

Jan. 20, 1953

H. P. ROTH ET AL
CRASH HELMET

2,625,683

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3 Sheets-Sheet 1

FIG. 2.

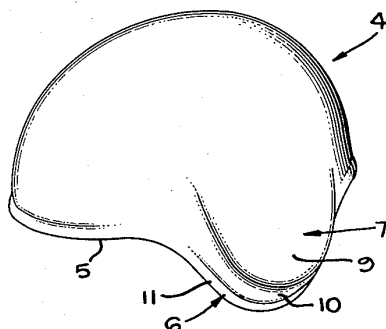


FIG. 1.

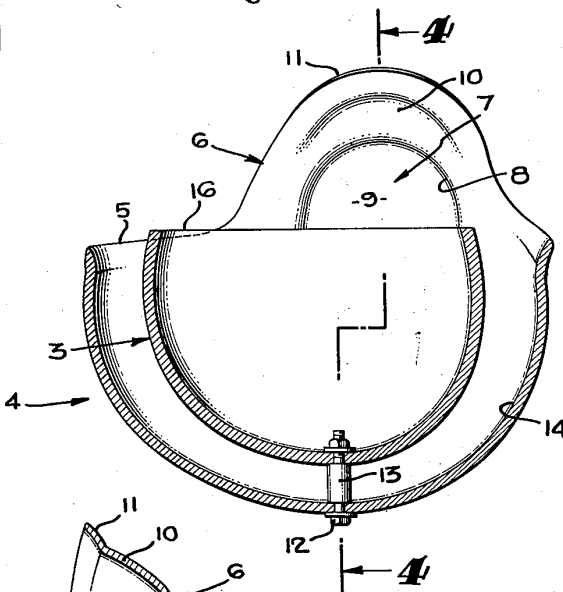
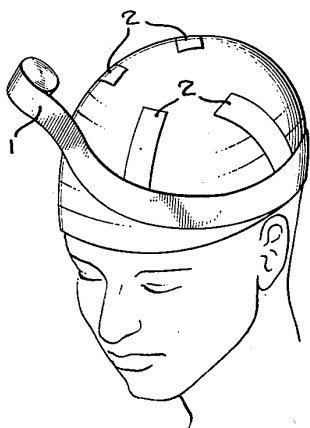


FIG. 4.

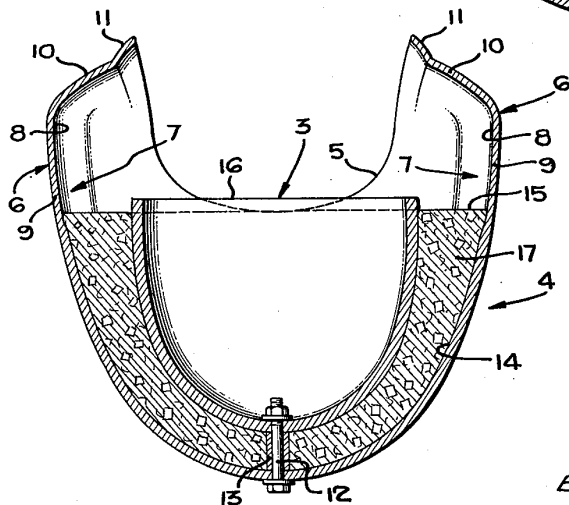


FIG. 3.

