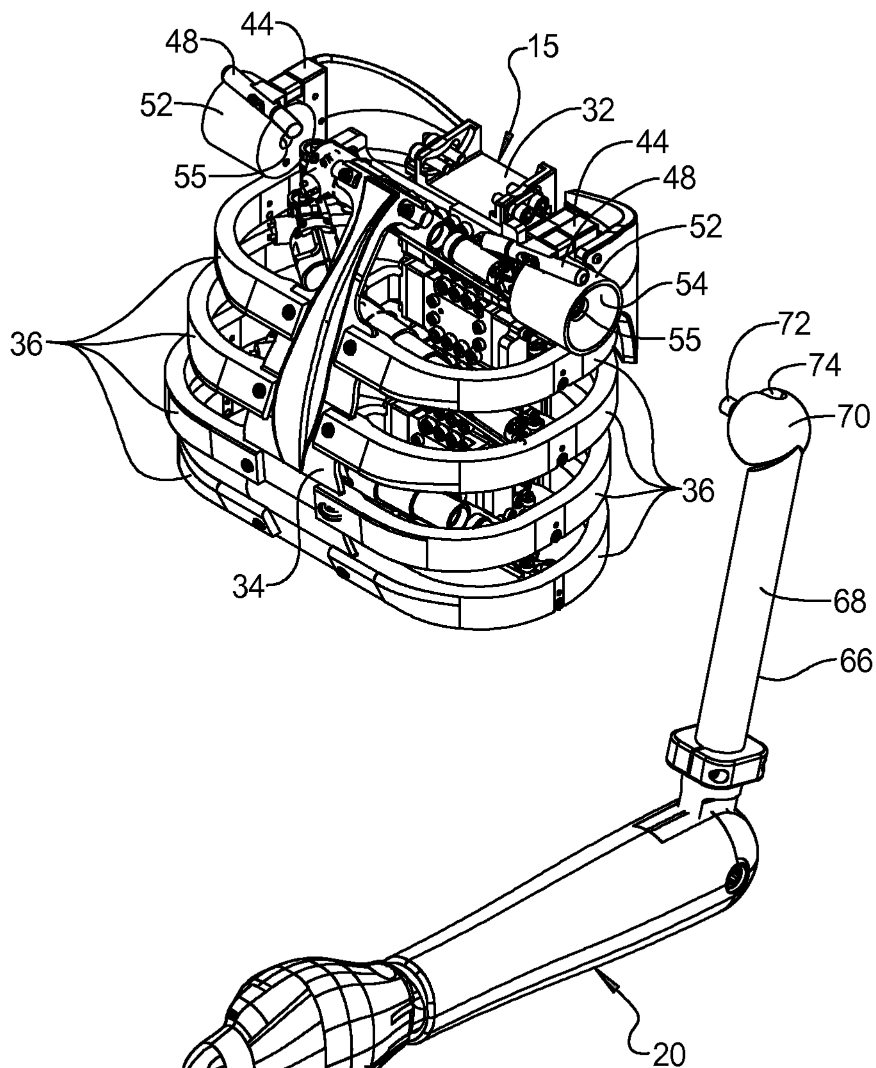

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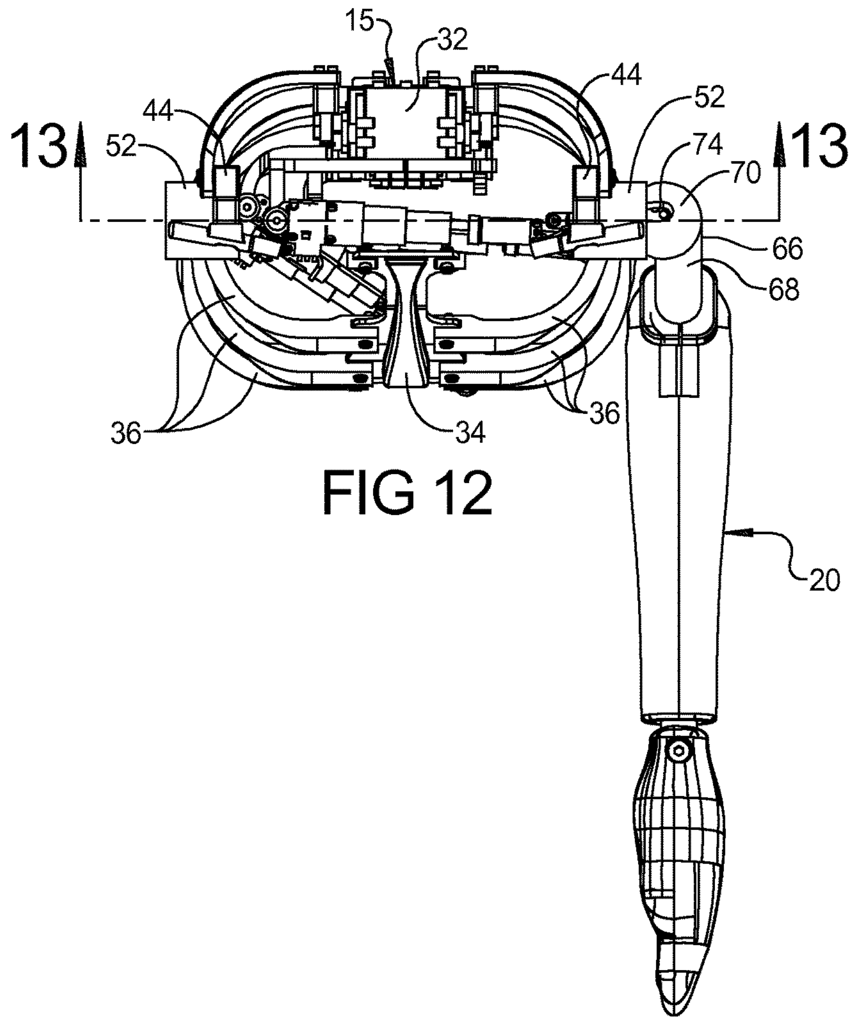
