April 3, 1962 J. K. WIDENOR 3,027,562

SKIN DIVER'S MASK

Filed July 6, 1960

Fig. 1.

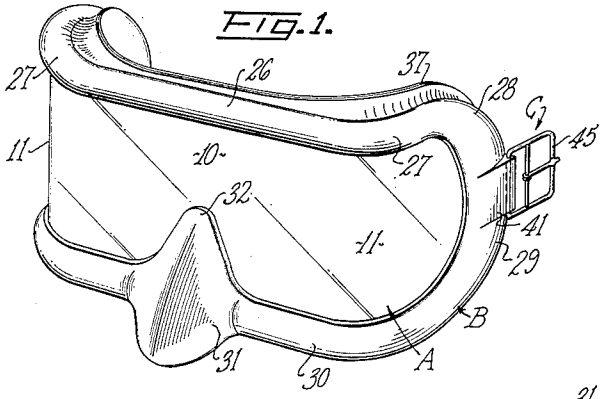
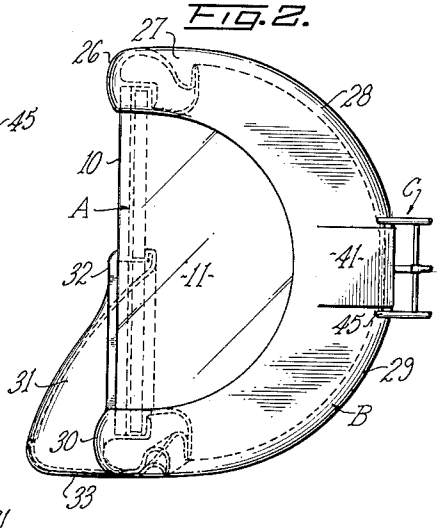


Fig. 2.



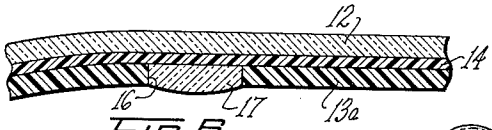


Fig. 6.

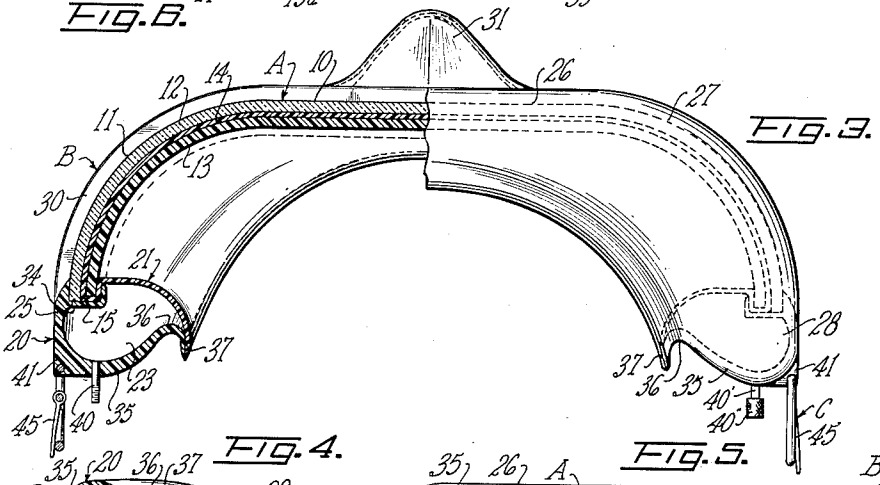


Fig. 3.

Fig. 4.

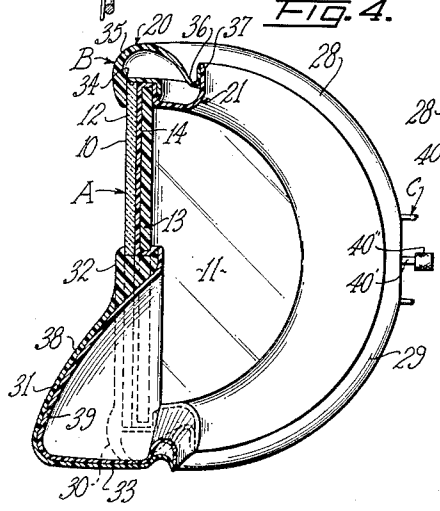
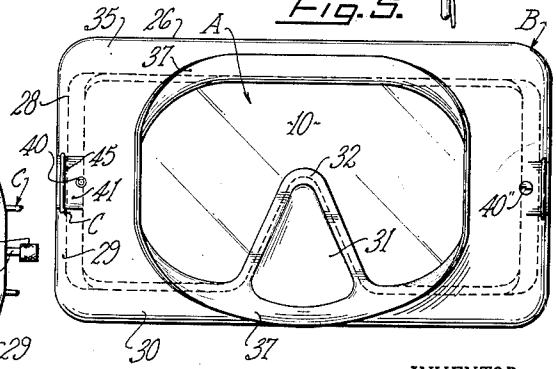


Fig. 5.