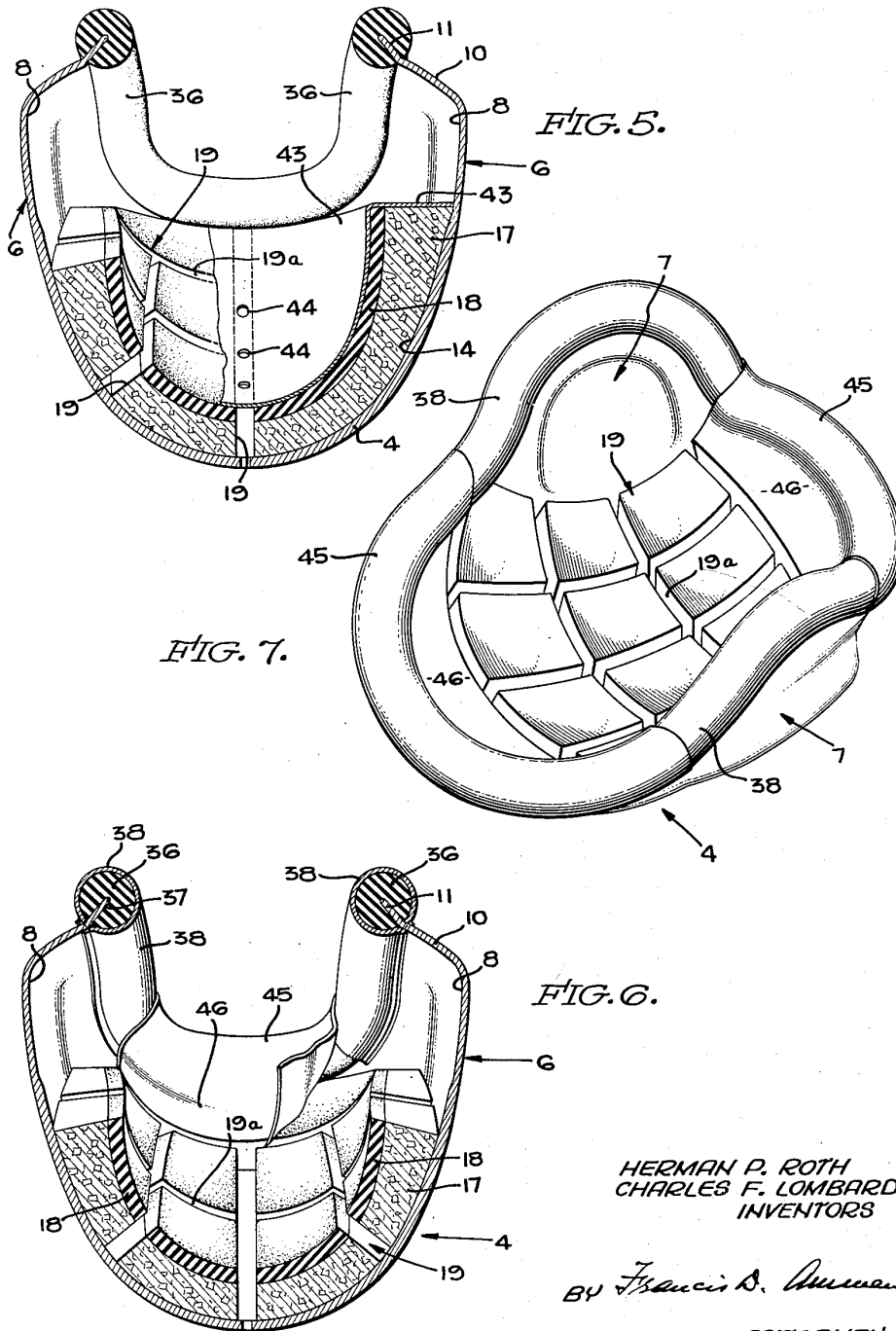
HERMAN P. ROTH
CHARLES F. LOMBARD
INVENTORS

BY *Francis D. Dummer*

ATTORNEY

Filed Dec. 8, 1947

3 Sheets-Sheet 2



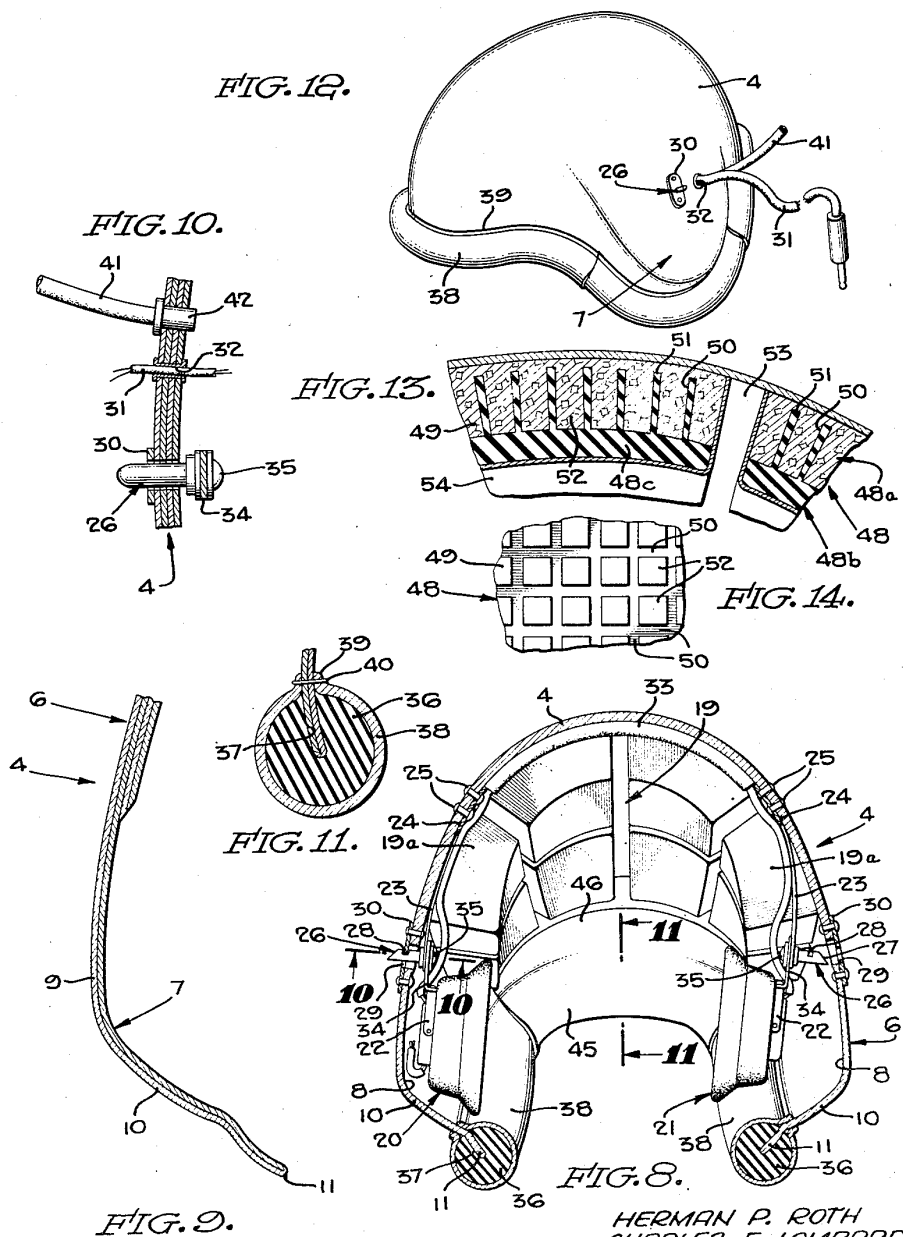
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3 Sheets-Sheet 3



