The “Delphin” and the “Dräger- Barakuda” diving equipment for sports divers

By Franz Rothbrust, Chairman HDS Germany.

Photo: David Dekker

Introduction

The “Delphin” was the first regulator to be produced in Germany for sports divers. It was pendulum-breathing*, single-stage and developed by Dräger at Lübeck. Unusually, in an era of twin hose regulators, it had only one corrugated hose, terminating in a right-angled metal tube which mounted the mouthpiece. It is unusual to look at, so what is different about this particular design? In the modern sense of the word it is certainly not a single hose regulator. Its genre, as defined by the diving equipment manufacturer MEDI of Leipzig, is "Compact Regulator". That is, regulators in which the pressure reduction valve and the exhalation valve are housed together in a compact body, with any breathing tube or tubes being used under ambient pressure.

As simple as that may seem, even the name Delphin has its problems, as it is usually called “Delphin II”, a name that in fact not only covers the regulator itself but the complete diving equipment, consisting of the regulator together with the compressed air cylinder, its harness and standby control valve.

The reason is that a Delphin I oxygen rebreather was already available when it was developed and it was to be followed by Delphin III SCUBA cylinders. The result is something of a muddle, with contemporary Dräger and Barakuda catalogues describing it variously as Delphin and Delphin II. So, to avoid any further confusion we will describe it simply as the Delphin.

A Look Back: Revolutionary contributions from France

The provenance of the Delphin's design lay with the Rouquayrol and Denayrouze regulator, which was central to the functioning and reliably controlled breathing air supply equipment that they patented in 1867. This device and its immediate successors were relatively cumbersome and heavy but still used underwater by divers in an upright position wearing heavy boots. It would take more than half a century until the first lightweight diving equipment became available, together with the fins that allowed them to freely swim around underwater.

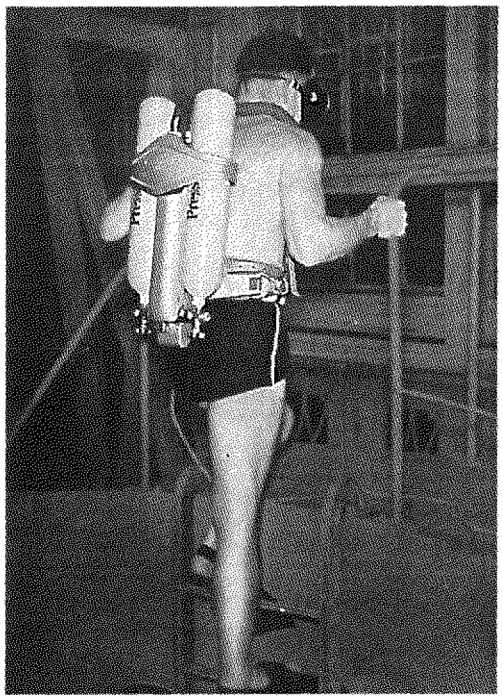
The first fully automatic compressed air regulator for swimming divers** was developed jointly by Emile Gagnan and Jacques Cousteau; Gagnan already had experience in the design and production of pressure reducers, to which Cousteau contributed his diving skills. However, the two Frenchmen did not invent the regulator as we know it. What they did was to rearrange and improve existing technical components which resulted in their 'Scaphandre Autonome' whose main innovation was a second corrugated hose which took exhaled air from the mouthpiece to an exhalation valve. This was mounted next to the diaphragm in a compact box shaped housing, mounted with the pressure reduction valve between two cylinders worn on the diver's back. Importantly, being mounted close together meant that the diaphragm and the exhaust valve were at the same ambient pressure, so that the automatic nature of the regulator could not initiate a free-flow of air due to a pressure difference. Consequently the diver could adopt a variety of positions underwater without any interruption to the air supply at the correct pressure. With previous equipment, from Fernez, Le Prieur and Commeinhes, it had been necessary to manually adjust the regulator to account for diver trim and position while underwater (1).

