

June 25, 1957

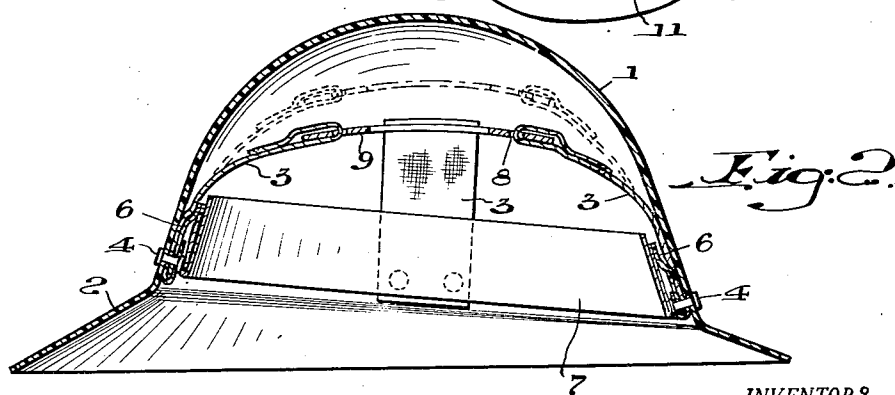
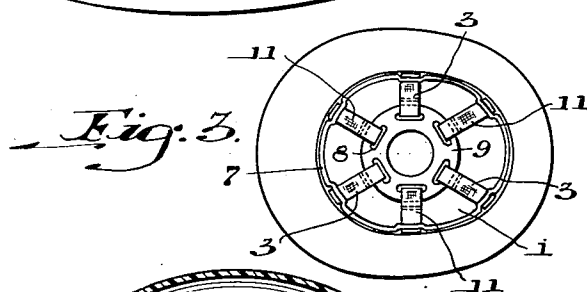
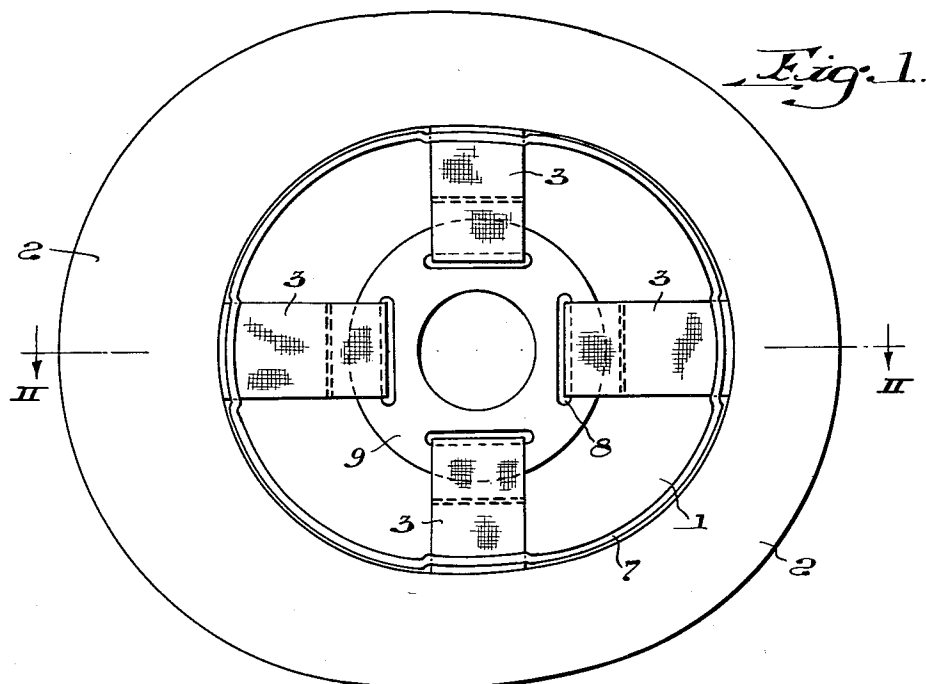
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2,796,609