HERMAN P. ROTH
CHARLES F. LOMBARD
INVENTORS

BY *Francis D. Ammer*
ATTORNEY

UNITED STATES PATENT OFFICE

2,625,683

CRASH HELMET

Herman P. Roth, Manhattan Beach, and Charles F. Lombard, South Pasadena, Calif., assignors to Protection, Inc., Los Angeles, Calif., a corporation of California

Application December 8, 1947, Serial No. 790,256

18 Claims. (Cl. 2-6)

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This invention relates to a type of helmet to be worn by a flyer, and the principal object of the invention is to provide a helmet that will protect the flyer's head in case of a crash landing, collision in flight, or any other accident. The invention also resides in the method for making the helmet.

Another object of the invention is to provide a helmet of this type, of light weight, and which is so constructed that any impact force acting upon the helmet, will be largely absorbed and distributed before the impact from the force or blow is imparted to the flyer's head.

Another object of the invention is to provide an integrated material composed of an energy-absorbing element and a liner element interlocked or "keyed" together to form a sheet material capable of being used as an energy-absorbing protection for any specific purpose; and to provide a form of interlock between the said two elements which will co-operate to combine lightness and flexibility. These qualities particularly adapt this integrated material to function as an inner wall for the outer shell of a crash helmet.

Another object of the invention is to provide a helmet of this type, having means for mounting ear phones in the helmet in such a way that they will not interfere with the placing of the helmet on the flyer's head; while at the same time, after the helmet has been put in place, the phones will lie closely against the flyer's ears, thereby enabling them to operate with their usual efficiency.

Another object of the invention is to provide a simple method, the practice of which will insure that the helmet will fit with substantial accuracy to the shape and size of the flyer's head.

Another object of the invention is to provide a composite material which is embodied in the construction of the helmet, and which will operate efficiently to absorb impact energy, and substantially prevent their transmission, within limits of course, to the flyer's head; also, to provide efficient means, and a simple method for facilitating the placement of a protective wall of this impact-absorbing composition within the outer shell of the helmet.

Another object of the invention is to provide a helmet of this type with means for effectively ventilating its interior to prevent overheating of the flyer's head when wearing the helmet.

The helmet of the present invention comprises a rigid outer shell, a layer just within the outer shell, of energy-absorbing material; and preferably includes a second, or inner layer of resilient material. The function of the rigid outer shell is

