A COMPARATIVE EVALUATION OF THE STANDARD U.S. NAVY SHALLOW WATER DIVER'S MASK AND THE COMMERCIAL P AND E. MANUFACTURING COMPANY'S MASK

C. M. Prickett, et al

Navy Experimental Diving Unit
Washington, D.C.

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U. S. NAVY EXPERIMENTAL DIVING UNIT
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EVALUATION REPORT 12-59

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PROJECT NS 185-005 SUBTASK 2 TEST 13

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13 ABSTRACT

A new commercial shallow water diver's mask is evaluated in comparison with the older U.S. N. Standard Shallow Water Diver's Mask ("Jack Brown"). The new mask, manufactured by P & E Manufacturing Co., is considered a good shallow water mask but is in no way superior. The standard mask is preferred. Several deficiencies in the P & E Mask are noted.

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SUMMARY

PROBLEM:

1. Is the P & E shallow water diver's mask satisfactory?

2. Is it superior to or preferred over the standard mask?

FINDINGS:

1. The P & E mask is basically a satisfactory shallow water mask.

2. All the subjects preferred the Standard (Jack Brown) mask to the P & E.

3. The P & E mask has several deficiencies which should be corrected before it could be accepted in any case.

RECOMMENDATIONS:

1. It is recommended that the P & E mask not be accepted for Navy use in place of or as a substitute for the Standard Mask.

2. Further field evaluation of the P & E mask is not recommended.

3. If the P & E mask is considered as an emergency replacement for the Standard Mask, it is recommended that the several deficiencies be corrected, especially a redesign of the head harness.

ADMINISTRATIVE INFORMATION

Ref: (a) Diving Officer, U.S. Naval Repair Facility, San Diego, Calif. ltr ser 747 of 19 March 1958.
(b) P & E Mfgr. Co., Costa Mesa, Calif. ltr of 2 May 1958 to BuShips; with BuShips 1st End. ser 538-1019 of 8 May 1958.
(c) Telcon of 29 May 1958, Mr. M. Foran, BuShips (Code 638) to LCDR W. F. Searles Jr., USN, Project Officer, Experimental Diving Unit.

By reference (a), the Diving Officer of Naval Repair Facility, San Diego reported the use in his activiity of a new shallow water diving mask manufactured by the P & E Manufacturing Co. of 660 W. 17th St., Costa Mesa, recommending further trials and evaluation in view of his favorable experience with it. By reference (b), the manufacturer requested an evaluation and the Bureau of Ships passed the task to the Experimental Diving Unit for action. By reference (c), the Bureau of Ships assigned Project Number NS 185-005, Subtask 2, Test 13 to this project and designated it as a priority C evaluation.

C. M. PRICKETT, GM1(DV), USN was designated as Project Engineer and LCDR W. F. SEARLE, Jr., USN, as Project Officer. Work commenced 1 June 1958 and was completed 15 December 1958. The following breakdown indicates manhours expended on this project:

DESCRIPTION	MANHOURS
Initial mechanical evaluation	8
Subjective dives	100
Control Valve and Non-Return Valve Tests	10
Visual Perimeter Tests	8
Photography and Drafting	2
Report Preparation and Clerical Services	24
TOTAL	152

Charges encurred in the execution of this project were lodged against allotment 16102/59.

This is the first and final report issued under this project test number. This report is issued in the Evaluation Report series of the Experimental Diving Unit and is distributed only to the Bureau of Ships. Further distribution will be made only as directed by that bureau.

The P & E mask and accessories were returned to the manufacturer on 4 February 1959.

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1. INTRODUCTION

1.1 Introduction

1.1.1 Since late in World War II, shallow water diving in the Navy has been conducted using a face mask known as the U.S. Navy Standard Shallow Water Diver's Mask. This mask is generally referred to as the "Jack Brown" mask and has been manufactured on Navy contract by the Diving Equipment Supply Co. (DESCO) of Milwaukee (stock no. 04220-233-6665).

