THE FIRST DEMAND VALVE?

John Bevan

Recently, while innocently browsing through the fascinating archives of the Patent Office, I stumbled across a truly remarkable discovery. I found that in London, on June 19, 1838, some 30 years before Rouquayrol and Danayrouze patented their demand valve, a Mr William Edward Newton first filed a patent for a diaphragm-actuated, twin-hose demand valve for divers.

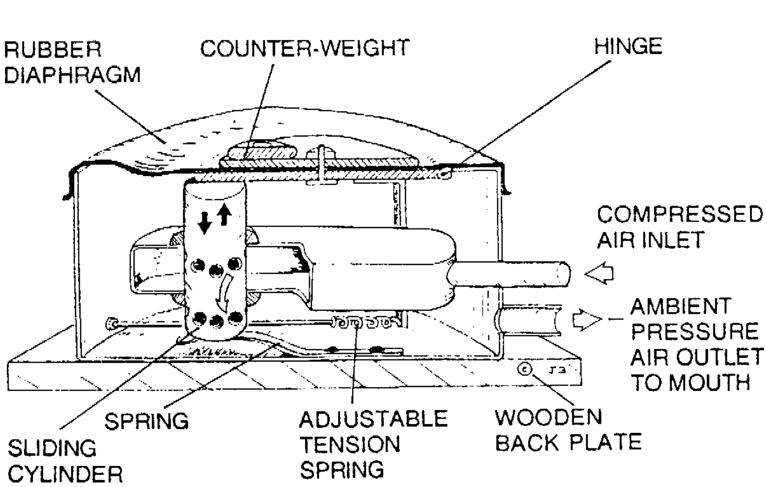
Now it was Rouquayrol and Danayrouze in 1872, and later still, Cousteau and Gagnan, who are popularly credited with inventing the first working demand valves. So is it possible that Newton's demand valve patent of 1838 displaces these august names into second and third places?

To be absolutely fair, it would largely depend on whether or not Newton's precedent was a viable, workable design. Unfortunately, my research to date has failed to turn up any reports of its actual construction or use.

Let us look at the Newton design, the purpose of which was to "supply air to the diver in a regular and uniform manner, and not by puffs, as it would be if conveyed to him directly from a pump".

The valve itself, which Newton dubbed the "manometre" was mounted on a flat piece of wood and strapped to the back of the diver. A circular diaphragm, which was made of india rubber or oiled silk, covered the top of a cylindrical housing or "box". This diaphragm was stiffened by being sandwiched between two thin wooden plates which, in turn, were hinged to the main housing. Newton termed this a "lid" to the "box".

An elegant arrangement consisting of an adjustable spring and counter-weight provided the diver with the facility to "tune" the diaphragm in a similar way that the second stage of some single-hose demand valves are adjusted to this day.



The next component of the demand valve further demonstrates the classical simplicity and brilliance of Victorian engineering. The diaphragm was drawn inwards as the diver began to inhale. This movement caused a cylinder (a "peculiarly formed valve") to slide through a flattened tube which was connected to the source of compressed air to pass from the inside of the flattened tube into the cylinder and out again into the void enclosed behind the diaphragm. From here it was conveyed directly to the mouth of the diver. The air would thus continue to flow until the diver had completed his inhalation. At this point the pressure beneath the diaphragm would rise again the meet the ambient pressure, whereupon a small spring returned the sliding cylinder together with the diaphragm back to the "off" position, shutting off the supply of compressed air.

In this position none of the holes in the sliding cylinder was in communication with either the voids behind the diaphragm or within the compressed air supply hose. The valve thus supplied the diver with air only on demand, in the same way as demand valves work today.

A further beautiful aspect of this particular design is that since there is no change in overall surface area of the moving parts exposed to differential pressure during the sliding movement of the cylinder, the valve is perfectly balanced.

