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NORTHERN ZONE

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S.C.U.B.A.
THEORY NOTES

1985

NORTHERN ZONE — S.C.U.B.A. THEORY NOTES

When a person first enters the water, he is affected in five ways:—

1. BREATHING

Is affected by the increased pressure of the water surrounding the chest.

2. LIGHT AND SIGHT

Objects seem to be closer and 1/3rd. larger than they are; i.e. an object 9ft. long on land would seem to be 12ft. long submerged.

Colours are absorbed by the water. Infra-red is absorbed in the first 3ft., orange at 15ft. and yellow at 30ft. From about 60ft. on only blue greens and blue greys can be seen.

3. DENSITY

Body movements are restricted by the drag resistance and density of the water.

4. BOUYANCY

This is another problem as the body has a tendancy to float. A lead belt may have to be worn. If wearing a wet suit, weights will have to be added due to the increased bouancy caused by bubbles of nitrogen in the suit itself.

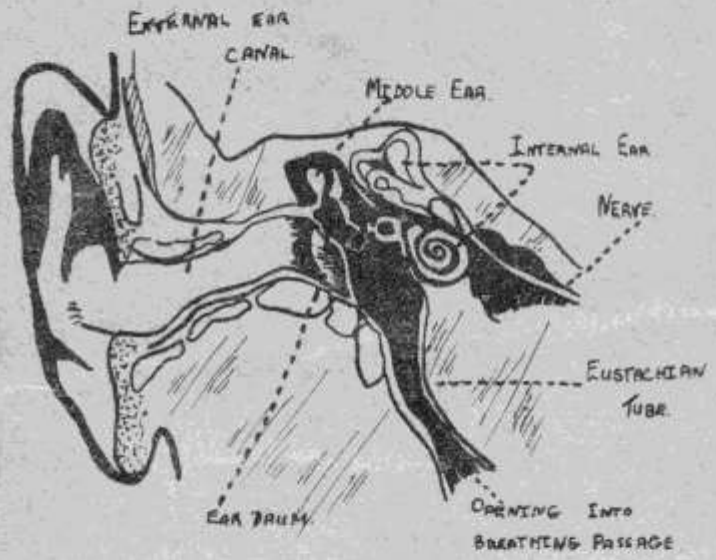
5. PRESSURE

Increases as you descend. Its effects are noticed on the mask, ears and sinuses, and also on the property of the gases breathed when using scuba.

The best mask to have is a compensator. This type allows a diver to clear his ears easily when descending.

We find that when one goes deeper, water pressure increases and is felt in your EARS and SINUSES. The way

to overcome this, is to either clench your teeth and swallow, or blow air into the mask while holding against it. If these methods do not work, pinch your nose and blow against it. When doing these things, air is blown from the lungs through your eustachian tube into your inner ear and sinuses, thus equalizing the air pressure inside to the water pressure outside. (see diagrams)



You may also find that pressure forces your mask onto your face. To prevent this, blow through your nose into the mask, thus equalizing the pressures.

A wet suit is an asset! It keeps you warm, minimizes fatigue and acts as a safety float if you get into difficulties. Other reasons for wearing a wet suit are to prevent marine animals stinging you, and it also offers some protection from being cut on rocks etc.

MEDICAL ASPECTS OF DIVING

Anoxia: Lack of sufficient oxygen to lungs, blood and tissues.

When tissues have insufficient oxygen they function abnormally and die. The cells from the brain die if not supplied with oxygen for more than two minutes.

SYMPTOMS: Drunken feeling, lack of mental control and slight increases in breathing rate. Unconsciousness.

TREATMENT: Fresh air, and artificial respiration.

The main causes of anoxia are:

(a) Running out of air whilst SCUBA diving.

(b) Breathing from a cylinder filled with impure air.

(c) Hyperventilation when snorkel diving. This flushes **CO_2 (the stimulus for breathing), from the lungs.** When you dive, by the time the CO_2 builds up enough to compel the respiratory system to function, the oxygen level could drop to a critical point 12% at the surface. If it does during ascent blackouts will occur without warning, due to the decrease in the partial pressure of the remaining oxygen.

Blackouts will occur without warning or symptoms.

Drowning: Artificial Respiration (See pamphlet.)

USING A SCUBA

Before using a Scuba it pays to know how one works. There are three basic parts of an aqualung.

