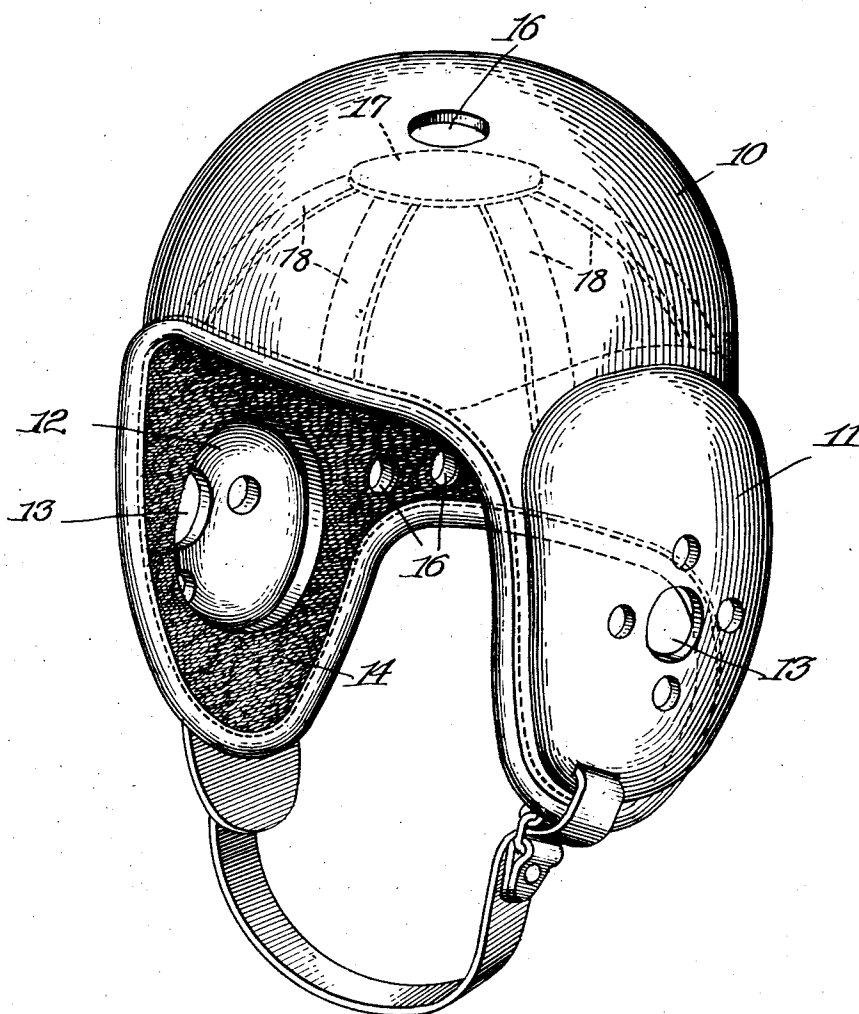


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PROTECTIVE HELMET
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2,297,874

PROTECTIVE HELMET

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2 Claims. (Cl. 2—3)

This invention relates to a protective helmet, and particularly to one formed from a unitary skull shaped plate of hard resilient waterproof material.

There has been for some time a considerable demand for a protective helmet of resilient waterproof material of great strength. Helmets of this type are necessary in football, polo, and certain other strenuous sports, and also in many occupations, such, for example, as for the crew of a tank, racing drivers, army aviators, or in any other occupation where the head is likely to be brought into violent contact with any hard object.

The helmets now in use are either leather or similar pads or are built up from a combination of fibrous material or fibre board in combination with other parts such as lining, cover, etc. All of the materials now employed for this purpose are extremely susceptible to water, either from outside the helmet or water generated by perspiration inside the helmet, and once wet, lose their effectiveness as well as becoming heavy, cold and clammy. At the same time none of the protective devices now on the market having any strength can be made in a single piece, and none of them have the shock, impact or wear resistance desirable in a helmet.

In accordance with the present invention a helmet is prepared which is completely waterproof, which may be prepared in a single piece, which has tensile strength, impact resistance and wear resistance far exceeding anything heretofore on the market, but which is still resilient.