The regulator was marketed under the name "CG 45" from 1946. It had a revolutionary impact for several international patents were filed. The initials "C" and "G" stand for Cousteau and Gagnan and "45" for the year of Patent application. The design developed by Cousteau and Gagnan was groundbreaking. From that time until this, compressed air SCUBA regulators have been constructed on the same principle.

"CG 45" from "La Spirotechnique". This version with a small company label and the words "La Spirotechnique SA" was produced from 1947 to 1955. Photo: David Dekker.

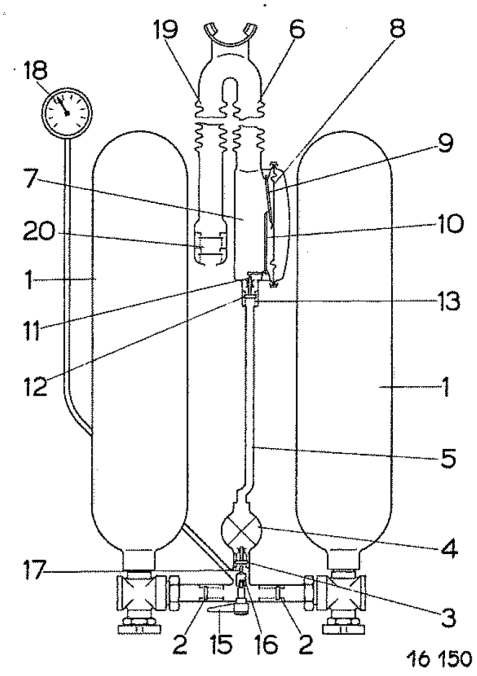
The earliest autonomous compressed air diving apparatuses from Dräger

In the early 1950s Dräger had the "R16000" compressed air breathing apparatus in development. Its regulator the "PA40" was not a compact regulator, but constructed from a separate first and second stage. These were combined between the two air cylinders and were not removable.



15066

Bild 5. Erprobung des Preßluftatmers im Taucherhaus des Drägerwerkes



Nr. 223 März/Dezember 1953

Legend: **1** Compressed air cylinders;**2** Check valves; **3** Throttle valve for reserve;**4** Pressure-reducer; **5** Pipeline; **6** Inhalation hose; **7** Regulator; **8** Diaphragm; **9**&**10** Regulator valve actuating levers; **11** valve stem; **12** Valve; **13** spring; **15** Reserve lever; **16**&**17** Shaft and spindle of reserve circuit;**18** Pressure gauge; **19** Exhalation hose; **20** Twin exhalation valve. Both pictures: *Drägerheft*, No. 223 1953.

Such compressed air breathing apparatus were expensive to purchase, maintain and operate, and were therefore reserved for professional users. This also applied to similar apparatus from France (Commeinhes) and England (Siebe-Gorman).

Dräger, Barakuda diving apparatus "Delphin II" and "Delphin III"

In 1949, two former combat swimmers of the German Navy, Hans-Joachim Bergan and Dr. Kurt Ristau formed the company Barakuda Watersports GmbH in Hamburg. The lectures, films and books of Hans Hass and Jacques Cousteau had created a demand for Scuba diving equipment.

Back in the early 1950s therefore, Barakuda approached Dräger, to develop Scuba devices that should be affordable for everyone. Their first project was the oxygen rebreather "Delphin I". It was offered for sale by Barakuda in 1953. The year previously, it had been available from Dräger as "oxygen rebreather Type 138". In the same year, Dräger offered Barakuda the Scuba model "Delphin II" with either a 4- or 5-litre cylinder. This was the first equipment Dräger had designed for sports

divers. It was followed in 1956 by the SCUBA “Delphin III”, which was equipped with two 4-litre cylinders.

In the 1950s, the regulators were used by several people within dive associations, therefore a personalised mouthpiece made sense for reasons of hygiene. Why the corrugated hose was not interchangeable for the same reason, is unknown. This became possible with a later variant.