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3,027,562
SKIN DIVER'S MASK

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12 Claims. (Cl. 2—14)

This invention relates to skin divers' masks and has as its general object to provide an improved mask which can be used both by amateurs and professionals in free diving operations.

A major object of the invention is to provide a mask having a 180° field of vision. One of the most annoying, if not dangerous limitations of present free diving apparatus is the restriction of the field of vision imposed by the face mask. Several attempts have been made to correct the defects of conventional masks, including the use of slightly convex lenses, lenses set in closer proximity to the eyes, and side view lenses. In all of these cases, however, the actual increase in the field of vision is either very slight or is offset by the introduction of new problems, such as distortion and sealing of the mask to the face.

With the foregoing problems in mind, the general object of this invention is to provide a face mask that will increase the field of vision to include peripheral vision while keeping distortion at a minimum and assuring a comfortable fit to the diver's face.

A further object is to provide such a mask which in addition to the improved features mentioned above, retains valuable characteristics of existing masks in that it will cover the eyes and nose, and will permit equalization of pressure on the eyes with changes in depth.

A further object is to provide such a mask having a water filled section in which water, under slightly greater than ambient pressure, will function to hold the lens section of the mask firmly in place, while at the same time providing a flexible, comfortable seal between the mask and the diver's face.

Another object is to provide a mask having a lens mounting entirely surrounding an inner lens section so as to prevent any possibility of leakage between the two.

Another object is to provide such a mask which avoids the necessity for a peripheral metallic band to seal the lens mounting to the lens.

A further object is to provide such a mask wherein the lens mounting is self-adapting to faces of varying contours and sizes, the fit being independent of the surrounding pressure because of the virtual incompressibility of the water which is contained in the lens mounting.

A further object is to provide a mask having improved laminated, double lens structure providing added protection against shock.

Another object is to provide a mask having a lens mounting covering the nose in a manner to enable the diver to pinch his nostrils together in order to aid in equalization of the external pressure on his ear drums.

A still further object is to provide a mask having an inner lens section that is adapted to be used as a corrective lens holder for those divers requiring correction of vision.

Other objects and advantages will become apparent in the ensuing specifications and appended drawing in which:

FIG. 1 is a perspective view of a mask embodying my invention;

FIG. 2 is an end view thereof, with parts broken away and shown in section;

FIG. 3 is a plan view of the same with one half of the mask shown in horizontal section;

FIG. 4 is a vertical transverse medial sectional view of the mask;

FIG. 5 is a rear elevational view of the mask;

FIG. 6 is a fragmentary detail sectional view of a modified form of the lens structure.

Referring now to the drawings in detail, my improved mask comprises, in general, a lens unit indicated generally at A, a lens mounting frame, indicated generally at B, and auxiliary parts such as a head harness C for securing the mask to a diver's face.

The lens unit A, in its longitudinal contour, presents a flat medial front portion **10** for straight forward vision and a pair of approximately quarter-cylindrical lateral portions **11** for peripheral vision, the lens designed to be located in the closest practical proximity to the eyes while providing a continuous surface covering the normal field of vision. The lateral sections **11** each have a radius of curvature large enough to minimize distortion caused by water-to-air refraction, yet not large enough to exceed a practical size limit for the lens. The lateral portions **11** are located and contoured so as to be substantially coaxial with the vertical axes intersecting the eye pupils of the diver wearing the mask. The flat area **10** is that portion of the lens which covers the area of overlapping vision of the two eyes (approximately 90° as measured in a horizontal plane from the point midway between the pupils). This medial area of the lens is optically flat in order to avoid a double image.