A more or less competitive shallow water diver's mask has been produced by the P & E Manufacturing Co. of Costa Mesa, California and forwarded by the Bureau of Ships to EDU for evaluation.

1.1.2 The P & E mask is being evaluated merely as a new piece of equipment and at the manufacturer's request. There is no known objection from the operating forces regarding the Standard mask.

1.2 Objective

1.2.1 The objective of this evaluation is to compare the P & E mask with the Standard mask and to determine if the former is sufficiently better (if at all) to warrant its use.

1.3 Scope

1.3.1 The scope of this project was limited to wet chamber dives of not greater than 200 feet. The shallow water diver's dress was not used.

2. DESCRIPTION

2.1 Mask

2.1.1 The entire P & E mask with accessories is shown in figure 1. The mask proper is a chrome plated brass or bronze casting with glass faceplate cemented and clamped into a recess with an outer flange. Bolted at the back of the mask body is a molded rubber adaptor onto which is cemented a molded sponge rubber piece which fits the diver's face. This sponge rubber piece has a chin recess molded into it. Into the rubber adaptor are molded five open hooks for attaching the head harness; one at the top center and two on each side. In figure 1, the chin of the rubber adaptor may be seen below the mask body and the sponge rubber piece is visible through the face piece.

2.1.2 The overall mask (including harness but excluding accessories) weighs 7.75 pounds. The mask less harness weighs 7 pounds. The faceplate is approximately 7.3 x 5.7 inches; the extreme dimensions of the unit are 11 inches across at the valve handles, approximately 8.75 inches from top to bottom of rubber adaptor and 5 inches from front of faceplate to back of rubber adaptor.

2.1.3 The faceplate is clear glass; however, the manufacturer did not indicate the type of glass. In disassembling the unit to investigate maintenance features, the glass easily chipped at the edge and it is assumed not to be safety glass.

2.1.4 Into the bottom of the mask body are soldered two 1/2" elbows onto which the exhaust "flapper" valves are rubber taped. The two flapper valves are visible in figure 1.

2.2 Control Valve

2.2.1 As indicated in figure 1, there is a valve on each side of the mask body. On the diver's right (left in figure 1) is the combination control valve-non-return valve; on the diver's left is a bleed valve for inflating the suit.

2.2.2 The control valve is a disc valve with a spring loaded non-return on the downstream (mask) side. The construction of the valve is simple and appears to be reliable. The air supply hose connects to the control valve nipple which extends approximately 2 inches at a slightly obtuse angle from the valve body and is fitted with a standard male oxygen thread. The nipple and thread are visible in figure 1.

2.2.3 The bleed valve is essentially the same as the control valve, less the non-return feature. The hose nipple is the same except that it is not threaded.

2.3 Harness

2.3.1 The harness is laid out in figure 1. It is a molded flat piece of rubber, the five strap tabs molded integral with the back. The tabs have a molded thread (slightly visible in figure 1 on the reverse side of the tabs). The harness attaches with the brass clips to the five open hooks on the mask's rubber adaptor. These clips fit into the threads on the harness tabs but are not readily adjustable.

2.3.2 The head harness is separate from the body of the mask. The rubber is only mildly elastic and so the harness can not easily be pulled down over the head if permanently attached to the mask.

2.4 Accessories

2.4.1 A corrugated rubber tube (1/4" i.d. x 7" long) with a brass fitting on the end was supplied for connecting the mask's bleed valve to a shallow water suit. Two molded exhaust flapper valve-check valve assemblies were also furnished for installation in the suit. The items are shown in figure 1 but were not installed or tested.

3. PROCEDURE

3.1 Subjective Test Dives

3.1.1 The P & E mask pictured in figure 1 and a Standard U.S. Navy Shallow Water Mask ("Jack Brown") were installed in the wet chamber of EDU. Over a period of approximately four months, these masks were worn, on a day to day basis, by the tenders during the execution of other projects. (Normal procedure at EDU is exclusive use of the Standard Mask.) Over 100 dives of varying depths were made to as much as 200 ft. and for durations of up to two hours. Subjects adjusted masks and air supply underwater, tried all sorts of positions, flooded and cleared and ditched and redonned the masks underwater. Subjects alternated between use of the P & E and Standard mask. The project engineer kept a log of each dive and the subjects' comments.