(a) Cylinder: There are many cylinders on the market, but all must be treated the same.

An aqualung should be respected, for, if it explodes when fully charged, the result would be similar to that made by a considerable quantity of explosives.

A cylinder should be stored in an upright position, for if there is any water inside, it will lie on the botttom of the cylinder, which is the thickest part, so rusting will then be confined to this secion .

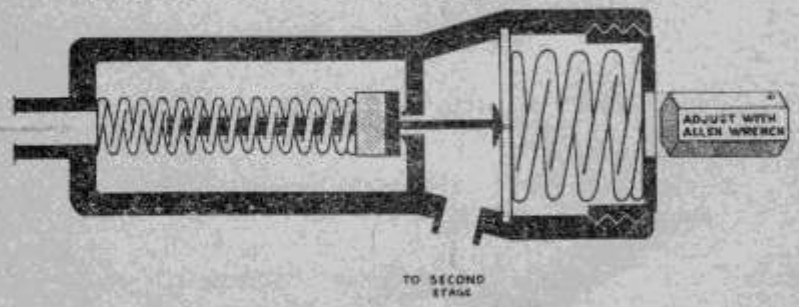
A cylinder should be tested every year for rust and fatigue. The outside of the cylinders should be kept clean and well painted. You should wash your equipment out in fresh water after use. Cylinders should not be picked up by the taps or regulators. Regulators should be removed immediately after use.

(b) Regulators: Two types of regulators are available for Scuba — two stage and single stage (as shown in diagrams). The two stage can have either one or two hoses.

(c) Harness: The harness should be fitted with quick release buckles, so that if you have to ditch your gear at any time, you can easily do so.

The aqualung should be worn so that the demand valve on a twin hose unit sits between the wearers shoulderblades. This allows you to breathe air at the pressure closest to that in your lungs. Waist straps should be high to allow your weight belt to be worn over your harness.

SINGLE HOSE — FIRST STAGE REGULATOR



FIRST BREATHING

The main thing to remember if you jump to enter the water is to hold your mask. This will prevent it coming off. Jump in a vertical position, or roll backwards, but never jump face down.

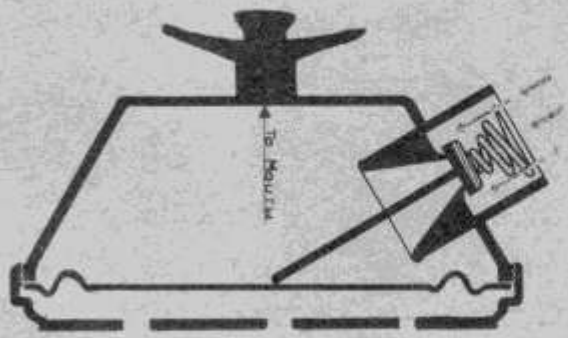
Always wear a knife in case of entanlgement in rope, etc.

(a) Clearing the Mask: To clear the mask, you should hold your mask with your fingers pressing down on the edge closest to the surface. Tilt your head back, or roll sideways, and blow through your nose till all the water in the mask has been blown out of the bottom.

(b) The Way to Swim: When swimming on the surface with a Scuba use your snorkel to conserve air . If your Scuba is too heavy on your back, roll over so that it is underwater, thus reducing the weight.

When swimming underwater use only your legs to swim with, as using your hands only hinders movement and makes you use up too much air. Hands should be held at your sides, or in a position where the least amount of resistance is produced. When kicking, slightly stiffened legs and pointed toes give the best propulsion.

SINGLE HOSE — SECOND STAGE REGULATOR



At this stage some physical aspects related to diving should be mentioned.

Pressure also effects the properties of gases in air. Atmospheric air contains Oxygen (21%), Nitrogen (78%), Carbon Dioxide (.03%), and .97% rare gases etc. As pressure increases, the toxity of gas along with its partial pressure is increased. Oxygen at a pressure of 29.4 lb. per sq. inch (2 atmospheres), is poisonous. Other gases are also affected by pressure but their effects are revealed to their properties. The main ones are Carbon Monoxide (C), Carbon Dioxide (CO_2) and Nitrogen (N).

PARTIAL PRESSURES

Dalton's law states that: The total pressure exerted by a mixture of gases is the sum of the pressures that would be exerted by each of the gases if it alone were present and occupied the total volume.

Say for example that atmospheric air contains 80% Nitrogen and 20% oxygen.