The lens unit A is laminated structure comprising inner and outer laminations of clear crown glass or acrylic sheet having a thickness in the range of 0.125 inch; together with a relatively thin middle layer **14** of clear plastic material securely mounted between the outer and inner layers **12** and **13**. In fabricating this laminated lens structure, the invention may utilize well known laminating techniques such as are employed in the manufacture of safety glass for automobiles, or the sheets may be held in assembled relation (without surface bonding) by mounting of their margins in the frame B.

The middle lamination **14** has an extended marginal portion **15** by means of which it is integrally joined to the mounting frame B as more fully described hereinafter.

The inner and outer layers **12** and **13** function as protective rigid supports for the thin middle layer **14**. While the middle layer **14** in itself would provide a transparent barrier between the diver's face and the external water within the outline of the frame B, it would distort the field of vision considerably because of its flexibility. With the addition of the outer glass layer **12**, rigidifying support would be provided, but fogging on the inner surface of the plastic layer would become a problem as well as a possible distorting factor. The inner layer **13** would likewise provide rigidifying support, but without the outer layer, the outer surface of the plastic middle lamination sheet **14**, which could be easily scratched, would gradually become obscured by surface abrasions until its optical character would become unsatisfactory. The entire combination of the outer and inner hard rigid lens sections and the laminating middle layer thus becomes an optimum structure, with the three units reinforcing one another both functionally and structurally.

The invention contemplates the use of the inner lens section **13** for obtaining a vision corrective effect for use by divers having abnormal vision requiring correction. For this purpose, it is preferable that the inner lens section **13** be of acrylic plastic resin rather than glass. For this purpose, as shown in FIG. 6, the inner section **13***a* may be provided with a pair of apertures **16** in which are received corrective lens units **17** having optical characteristics fitted to the correction requirements of the individual by optometry prescription, the same as in the fitting of a pair of lenses. The marginal contour of lens units **17** is matched to that of the apertures **16** so that the lenses snugly fill the apertures and the lens section

13*a* becomes a frame for the lenses 17. While this marginal contour may be of any selected shape, either oval or polygonal, for maximum simplicity, it may be made circular to receive a lens of conventionally circular peripheral shape. Furthermore, the inner lens section 13*a* may be of plasticized resin, sufficiently soft so that an interference fit may be provided between the periphery of the lenses 17 and the apertures 16, the lenses being forced into the apertures after application of a suitable adhesive, or solvent such as to soften the surface of the material of lens section 13*a* framing the apertures, so that upon drying, the lenses will be securely held.

The outer faces of lenses 17 do not project beyond the extended outer surface of inner lens section 13*a*. They may in face be conformed to the inner surface of middle lamination 14 and mounted in full contact therewith or, alternatiyely, may be convex or concave, with a sealed-in air space between the outer faces of the lenses and the lamination 14.

The inner lens section 13*a* in this modified construction functions both as a frame for lenses 17 and as a transparent lens section which provides an extended field of uncorrected vision beyond the lenses 17 out to the lateral extremities of the lens unit A and between the lenses 17, the straight forward vision through the lenses 17 being corrected for direct, detailed observation of a selected under-water subject.

The mounting frame B, in general, comprises outward and inward sections 20 and 21 respectively which are preformed by suitable molding techniques and are assembled and bonded to one another in a manner to cooperatively provide (*a*) a framing channel in which the periphery of lens unit A is mounted, and (*b*) a tubular structure defining a chamber 23 adapted to be filled with water so as to be substantially incompressible and so as to develop therein a hydrostatic pressure substantially equalized with that of ambient pressure in the body of water in which the diver is immersed. The outer frame section 20 is compression molded from flexible vinyl plastic material (preferably translucent or opaque) such as polyvinylchloride, polyvinyl acetate, polyvinyl chloride acetate, polyvinylidene chloride, polyvinyl butyral, and polyvinylidene acrylo-nitrite. In cross section (FIG. 3) it includes a side wall portion 25 which, in circumferential configuration, extends in a straight stretch 26 (FIG. 1) across the top of the mask (forehead area) following the straight upper central portion of the margin of lens unit A, thence is curved rearwardly at both ends at 27 to follow the curvature of the side portions 11 of the lens unit A, thence is curved sharply downwardly in upward corner areas 28 to define convexly curved side portions 29, which are curved broadly toward the nose area at the bottom of the mask and extended inwardly at 30 to an integral nose section 31 which joins the lower portions 30.

The outer frame section 20 constitutes a skirt extending from the lens unit A to the wearer's face and is referred to as such in the appended claims.