3.1.2 Following is a list of diver subjects whose comments were taken both for the P & E mask and the Standard mask:

TRIPP, J.E., DC1(DV), USN, Age 30, Height 5'9", Weight 175, stocky build, graduate of deep sea diving school plus 7 years experience in diving.

DIMMICK,J.M., MM1(DV), USN, Age 26, Height 5'11", Weight 138, slender build, graduate of deep sea diving school plus 7 years expereince in diving.

GWINN, R.L., MM1(DV), USN, Age 26, Height 5'11", Weight 138, slender build, graduate of salvage school and cross training deep sea diving school plus 4 years experience in diving.

WILEY, L.L., BM2(DV), USN, Age 32, Height 5'6 1/2", Weight 147, medium build graduate of deep sea diving school plus 5 years experience in diving.

PRICKETT, C.M., GM1(DV), USN, Age 36, Height 5'10", Weight 175, stocky build, graduate of deep sea diving school and cross training, 14 years diving experinece.

SUBLIA, T.A., HM1(DV), USN, Age 33, Height 5'9", Weight 150, stocky build, graduate of deep sea diving school plus 12 years diving experience.

HASLIP, G.(n), GM1(DV), USN, Age 30, Height 6'1", Weight 160, slender build, graduate of deep sea diving school plus 10 years diving experience.

LEYDEN, C.J., BM1(DV), USN, Age 30, Height 5'11", Weight 178, heavy build, graduate of deep sea diving school and salvage school plus 8 years experience in diving.

JAMES, T.W., HM1(DV)USN, Age 37, Height 6', Weight 198, stocky build, graduate of deep sea diving school plus 6 years diving experience.

MICHIELSEN, C.E., HM1(DV), USN, Age 35, Height 5'11 1/2", Weight 188, stocky build, graduate of deep sea diving school plus 7 years diving experience.

POWELL, B.L., TMC(DV), USN, Age 38, Height 5'10", Weight 175, medium build, graduate of deep sea diving school plus 19 years diving experience.

LCDR W. F. SEARLE, Jr., USN, Age 35, Height 5'11", Weight 180, stocky build, two years diving experience at EDU and one year in field.

LT P.G. LINAWEAVER, Jr., MC, USN, Age 29, Height 5'10 1/2", Weight 140, slender build, graduate of deep sea diving school, Submarine Medical Officer course and one year diving experience at EDU.

ENS G. M. JANNEY, USNR, Age 24, Height 5'8", Weight 165, medium build, graduate of U.S. Navy Underwater Swimmers School and one year diving experience at EDU.

3.2 Control Valve and Non-Return Valve Tests

3.2.1 The control valve of the P & E mask was connected to a large (30 cfm) Fisher-Porter Co. laboratory flowmeter and with a supply pressure of 50 psi, the flow capacity at different openings (turns open) was measured. A similar test of the Standard U.S. Navy Shallow Water and Deep Sea control valves was made for the purpose of comparison.

3.2.2 The non-return valve in the P & E mask was tested by connecting a clear plastic tube to the valve body's air inlet. With the control valve wide open, the entire valve body assembly was lowered into water in 1/2" increments, the open end of the plastic tube being vented above the surface. Any leakage in the non-return valve would have been indicated by water coming up into the tube. The more stringent conditions in such a test would be at the very shallow depths where the water head operating to close the non-return valve (and in conjunction with the spring) is minimum. The Standard U.S. Navy non-return valve (manufactured by Wm. Schrader Co.) was similarly tested.

3.3 Visual Perimeter Tests

3.3.1 The underwater visual field perimeters of the P & E mask were measured following the standard EDU procedure used for scuba masks as described by Workman and Prickett (EDU Evaluation Report 4-57, "Visual Field Perimeter and Distortion in Diving Masks"). This data is compared to similar data for the "Jack Brown" mask.