Barakuda catalogue of August 1953 Page 1.
The complete unit cost 250 DM, which was a lot of money for that time. In Germany the average monthly income was only 350 DM. Because of its low weight the "Delphin II" was ideal as a ladies' Aqualung. In addition to the harness there are also the cylinder straps made of fabric tape after the French model of La Spirotechnique, very "à la mode".

A. Besondere Kennzeichen

Nur Preßluft, keine Chemikalien!

Das „Delphin II"-Gerät ist ein freitragbares Preßluft-Tauchgerät; es arbeitet ausschließlich mit komprimierter Atemluft (Preßluft). Chemikalien, wie Atemkalk u. dgl. mehr, werden nicht verwendet.

Sicherheit!

Die Forderung nach unbedingter Sicherheit, auch bei Benutzung durch den Laien, ist mit diesem Gerät in hohem Maße erfüllt.

Unkompliziert!

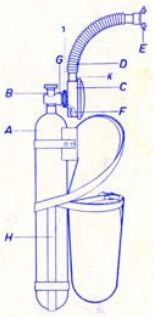
Bei denkbar einfacher Wartung und Bedienung genügt eine kurze fachmännische Einweisung und Schulung am Gerät, um jeden gesunden Menschen zu guten Tauchergebnissen gelangen zu lassen.

Niedrige Kosten!

Der niedrige Anschaffungspreis und die geringen Betriebskosten ermöglichen allen am Tauchen interessierten Personen die Verwendung dieses Gerätes.

B. Vorbereitungen zum Gebrauch des Gerätes

1. Preßluftflasche (A) mit ölfreier Preßluft auf 200 at füllen lassen (neugelieferte Geräte und Ersatzflaschen sind stets gefüllt). Beim Füllen erwärmt sich die Preßluft, es muß daher auf etwa 220 at gefüllt werden, um bei normaler Temperatur 200 at Fülldruck zu erhalten.
2. Die Gurtband-Tragevorrichtung (H) wird an der Flasche befestigt und Ober- und Unterteil der Vorrichtung fest verbunden. Der Anschlußstutzen (G) für den Lungenautomat (C) muß zur Trageriemenseite zeigen.
3. Der Lungenautomat „Delphin II" (C) wird von Hand so an das Flaschenventil geschraubt, daß die Sieböffnung (F) für den Luftaustritt nach unten, der Schlauchstutzen (K) schräg nach oben zeigt. Die Anschlußverschraubungen (J) bis zum Anschlag drehen. Das Flaschenventil (B) öffnen und wieder schließen, jetzt am Mundstück (E) saugen, bis keine Luft mehr nachströmt. Durch weiteres Saugen feststellen, ob der Lungenautomat dicht ist.



Dräger-Barakuda-Kleintauchgerät „Delphin II":
A - Preßluftflasche B - Flaschenventil C - Lungenautomat D - Atemschlauch
E - Mundstück F - Ausatemventil G - Anschlußstutzen für Lungenautomat
H - Gurtband-Tragevorrichtung J - Anschlußverschraubung K - Schlauchstutzen

C. Beschreibung, Funktionen und technische Daten

Das Dräger-Barakuda-Kleintauchgerät „Delphin II", welches wahlweise mit einer 4-l- bzw. 5-l-Preßluftflasche geliefert werden kann, ermöglicht einen ununterbrochenen Aufenthalt unter Wasser von einer Dauer bis zu 25 bzw. 33 Minuten. Die Tauchdauer ist vom Luftbedarf des Tauchers und von der Tauchtiefe abhängig. Vermöge einer Tragevorrichtung wird das Gerät auf dem Rücken festgeschnallt und mitgeführt. Es ist von äußerer Luftzufuhr völlig unabhängig.