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FIG 12

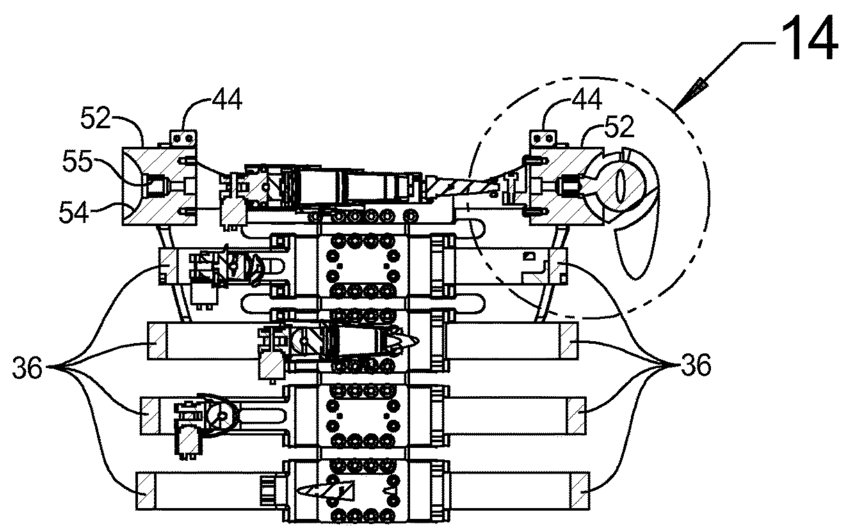
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FIG 13