4. RESULTS

4.1 Subjective Comments

4.1.1 The comments from the numerous subjects covering approximately 100 dives have been reviewed and assimilated and are reported here under common characteristic rather than for the man making the dive. There was general agreement among the divers after initial indoctrinational dives and familiarization with the mask. All comments below may be assumed to be general (for all divers) except where noted otherwise.

4.1.2 Head Straps, Hardness and Adjustment of Mask. As indicated in 2.3.2, the tubber of the harness of the P & E mask is not very elastic. All subjects complained of difficulty in adjusting the mask both when initially donning it and also when readjusting underwater. The strap and clip design does not lend itself to adjustment. Several of the divers felt they had to make the mask too tight (shorten straps) to ensure a good fit. It is felt that all divers eventually adjusted the P & E mask to be much tighter than normal for the "Jack Brown". This, along with the stiffer rubber in the straps, no doubt permitted a slightly higher air pressure inside the P & E mask and is the reason the mask is less easily flooded (see below). It is normal practice in shallow water diving to readjust the mask underwater Some divers pull the straps up tightly before entering the water and then loosen and adjust underwater; some divers are in the habit of holding the mask against the face with the strap loosely draped over the head until after entering the water and to then do all the adjustment in the water. Quoting Dimmick: "Could not adjust head harness no matter how hard I pulled on the straps. Not even on the surface." Similarly quoting Wiley: "The mask strap took considerable time to adjust and could not be readjusted after

in the water". This lack of adjustment and elasticity in the straps generally makes the mask difficult to put on and take off. In tests of underwater ditching and redonning, the results were all negative in that a satisfactory fit after redonning was not possible and it took too long to get the mask back on. Two of the subjects remarked that the head harness took so long to get on and get adjusted that use of the mask for emergency standby service (as is frequently done) would be questionable.

4.1.3 Head Harness - Detachable vs. Semi Permanent. The fact that the head harness was not permanently attached to the mask bothered most of the divers. There may be a slight psychological factor in this mild distrust and this in turn may lend to the tendency to cinch up the straps too tightly as noted above. This feature however, makes it highly hazardous to ditch the mask underwater with the intention of redonning; the harness comes loose from the mask. (This condition is aggravated by the considerable difficulty in pulling the harness off or on over the head.) It may be argued that this ditching and redonning is an unrealistic test but on the other hand, it is not unrealistic to anticipate taking a shallow water mask down to a scuba diver for use during decompression stops.

4.1.4 Flooding and Clearing. As was indicated in 4.1.2 above, the P & E mask was found to be very difficult to flood; or more properly stated, its tendency to flood-out was negligible. This is attributed to the relatively good fit of the mask adaptor piece and to the higher air pressure in the mask. When deliberately flooded (and after redonning following ditching) there was no difficulty in clearing the mask. In these two respects, the P & E mask is as well liked as the standard mask.

4.1.5 Fit and Comfort. There was general agreement among the subjects that once the mask was adjusted and underwater the fit to the face was good and overall comfort was equal to the standard mask. In this regard, Haslip stated as follows: "Do not see any great advantage over the 'Jack Brown' but certainly no disadvantage." Men with a round or "moon" face have no comfort problems at all with the P & E mask while a man with a slender face has some trouble adjusting for comfort.

4.1.6 Weight and Size. The initial reaction of all the divers to the P & E mask was negative as regards its weight and size. All subjects continued to regard this weight (when out of the water) as objectionable, especially when compared to the Standard mask. The P & E mask assembly weighs 7 3/4 pounds as compared to the Standard (Jack Brown) mask's 3 pounds, 2 oz. (including control and non-return valves). This objection to the P & E mask persisted in all subjects notwithstanding the essentially neutral weight once underwater. Several (but not all) of the subjects objected to the greater bulk and volume of the P & E mask but could give no concrete reasons for their objection. (Psychologically speaking, they simply did not care for the idea of so much mask hanging in front of them).

