example and not by way of limitation. It is merely provided to aid the reader in understanding some of the aspects of the invention.

~~In one embodiment, an energy absorber comprises an intermediate portion interconnecting a first end and a second end. The intermediate portion and the first and second ends are on the same plane. The intermediate portion includes curved portions configured and arranged to deform and begin to straighten when subjected to a pre-determined load to absorb energy from the pre-determined load.~~

~~In one embodiment, an energy absorber comprises an intermediate portion interconnecting a first end and a second end. The intermediate portion and the first and second ends are on the same plane. The intermediate portion includes curved portions configured and arranged to deform and begin to straighten when subjected to a pre-determined load to absorb energy from the pre-determined load. At least one first protrusion and at least one first notch are in opposing portions of the first end and the intermediate portion, and at least one second protrusion and at least one second notch are in opposing portions of the second end and the intermediate portion. The first and second notches are configured and arranged to receive the respective first and second protrusions to prevent material from getting caught in the energy absorber.~~

~~In one embodiment, a method of making an energy absorber comprises obtaining a piece of stainless steel having a thickness of 0.250 to 0.500 inch and cutting the stainless steel to form an intermediate portion interconnecting a first end and a second end on the same plane. The intermediate portion includes curved portions and the first and second ends include apertures formed therein. The curved portions deform and begin to straighten out when subjected to a pre-determined load to absorb energy from the pre-determined load.~~

According to an aspect of the present invention, there is provided an energy absorber, comprising: an intermediate portion interconnecting a first end and a second end, the intermediate portion and the first and second ends being on the same plane, the intermediate portion including curved portions configured and arranged to deform and begin to straighten when subjected to a pre-determined load to absorb energy from the pre-determined load; at least one first protrusion and at least one first notch in opposing portions of the first end and the intermediate portion; at least one second protrusion and at least one second notch in opposing portions of the second end and the intermediate

portion; and wherein the first and second notches are configured and arranged to receive the respective first and second protrusions to prevent material from getting caught in the energy absorber, and wherein the first and second protrusions move out of the respective first and second notches without deforming when subjected to the predetermined load and the first and second ends pull apart.

According to another aspect of the present invention, there is provided an energy absorber, comprising: an intermediate portion interconnecting a first end and a second end, the intermediate portion and the first and second ends being on the same plane, the intermediate portion including curved portions configured and arranged to deform and begin to straighten when subjected to a pre-determined load to absorb energy from the pre-determined load; at least one first protrusion and at least one first notch in opposing portions of the first end and the intermediate portion; at least one second protrusion and at least one second notch in opposing portions of the second end and the intermediate portion; and wherein the first and second notches are configured and arranged to receive the respective first and second protrusions to prevent material from getting caught in the energy absorber, and wherein the energy absorber acts like a spring when subjected to a smaller load than the pre-determined load and returns to a substantially original shape when no longer subjected to the smaller load.

According to another aspect of the present invention, there is provided a method of making an energy absorber, comprising: obtaining a piece of stainless steel having a thickness of 0.250 to 0.500 inch (6.35 mm to 12.7 mm); and cutting the stainless steel to form an intermediate portion interconnecting a first end and a second end, a first protrusion and a first notch in opposing portions of the first end and the intermediate portion, and a second protrusion and a second notch in opposing portions of the second end and the intermediate portion on the same plane, the intermediate portion including curved portions and the first and second ends including apertures formed therein, the curved portions deform and begin to straighten out when subjected to a pre-determined load to absorb energy from the pre-determined load, the notches configured and arranged to receive the protrusions to prevent material from getting caught in the energy absorber, the first and second notches being configured and arranged to receive the respective first and second protrusions to prevent material from getting caught in the energy absorber, and the first and second protrusions being configured and arranged

to move out of the respective first and second notches without deforming when subjected to the predetermined load and the first and second ends pull apart.

Brief Description of the Drawings

The present invention can be more easily understood, and further advantages and uses thereof can be more readily apparent, when considered in view of the detailed description and the following Figures in which:

WE CLAIM:

1. An energy absorber, comprising:

an intermediate portion interconnecting a first end and a second end, the intermediate portion and the first and second ends being on the same plane, the intermediate portion including curved portions configured and arranged to deform and begin to straighten when subjected to a pre-determined load to absorb energy from the pre-determined load.