The nose portion 31 is of U-section transversely, and is inclined downwardly and forwardly from an upward extremity 32 which is located approximately at the center of the lens unit A, to a lower forward tip from which a bottom wall 33 extends rearwardly.

Outer frame section 20 has an integral channel section 34 throughout the circumferential extent thereof, and bridging over the upper extremity 32 of the nose portion 31. This portion of the inward margin of frame section 20, corresponding to the upper extremity 32 of the nose portion, is in the form of a peak at the lower center of the frame as indicated in FIG. 1. The lower central area of the lens unit A is provided with a notch of corresponding contour to receive this peaked portion of the frame B.

Returning to the cross sectional form of the outer frame section 20 as shown in FIG. 3, a rim 35 extends rearwardly from the upper and lower stretches 26 and 30 of the frame section 20, and inwardly toward the eye areas from the side portions 28, 29 thereof. The rim 35 has a re-entrant portion 36 which extends downwardly in the forehead area 26, upwardly in the bottom area 30 and forwardly in the side areas 28, 29. Re-entrant portion 36 is reversely curved, upwardly in the forehead area 26, downwardly in the lower areas 30 and rearwardly in the side areas 28, 29 providing a laminar portion of a face-contacting lip 37 which extends around the entire circumference of the frame B and functions to seal the mask to the face of the wearer. The lip 37 has sufficient flexibility to yield to the contours of the wearer's face, and becomes sealed thereto by the pressure of ambient water bearing against its outward face. The marginal areas may be feathered to a fairly thin edge, as indicated, for added flexibility.

As will be best seen in FIG. 3, the outer frame section 20 is of substantial thickness in cross section, for providing form-retaining stiffness in the frame as a whole.

The inner frame section 21 is of relatively thin, flexible sheet material, compression molded from a clear, flexible thermoplastic resin in relatively thin sheet form. It may have a thickness of only .020 inch. Circumferentially, it is co-extensive with the outer frame section 20.

The inward marginal portion of inner frame section 21 is marginally conformed to the reversely curved marginal portion of rim 35 of the outer frame section 20 and is laminated thereto to provide the inner wall of lip 37. The outward marginal area of inner frame section 21 is integrally joined to the marginal portion 15 of middle lamination 14 of lens A, marginal portion 15 being of channel section proportioned to receive the marginal portion of inner lens sheet 13, and, along with the margin of the outer lens sheet 12, being framed within the channel section 34 of outer frame section 20. Channel sections 15 and 34 cooperatively constitute a mounting channel in which the marginal portion of lens unit A is mounted.

The nose portion 31 of the frame B, as shown in FIG. 4, comprises respective pocket members 38 and 29 in the outer and inner frame sections 20 and 21 respectively, these pocket members being in full-conforming nested relation throughout their respective areas.

The chamber 23 extends around the entire circumference of the frame B. In the nose area, it is of reduced cross-sectional area as indicated in FIG. 4.

One or more apertures are punched in the rim 35 of the frame unit B and valved filling stems 40, 40′ are cemented into these apertures. The stems 40, 40′ provide for filling the chamber 23 of frame unit B with water injected from a squeeze bulb through the valve units. One of the stems 40 is provided with a check valve which permits water to be pumped into the chamber 23 but prevents escape therefrom. The other stem 40′ is provided with an internally threaded valve cap 40″ which may be removed while water is being pumped through the valved inlet stem 40, thus to bleeed air from the remote area of the chamber 23. When most of the chamber has been filled and only a small amount of air remains to be bled, the cap 40″ may be attached to stem 40′ and left loose while the balance of the air is bled out of the chamber, and then tightened to seal the chamber. Stem 40′ is a bleeding stem.

A standard stainless steel screw clamp may be used to secure the squeeze bulb to the inlet stem 40 during filling operation.

Formed at the rear extremities of the side portions 29 of the outer frame section 20 are a pair of lugs 41. The head harness includes a strap which is secured to the lugs 41 by suitable buckles 45 (not shown) into which the ends of the strap are secured. Buckles 45 are pivotally attached to the ends of pins 42 extended vertically through the lugs 41.