4.1.7 Visibility. All of the divers reported the visibility (subjectively speaking) as very good and equal to or better than the Standard mask. (There is no reported shortcoming in this respect in the latter.) See below for actual visual perimeter results.

4.1.8 Noise - Control Valve and Exhaust Valves. All the subjects reported excessive noise or chatter in the P & E control valve as compared to the essentially quiet operation in the Standard control valve. Considering the P & E valve's design, it is suspected that this noise may emanate from the check valve stem's vibrating against the counter-bore in the control valve stem (counter-bore acts as

the check valve's stem guide). In this respect, the P & E mask's control valve is unsatisfactory. One subject also reported excess fluttering noise from the P & E mask exhaust flapper valves but this was not a general observation.

4.1.9 Control Valve Adjustment. The P & E mask control valve was reported to be satisfactory as regards sensitivity and ease of adjustment. One subject on an especially long dive wherein he set the valve and then did not readjust, reported that the excess chatter was accompanied by a slow closing of the valve to the point where he eventually became starved for air. It is suspected that the two problems (noise and vibrating closed) are closely related.

4.1.10 Material. Overall, the P & E mask and harness appear to be well made. As noted in 4.1.6 above, the weight is objectionable. The glass faceplate, as noted in 2.1.3, appears not to be safety glass. Over a period of several months' use the sponge rubber face adaptor came completely unglued from the hard rubber portion of the mask. Also, the top center strap of the harness broke in the area where the adjusting clip was located. This latter is attributed to the lack of elasticity in the rubber and to the very great difficulty in pulling on or off and adjusting the mask. Some difficulty was experienced in keeping the control valve body from leaking in way of the soft copper gasket at the mask frame. A redesign of the joint to adapt a rubber O-ring seal would correct this.

4.2 Control Valve Steady State Flow Test

4.2.1 Comparative results of the steady state flow test of the P & E and Standard control valves were as follows:

Turns Control Valve Open	FLOW RATE IN CFM		
	P & E	Standard (Jack Brown)	Deep Sea
1/8	3.3	7.5	7.7
3/10	6.5		
1/4	9.0	10.0	12.0
5/16	13.2		
3/8	14.3		
1/2	15.7	17.0	12.9
5/8	16.2		
3/4	17.0	17.0	13.6
1	17.5	17.7	16.0
1-1/8	17.8	17.8	16.2
1-1/4	17.8	17.9	17.7
1-1/2	18.0	18.0	22.7
1-3/4	18.0	18.3	32.5*
2		18.3	
2-1/2		18.3*	
2-7/8	18.0*		

*FULL OPEN

4.3 Non-Return Valve - Back Pressure Test.

4.3.1 The results of the back pressure tests of both the Standard (Schrader) and the P & E non-return valves were satisfactory.

4.4 Visual Perimeters

4.4.1 Visual field perimeters as measured for the P & E Mask are plotted in figure 2. For purposes of comparison, the visual field perimeters for the Standard (Jack Brown) shallow water mask as previously reported in EDU Evaluation Report 4-57 are duplicated here as figure 3.

5. DISCUSSION

5.1 Subjective Evaluation

5.1.1 It is the general opinion of the several enlisted and officer divers who have used the P & E mask in this evaluation that the mask could be used if it were supplied and that there would be no extreme objections to it if the head harness were improved. However, all the divers see no advantage in the P & E mask over the U.S.N. Standard mask and, to a man, all prefer the Standard. A third shallow water diver's mask was evaluated concurrently with this project and is the subject of a separate report. This third mask was actually preferred over the Standard by many of the subjects, but again, the feeling was not strong enough in disfavor of the Standard to warrant its abandonment.

5.1.2 There were several specific objections to the P & E mask which bear further discussion. First, the considerable weight and bulk of the mask (dry) and its seemingly large (volume) mask cavity seem unnecessary. The weight is a real problem when out of the water. The very slight improvement in visibility as a consequence of the larger facepiece is not sufficient to warrant the mask's increased size. Secondly, the head harness requires a complete redesign. It should be attached permanently to the mask, should be more elastic to facilitate donning and removal either on the surface or underwater and, most important, it should be so designed that the diver can easily adjust it at any time underwater. Thirdly, the control valve chatter and the possibility of its vibrating closed must be eliminated.