A helmet prepared in accordance with the invention and constructed especially for football is illustrated somewhat diagrammatically in the drawing. It comprises an integral skull shaped plate 10 which is enlarged at its lower extremities into two lobes 11 and 12 to provide room for the ears. These lobes are pierced at the proper points with one or more openings 13. A lining 14 of any suitable material, such as padded leather, may be placed inside the lower portion of the helmet. It is one of the advantages of the material here employed that it can readily be stitched in this manner. A plurality of ventilating openings 16 are preferably incorporated in the top of the helmet and around the sides. The usual pad 17, held away from the crown of the helmet by the elastics 18, is preferably incorporated to avoid direct contact of the skull and the helmet.

If desired, the helmet may be reinforced by a metal skull shaped sheet sweated inside the plate 10 or between two plates 10 in the manner hereinafter described.

The integral plate 10 is composed of a molded composition which is formed on a mold while hot into the desired shape. The preferred material

for this purpose is a mixture consisting essentially of thermoplastic rubber and ordinary natural or synthetic rubber. The proportions of thermoplastic and natural rubber must be carefully adjusted. The preferred material is prepared from 4.5 lbs. of pale crepe rubber, 6.5 lbs. of a thermoplastic rubber such as the product now prepared by the du Pont Company and known as Isolac which is prepared in accordance with the disclosure of Williams Patent 2,158,530, 1.5 lbs. of zinc oxide which is used as a filler, 2 lbs. of whitening employed for the same purpose, and small amounts of sulphur and suitable vulcanizing accelerators and retarders. In combination with the above formula, it is preferred to use 2 oz. of stearic acid, 3 oz. of the accelerator Zenite A, 1 oz. of diorthothioguanadine, 0.8 oz. of Retarder W, 4.25 oz. of sulphur, and 1.2 oz. of an anti-aging material such as that known as Antox. The amounts of filler may be varied considerably in the above combination. The vulcanizing ingredients used may be varied to suit the individual requirements or the particular rubber employed.

The ratio of thermoplastic and natural rubber, however, should be held within close limits. A formula in which 8 lbs. of thermoplastic rubber and 4 lbs. of normal rubber are employed produces a plate which is extremely hard and is about the limit to which the proportion of thermoplastic rubber can be increased.

On the other hand, a combination in which 5 lbs. of normal rubber and 5.75 lbs. of thermoplastic rubber is used, is about as soft a product as will provide protective value under normal circumstances.

In the following formulae, formula A represents the preferred form; formula B, the approximate maximum ratio of thermoplastic to natural rubber; and formula C, the approximate minimum ratio of thermoplastic to normal rubber.

	A		B		C	
	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.
Pale crepe	4.5	0	4	0	5	0
Isolac	6.5	0	8	0	5.75	0
Zinc oxide	1.5	0	2.5	0	0	12
Stearic acid	0	2	0	2	0	2
Whitening	2	0	1	0	4	0
Rayox			0	8		
Zenite A	0	3	0	3	0	2.6
D. O. T. G.	0	1	0	1	0	.86
Retarder W	0	0.8	0	0.8		
Sulphur	0	4.25	0	4	0	4
Antox	0	1.2	0	1.2	0	1.2

It will be noted that in the above formulae the amount of filler is increased considerably in the softer composition C, which partially offsets the drop in quantity of thermoplastic rubber.

Football helmets prepared in accordance with the above formulae show most remarkable prop-

erties. In the following tables are shown the tensile strength, elongation, breaking load, and yield point of portions cut from the material with a dumbbell die measuring 0.25 inch at its narrowest point, which were subjected to the tests.

Tensile strength	Elongation	Breaking load	Yield point
A			
Pounds	Percent	Pounds	Pounds
1716.9	150	91	91
1670.8	300	100	100
1679.0	200	102	102
1670.8	300	100	100
1720.9	400	99	99
Averages			
Pounds	Percent	Pounds	Pounds
1691.6	270	98.4	98.4
B			
Pounds	Percent	Pounds	Pounds
2055.1	250	123	123
2146.7	350	128	128
2146.7	175	128	128
1984.7	275	117	117
2001.6	325	99	99
Averages			
Pounds	Percent	Pounds	Pounds
2066.9	275	119.0	119.0
C			
Pounds	Percent	Pounds	Pounds
1408.8	425	84	72
1542.9	625	92	79
1559.7	600	93	76
1581.3	600	95	72
1408.8	450	84	72
Averages			
Pounds	Percent	Pounds	Pounds
1500.3	540	89.6	74.2

A penetration test made by dropping a needle with the weight of 150 grams a distance of one inch was made on the three samples with the following results:

Sample A	Sample B	Sample C
Millimeters	Millimeters	Millimeters
1.3	1.3	1.6
1.4	1.3	1.1
1.2	1.3	1.7
1.2	1.3	1.5
1.0	1.1	1.4
Average Penetration		
Millimeters	Millimeters	Millimeters
1.22	1.26	1.46

All of the samples were tested for impact resistance, using an 11 lb. weight which was allowed to fall on edge against the helmet, the latter being held in a form which did not provide the spot hit with any support. In all cases the helmet successfully resisted a fall of the weight up to and including a distance of 5 feet.