2. The energy absorber of claim 1, further comprising notches proximate the ends and pins held in place by friction within the notches, the pins preventing material from getting caught in the energy absorber, assisting in stiffening the energy absorber, and assisting in pre-stressing the energy absorber so that the energy absorber will not open up when subjected to a load less than the pre-determined load.

3. The energy absorber of claim 2, wherein the pins simply fall out of the notches when the energy absorber deforms.

4. The energy absorber of claim 1, further comprising lobes in the intermediate portion to facilitate deformation of the intermediate portion.

5. The energy absorber of claim 1, further comprising voids in the intermediate portion to facilitate deformation of the intermediate portion.

6. The energy absorber of claim 1, further comprising:

at least one first protrusion and at least one first notch in opposing portions of the first end and the intermediate portion;

at least one second protrusion and at least one second notch in opposing portions of the second end and the intermediate portion; and

wherein the first and second notches are configured and arranged to receive the respective first and second protrusions to prevent material from getting caught in the energy absorber.

7. The energy absorber of claim 1, wherein the intermediate portion and the first and second ends are made from a piece of stainless steel having a thickness of approximately 0.250 to 0.500 inch.

8. The energy absorber of claim 1, wherein the intermediate portion begins to deform when subjected to a load of at least 6 kN.

9. The energy absorber of claim 1, wherein back sections of the curved portions have a radius of approximately 0.060 to 0.125 inch.

10. An energy absorber, comprising:

an intermediate portion interconnecting a first end and a second end, the intermediate portion and the first and second ends being on the same plane, the intermediate portion including curved portions configured and arranged to deform and begin to straighten when subjected to a pre-determined load to absorb energy from the pre-determined load;

at least one first protrusion and at least one first notch in opposing portions of the first end and the intermediate portion;

at least one second protrusion and at least one second notch in opposing portions of the second end and the intermediate portion; and

wherein the first and second notches are configured and arranged to receive the respective first and second protrusions to prevent material from getting caught in the energy absorber.

11. The energy absorber of claim 10, wherein the first end and the intermediate portion proximate the first end each includes a first protrusion and a first notch, the first protrusion of the first end corresponding with the first notch of the intermediate portion and the first protrusion of the intermediate portion corresponding with the first notch of the first end.

12. The energy absorber of claim 10, wherein the second end and the intermediate portion proximate the second end each includes a second protrusion and a second notch, the second protrusion of the second end corresponding with the second notch of the intermediate portion and the second protrusion of the intermediate portion corresponding with the second notch of the second end.

13. The energy absorber of claim 10, wherein the intermediate portion begins to deform when subjected to a load of at least 6 kN.

14. The energy absorber of claim 10, wherein back sections of the curved portions have a radius of approximately 0.060 to 0.125 inch.

15. A method of making an energy absorber, comprising:

obtaining a piece of stainless steel having a thickness of 0.250 to 0.500 inch; and

cutting the stainless steel to form an intermediate portion interconnecting a first end and a second end on the same plane, the intermediate portion including curved portions and the first and second ends including apertures formed therein, the curved portions deform and begin to straighten out when subjected to a pre-determined load to absorb energy from the pre-determined load.

16. The method of claim 15, wherein the stainless steel has a thickness of approximately 0.375 inch.

17. The method of claim 15, wherein the stainless steel is cut using a laser cutter or a water jet.

18. The method of claim 15, further comprising forming lobes in the intermediate portion when cutting the stainless steel.

19. The method of claim 15, further comprising forming notches in the intermediate portion and the first and second ends when cutting the stainless steel and then inserting pins into the notches.

20. The method of claim 15, further comprising forming a first protrusion and a first notch in opposing portions of the first end and the intermediate portion and forming a second protrusion and a second notch in opposing portions of the second end and the intermediate portion, the notches configured and arranged to receive the protrusions to prevent material from getting caught in the energy absorber.