5.1.3 So far as the material of the mask is concerned, the redesign of the head harness should take into account the broken strap and provide sufficient elasticity for adjustment and for stretching over the head. The faceplate should be plate or safety glass and the rubber cement used to secure the sponge rubber facepiece to the adaptor should be selected to ensure that it stands up indefinitely underwater.

5.2 Air Supply

5.2.1 As indicated in the table in 4.2.1 above, the P & E mask's control valve supplies as much air and gives as adequate control as the Standard control valve. The P & E mask's valve's tendency to vibrate closed has been noted above.

5.3 Visibility

5.3.1 The visibility of the P & E mask is very good and, to a degree, better than the Standard mask. There has, however, never been any objection to the Standard mask's field of vision and, even during this evalution when specific comparison

of the two was stressed, there still is no objection and consequently no reason to prefer the P & E.

6. CONCLUSION

6.1 Conclusions

6.1.1 It is concluded that the P & E Manufacturing Co.'s shallow water diver's mask is a good mask but with several minor deficiencies and that it is no better than the current U.S. Navy Standard Shallow Water Mask.

6.1.2 Based on subjective evaluation by a representative population of experienced divers, it is concluded that the Standard ("Jack Brown") mask is preferred to the P & E Mask.

6.2 Recommendations

6.2.1 It is recommended that the P & E mask not be accepted for use in the Navy. The current Standard ("Jack Brown") mask is preferred.

6.2.2 If the P & E mask is supplied as an alternate or emergency substitute mask, it is recommended that the several deficiencies noted in this evaluation be corrected and especially that the head harness be redesigned and permanently attached to the mask proper.