Das „Delphin II"-Gerät ist ein rein lungenautomatisches Gerät ohne Rückgewinnung der Ausatemluft, d. h. die Einatemluft wird dem Gerät entnommen, die Ausatemluft entweicht durch ein Ausatemventil ins Wasser.

Die Atemluft befindet sich unter 200 at Druck in der Preßluftflasche. Die hochkomprimierte Atemluft strömt durch einen Druckminderer, der den Hochdruck in einen jeweils erträglichen Arbeitsdruck umwandelt, zum Lungenautomaten, dessen Ventil unter Zwischenschaltung einer Hebelübersetzung mit einer Membran in Verbindung steht. Der sehr geringe Unterdruck, der beim Einatmen entsteht, öffnet das lungenautomatische Ventil, das gerade soviel Atemluft spendet, wie zum Füllen der Lungen erforderlich ist. Bei Beendigung der Einatmung schließt sich dieses Ventil selbsttätig.

Die Ausatemluft wird wieder in den Lungenautomaten hineingeatmet und verläßt diesen durch ein geschützt angeordnetes Ausatemventil. Bei zunehmender Tauchtiefe sorgt der Lungenautomat selbsttätig für den Druckausgleich im Gerät. Infolgedessen bleibt der Atemwiderstand konstant.

D. Anweisung für den Gebrauch

1. Das Flaschenventil mit 1½ bis 2 Umdrehungen öffnen.
2. Das Gerät anlegen, d. h. mit den Armen durch die Trageriemen schlüpfen, den Schrittriemen nach vorn durch die Schrittöffnung der Beine führen und auf den Leibriemen ziehen. Leibriemen durch Doppelöse festziehen. Bei richtigem Paß-Sitz liegt der Lungenautomat etwa zwischen den Schulterblättern am Körper an.
3. Jetzt das übrige Gerät, z. B. Schwimmflossen, Tauchbrille, Nasenklemme, Ohrenstöpsel und Sicherheitsleine anlegen.
4. Mundstück in den Mund nehmen, dabei die beiden Beißzapfen mit den Zähnen festhalten. Durch mehrmaliges kräftiges Durchatmen prüfen, ob der Lungenautomat genügend Luft spendet und nun langsam ins Wasser steigen.
5. Dicht unter der Wasseroberfläche während der Dauer einiger Atemzüge verharren, um sich an die neuen Atemverhältnisse unter Wasser zu gewöhnen; erst danach mit dem Tauchen beginnen.
6. Neigt sich der Preßluftvorrat der mitgeführten Flasche dem Ende zu, empfindet der Taucher eine merkliche Behinderung der Einatmung. Dies ist ein Auftauchzeichen, welches zeitlich so eingestellt ist, daß ein ruhiges Auftauchen mit dem Rest der Atemluft gewährleistet ist.
7. Ist beim Tauchen oder Schwimmen Wasser durch das Mundstück in den Atemschlauch und weiter in den Lungenautomaten eingedrungen, so kann dieses durch kräftiges Hineinpusten in das Mundstück bei der Ausatmung fast restlos entfernt werden. Der Faltenschlauch soll hierbei so gehalten werden daß er Gefälle zum Lungenautomaten hat. Geübte Taucher werden bei diesem Vorgang nicht einmal aufzutauchen brauchen.
8. Ist das Gerät ausgeatmet oder soll der Tauchvorgang unterbrochen werden, nehme man nach dem Auftauchen das Mundstück aus dem Mund und begebe sich an Land. Das Flaschenventil ist jetzt zu schließen und der Lungenautomat durch Saugen am Mundstück drucklos zu machen.
9. Bei Flaschenwechsel (wenn Flasche leergeatmet) läßt sich die Anschlußverschraubung nur lösen, wenn der Lungenautomat vorher durch Absaugen vom Druck entlastet worden ist.