CLAIMS:

1. An energy absorber, comprising:

an intermediate portion interconnecting a first end and a second end, the intermediate portion and the first and second ends being on the same plane, the intermediate portion including curved portions configured and arranged to deform and begin to straighten when subjected to a pre-determined load to absorb energy from the pre-determined load;

at least one first protrusion and at least one first notch in opposing portions of the first end and the intermediate portion;

at least one second protrusion and at least one second notch in opposing portions of the second end and the intermediate portion; and

wherein the first and second notches are configured and arranged to receive the respective first and second protrusions to prevent material from getting caught in the energy absorber, and wherein the first and second protrusions move out of the respective first and second notches without deforming when subjected to the predetermined load and the first and second ends pull apart.

2. The energy absorber of claim 1, further comprising lobes in the intermediate portion to facilitate deformation of the intermediate portion.

3. The energy absorber of claim 1, further comprising voids in the intermediate portion to facilitate deformation of the intermediate portion.

4. The energy absorber of claim 1, wherein the intermediate portion and the first and second ends are made from a piece of stainless steel having a thickness of approximately 0.250 to 0.500 inch (6.35 mm to 12.7 mm).

5. The energy absorber of claim 1, wherein the intermediate portion begins to deform when subjected to a load of at least 6 kN.

6. The energy absorber of claim 1, wherein back sections of the curved portions have a radius of approximately 0.060 to 0.125 inch (1.524 mm to 3.175 mm).

7. An energy absorber, comprising:

an intermediate portion interconnecting a first end and a second end, the intermediate portion and the first and second ends being on the same plane, the intermediate portion including curved portions configured and arranged to deform and begin to straighten when subjected to a pre-determined load to absorb energy from the pre-determined load;

at least one first protrusion and at least one first notch in opposing portions of the first end and the intermediate portion;

at least one second protrusion and at least one second notch in opposing portions of the second end and the intermediate portion; and

wherein the first and second notches are configured and arranged to receive the respective first and second protrusions to prevent material from getting caught in the energy absorber, and wherein the energy absorber acts like a spring when subjected to a smaller load than the pre-determined load and returns to a substantially original shape when no longer subjected to the smaller load.

8. The energy absorber of claim 7, wherein the first end and the intermediate portion proximate the first end each includes a first protrusion and a first notch, the first protrusion of the first end corresponding with the first notch of the intermediate portion and the first protrusion of the intermediate portion corresponding with the first notch of the first end.

9. The energy absorber of claim 7, wherein the second end and the intermediate portion proximate the second end each includes a second protrusion and a second notch, the second protrusion of the second end corresponding with the second notch of the intermediate portion and the second protrusion of the intermediate portion corresponding with the second notch of the second end.

10. The energy absorber of claim 7, wherein the intermediate portion begins to deform when subjected to a load of at least 6 kN.

11. The energy absorber of claim 7, wherein back sections of the curved portions have a radius of approximately 0.060 to 0.125 inch (1.524 mm to 3.175 mm).

12. A method of making an energy absorber, comprising:

obtaining a piece of stainless steel having a thickness of 0.250 to 0.500 inch (6.35 mm to 12.7 mm); and

cutting the stainless steel to form an intermediate portion interconnecting a first end and a second end, a first protrusion and a first notch in opposing portions of the first end and the intermediate portion, and a second protrusion and a second notch in opposing portions of the second end and the intermediate portion on the same plane, the intermediate portion including curved portions and the first and second ends including apertures formed therein, the curved portions deform and begin to straighten out when subjected to a pre-determined load to absorb energy from the pre-determined load, the notches configured and arranged to receive the protrusions to prevent material from getting caught in the energy absorber, the first and second notches being configured and arranged to receive the respective first and second protrusions to prevent material from getting caught in the energy absorber, and the first and second protrusions being configured and arranged to move out of the respective first and second notches without deforming when subjected to the predetermined load and the first and second ends pull apart.

13. The method of claim 12, wherein the stainless steel has a thickness of approximately 0.375 inch (9.525 mm).

14. The method of claim 12, wherein the stainless steel is cut using a laser cutter or a water jet.

15. The method of claim 12, further comprising forming lobes in the intermediate portion when cutting the stainless steel.