The partial pressure at the surface:—

$$\text{Nitrogen} = \frac{80}{100} \times 14.7 = 11.76$$

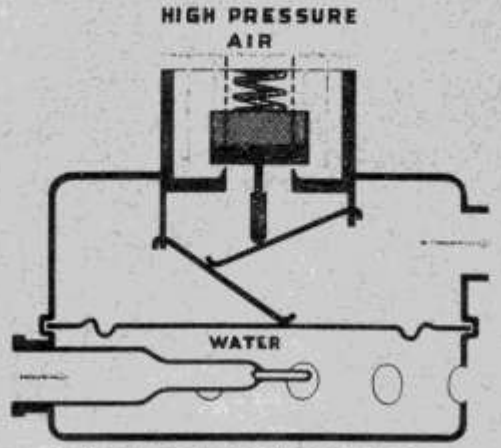
$$\text{Oxygen} = \frac{20}{100} \times 14.7 = 2.94$$

The partial presure at 33' (1 atm.):—

$$\text{Nitrogen} = \frac{80}{100} \times 29.4 = 23.52$$

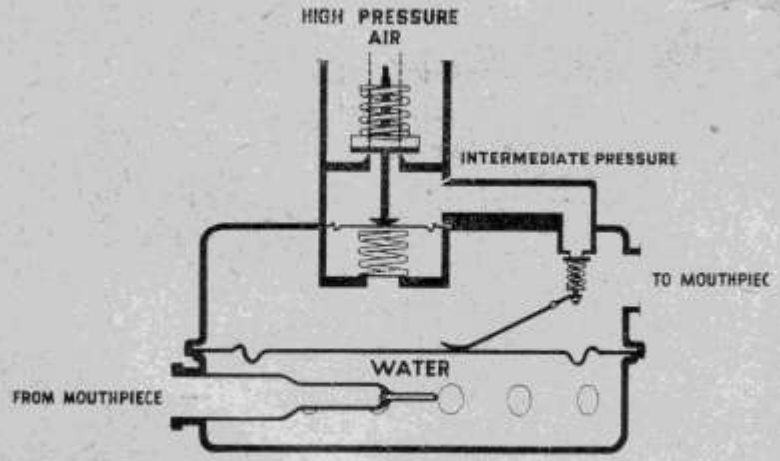
$$\text{Oxygen} = \frac{20}{100} \times 29.4 = 5.88$$

TWIN HOSE — SINGLE STAGE RGULATOR



UP STREAM VALVE SEAT

TWIN HOSE — SECOND STAGE REGULATOR



An atmosphere is the depth of water which exerts the same pressure as atmospheric air does at sea level.

Pressure of Air — 14.7 p.s.i.
Corresponding depth of salt water — 33 ft.
Corresponding depth of fresh water — 34 ft.

When calculating in atmospheres it must be noted that for the initial stage, from 0 to 33ft., a pressure equal to 29.4 p.s.i. or 2 ats. is exerted. This is caused by the additional weight which atmospheric air exerts onto the water. For every additional 33ft. after the first, only 14.7 p.si. is added, eg. 99ft. equals 4 ats. equals 58.8 p.s.i. For working purposes, .445 p.s.i. per foot, can be used.

If a volume of air (say in a balloon) is taken underwater a change in its volume as you descend would be noted. We work on the principle of atmospheres mentioned before and Boyles Law, which states: "If the temperature is kept constant, volume will vary inversely with the absolute pressure." Seeing there is no great change of temperature in water this section of the Law can be disregarded.

In the first 33ft. the air in the balloon would be subject to 2 ats. Therefore its volume would be decreased to ½. But at 66ft. it would be only cut to 1/3rd and at 99ft. a ¼ of its original volume.

This law is used for calculating problems related to volumes of gas under pressure

FURTHER MEDICAL ASPECTS OF SCUBA DIVING

a. AIR EMBOLISM

When Scuba diving you should never hold your breath while ascending. If you do, the air in your lungs expands and bursts the small sacs (alveoli) which hold the air. The capillaries which surround these rupture, and bubbles of air enter the bloodstream. The effect is similar to the bends, except the bubbles come straight from the lungs. (See bends)

An ascent of only 4ft. can lead to air embolism.

SYMPTOMS: Bloody froth at mouth; Pain in chest and limbs; Wheezing; Respiratory Difficulties.