E. Behandlung des Gerätes nach dem Gebrauch

1. Lungenautomat von der Flasche abschrauben und vornehmlich nach dem Tauchen in Salz oder gechlortem Wasser sofort mit reinem Süßwasser durchspülen. Am besten einen Wasserhahn leicht öffnen und das Mundstück so

An die

BARAKUDA-GESELLSCHAFT

HAMBURG 20

HEILWIGSTRASSE 118

Barakuda catalogue of August 1953 Page 2
Double page, left half

öffnet das lungenautomatische Ventil, das gerade soviel Atemluft spendet, wie zum Füllen der Lungen erforderlich ist. Bei Beendigung der Einatmung schließt sich dieses Ventil selbsttätig.

Die Ausatemluft wird wieder in den Lungenautomaten hineingeatmet und verläßt diesen durch ein geschützt angeordnetes Ausatemventil. Bei zunehmender Tauchtiefe sorgt der Lungenautomat selbsttätig für den Druckausgleich im Gerät. Infolgedessen bleibt der Atemwiderstand konstant.

D. Anweisung für den Gebrauch

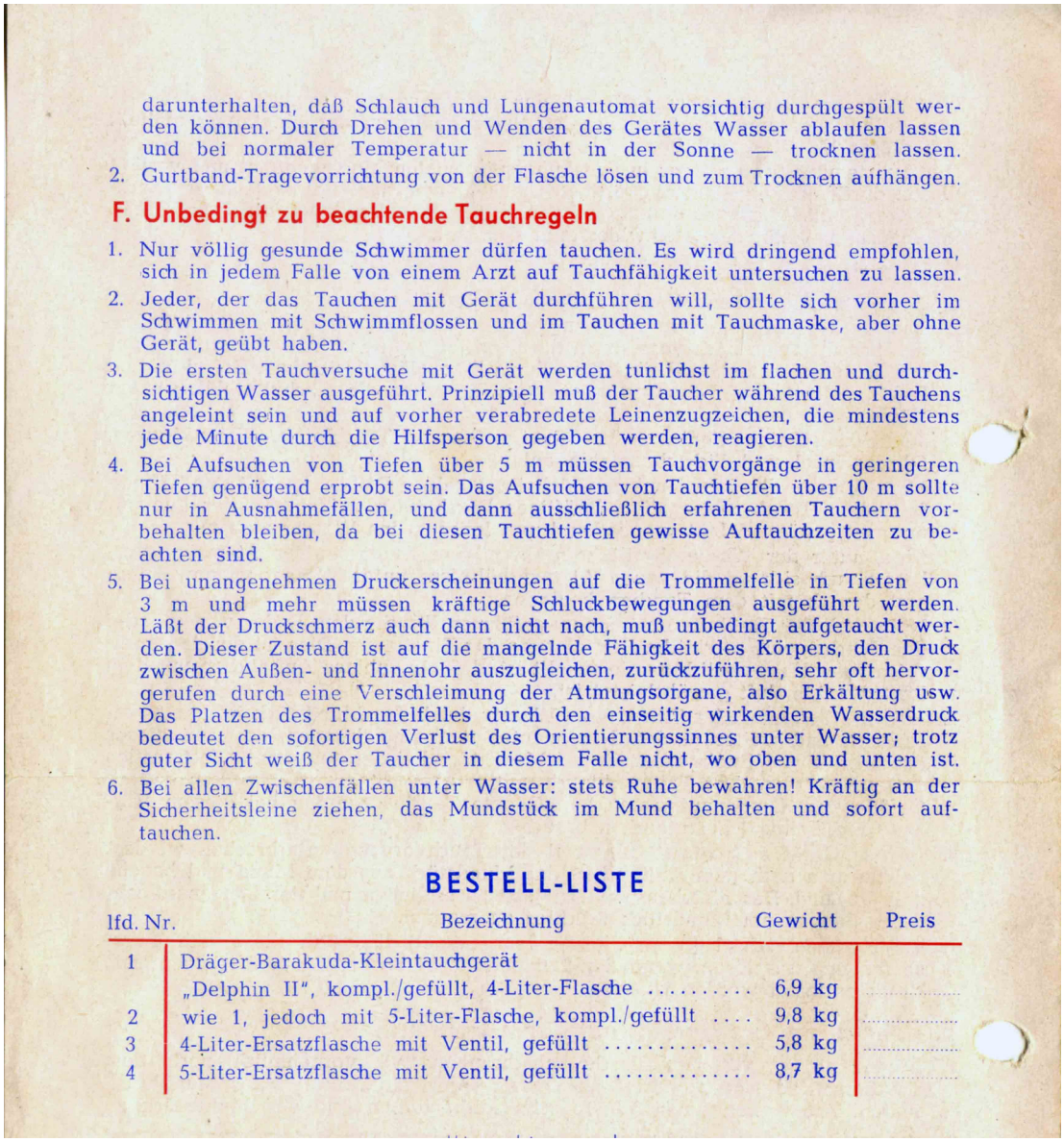
1. Das Flaschenventil mit 1½ bis 2 Umdrehungen öffnen.
2. Das Gerät anlegen, d. h. mit den Armen durch die Trageriemen schlüpfen, den Schrittriemen nach vorn durch die Schrittöffnung der Beine führen und auf den Leibriemen ziehen. Leibriemen durch Doppelöse festziehen. Bei richtigem Paß-Sitz liegt der Lungenautomat etwa zwischen den Schulterblättern am Körper an.
3. Jetzt das übrige Gerät, z. B. Schwimmflossen, Tauchbrille, Nasenklemme, Ohrenstöpsel und Sicherheitsleine anlegen.
4. Mundstück in den Mund nehmen, dabei die beiden Beißzapfen mit den Zähnen festhalten. Durch mehrmaliges kräftiges Durchatmen prüfen, ob der Lungenautomat genügend Luft spendet und nun langsam ins Wasser steigen.
5. Dicht unter der Wasseroberfläche während der Dauer einiger Atemzüge verharren, um sich an die neuen Atemverhältnisse unter Wasser zu gewöhnen; erst danach mit dem Tauchen beginnen.