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to distribute any force applied locally on the outside of the shell so that it will act on as large an area as possible within the helmet. Previously helmets have been constructed employing a relatively rigid or hard outer shell as a means for distributing locally applied force but these helmets have relied either solely on the use of such a hard outer shell or combined such a hard outer shell with an inner lining of resilient material, such as sponge rubber. The helmet of the present invention involves a new concept in the matter of the energy-absorbing liner for the rigid outer shell. When a helmet is constructed with a rigid outer shell with a resilient lining, the resilient lining functions merely to slightly delay the application of the force of the impact to the head of the wearer by temporarily storing and then transmitting the impact energy. The present invention involves the employment of a substantially rigid outer shell and an energy-absorbing layer composed of a non-resilient material which is capable of being crushed under the action of an impact force. This layer of material has characteristics that enable it to be crushed (within limits) without transmitting the force that crushes it. For example, by providing a layer of material between the rigid shell and a relatively thin resilient inner lining worn for comfort by the wearer, the energy of impact on the outer shell is first distributed to the lining of crushable material. When the force of the impact rises to that necessary to start crushing this layer, further rapid rise of the resistance to the impact force does not occur until the layer undergoes substantially complete crushing. In other words, within limits, the crushing force is absorbed and confined in its action to the crushed or partially crushed liner. In this way the layer of crushable material within the helmet of the present invention protects the wearer by absorbing the impact energy by the work done in crushing it, as contrasted with storing and passing it on to the wearer's head, as occurs with a resilient liner.

Further objects of the invention will appear hereinafter.

The invention consists in the novel steps, combination of steps, and features of construction of the helmet to be described hereinafter, all of which contribute to produce an efficient crash helmet and method of producing the same.

A preferred embodiment of the invention is described in the following specification, while the broad scope of the invention is pointed out in the appended claims.

In the drawings:

Fig. 1 is a perspective illustrating a method which we prefer to employ in producing a molding shell which fits accurately to the flyer's head, and which is employed in embodying the protective wall within the outer shell of the helmet.

Fig. 2 is a perspective of the outer shell of the helmet.

Fig. 3 is a section taken in the front and rear medial plane of the helmet, illustrating one of the steps in the method of producing the helmet, and utilizing the molding shell, which is illustrated in the act of being formed in Fig. 1.

Fig. 4 is a vertical cross-section through the helmet, taken on the line 4—4 of Fig. 3, but illustrating the method at a further stage of progress in which the impact-absorbent wall is placed between the outer shell and the molding shell which is temporarily held within the same.

Fig. 5 is a vertical cross-section taken in a transverse plane through the partially completed helmet. The right half portion of this figure particularly illustrates the location of the inner liner, with respect to the impact-absorbing wall, together with a flexible innermost lining that comes directly in contact with the flyer's head. The left portion of this figure shows this flexible lining broken away to illustrate particularly a preferred manner for effecting the ventilating of the helmet.

Fig. 6 is a view somewhat similar to Fig. 5, but particularly illustrating the two ear phone pockets or recesses that are formed in the outer shell. This view also illustrates the manner of applying flexible binding at the front and rear edges of the opening of the helmet.

Fig. 7 is a perspective illustrating the helmet in an inverted position, as it is illustrated in Figs. 3 to 6, and showing the same before the flexible innermost lining is put in place.

Fig. 8 is a cross-section in a transverse plane passing through the ear phone pockets or recesses, and showing the helmet in its natural upright position, but in this view the flexible innermost lining is omitted so as to show the ventilating grooves or channels that are formed in the protective wall. In this view one of the ear phones is shown latched in its outermost position as it would be when the helmet is being applied to the flyer's head, while the other ear phone is shown in its released position, which would enable it to hold itself in a yielding manner against the flyer's ear.

Fig. 9 is a fragmentary section upon an enlarged scale illustrating the detail of the layers of material that are molded and formed to the desired shape in the fabrication of the outer shell of the helmet.

Fig. 10 is a fragmentary horizontal section taken about on the line 10—10 of Fig. 8, and illustrating further details of the mounting for one of the ear phones, and the parts of the latch that we prefer to employ for holding the ear phones in an outer or withdrawn position at the time the helmet is being applied to the flyer's head. This view also illustrates the electric cord connection through the outer shell of the helmet, and the connection for the ventilating hose through which cool air is supplied to the ventilating ducts in the interior of the helmet.

Fig. 11 is a section taken about on the line 11—11 of Fig. 8, illustrating a detail of the flexible or elastic trim for the edge of the opening of

the helmet through which the flyer's head is inserted; and this view illustrates how this trim is secured to the edge of the opening and covered with a flexible sheath.

Fig. 12 is a perspective of the complete helmet, illustrating the electrical cord, and ventilating connections to the helmet.

Fig. 13 is a fragmentary view, that is to say, it is a sectional view through the wall of a helmet, consisting of an integrated material composed of an outer element of an energy-absorbing material interlocked with an inner element having characteristic resilience.

Fig. 14 is a fragmentary plan view of a portion of the face of the energy-absorbing element before uniting the element that has characteristic resilience thereto.