The plates used in these tests were about $\frac{3}{8}$ inch in average thickness. When subjected to a scuffing test sample A required in excess of 50,000 revolutions of the scuffing machine to wear a

hole through the specimen; sample B, over 108,000 revolutions; and sample C, over 45,000 revolutions.

A sample of the material one inch wide and 5.75 inches long was then tested for bending strength with the following results. The weights given are the weights required to bend the material each successive 10° out of line when held at one end. The set figure is the angle assumed one minute after the weight was released.

Bending test

Angle	First bend	Second bend	Third bend
A			
10°	4.00 lbs.		
20°	5.87		
30°	6.62	2.50 lbs.	2.00 lbs.
40°	6.87	4.12	3.75
50°	7.25	5.37	5.12
60°	7.00	6.50	6.12
Set	21.5°	24.5°	25.5°
B			
10°	5.00 lbs.		
20°	7.37	0.12 lbs.	
30°	8.12	2.75	2.25 lbs.
40°	8.12	4.25	3.75
50°	7.87	5.67	5.37
60°	7.50	7.12	6.87
Set	19.0°	22.0°	23.5°
C			
10°	2.50 lbs.		
20°	3.62	0.44 lbs.	0.06 lbs.
30°	4.12	2.00	1.62
40°	4.37	3.00	2.62
50°	4.50	3.62	3.50
60°	4.62	4.75	4.00
Set	18.0°	20.5°	23°

In forming the helmet, the materials in the formula are mixed together and vulcanized upon a mold of appropriate size and shape. The material must then be cooled upon a mold, but it has been discovered that after vulcanization is complete, the skull shaped plate may be removed from the forming mold and permitted to shrink to size upon various sized molds. For example, a forming mold of size $7\frac{3}{8}$ may be utilized with a plurality of cooling molds of that size and smaller, down to and including, for example, a $7\frac{1}{4}$ size. The ultimate size of the helmet will be determined by the size of the cooling mold employed. This makes it possible to produce the articles very much more cheaply than otherwise would be the case, since helmets of all usual sizes can be produced by utilizing forming molds of only two sizes, for example, $7\frac{3}{8}$ and $7\frac{1}{8}$. In this manner, it is also possible to sweat a metal plate inside the formed helmet by placing the metal plate over the cooling die and permitting the rubbery material to shrink into size about it. Furthermore, the helmet so formed may be provided with a second layer of the rubbery material so that the steel or other metal plate is completely surrounded by resilient material.

The completed plate will ordinarily have a thickness between about $\frac{1}{8}$ and $\frac{1}{4}$ inch, with approximately $\frac{3}{8}$ preferred. The tensile strength of the plate, for a thickness of approximately $\frac{3}{8}$ inch, should be between 1,250 and 2,500 lbs., the elongation between 250 and 600% and the yield point at least 70 lbs.

As described in the Williams Patent 2,158,530, the thermoplastic rubber may be prepared by

mixing natural rubber with a monohydric phenol and a catalyst, and heating. The resulting material is a rubber isomer which is very brittle at room temperatures. The preferred material is brown in color and has a softening point of approximately 140° F.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom.

What I claim as new, and desire to secure by Letters Patent, is:

1. A helmet including a skull shaped plate containing as its essential binding element a vul-

canized mixture of 1 to 2 parts of thermoplastic rubber and 1 part of rubber.

2. A protective device comprising an integral skull-shaped plate having a tensile strength between 1250 and 2500 lbs., an elongation between 250% and 600%, and a yield point of at least 70 lbs., said plate consisting essentially of a vulcanized plastic prepared by intimate admixture of thermoplastic rubber and rubber in the proportions of 1 to 2 parts of thermoplastic rubber to one of rubber, and including small proportions of filler and vulcanizing ingredients.

JOHN T. CLARK.