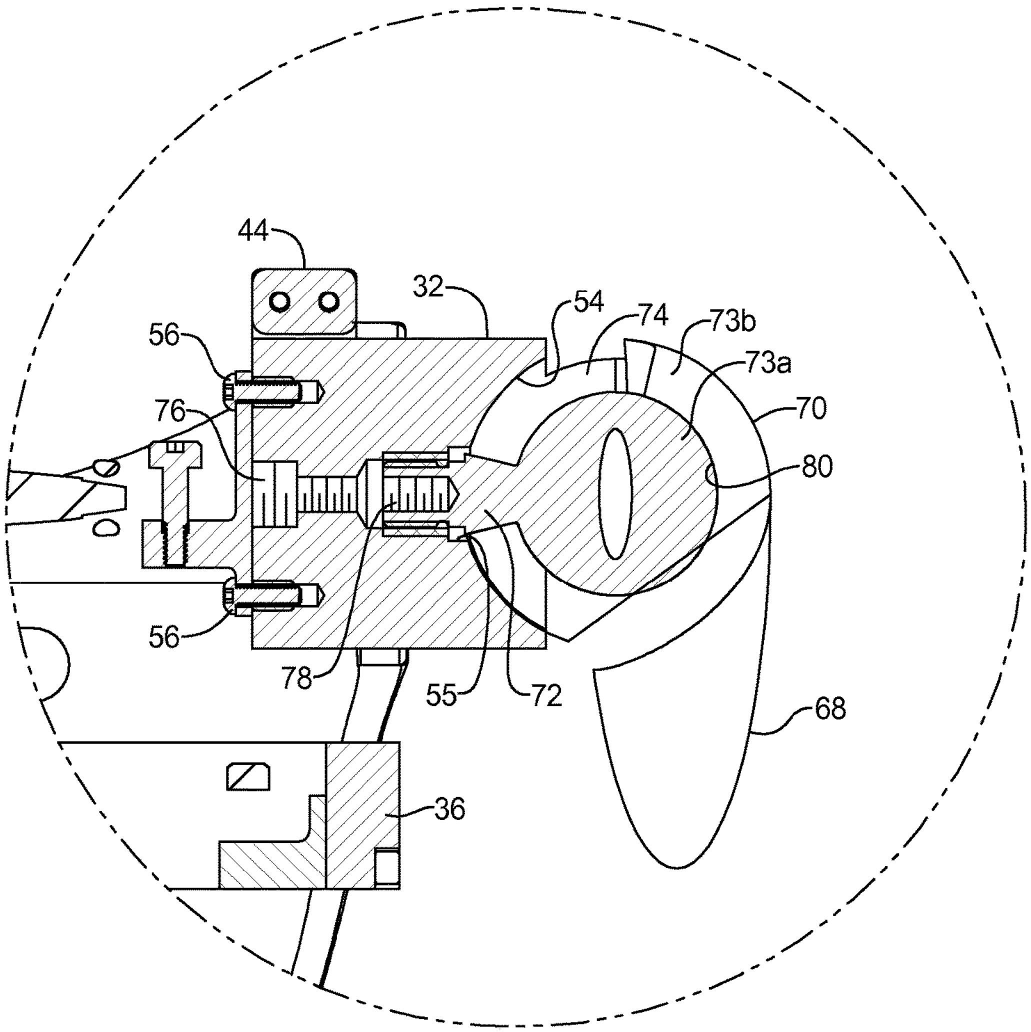

FIG 14

OMNI-DIRECTIONAL SHOULDER ASSEMBLY FOR CRASH TEST DUMMY

CROSS-REFERENCE TO RELATED APPLICATION(S)

The present application claims the benefit of Provisional Patent Application Ser. No. 62/051,574, filed Sep. 17, 2014.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to crash test dummies and, more particularly, to an omni-directional shoulder assembly for a crash test dummy.

2. Description of the Related Art

Automotive, aviation, and other vehicle manufacturers conduct a wide variety of collision testing to measure the effects of a collision on a vehicle and its occupants. Through collision testing, a vehicle manufacturer gains valuable information that can be used to improve the vehicle, authorities examine vehicles to submit type approval, and consumer organizations provide information on vehicle safety ratings to the public.

Collision testing often involves the use of anthropomorphic test devices, better known as “crash test dummies”, to estimate a human’s injury risk. The dummy must possess the general mechanical properties, dimensions, masses, joints, and joint stiffness of the humans of interest. In addition, they must possess sufficient mechanical impact response similitude and sensitivity to cause them to interact with the vehicle’s interior in a human-like manner.

The crash test dummy typically includes a head assembly, spine assembly (including neck), rib cage assembly, abdomen, pelvis assembly, right and left arm assemblies, and right and left leg assemblies. Generally, the arm assembly has an upper arm assembly and a lower arm assembly. The upper arm assembly is typically connected to a shoulder assembly, which, in turn, is typically connected to the spine assembly.

Currently, there are no omni-directional crash test dummies for use in vehicle crash testing. These same crash test dummies suffer from a stiff metal upper arm bone that protects the rib cage from deformation and can generate high forces on the shoulder assembly. In addition, these crash test dummies do not have a shoulder assembly to move in three-dimensional space to mimic that of the human being. Thus, there is a need in the art for an omni-directional shoulder assembly for a crash test dummy that provides for a human range of motion in all three axes of a shoulder.