6. Neigt sich der Preßluftvorrat der mitgeführten Flasche dem Ende zu, empfindet der Taucher eine merkliche Behinderung der Einatmung. Dies ist ein Auftauchzeichen, welches zeitlich so eingestellt ist, daß ein ruhiges Auftauchen mit dem Rest der Atemluft gewährleistet ist.
7. Ist beim Tauchen oder Schwimmen Wasser durch das Mundstück in den Atemschlauch und weiter in den Lungenautomaten eingedrungen, so kann dieses durch kräftiges Hineinpusten in das Mundstück bei der Ausatmung fast restlos entfernt werden. Der Faltenschlauch soll hierbei so gehalten werden daß er Gefälle zum Lungenautomaten hat. Geübte Taucher werden bei diesem Vorgang nicht einmal aufzutauchen brauchen.
8. Ist das Gerät ausgeatmet oder soll der Tauchvorgang unterbrochen werden, nehme man nach dem Auftauchen das Mundstück aus dem Mund und begebe sich an Land. Das Flaschenventil ist jetzt zu schließen und der Lungenautomat durch Saugen am Mundstück drucklos zu machen.
9. Bei Flaschenwechsel (wenn Flasche leergeatmet) läßt sich die Anschlußverschraubung nur lösen, wenn der Lungenautomat vorher durch Absaugen vom Druck entlastet worden ist.

E. Behandlung des Gerätes nach dem Gebrauch

1. Lungenautomat von der Flasche abschrauben und vornehmlich nach dem Tauchen in Salz oder gechlortem Wasser sofort mit reinem Süßwasser durchspülen. Am besten einen Wasserhahn leicht öffnen und das Mundstück so

Barakuda-Katalog vom August 1953, Seite 3

Barakuda catalogue of August 1953 Page 3



darunterhalten, daß Schlauch und Lungenautomat vorsichtig durchgespült werden können. Durch Drehen und Wenden des Gerätes Wasser ablaufen lassen und bei normaler Temperatur — nicht in der Sonne — trocknen lassen.