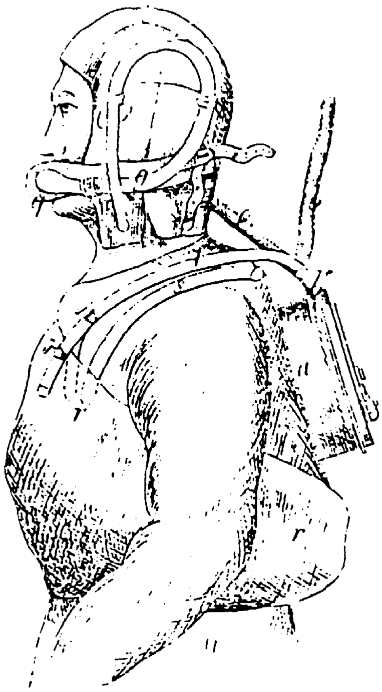
Even more remarkable features were ahead of the much later Cousteau-Gagnan product. The inspired air was conducted to a mouthpiece which also incorporated an exhaust tube. Within this mouthpiece, two spring-loaded non-return valves ensured that water could not be sucked back into the mouth, and equally, any water that may have got in could be vented safely through the exhaust tube.

A further simple but effective feature to avoid the ingress of water was provided by looping the exhaust tube at the side of the diver's head "so that in whatever position the diver may be placed, the end of the tube is never upper most and consequently, there is no danger of being drowned".

This general arrangement incidentally provided a safety mechanism whereby any compressed air that may have leaked through the demand valve could be vented safely through the mouthpiece and exhaust tube into the sea, just as in modern demand valves.

Finally, we discover a direct feed facility into a "stab jacket"*, complete with open/shut valves and left/right equalisation tube. This Newton described as "a waistcoat, at the lower part of which a sort of bag is attached, made of any flexible water-proof material".

The compressed air supply for the direct feed came from a T connection into the main air



This drawing from Newton's patent specification shows the demand valve on the diver's back and the "stab jacket"on his chest and under his arms with the looped exhaust tube by his head.

supply hose, just before its connection with the demand valve. The piping and valving arrangement to the stab jacket was such that air could be vented during ascent, though it clearly lacked the sophistication of the modern safety blow-off valve.

In the early 1800s there was obviously no method of compressing air sufficiently to produce a self contained breathing system, so the compressed air supply for Newton's patent was a low-pressure reservoir maintained by a pump on the surface.

The original Rouquayrol and Danayrouze apparatus was, like the Newton apparatus, a surface-demand breathing apparatus, though it did take the first step towards self-containment.

So there we have it - a truly incredible discovery! Anyone wishing to obtain a full copy of this patent can do so by application to the Patent Office in London. The title is simply, "Diving Apparatus", patent number 7695, dated 19th June 1838, patentee William Edward Newton.

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* "stab jacket" is short for "stabilising jacket" which is the UK term for a jacket-type buoyancy compensator.

MIDDLE EAR BAROTRAUMA IN SCUBA DIVING TRAINEES

H N Staunstrup, L Knudsen B Malling and P Paaske

Abstract

Twenty-one male scuba diver trainees were investigated during their diving course, where they did from 2-7 dives (in all 104 dives). Before and after each dive, they were investigated by a questionnaire (comprising questions of tubal dysfunction and other otological symptoms), by otoscopy and by tympanometry.

Forty-eight per cent of the divers experienced symptoms of tubal dysfunction at some time. Otoscopy mainly revealed minor degrees of barotraumas to the middle ears. In only two cases we saw bleeding in the tympanic membrane. Otoscopic findings correlated to symptoms of tubal dysfunction ($p < 0.05$). Tympanometry revealed no further signs of barotrauma than those seen by otoscopy.

Symptoms and signs of middle ear barotraumas are often seen in scuba divers, but mostly they are of minor degree.

Introduction

Authors describing aural problems in divers have stated that middle ear (ME) barotrauma is the most common malady experienced by divers.[1-5]

The mechanism and pathophysiology of ME barotrauma has been described in detail by several authors.[1-5] The capability of opening the Eustachian tube (ET), which is essential for avoiding ME barotrauma has been described by P.W. Head.[5] ME Barotrauma is seen in the tympanic membrane (TM), but reflects the damage in the ME mucosa. Recreational diving is one of the most expanding sports, and the purpose of our study was to investigate how often ME barotraumas occur in sports divers and how serious the traumas are. We investigated scuba diver trainees by questionnaire, otoscopy and tympanometry.

Subjects and Methods

Twenty-one male scuba diver trainees doing a basic scuba diver course were investigated. Prior to the diving course the students had passed a medical examination by a general practitioner. The examination included a history of actual or previous otological disorders, an otoscopy and a simple test for hearing loss (hearing whispering at a distance of three metres). All students in our study were further examined at the Ear, Nose and Throat Department, University Hospital, Århus. They were otoscopied under a microscope, and their tubal function was investigated with Imped-