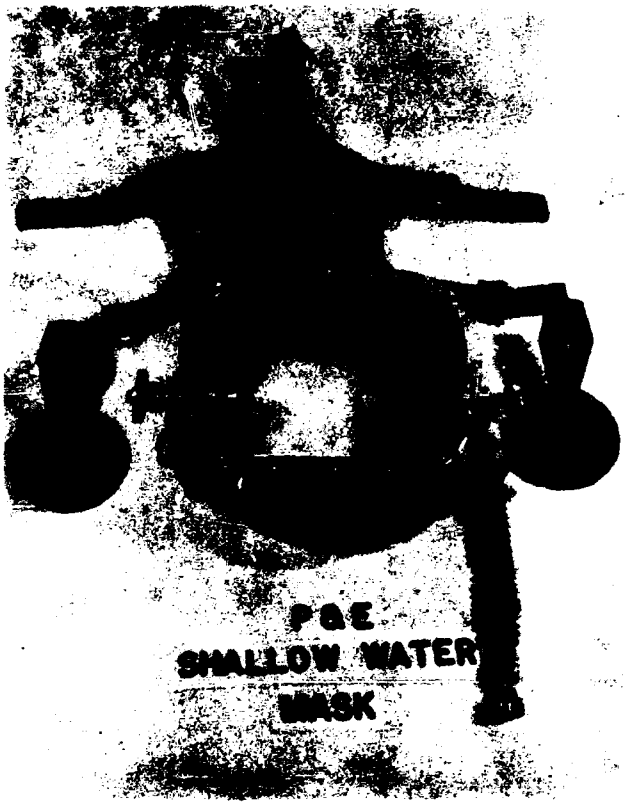
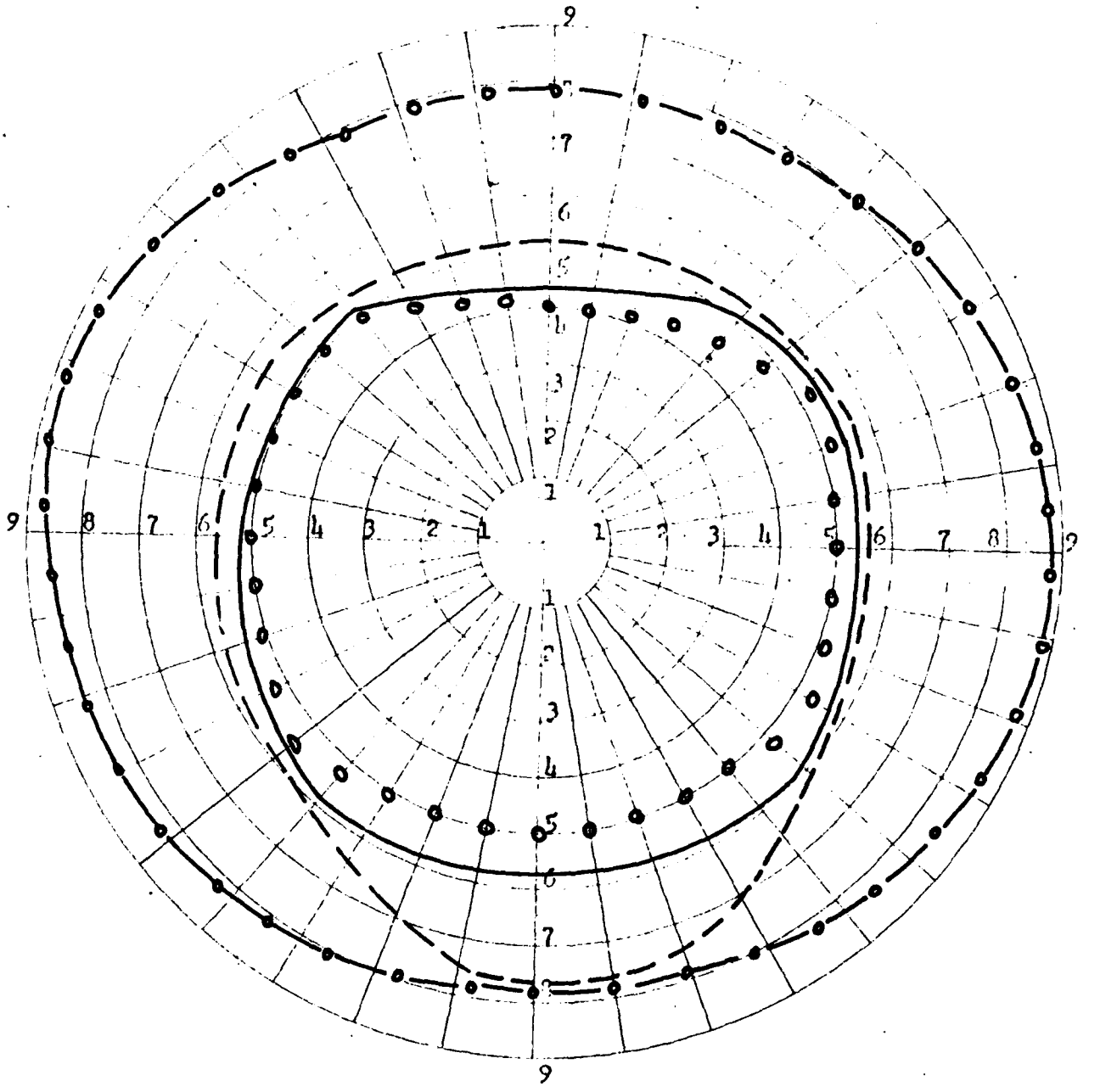


FIGURE 1.