Referring now particularly to Figs. 1 to 4, inclusive, in practicing this invention it is desirable, but not essential, to have the helmet fit closely to the size and shape of the flyer's head. For this reason it is preferable to use the head of the flyer who is to wear the helmet, in the first step of our method in producing a molding shell that is employed in a later step of the method. This includes the placement of a protective wall within the outer shell of the helmet. The preparation of this molding shell may be accomplished in any suitable manner, but if desired, it can be effected in the manner illustrated in Fig. 1, in which figure 1 indicates a strip of material that can be applied to the flyer's head, in a moist condition, in such a way as to fashion a "skull cap" on his head which preferably is protected by a close-fitting bathing cap. For this purpose we prefer to employ a material known as plaster bandage, and which is used by surgeons in forming casts around broken limbs, or in similar situations. The body of this bandage is saturated with a substance that will harden after the bandage has been applied to one's body. Although the illustration shows the bandage 1 being applied from a roll, in practice, this may be accomplished by employing short pieces such as the short pieces 2 which are applied to the flyer's head at different points, and extending in any direction desired. In this way a thin rigid shell 3 is formed (see Fig. 4) after the material sets.

In accordance with our method we also employ an outer shell which may be formed in any well known desired manner. For our purposes we would employ an outer shell 4, which is of considerably larger dimension than the inner shell 3, but which has the same general form in cross-section in corresponding planes, together with other features hereinafter described. This shell 4 is preferably formed of a composite material consisting of a multiplicity of layers of fiber glass cloth, bonded together into a single wall structure by means of a thermally processed plastic material, which is preferably of thermosetting type. The fiber glass cloth is applied in a succession of layers on a form having a size and shape which will give the outer shell 4 the desired form. Before placement on the form, the fiber glass cloth is impregnated with the plastic material which is then in fluid state. After all the desired layers of glass cloth are in place, heat and pressure, suitable to the particular plastic material employed, are applied, with the result that the layers of cloth are compacted and, as the plastic material sets, adhere firmly together in a wall structure which possesses relatively high strength for a given weight of material.

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In the body of outer shell 4, we prefer to employ approximately four layers of the fiber glass cloth, and this thickness of wall is maintained down to the peripheral edge 5 of the body of the helmet (see Figs. 3 and 4). The material below this edge as illustrated in Fig. 2, is fashioned into two ear lobes, or extensions 6 in which we prefer to employ a less number of layers of the fiber glass, for example, two layers. This is indicated in Fig. 9, in which we indicate the approximate form of a full size section through the side wall of the helmet at a point which will be located over one of the flyer's ears. At these points the material out of which the wall of the outer shell is formed, is shaped into a "blister" 7, which projects out sufficiently from the normal convex surface of the outer shell, to enable an ear pocket or recess 8 to be formed in the outer shell at each side. In the upright position of the helmet as illustrated in Fig. 2, the wall 9 of these pockets has an inwardly disposed extension 10, the lower edge 11 of which widens out below and merges into the peripheral edge 5 of the helmet, already referred to.

The overall size of the outer shell 4 should be such that protective material, having sufficient minimum thicknesses in various locations, can be provided between the shell 4 and the head of the wearer. We prefer to provide a minimum of approximately one-half inch of protective material between the outer shell 4 and the back, sides and top of the wearer's head, but to increase the protective layer to approximately one inch in the frontal area. It is desirable that the space occupied by the protective material not exceed the thicknesses herein specified, by more than approximately one-quarter inch, since otherwise the helmet would tend to become undesirably cumbersome and heavy. It is therefore necessary, in order to provide a nice fit for persons having various head dimensions, to provide for making outer shell 4 in several sizes. A suitable size is chosen for use in steps hereinafter described.

The two shells, namely, the inner shell 3 and the outer shell 4, are then set up as indicated in Fig. 4, the inner shell 3 being held approximately in a central position within the outer shell. This may be accomplished in any suitable manner, but preferably by means of one or more screws or bolts 12 applied as indicated in Fig. 4. The body of this bolt is surrounded by a short sleeve 13, which operates as a spacer or distance piece for holding the walls of the two shells spaced apart a desired amount to provide a wall space, or molding space 14, as indicated in Fig. 3.