PROTECTIVE HELMET WITH SHOCK ABSORBING SUSPENSION

Filed Nov. 10, 1953

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

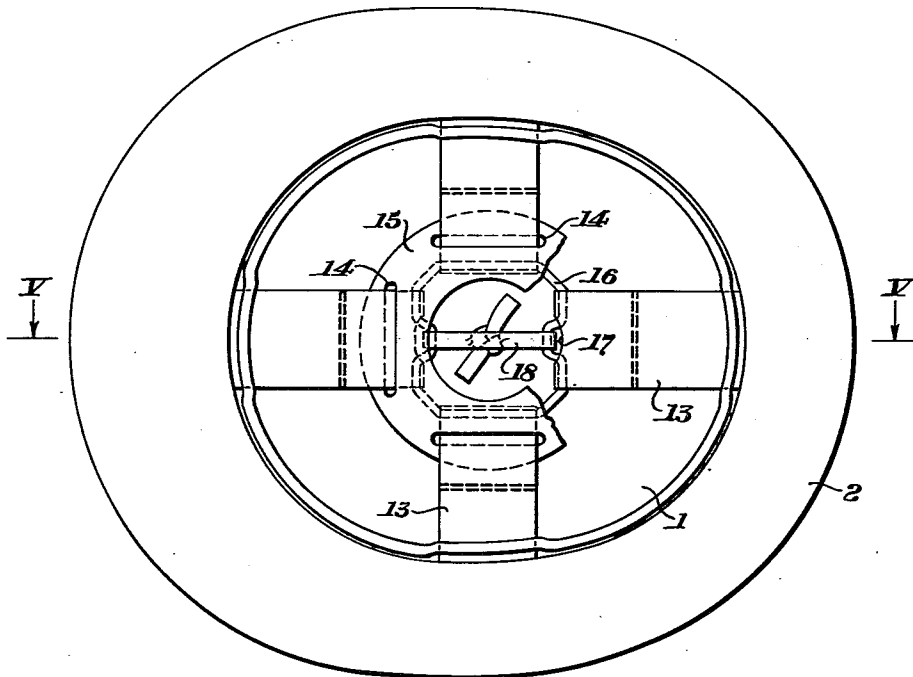


Fig. 4.

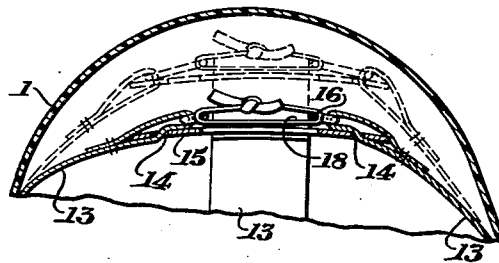


Fig. 5.

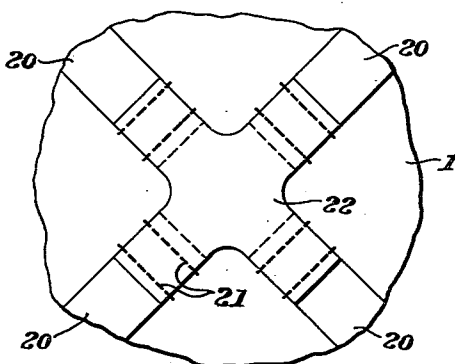


Fig. 6.

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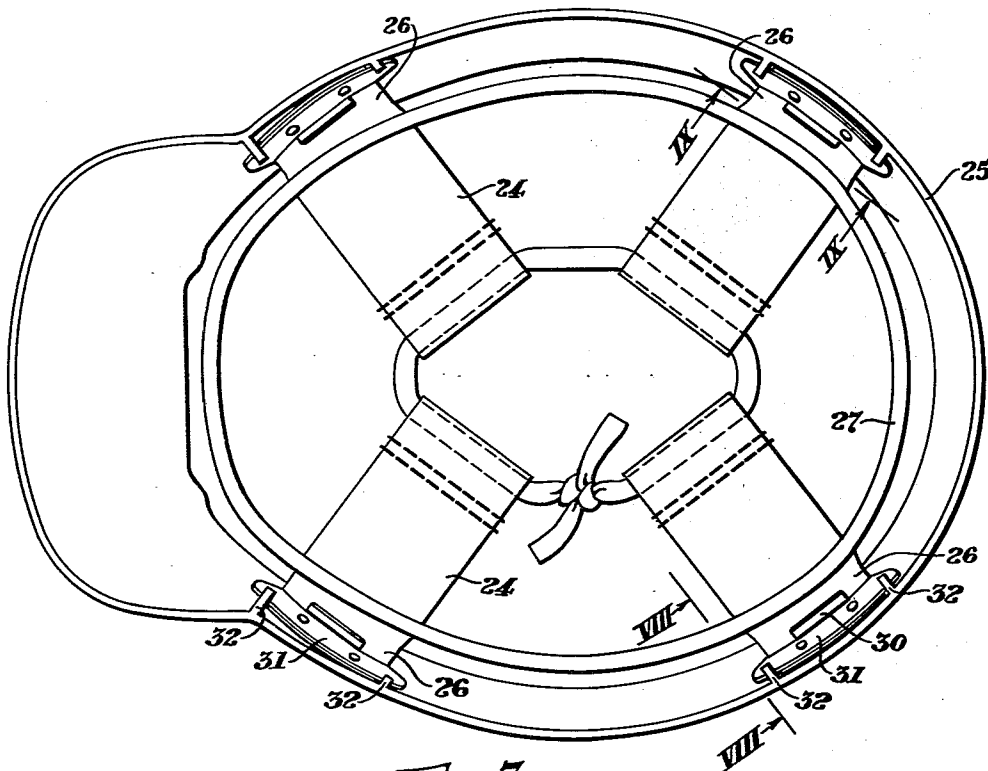