SUMMARY OF THE INVENTION

Accordingly, the present invention is an omni-directional shoulder assembly for a crash test dummy. The shoulder assembly includes a movable clavicle adapted for attachment to a spine of the crash test dummy for freedom of movement in three-dimensional space and a scapula non-rigidly adapted mounted for attachment to the spine for freedom of movement in three-dimensional space. The shoulder assembly includes a shoulder cup member adapted for attachment to the spine in a plurality of axes for a shoulder joint, and an upper arm assembly having an arm bone made of a plastic material for operative attachment to the shoulder cup member to allow an impact on the shoulder joint of the dummy to move the shoulder assembly towards the spine.

In addition, the present invention is a crash test dummy including a body and a spine assembly operatively attached to the body. The crash test dummy also includes an omni-directional shoulder assembly connected to the spine assembly. The shoulder assembly includes a movable clavicle for attachment to a spine assembly of the crash test dummy for freedom of movement in three-dimensional space and a scapula non-rigidly mounted for attachment to the spine assembly for freedom of movement in three-dimensional space. The shoulder assembly includes a shoulder cup member for attachment to the spine assembly in a plurality of axes for a shoulder joint, and an upper arm assembly having an arm bone made of a plastic material for operative attachment to the shoulder cup member to allow an impact on the shoulder joint of the dummy to move the shoulder assembly towards the spine assembly.

One advantage of the present invention is that a new omni-directional shoulder assembly is provided for a crash test dummy. Another advantage of the present invention is that the omni-directional shoulder assembly provides for a human range of motion in all three axes of a shoulder joint for the crash test dummy. Yet another advantage of the present invention is that the omni-directional shoulder assembly includes a non-rigidly mounted scapula and clavicle that are free to move in three-dimensional space for the crash test dummy. Still another advantage of the present invention is that the omni-directional shoulder assembly includes a humerus bone attached with a ball joint and the bone is made of a plastic material to mimic human skeletal weight and strength for the crash test dummy. A further advantage of the present invention is that the omni-directional shoulder assembly is a surrogate to mimic human responses in a vehicle safety restraint system for different modes of impact during vehicle crashes for the crash test dummy.

Other features and advantages of the present invention will be readily appreciated, as the same becomes better understood, after reading the subsequent description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of one embodiment of a crash test dummy, according to one embodiment of the present invention.

FIG. **2** is a perspective view of an omni-directional shoulder assembly, according to one embodiment of the present invention, of the crash test dummy of FIG. **1**.

FIG. **3** is another perspective view of the omni-directional shoulder assembly of FIG. **2** for the crash test dummy of FIG. **1**.

FIG. **4** is yet another perspective view of the omni-directional shoulder assembly of FIG. **2** for the crash test dummy of FIG. **1**.

FIG. **5** is a front view of the omni-directional shoulder assembly of FIG. **2** illustrated in operational relationship with a portion of the crash test dummy of FIG. **1**.

FIG. **6** is a left side view of the omni-directional shoulder assembly of FIG. **5**.

FIG. **7** is a rear view of the omni-directional shoulder assembly of FIG. **5**.

FIG. **8** is a right side view of the omni-directional shoulder assembly of FIG. **5**.

FIG. **9** is a top view of the omni-directional shoulder assembly of FIG. **5**.

FIG. **10** is a bottom view of the omni-directional shoulder assembly of FIG. **5**.

FIG. **11** is a perspective exploded view of the omni-directional shoulder assembly of FIG. **5** illustrating an arm assembly of the crash test dummy of FIG. **1**.

FIG. **12** is a top view of the omni-directional shoulder assembly of FIG. **5** illustrating an arm assembly of the crash test dummy of FIG. **1**.

FIG. **13** is a sectional view taken along line **13-13** of FIG. **12**.

FIG. **14** is an enlarged view of a portion of the omni-directional shoulder assembly in circle **14** of FIG. **13**.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Referring to the drawings and in particular FIG. **1**, one embodiment of a crash test dummy, according to the present invention, is generally indicated at **12**. The crash test dummy **12** is of a 10.5 year old child and is illustrated in a standing position. This crash test dummy **12** is used primarily to test the performance of automotive interiors and restraint systems for front and rear seat occupants. The size and weight of the crash test dummy **12** are based on anthropometric studies, which are typically done separately by the following organizations, University of Michigan Transportation Research Institute (UMTRI), U.S. Military Anthropometry Survey (ANSUR), and Civilian American and European Surface Anthropometry Resource (CESAR). It should be appreciated that ranges of motions, centers of gravity, and segment masses simulate those of human subjects defined by the anthropometric data.