P&E MANUFACTURING CO INC.
SHALLOW WATER DIVERS MASK
VISUAL FIELD PERIMITERS
AVERAGE OF THREE SUBJECTS IN AIR AND WATER

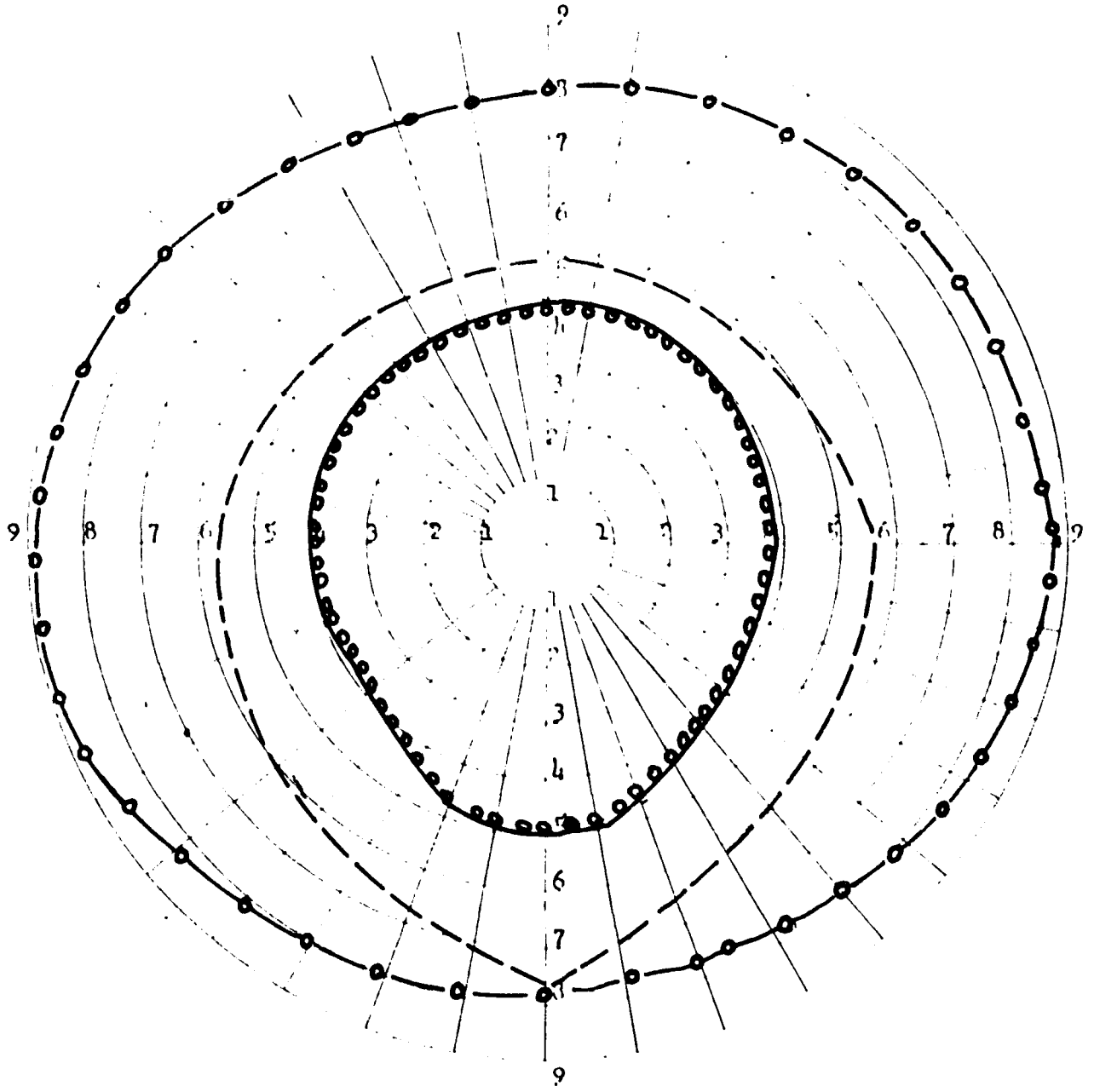


PERIMETER - NO MASK
PERIMETER - WITH MASK
DISTORTION - NO MASK
DISTORTION - WITH MASK

FIG. 2

STANDARD U. S NAVY
SHALLOW WATER DIVERS MASK
(JACK BROWN)

VISUAL FIELD PERIMITERS
AVERAGE OF THREE SUBJECTS IN AIR AND WATER



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