In the assembly of the various sections of the mask, the outer lens sheet 12 is assembled in the channel sec-

tion 34 of the outer frame section 20, the inward lens sheet 13 is correspondingly mounted in the channel section 15 of the inner frame section 21; and the two frame sections are then fitted together, spreading the channel section 34 of outer frame section 20 sufficiently to receive the channel section 15 of the inner frame section 21, and cementing or otherwise bonding (e.g. heat sealing) the channel sections 15 and 34 together. In using the cementing method, suitable coating or coatings of cement are applied to one or both of the surfaces of these channel sections which come together in the assembled structure. Cementing (or other type of bonding) may also be utilized to bond to one another the respective sections 38 and 39 of the nose portion 31 of the frame B, between the nested surfaces thereof. Also, suitable bonding is utilized in laminating the margins of frame sections 20 and 21 to one another to produce the lip 37.

In the assembled mask, the lens unit A is of sandwich structure, resembling a laminated structure, but without surface bonding between the interengaging faces of its component sheets. These faces are, however, maintained snugly in contact with one another by hydrostatic pressure acting on the framing channel 15, 34 of the frame B with improved optical properties.

This completes the assembly of the mounting frame B to the lens unit A and the sealing chamber 23.

In use, the mask is prepared by filling the chamber 23 with water, the water preferably being pumped into the chamber under some pressure. The mask is applied to the face, with the nose extending into the nose pocket defined by nose section 31 and with the lip 37 sealing the mask to the face across the forehead, around the eyes, down the cheeks, across the upper lip area and beneath the nose. The nose portion 31 is sufficiently flexible to be fitted snugly against the nose by the inward pressure of water against it when the diver descends beneath the surface. The sealing lip 37 will be sealed to the face by the pressure of water. The pressure of water, applied to the body of water in chamber 23 through the flexible walls of mounting frame B, will cause the pressure in the chamber 23 to increase in step with the increasing ambient pressure as the diver descends. Flexing inwardly under the increasing pressure (except in the forward marginal area where it is rigidly supported by the margin of lens unit A) the mounting frame B would transfer the increasing pressure to the small body of air trapped between the mask and the face, thus automatically equalizing the pressure within the mask with ambient water pressure. The diver can prevent undue inward shrinking of the frame under increasing pressure (where he is using a Scuba pressurized air breathing device) by expelling through the nostrils into the trapped air space within the mask, to an extent sufficient to make the required pressure adjustment therein, a quantity of the air being expired during breathing (which air is automatically maintained at substantially ambient water pressure by the regulator mechanism of the Scuba apparatus). The inward pressure of ambient water through filled chamber 23 to the trapped air body will supplement such operation by the diver and will automatically regulate the trapped air pressure to correct for any failure of the diver to completely equalize the pressure through expiration into the mask. At other times, the pressure of ambient water applied through the flexible nose portion 31 to the sides of the diver's nose may be allowed to clinch the nose to a closed condition to aid in equalization of the external pressure on his ear drums.

In ascending, the excess air in the trapped air space, as it expands with reduced pressure, will escape past the sealing lip 37 which acts as a valve in its flexible contact against the face.

In filling the chamber 23 from the squeeze bulb, the mask is immersed in a body of water. The squeeze bulb, with check valves at both ends, providing a one-way flow through the bulb, is then actuated to draw in water through its rear valve and to pump it through its forward valve (connected to the inlet 40) into the chamber 23. After the chamber 23 is filled, additional water may be pumped into it to distend its highly flexible inward frame section 21 to better fit the contours of the face, where necessary. In fitting the mask to the face, it is adjusted until no air may enter between the mask and the face when submerged. If he prefers to do so, the diver may first attach the mask to his face, then descend into the water until the mask is fully submerged, and then operate the squeeze bulb to pump water into chamber 23.

In using the mask, the diver may clear the same of any water which may have entered the trapped air space, by tilting the head and snorting into the mask, allowing the water to escape past the flexible lip 37. As an alternative, the under portion 33 of nose section 31 may be provided with a one-way clearing valve.

The pressure of the water in chamber 23, acting against the walls of frame channel 34 will press these walls firmly against the marginal areas of the lens unit A, thus tightly sealing and securing the periphery of the lens unit in the frame. This makes it possible to dispense with any cemented attachment of the channel sections 15 and 34 to the periphery of the lens unit A.

The equalization of pressure in the sealed air space within the mask to ambient pressure serves not only to support the lens unit in full correct spacing forwardly of the face, but also to equalize the pressure on the diver's eyeballs with his internal bodily pressure derived from lung pressure regulated by a Scuba pressure-breathing apparatus.