Fig. 7

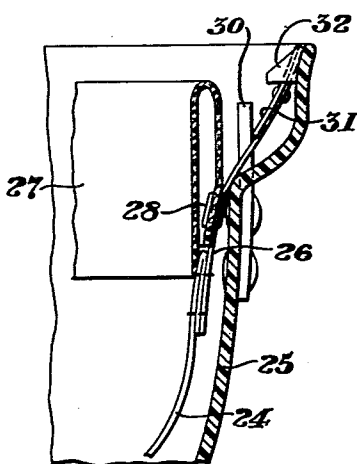


Fig. 8

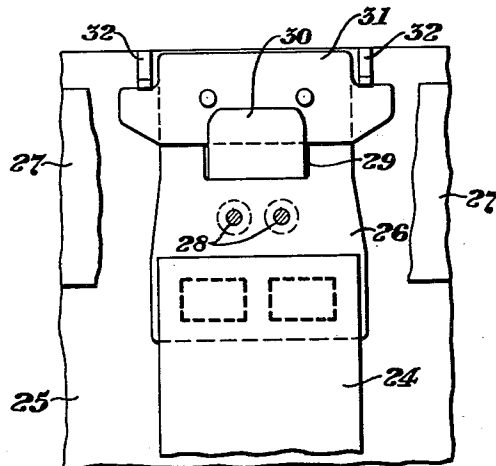


Fig. 9

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1

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PROTECTIVE HELMET WITH SHOCK ABSORBING SUSPENSION

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Application November 10, 1953, Serial No. 391,343

9 Claims. (Cl. 2—3)

This invention relates to protective helmets or safety hats, and more particularly to means therein for absorbing the shock of accidental impacts.

The well known protective helmet or hat worn by industrial workers and miners has a rigid shell in which there is a suspension, which includes a cradle of straps that rest on the head with their lower ends connected to the lower part of the shell. The purpose of the suspension is to fit the helmet to the head and space the head from the crown so that impacts against the crown will not be transmitted directly to the head. Cradle straps are ordinarily made from a woven webbing that has a high degree of elasticity. These straps transmit force to the wearer's head during impact in the following manner. The initial transfer begins at the instant of impact and rapidly increases to the point where the webbing ceases to stretch. At this instant the magnitude of the force becomes great if the impact is one of high energy. If the impacting mass is substantially balanced on the shell or has partly penetrated and is being loosely held by the shell, the energy transfer does not stop when this mass is halted in its downward travel. The energy stored in the elastic webbing through its elongation is now released and the impacting mass is accelerated upward. As it is propelled away from the shell, there is a corresponding reacting force on the head. Below its elastic limit the webbing acts as a storer of energy, similar to a spring, and not as an absorber.

It is among the objects of this invention to provide a protective helmet in which the suspension serves as a real shock absorber, and in which the suspension can retain the same appearance as heretofore.

In accordance with this invention the inside of the rigid shell of a helmet is provided with a head cradle, portions of which are formed from an energy absorbing material, which is one that is permanently stretchable under strain but is unstretched when installed in the shell. Consequently, if the shell of the helmet accidentally receives a downward impact greater than a predetermined value, the force will stretch the straps to elongate them permanently, and while the straps are elongating they will absorb energy from the force of the impact and thus serve as shock absorbers.

The invention is illustrated in the accompanying drawings, in which:

Fig. 1 is a bottom view of a helmet looking up into it;

Fig. 2 is a longitudinal section taken on the line II—II of Fig. 1;

Fig. 3 is a reduced fragmentary bottom view of a modification;

Fig. 4 is a bottom view of another embodiment;

Fig. 5 is a fragmentary longitudinal section taken on the line V—V of Fig. 4;

Fig. 6 is a fragmentary bottom view of a modified cradle;

Fig. 7 is a bottom view of a still further embodiment of the invention; and

Figs. 8 and 9 are enlarged fragmentary vertical sections

2

taken on the lines VIII—VIII and IX—IX, respectively, of Fig. 7.