As illustrated in FIG. **1**, the crash test dummy **12** includes a head assembly, generally indicated at **14**. The crash test dummy **12** also includes a spine assembly, generally indicated at **15**, (FIG. **2**) having an upper end mounted to the head assembly **14** and a lower end extending into a torso area of the crash test dummy **12**. It should be appreciated that the spine assembly **15** includes a neck (not shown) attached to the head assembly **14**.

The torso area of the crash test dummy **12** also includes a rib cage or torso assembly, generally indicated at **16**, connected to the spine assembly **15**. The crash test dummy **12** also has a pair of arm assemblies including a right arm assembly, generally indicated at **18**, and a left arm assembly, generally indicated at **20**, which are attached to the crash test dummy **12** via an omni-directional shoulder assembly **30**, according to the present invention, to be described. It should be appreciated that a lower end of the spine assembly **15** is connected to a lumbar-thoracic adapter (not shown), which is connected to a lumbar to pelvic adapter (not shown).

As illustrated in the FIG. **1**, the crash test dummy **12** includes a pelvis assembly, generally indicated at **22**, connected to the adapter. The crash test dummy **12** also includes a right leg assembly **24** and a left leg assembly **26**, which are attached to the pelvis assembly **22**. It should be appreciated that various components of the crash test dummy **12** may be covered in a polyvinyl skin such as a flesh and skin assembly, generally indicated at **28** and partially shown, for biofidelity of the crash test dummy **12**.

Referring to FIGS. **2** through **14**, one embodiment of an omni-directional shoulder assembly **30**, according to the present invention, is shown for the crash test dummy **12**. The shoulder assembly **30** can be used on both the right hand and left hand positions of the crash test dummy **12** with different parts mirrored on a mid-sagittal plane. In the embodiment illustrated, one shoulder assembly **30** is on the right hand position of the crash test dummy **12** and another shoulder assembly **30** is on the left hand position of the crash test dummy **12**. Since the shoulder assembly **30** is symmetric for each of the right hand and left hand positions of the crash test dummy **12**, only one shoulder assembly **30** will be subsequently described. It should be appreciated that the subsequent description of the shoulder assembly **30** is the same for both the right hand and left hand positions of the crash test dummy **12**.

As illustrated, the shoulder assembly **30** is connected to the spine assembly **15**. The spine assembly **15** includes a neck (not shown) connected to the head assembly **14** and a spine box **32** connected to the neck. The neck has a lower end connected to by a suitable attachment such as one or more fasteners (not shown) to the spine box **32**. It should be appreciated that the fasteners threadably engage apertures (not shown) in the spine box **32** to secure the neck to the spine box **32**.

The torso assembly **16** includes a sternum **34** spaced forwardly from the spine box **32**. The sternum **34** is generally rectangular in shape, but may be any suitable shape. The torso assembly **16** also includes one or more ribs **36** extending between the spine box **32** and sternum **34**. The ribs **36** are generally arcuate in shape and generally rectangular in cross-sectional shape, but may be any suitable shape. The ribs **36** are vertically spaced along the spine box **32** and sternum **34**. The ribs **36** are connected to the spine box **32** and sternum **34** by a suitable mechanism such as one or more fasteners **38**.

As illustrated in one embodiment, the shoulder assembly **30** includes a pair of scapulas **40** connected to the spine box **32**. The scapulas **40** are generally triangular and arcuate in shape. The scapulas **40** are made of a plastic material such as polyurethane. The scapulas **40** have one end mounted to one or more mounting members **41** of the spine box **32** by a suitable mechanism such as one or more fasteners **42**. The mounting members **41** are generally rectangular in shape, but may be any suitable shape. The mounting members **41** are made of an elastomeric material such as rubber. The mounting members **41** are mounted to the spine box **32** by one or more fasteners **38**. The scapulas **40** are non-rigidly mounted to the spine box **32** via the mounting members **41** such that the scapulas **40** are free to move in three-dimensional space. It should be appreciated that the scapula **40** has the ability to slide freely and is not rigidly affixed to the spine box **32**. It should also be appreciated that the mounting members **41** allow the scapulas **40** to slide over the ribs **36** without contacting them.