2. Gurtband-Tragevorrichtung von der Flasche lösen und zum Trocknen aufhängen.

F. Unbedingt zu beachtende Tauchregeln

1. Nur völlig gesunde Schwimmer dürfen tauchen. Es wird dringend empfohlen, sich in jedem Falle von einem Arzt auf Tauchfähigkeit untersuchen zu lassen.
2. Jeder, der das Tauchen mit Gerät durchführen will, sollte sich vorher im Schwimmen mit Schwimmflossen und im Tauchen mit Tauchmaske, aber ohne Gerät, geübt haben.
3. Die ersten Tauchversuche mit Gerät werden tunlichst im flachen und durchsichtigen Wasser ausgeführt. Prinzipiell muß der Taucher während des Tauchens angeleint sein und auf vorher verabredete Leinenzugzeichen, die mindestens jede Minute durch die Hilfsperson gegeben werden, reagieren.
4. Bei Aufsuchen von Tiefen über 5 m müssen Tauchvorgänge in geringeren Tiefen genügend erprobt sein. Das Aufsuchen von Tauchtiefen über 10 m sollte nur in Ausnahmefällen, und dann ausschließlich erfahrenen Tauchern vorbehalten bleiben, da bei diesen Tauchtiefen gewisse Auftauchzeiten zu beachten sind.
5. Bei unangenehmen Druckerscheinungen auf die Trommelfelle in Tiefen von 3 m und mehr müssen kräftige Schluckbewegungen ausgeführt werden. Läßt der Druckschmerz auch dann nicht nach, muß unbedingt aufgetaucht werden. Dieser Zustand ist auf die mangelnde Fähigkeit des Körpers, den Druck zwischen Außen- und Innenohr auszugleichen, zurückzuführen, sehr oft hervorgerufen durch eine Verschleimung der Atmungsorgane, also Erkältung usw. Das Platzen des Trommelfelles durch den einseitig wirkenden Wasserdruck bedeutet den sofortigen Verlust des Orientierungssinnes unter Wasser; trotz guter Sicht weiß der Taucher in diesem Falle nicht, wo oben und unten ist.
6. Bei allen Zwischenfällen unter Wasser: stets Ruhe bewahren! Kräftig an der Sicherheitsleine ziehen, das Mundstück im Mund behalten und sofort auftauchen.

BESTELL-LISTE

lfd. Nr.	Bezeichnung	Gewicht	Preis
1	Dräger-Barakuda-Kleintauchgerät „Delphin II", kompl./gefüllt, 4-Liter-Flasche	6,9 kg	.....
2	wie 1, jedoch mit 5-Liter-Flasche, kompl./gefüllt	9,8 kg	.....
3	4-Liter-Ersatzflasche mit Ventil, gefüllt	5,8 kg	.....
4	5-Liter-Ersatzflasche mit Ventil, gefüllt	8,7 kg	.....

Barakuda catalogue of August 1953 Page 4

At that time, the manuals, in addition to the technical description and instructions for handling, usually had a small "diving instruction course". It is noticeable in some places, how much sport diving was still in its infancy. It was recommended under "D 3" to use ear plugs. Pressure equalization masks did not exist and so it was recommended from 3 m depth to make "vigorous swallowing movements" under "F 5".