Referring to Figs. 1 and 2 of the drawings, the helmet may be made in conventional form of any suitable material, such as metal or laminated plastic, which will provide it with a shell consisting of a dome shape rigid crown 1 surrounded by a rigid brim 2. The suspension inside the crown includes several flexible cradle straps 3 extending up into the crown from circumferentially spaced points around its lower part. The lower end of each strap is doubled back upon itself and rigidly connected to the crown by a pair of rivets 4. The two rivets also extend through the lower end of a fairly stiff fiber strip 6 in the folded part of the strap. The upper end of each fiber strip is sewed to the upper edge of the outer layer of a head band 7. The upper end of each cradle strap extends through a slot 8 in a leather ring 9 and is folded back over the upper part of the strap and sewed to it. Consequently, the upper ends of the straps are connected together at spaced intervals by the leather ring. The straps and ring fit over the head of the wearer and hold the shell in position with its top spaced from the head.

In accordance with this invention the cradle straps are made from a material that will permanently absorb the energy required to stretch it. Such a material may be made from undrawn synthetic plastic fibers that are capable of being elongated without recovery, and the elastic limit of which is exceeded practically as soon as they start to stretch. Another quality of this material is that the tensile strength per unit of cross sectional area increases after the elastic limit is reached, instead of decreasing like conventional materials. Certain polyamides and polymers of vinyl compounds, such as polyvinylidene chloride, are suitable for this purpose. A characteristic of such polymers is that they include long-chain molecules and are of crystalline structure having at least some of their crystals randomly disposed. Instead of being in the form of fibers, the straps can be formed of solid strips of an organic compound of the same composition as the fibers just mentioned. When the straps are stretched they neck down as their molecules are drawn out into parallel relation with one another. A downward impact on the helmet of sufficient force; that is, a force great enough to stretch the straps, will elongate them permanently. While elongating they will absorb a considerable amount of energy from the force, and since they will not recoil or recover when the force is removed, they serve as true shock absorbers that do not transmit the absorbed energy to the head. The tensile strength of the straps after being stretched should be greater than their original undrawn strength.

In some cases, as shown in Fig. 3, it may be desirable to combine straps of the character just described with cradle straps 11 made from elastic webbing having an ultimate tensile strength above the draw load of the non-elastic straps. The effect of a severe blow against such a helmet within its energy-absorbing limits will be as follows. The non-elastic straps will stretch or draw, absorbing energy. The elastic straps, which even may have slack in them, will stretch readily at first, but as their elongation increases it will require a greater and greater tensile pull for further increments of elongation. The combined effect is to actually absorb energy in the suspension through the permanent deformation of the non-elastic straps, to prevent high shock values from reaching the wearer's head by distributing energy absorption over a longer period of time, and to prevent excessive deformation of the suspension which would result in direct contact between the wearer's head and the helmet shell, through the gradually increasing arresting action of the non-elastic straps.

3

Instead of using cradle straps of two different types, it is possible to make all of the straps alike, with each strap formed from a mixture of both elastic and undrawn permanently stretchable material.

In the modification of the invention shown in Figs. 4 and 5, conventional cradle straps 13 are used, which are made from cotton webbing or the like. The upper ends of the straps are looped through slots 14 in a leather ring 15 like the one shown in Fig. 1. However, in this case the loops extend above the ring and toward one another and are connected by a cord 16 extending through their upper ends. To allow for adjusting the size of the cradle, the upper ends of two opposite loops may be provided with openings 17, through which portions of the cord can extend so that they can be connected by a lace 18 that can be tightened in order to pull the upper ends of the straps more closely together. The cord is formed from undrawn permanently-stretchable material such as has been described hereinbefore. Accordingly, if the helmet receives a strong downward impact, the cord will elongate permanently and thereby absorb a great deal of the shock. Stretching of the cord is stopped, before the top of the shell can strike the top of the head, by means of the leather ring 15 which can move upward in the strap loops only until the outer walls of its slots 14 engage the upper ends of the loops. In such a case the ring will prevent the upper ends of the straps from moving any farther apart, and the straps will keep the ring from moving any farther upward in the shell.

A simple adaptation of the principle of this invention is disclosed in Fig. 6, where the cradle straps 20 again are formed from conventional material, such as cotton webbing. The upper ends of the straps, instead of being provided with loops, are attached by stitching 21 or the like to the four arms of a cross shape member 22 made from an undrawn permanently-stretchable material such as disclosed above. This member will absorb the shock of a strong impact on the helmet by stretching and not recovering.