The shoulder assembly **30** also includes a pair of mounting brackets **44** at one end of the scapulas **40** and connected to the scapulas **40** by a suitable mechanism such as fasteners **46**. The mounting bracket **44** is made of a metal material such as steel and aluminum. The shoulder assembly **30** also includes a pair of clavicles **48** mounted to the sternum **34** and to one or more mounting members **45** of the mounting brackets **44** by a suitable mechanism such as fasteners **50**. The mounting members **45** are generally rectangular in shape, but may be any suitable shape. The mounting members **45** are made of an elastomeric material such as rubber. The clavicles **48** are generally cylindrical in shape and extend transversely across the torso. The clavicles **48** are non-rigidly mounted via the mounting members **45** to the mounting brackets **44** such that the clavicles **48** are free to move in three-dimensional space. It should be appreciated that the clavicles **48** have a free range of motion and are not rigidly attached to the sternum **34**.

In operation, an impact on the shoulder assembly **30** of the crash test dummy **12** would move the shoulder assembly **30** towards the spine assembly **15**. The shoulder assembly **30** is supported only by the scapula **40** and clavicle **48**. The mounting members **41** and **45** would shear and stretch towards the spine assembly **15** which, in turn, would allow the scapula **40** to slide over the ribs **36** without any contact being applied to the ribs **36**. Although the scapula **40** and clavicle **48** are attached to the spine assembly **15** and sternum **34**, the mounting members **41** and **45** allow for movement of the scapula **40** and clavicle **48** without having any or minimal movement to the remainder of the crash test dummy **12**.

The shoulder assembly **30** also includes a shoulder cup member **52** mounted to the mounting bracket **44**. The shoulder cup member **52** is generally cylindrical in shape and extends laterally. The shoulder cup member **52** has a socket **54** extending axially therein to form a shoulder ball joint. The socket **54** is generally hemi-spherical in shape. The shoulder cup member **52** also has an aperture **55** extending from a bottom of the socket **54** axially therethrough. The shoulder cup member **52** is made of a metal material such as steel and aluminum. The shoulder cup member **52** is connected to the mounting bracket **44** by a suitable mechanism such as fasteners **56**.

The shoulder assembly **30** also includes a pair of breastplates **58** connected to the clavicles **48**. The breastplates **58** are generally trapezoidal in shape and extend from a relatively large width first end **60** to a relatively smaller width second end **62**. The first end **60** is generally arcuate in shape and disposed over the clavicle **48**. The breastplates **58** are made of a plastic material. The breastplates **58** may be secured to the clavicle **48** and ribs **36** by a suitable mechanism such as fasteners **64**.

The shoulder assembly **30** further includes an upper arm portion **66** of the arm assembly **18**, **20**. The upper arm portion **66** includes a humerous bone **68** disposed therein and extending axially. The upper arm portion **66** is made with solid flesh (not shown) extending around the bone **68**. The bone **68** is made of a plastic material such as nylon. The upper arm portion **66** includes a ball **70** at one end of the bone **68** having a threaded fastener **72** molded inside it. The ball **70** has an inner portion **73***a* made of a metal material such as aluminum and may have an outer portion **73***b* made of an elastomeric material such as urethane molded around the inner portion **73***a*. The ball **70** is disposed in the socket **54** and connected to the socket portion **54**. The ball **70** also has a slot **74** in the outer portion **73***b*. The threaded fastener **72** on the ball **70** gets threaded into the shoulder cup **52**. A fastener **76** is inserted into the opposite end of the shoulder cup **52** and into a threaded hole **78** in the end of the threaded fastener **72** which keeps the threaded fastener **72** from backing out when the upper arm portion **66** rotates. The bone **68** has an aperture **80** extending therethrough disposed about the inner portion **73***a* of the ball **70** and in the slot **74** of the outer portion **73***b* of the ball **70**. It should be appreciated that the outer portion **73***a* rides inside the socket **54** on the shoulder cup **52**. It should also be appreciated that the ball joint allows the arm assembly **20** to be lifted up and down and allows the entire arm assembly **20** to rotate 360 degrees inside the shoulder cup **52**. It should be appreciated that the bone **68** is attached with the ball joint and the bone structures are made of plastic materials to mimic human skeletal weight and strength.