In this space 14 we place an energy-absorbing, or impact-absorbing, material. We do not limit ourselves in the practice of this invention to any particular material for this purpose, but it should be a material which has a resistance to crushing which increases relatively little while the material is crushed to one-half or less of its original thickness under an impact or compressive force. A material having this characteristic is highly advantageous when used in this way, since it functions to absorb and dissipate energy delivered to the outer shell 4 during an impact blow, and is far superior to an elastic substance which will function to become compressed, and after compression will impart substantially the full energy of the impact blows at the side or face of the material remote from the side at which the impact occurred. We prefer to employ for this energy-absorbent wall or outer liner, a cellular mate-

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rial such as cellular cellulose-acetate, whose cellular structure will be destroyed whenever the compressive force developed during an impact blow exceeds the inherent crushing strength of the material, and which will consequently absorb and dissipate energy. For this purpose we may employ polystyrene foam, or hard foam rubber. However, cellular cellulose-acetate is preferably employed in pieces, which should be as large as possible, and they should substantially cover the entire interior surface of the outer shell 4 except in the space required for earphones, and except for channels provided for ventilation. The pieces of cellular cellulose-acetate may be formed so that they fit and may be attached to the interior of the outer shell 4 by any convenient means such as a suitable cement, and have their inward faces contoured so that after application of cushioning and trim layers hereinafter described, a comfortable fit for the head of the wearer is assured. In practice, expenditure of considerable time, and use of rather complicated procedures, is required in order to assure comfortable fit when the cellular cellulose-acetate is employed in relatively large pieces. Since the desired mechanical characteristics of the cellular cellulose-acetate are substantially retained when it is employed in the form of a larger number of smaller pieces instead of a fewer number of larger pieces, we prefer to employ this material divided or diced into relatively small bodies; and in order to facilitate their embodiment in a protective wall within the outer shell 4, we prefer to employ a binder of suitable material, such as a thermosetting elastomer which may be a synthetic resin.

However, the invention may be practiced by employing a cementitious material as the binder carrying small bodies of an energy-absorbent material, the cementitious material being of a character to solidify or set after a time, or of a character such that it could be caused to solidify through some other agency or treatment.

In order to lighten the weight of this wall without detracting materially from its impact-resistant characteristics, we prefer to admix a quantity of ammonium carbonate, which operates as a foaming agent developing occluded gases, which give a cellular form to the binder, which co-operates with the cellular structure of the cellulose-acetate in maintaining a low specific gravity for the wall composition. The binder with the cellulose-acetate bodies carried in it, is in a fluid state having more or less viscosity, and after being poured into place, the composition should be rammed down into the molding space 14 and finished off with a flat surface 15 near the upper edge 16 of the molding shell 3. (See Fig. 4.)

The entire assembly shown in Fig. 4, is then heated to approximately 200 to 250° F. for about one hour. This will set the elastomer, such as any synthetic resin, or equivalent substance, which serves as the binder for the cellulose-acetate bodies, and will simultaneously cause operation of the foaming agent to give a cellular structure to the binder.

This assembly, consisting of the outer shell and a relatively thick protective wall 17, should have an inner liner or cushioning layer 18 applied to the same (see Figs. 5 and 6), which layer may be of any resilient or cushioning material such as foam, or sponge, rubber. It may be secured to the inner face of the protective wall 17 in any

suitable manner, for example, by cementing the two contacting faces together.

For ventilation purposes, to keep the interior of the helmet cool, and to provide channels for wires connected to the ear phones, if relatively large blocks of energy-absorbent material are employed, we space them apart to form a ventilating channel system. If we use small dice of energy-absorbent material in a binder, we prefer to cut a system of grooves 19 through the inner layer of rubber and the protective wall 17. If desired these grooves may include a transverse channel or groove 19a (see Fig. 7) which may, if desired, be located about in line with the side lobes 7 for the flyer's ears.

The ear phones 20 and 21 (see Fig. 8) are preferably mounted against the inner face of the outer shell 4, in such a way that after the flyer has donned the helmet, they will press themselves yieldingly but with not too great force against the flyer's ears. And this construction should be such that when the helmet is being put on, the phones will hold themselves in a withdrawn position so as to permit them to be passed down over the flyer's ears. In Fig. 8 the ear phone 20 is illustrated in this withdrawn relation in which it is latched back by means that will be presently described, while the other phone 21 is shown with the latch released to permit the phone to move inwardly. Each ear phone is preferably secured to a yoke 22, the middle portion of which is secured to the end of a leaf spring 23, the shank 24 of which is attached by suitable fastening means, such as rivets 25, to the outer shell, 4.

Near the position of the ear phones, latching means is provided, including a latching stem 26, which has an inclined end face 27 and notch 28 on its upper side. When the ear phone is disposed in its latched-out position as illustrated at the left of Fig. 8, this notch 28 engages the edge of an opening 29 in the latch plate 30. After the flyer has donned the helmet, he exerts a slight downward pressure on the projecting ends of the latching stems 26, and this releases their notches 28 from their latch plates 30, whereupon the resiliency in the leaf springs 23 will swing the ear phones in against his ears.

When a flyer takes off his helmet, he should push his ear phones outwardly to latch them in their withdrawn positions. When they are pushed out in this way, the inclined faces 27 engage the edges of the openings 29, and as this outward movement is completed, the notches 28 will snap over the edges of their openings.