A still further embodiment of the invention is illustrated in the last three figures of the drawing. In this form the permanently-stretchable members are connected to the lower ends of conventional cradle straps 24 and are used for connecting the straps to the lower part of the rigid shell 25 of the helmet. Each of these terminal members includes a flexible strip 26 that may be sewed or otherwise attached to the lower end of one of the straps. The sweat band 27 may be connected by rivets 28 to the several strips. The central portion of each strip, below the rivets, is provided with a rectangular opening 29, through which a rigid tongue 30 extends. The tongues are riveted to the outside of the shell and extend down through slots in the flaring lower part of the shell. To prevent the flexible strips from sliding down off the lower ends of the tongues, a cross bar 31 is secured to the lower end of each strip and projects from its opposite sides. The upper edge of the bar may substantially engage the outer surface of the adjoining tongue, but the lower edges of the projecting ends of the bar engage the upper surfaces of a pair of inwardly projecting ears 32 integral with the shell. Consequently, strips 26 normally can move neither upward nor downward after they have been fitted over the tongues. If the helmet is subjected to a severe impact, a great deal of the energy from the impact will be absorbed by the flexible strips as they are stretched upward in the shell by the cradle straps.

According to the provisions of the patent statutes, we have explained the principle of our invention and have illustrated and described what we now consider to represent its best embodiment. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. A protective helmet comprising a rigid shell, and a

4

head cradle mounted in the shell, portions of the cradle being formed from a long-chain crystalline polymer having at least some of its crystals randomly disposed, said cradle being spaced from the top of the shell such that the elastic limit of said portions is exceeded before the cradle contacts the top of the shell, whereby when in use the shell accidentally receives a downward impact of sufficient force, said portions will be elongated permanently and while elongating will absorb energy from said force and thereby absorb the shock.

2. A helmet in accordance with claim 1, including means limiting said elongation of said cradle portions before the top of the shell can strike the top of the head of the wearer of the helmet.

3. A protective helmet comprising a rigid shell, straps therein having lower ends connected with the lower part of the shell, and means connecting the upper ends of the straps to form a head cradle, said means being formed from a long-chain crystalline polymer having at least some of its crystals randomly disposed, said cradle being spaced from the top of the shell such that the elastic limit of said means is exceeded before the cradle contacts the top of the shell, whereby when in use the shell accidentally receives a downward impact of sufficient force, said connecting means will be elongated permanently and while elongating will absorb energy from said force and thereby absorb the shock.

4. A helmet in accordance with claim 2, wherein said connecting means is a cord laced through the upper ends of the straps, and an adjustable lace connects opposite sides of the cord to vary the size of the cradle.

5. A helmet in accordance with claim 2, including means connected with the upper ends of said straps to limit the distance they can be separated from one another if said polymer elongates.

6. A protective helmet comprising a rigid shell, substantially non-elastic straps therein having lower ends connected with the lower part of the shell, the upper ends of the straps being formed into loops, a cord extending through the loops to connect the upper ends of the straps and thereby form a head cradle, the cord being formed from a long-chain crystalline polymer having at least some of its crystals randomly disposed, said cradle being spaced from the top of the shell such that the elastic limit of said cord is exceeded before the cradle contacts the top of the shell, and a flexible ring extending loosely through said loops to permit the upper ends of the straps to be separated only a predetermined amount if said cord is elongated when said shell accidentally receives a downward impact.

7. A protective helmet comprising a rigid shell, substantially non-elastic head-cradling straps therein, terminal members secured to the lower ends of the straps, means connecting said members to the lower part of the shell, and means connecting the upper ends of the straps to form a head cradle, said terminal members being formed from a long-chain crystalline polymer having at least some of its crystals randomly disposed, said cradle being spaced from the top of the shell such that the elastic limit of said members is exceeded before the cradle contacts the top of the shell, whereby when in use the shell accidentally receives a downward impact of sufficient force, said members will be elongated permanently and while elongating will absorb energy from said force and serve as shock absorbers.

8. A protective helmet comprising a rigid shell, head engaging straps therein having lower portions connected with the lower part of the shell, means connecting the upper portions of the straps to form a head cradle, said cradle being spaced from the top of the shell; and said means comprising an adjustable member for varying the size of the cradle and a limiting member for limiting the separation of said upper portions to prevent the top of

75

the cradle from contacting the top of the shell when said adjustable member becomes inoperative.

9. A helmet in accordance with claim 8, in which said adjustable member comprises loops adjustably secured by connecting means extending therethrough, and said limiting member comprising loops loosely secured by a slidably mounted restraining means. 5

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