Accordingly, the omni-directional shoulder assembly **30** of the present invention allows omni direction measurements. In addition, the omni-directional shoulder assembly **30** of the present invention meets lateral and frontal biofidelity of the crash test dummy **12**. The omni-directional shoulder assembly **30** also has the ability to move in three-dimensional space (i.e., all three axes) to mimic that of a human being. It should be appreciated that the crash test dummy **12** with the omni-directional shoulder assembly **30** is a surrogate to mimic human responses in an automotive restraint system for different modes of impact during automobile crash tests.

The present invention has been described in an illustrative manner. It is to be understood that the terminology, which has been used, is intended to be in the nature of words of description rather than of limitation.

Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, the present invention may be practiced other than as specifically described.

What is claimed is:

1. A shoulder assembly for a crash test dummy comprising:

a movable clavicle adapted for attachment to a spine of the crash test dummy for freedom of movement in three-dimensional space;

a scapula adapted to be non-rigidly mounted to the spine for freedom of movement in three-dimensional space;

a shoulder cup member adapted for attachment to the spine in a plurality of axes for a shoulder joint;

an upper arm assembly having an arm bone made of a plastic material and having a ball at one end for connection to said shoulder cup member to allow an impact on the shoulder joint of the dummy to move the shoulder assembly towards the spine, said ball includes a slot therein to allow said bone to rotate; and

a first threaded fastener on said ball and being disposed in one end of said shoulder cup member and threadably engaging said shoulder cup member, said first threaded fastener having a threaded hole, and a second threaded fastener extending through an opposite end of said shoulder cup member and threadably engaging said threaded hole of said first threaded fastener to keep said threaded first fastener from backing out when said upper arm assembly rotates.

2. A shoulder assembly as set forth in claim **1** wherein said ball has an inner portion made of a metal material and an outer portion made of an elastomeric material disposed about an outer surface of said inner portion.

3. A shoulder assembly as set forth in claim **2** wherein said outer portion of said ball includes said slot therein.

4. A shoulder assembly as set forth in claim **1** including at least one mounting member adapted to be disposed between said scapula and the spine.

5. A shoulder assembly as set forth in claim **4** wherein said at least one mounting member is made of an elastomeric material.

6. A shoulder assembly as set forth in claim **1** including at least one mounting member connected to said clavicle.

7. A shoulder assembly as set forth in claim **6** wherein said at least one mounting member is made of an elastomeric material.

8. A crash test dummy comprising:

a body;

a spine assembly operatively attached to said body; and

a shoulder assembly operatively attached to said spine assembly and comprising a movable clavicle attached to said spine assembly for freedom of movement in three-dimensional space, a scapula non-rigidly mounted to said spine assembly for freedom of movement in three-dimensional space, a shoulder cup member attached to said spine assembly in a plurality of axes for a shoulder joint, and an upper arm assembly having an arm bone made of a plastic material and having a ball at one end for connection to said shoulder cup member to allow an impact on the shoulder joint of the dummy to move the shoulder assembly towards said spine assembly, said ball includes a slot therein to allow said bone to rotate; and

a first threaded fastener inside of said ball and being disposed in one end of said shoulder cup member and threadably engaging said shoulder cup member, said first threaded fastener having a threaded hole, and a second threaded fastener extending through an opposite end of said shoulder cup member and threadably engaging said threaded hole of said first threaded fastener to keep said first threaded fastener from backing out when said upper arm assembly rotates.

9. A crash test dummy as set forth in claim **8** wherein said ball has an inner portion made of a metal material and an outer portion made of an elastomeric material disposed about an outer surface of said inner portion.

10. A crash test dummy as set forth in claim **9** wherein said outer portion of said ball includes said slot therein.

11. A crash test dummy as set forth in claim **8** including at least one mounting member disposed between said scapula and said spine assembly.

12. A crash test dummy as set forth in claim **11** wherein said at least one mounting member is made of an elastomeric material.

13. A crash test dummy as set forth in claim **8** including at least one mounting member connected to said clavicle.

14. A crash test dummy as set forth in claim **13** wherein said at least one mounting member is made of an elastomeric material.

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