The circuit connections to the phones are brought in through an insulated electric cord 31 (see Figs. 10 and 12), which passes through a bushed opening 32 in the outer shell 4. This opening 32 is located at any convenient point, but must communicate with the channel system. The connection between the two phones is effected through a channel such as channel 19a, by carrying the electric cord in an insulating sheath 33 (see Fig. 8).

As illustrated in Fig. 8, the ear phones are not attached directly to the leaf springs 23, but each ear phone is carried on a bracket 34, which bracket is secured to the end of its spring by a fastening or rivet 35, which may be formed on the inner end of the latch stem 26.

The peripheral edge 5 of the body of the helmet, and the curved edges 11 under the lobes 7, are provided with a trim 36, which is preferably formed of a cushion-like material such as sponge rubber of substantially circular cross-section. 75

This trim is preferably in the form of a ring, which is cut longitudinally with a slot 37 into which the edge of the outer shell 4 is thrust. Fig. 11 illustrates a detail of this connection, and also shows a sheath 38 enveloping the trim. This sheath is in the form of a continuous strip that is wrapped around the side of the trim that is remote from the slot 37, and the edges 39 of the sheath are secured through the wall of the material by suitable fastening means 40.

When the helmet is being worn, if the weather is warm, the helmet can be ventilated by cool air delivered to it through a small flexible air hose 41 (see Figs. 10 and 12), the end of which is secured to a bushing 42. The inner end of this bushing should be located in line with one of the grooves of the groove system 19.

The cushioning layer 18 is preferably provided with a lining 43 of a soft material such as chamois, leather, or other suitable material. This is illustrated in Fig. 5, in which view ventilating openings 44 are shown in the chamois in line with one of the grooves of the ventilating channel system 19. Obviously, as many of these vents 44 as desired may be provided at other points on the lining 43. The sheathing for the trim 36, if desired, may be applied in four pieces, including the pieces 38 (see Fig. 11), which are two in number. These pieces, however, would not extend across the front and back, and at these points sheaths 45 would be employed, which would overlap the adjacent ends of the sheaths 38 (see Fig. 6), and the inner portions of these special sheaths 43 would be applied as an apron 46 extending over a portion of the inner face of the elastic cushioning layer 18.

If desired, the opening at which the bolt 12 is applied, can be left in the outer shell unplugged, and this opening can be located in line with one of the ventilating channels as illustrated in Fig. 5. This will give an outlet for some of the air that is circulated through the helmet.

While the manner of employing the energy-absorbing material 17 results in a crash helmet that will operate satisfactorily, we have originated an integrated composite sheet material which has the advantageous characteristics of the construction illustrated in Figs. 5 and 6, but which has an additional characteristic of lightness; and this characteristic is very desirable in a crash helmet, and also may be very desirable when such material is employed in other situations. This composite material, and the manner of employing it, is illustrated in Figs. 13 and 14. Referring to these figures, the integrated composite material 48 is composed of two elements 48a and 48b, which are manufactured so that they are interlocked or "keyed" together. In order to accomplish this, we prefer to form a sheet 49, a portion of which is illustrated in Fig. 14. This sheet is composed of cellular cellulose-acetate, and after forming a sheet of that material, we prefer to form a plurality of relatively deep grooves 50 that pass a considerable distance into the sheet on one face thereof. After forming this sheet 49 with the grooves 50, which preferably are disposed in two sets with one set running transversely to the other set, we use the grooved face of this sheet as a side wall for a mold in which the inner sheet or element 48b is molded, and this sheet or element 48b is composed of foam rubber, or any other suitable material having resilient characteristics. This foam rubber therefore will extend into the deep grooves 50 and form tongues 51 filling the same; and

these tongues are of course integral with the body 48c of this sheet. The presence of the grooves 50 extending as they do in directions transverse to each other, admirably adapts this composite sheet to taking compound curved form, which the material must have when applied to the inner face of the outer wall or shell 4 of the helmet. This adaptability is illustrated in Fig. 13, in which the roots of the tongues 51 become compressed and reduced in width by the relatively uncompressible columns or pillars 52 of the cellulose-acetate 48a. This integrated material can also be provided with ventilating channels such as the channel 53 illustrated in Fig. 13, and of course the channels 53 and the inner face of the element 48b can be provided with a liner 54 similar to the liner described in connection with Figs. 6 and 7.

If desired, sheets of small area of this integrated material may be lined on the foam rubber side of the material, with leather, chamois, or other suitable lining material, after which these sheets or "blocks" can be attached by cement, or otherwise, to the interior of the shell in a "pavement" pattern resembling the pattern illustrated in Fig. 14. These blocks can be disposed with their edges apart so as to form ventilating grooves between them; or the lining material may be put in place after cementing the blocks in their proper position, and then punched with ventilating holes through the lining to communicate with the ventilating channels.