Since the middle lamination 14 of lens A and the inner frame section 21 are integral portions of a common sheet of plastic material, the lens unit A will be hydraulically sealed in the frame B, with no possibility of water entering the mask around the periphery of the lens unit.

I claim:

1. In a diver's mask, in combination: a lens unit of sandwich structure comprising outer and inner layers of relatively rigid transparent sheet material and an intermediate connecting membrane of thin, tough flexible transparent sheet material assembled between said outer and inner layers and having a marginal portion projecting beyond the margins of said layers; and a frame including a mounting channel receiving the marginal portions of said outer and inner layers and including a skirt extending rearwardly from said mounting channel and terminating in a face-engaging sealing lip, said marginal membrane portion being an integral extension of said frame to hydraulically seal said lens unit to said frame.

2. A mask as defined in claim 1, wherein said outer and inner lens layers are of glass and said membrane is of plasticized thermoplastic resin.

3. A mask as defined in claim 1, including an inner frame section of thin flexible plastic sheet material marginally bonded to said skirt adjacent said mounting channel and said sealing lip and cooperating with said skirt to define a chamber adapted to be filled with a body of water in which hydrostatic pressure matching that of ambient water will be developed when the mask is immersed; and filling and bleeding stems for effecting injection of water into said chamber and bleeding of air therefrom.

4. A diver's mask as defined in claim 1, said lens unit including a flat central portion for direct forward vision, extending laterally approximately to the fore-aft eye axes of the wearer, and substantially quarter-cylindrical lateral portions tangent to said central portion at the respective ends thereof and curved rearwardly in substantially coaxial relation to the vertical eye axes of the wearer for peripheral vision.

5. A mask as defined in claim 3, wherein said mounting channel comprises flexible flanges which are sealed to said marginal lens portion by water pressure thereagainst.

6. In a diver's mask, in combination: a rigid lens unit having a central portion for direct forward vision and

geometrically continuous lateral portions tangent to said central portion and curved rearwardly therefrom for peripheral vision; and a frame including a mounting channel receiving the peripheral portion of said lens unit and sealed thereto, a skirt extending rearwardly from said mounting channel and terminating in a face-engaging lip for sealing the mask to a wearer's face, and an inner frame section sealed to said skirt along said channel and along said lip and cooperating therewith to define a chamber adapted to be filled with water to support said frame against collapsing under ambient water pressure, thereby to maintain said lens unit in a full spaced relation to the wearer's face with a sealed air space between the mask and the face.

7. A mask as defined in claim 6, wherein said skirt is of relatively thick-walled structure for primary form-sustaining support, and said inner frame section is of relatively thin, flexible sheet material.

8. A mask as defined in claim 7, wherein said frame has an aggregate flexibility such as to transmit ambient water pressure into said sealed air space for equalizing the pressure on the diver's eyeballs with lung pressure developed by use of a scuba.

9. A mask as defined in claim 6, including a check-valved water injection inlet stem attached to said frame and communicating with said chamber for filling the same, at one end of the frame, and an air-bleeding stem attached to the other end of said frame for bleeding air from said chamber during a filling operation, said bleeding stem having a screw cap for closing the same at the end of a bleeding operation.

10. In a diver's mask, in combination: a lens unit of sandwich structure comprising outer and inner layers of relatively rigid transparent sheet material and an intermediate connecting membrane of thin, tough, flexible transparent sheet material assembled between said outer and inner layers and having a marginal portion projecting beyond the margins of said layers; and a frame including an outer frame section having an inwardly extending forward wall portion and a rearwardly extending peripheral skirt terminating in a face-contacting sealing lip, and an inner wall portion marginally bonded to said sealing lip and extending forwardly in inwardly spaced relation to said skirt, and a mounting channel bridging between and joining the forward margin of said inner frame section to the inner margin of said forward wall portion and receiving said forward margin of said lens unit, said inner and outer frame sections cooperatively constituting a tubular structure defining a chamber adapted to be filled with a body of water in which hydrostatic pressure matching that of ambient water will be developed when the mask is submerged, and wherein said hydrostatic pressure, acting against the walls of said mounting channel, will press the same firmly against the marginal areas of said lens units to maintain said layers and membrane in assembly in said sandwich structure.

11. A mask as defined in claim 10, wherein said membrane, at its periphery, is integrally united to said mounting channel.

12. A mask as defined in claim 11, wherein said mounting channel has a rear wall constituting an integral connection between the periphery of said membrane and the forward extremity of said inner frame section.

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