TREATMENT: Immediate Recompression followed by controlled Decompression.

MEDIASTINAL EMPHYSEMA.

This is where air is forced into tissues in the middle of the chest.

SYMPTOMS: Trouble in breathing and swallowing; Pain in chest.

TREATMENT: Recompression, followed by controlled decompression.

SUSCUTANEOUS EMPHYSEMA

Usually in conjunction with Mediastinal Emphysema. It is where air is trapped at the base of the neck.

SYMPTOMS: Difficulties in speaking; Voice distortion.

TREATMENT: (As for Mediatstinal Emphysema).

SPONTANEOUS PNEUMOTHORAX

This occurs when air is forced through the lung wall and is trapped between the lungs and chest. This can lead to the total collapse of the lung on ascent.

SYMPTOMS: Pain in chest; Respiratory difficulties; Bleeding and frothing at the mouth.

TREATMENT: (As for Mediastinal Emphysema); In some cases a Doctor may have to insert a syringe to draw out excess air.

CASSION DISEASE OR BENDS

If a diver makes a descent and the pressure of the air he breathes is doubled, say, partial pressure of nitrogen will be twice as great as it was at the surface, and twice as much nitrogen can be dissolved in the blood.

Some of the nitrogen in the blood passes into the fatty tissues, paricularly those of the brain and spinal cord. When the partial pressure of nitrogen is high, as in deep diving, more nitrogen becomes dissolved in the tissues during shorter period of time. The amount of nitrogen thus dissolved depends on the depth and duration of the dive and the exertion of the diver.

If partial pressure of nitrogen has been maintained at a high level for sometime, relative to the depth, and it is suddenly reduced, the nitrogen will come out of solution quicker than it can be carried away by the blood to the lungs, it will form bubbles in the blood and tissues.

These bubbles may interfere with the normal workings of the body, e.g. the joints, causing pain and discomfort.

Symptoms are pain in the joints, paralysis. dizziness, swelling itching etc. and may occur immediately on ascending, or up to six hours after the dive.

TREATMENT: Recompression followed by controlled decompression. To prevent this use reliable Decompression Tables where necessary.

NITROGEN NARCOSIS

The effects of Narcosis usually occurs in depths greater than 150ft.

The narcotic properties of dissolved nitrogen under pressure affects the nervous system. In severe cases almost

complete lack of mental and muscular control results: when slightly affected, there is only a feeling similar to drunkedness. The deeper a diver goes, the more susceptible he is. Narcosis is overcome by ascending. It leaves no after effects.

The narcotic effect may differ from person to person. Similarly, it differs from one day to the next. On one particular day a diver may not be affected, the next he could be "way under".

CARBON MONOXIDE POISONING

This is caused by breathing air containing more than .001% Carbon Monoxide. Carbon Monoxide mainly gets into a cylinder from an oil lubricated compressor with insufficient filters or from a compressor which intakes exhaust fumes.

There are no reliable symptoms of this poisoning, and blackout can occur without warning.

EXHAUSTION

In steady prolonged exercise, as in diving, exhaustion may result, and is due to a number of factors.

The body tissues, and especially the muscles, burn glucose to produce energy for their activity, oxygen is necessary to allow this process to continue.

If a diver overexerts himself, and particularly if he becomes excited or cold, his body may be unable to cope with the added demands for energy for warmth etc. the muscles become starved of oxygen and glucose and don't function properly.

There are also changes in the brain giving rise to a feeling of discomfort and a sense of weariness.

Unconsciousness may quickly result.

Complete relaxation, and adequate oxygenation by resuming normal breathing is the only way of overcoming exhaustion.

After the victim leaves the water he should be kept warm and dry and given hot, sugared drinks.

SHARK ATTACKS.

Recent investigations carried out throughout the world have established the following facts:—

1. The victim should be kept quiet and NOT moved.
2. A Doctor should be summoned, along with an I.V. Plasma Kit.
3. Bleeding should be stopped with towels etc.
4. Tornaquets should not be used if at all possible.
5. Keep the victim calm. Make sure that he is not moved by anyone for ½ an hour unless absolutely necessary; this allows the main killer in shark attacks (shock), to pass. He may be moved after half an hour, but avoid unnecessary bumping etc.

BOOKS RECOMMENDED FOR FURTHER STUDY:

New Science of Skin and Scuba
U.S. Navy Manual.