While this integrated composite sheet material illustrated in Figs. 13 and 14 is particularly well adapted for use in a crash helmet, it is obvious that this sheet material could be very useful in many other situations where the duty of the material is to absorb energy and reduce the concussion effect of a blow delivered against the cellular outer element of the sheet.

Many other embodiments of the invention may be resorted to without departing from the spirit of the invention.

We claim as our invention:

1. In a flyer's crash helmet, the combination of an outer shell, an outer layer inside and adjacent the outer shell of energy-absorbing substantially inelastic material capable on impact of deforming and offering a resistance to such deformation, absorbing and dissipating a considerable impact force, and an inner layer lining the said outer layer composed of a material having considerable resiliency, said helmet having a cavity within the same constructed so as to fit substantially to the shape and size of the flyer's head.
2. A flyer's crash helmet according to claim 1 in which the said outer layer is composed of blocks of substantially inelastic energy-absorbent material dispersed in a molded thermosetting material.
3. A flyer's crash helmet according to claim 1 in which the said outer layer includes cellular bodies, and a bonding agent carrying the same.
4. A flyer's crash helmet according to claim 1 in which the said outer layer comprises small bodies of cellular cellulose-acetate packed in a thermosetting elastomer.
5. A flyer's crash helmet according to claim 1 in which the said outer layer comprises small bodies of cellular cellulose-acetate in a thermosetting elastomer containing a foaming agent imparting cellular structure thereto.
6. A flyer's crash helmet according to claim 1

in which the said outer layer comprises small bodies of cellular structure carried in a thermosetting elastomer containing ammonium carbonate.

7. A flyer's crash helmet according to claim 1 in which the surface of the inner layer adjacent to the said cavity is provided with ventilating ducts.

8. A flyer's crash helmet according to claim 1 in which the inner surface of the inner layer is provided with connected ventilating ducts; and including an innermost liner of relatively soft flimsy material.

9. A flyer's crash helmet according to claim 1 in which the said outer shell comprises adhering layers including plastic material.

10. A flyer's crash helmet according to claim 1 in which the said outer shell comprises adhering layers of fiber glass cloth.

11. A flyer's helmet according to claim 1 in which the said outer shell comprises adhering layers including plastic material, there being fewer of said layers at the lower edges of said shell than in the upper portion thereof.

12. A flyer's helmet according to claim 1 in which the said outer shell is formed with a recess at each side of the same for the flyer's ears, in combination with ear phones mounted in said recesses, and means for yieldingly supporting said ear phones on said outer shell to permit the same to move toward or from the flyer's ears.

13. A flyer's helmet according to claim 1 in which the said outer shell is formed with a recess at each side of the same for the flyer's ears, in combination with ear phones mounted in said recesses, means for yieldingly supporting said ear phones on said outer shell to permit the same to move toward or from the flyer's ears, and means associated with said ear phones for latching the same in an outwardly disposed position to provide clearance for the flyer's ears when the helmet is being placed on his head, and means for releasing the latching means to enable the ear phones to move substantially into contact with the flyer's ears.

14. Protecting means for reducing the effect of an impact force upon a portion of the human body, including a rigid wall and a liner within and adjacent the wall including a material functioning to crush, and deform under the action of said force, thereby limiting the transmitted force to an amount tolerable to the body, said material being substantially inelastic so that it will substantially maintain its deformed state, and thereby reduce said force; in combination with means for containing and enveloping said protecting means.

15. A protection device for protecting a portion of a human body from an impact force, which comprises a relatively hard outer shell and a layer of non-resilient, crushable, energy-absorbent material within the outer shell operating to maintain its deformed state after being subjected to the said force, and capable of limiting the transmitted force to an amount tolerable to the body.

16. A protection device for protecting a portion of a human body, which comprises a relatively hard outer shell and a layer of non-resilient, crushable, energy-absorbent material within the outer shell, and a lining of soft resilient material within the layer of crushable material.

17. A crash helmet for protecting a portion of a human head against impact, said crash helmet having a body including a substantially

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rigid shell, a layer inside and adjacent said shell including a material capable of disintegrating within the layer, and in disintegrating functioning to resist a force of sufficient magnitude to crush and partially deform the same, thereby limiting the transmitted force to an amount tolerable to the human head, said material being substantially inelastic so that it is incapable of storing up the said crushing force and transmitting it.

18. A crash helmet according to claim 17 including a liner within said shell, said liner being of an elastic character to adapt itself to the shape of the wearer's head.

HERMAN P. ROTH.

CHARLES F. LOMBARD.

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