ÜBERSICHT DER DELPHIN-MODELLE

a) Preßluft-Tauchgerät Modell „Delphin" II/800
Gerät mit einer 4-l-Preßluftflasche (115 mm ø) für 200 kg/cm² Gebrauchsdruck mit Lungenautomat, Gurtbandtragevorrichtung, Rückenblech und Schnellbänderung (Abb. 12). Diese Flasche ist auch für eine Erweiterung zum Flaschenpaket Modell 1600 „Baltic" zu verwenden, wozu auch der Delphin-Lungenautomat benutzt werden kann. In dieser Form entspricht das Gerät dem bisherigen Delphin III.

b) Preßluft-Tauchgerät Modell „Delphin" II/1000
Gerät mit einer 5-l-Preßluftflasche (140 mm ø) für 200 kg/cm² Gebrauchsdruck, mit Lungenautomat, Rohrtragegestell und Schnellbänderung (Abb. 11).

Delphin II/1000" The parts list on p.3 below the image can also be cut off for space reasons. (left) and "Delphin II/800" (right) single-cylinder devices in the Dräger catalogue of 1962. In order that the diving apparatus "Delphin II/800" does not hit the neck of the wearer, there is a top spacer on the bottle.
With the thicker walled 5l bottle of "Delphin II/1000" the tubular "spacer" support frame is not necessary.

"Delphin III" twin cylinder unit with reserve circuit in the Dräger catalogue 1957 next to the "Delphin II".

The "Delphin" Regulator.
The single-stage " Delphin" is a relatively simple construction, a "pendulum" design with only one corrugated hose for inhalation and exhalation. It could be concluded that it was also very easy in its function and handling, as described in the advertising brochures of Barakuda illustrated above. This is not the case, as in-depth analysis of the machines should show.

Why had Dräger and Barakuda offered such a simple regulator?

From that time forward several explanations have been found. One of the most important was probably to save costs. In the Brochure from 1953 it is clearly explained in "A". In the years of the early 1950s the German "economic miracle" was still in its infancy, the people earned little and needed their money for daily necessities. In addition, it was not always possible for German firms after World War II to export abroad. In England and some other countries there was a ban on imports of products from former war opponents. Therefore an expensive product in a limited market had hardly any chances of success. This is probably why they decided to look for a cheap single stage pressure reducer with only one breathing tube. With the single-hose solution Dräger could also bypass the patents of Cousteau and Gagnan and so save expensive royalties.

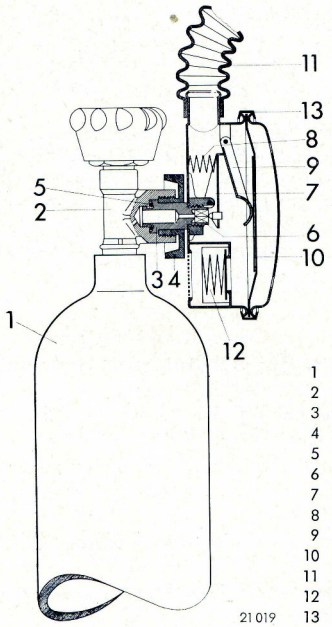
The "Delphin" was sold between 1953 to 1966. It was thus commercially available for longer than any of its successor models from Dräger.

The technical operation of the "Delphin" and its component parts

Wirkungsweise (s. a. Abb.3)

Die in der Preßluftflasche **1** gespeicherte Preßluft strömt bei geöffnetem Flaschenventil **2** zum Anschlußstutzen **3** und zum Schließbolzen **6** des Lungenautomaten. Beim Einatmen entsteht im Faltenschlauch **11** und im Raum links der Membran **10** ein geringer Unterdruck, unter dessen Einwirkung die Membran **10** sich nach links durchwölbt. Sie nimmt dabei den Oberhebel **9** mit, dessen Bewegung sich auf den Unterhebel **7** entgegen der Wirkung der Schließfeder **8** überträgt. Dadurch hebt sich die auf den Schließbolzen **6** drückende Stellschraube, und der viereckige Schließbolzen **6** kann jetzt durch den vor dem Ventilsitz befindlichen Druck angehoben werden. Die Preßluft strömt nun am Schließbolzen vorbei in den Lungenautomaten und zum Faltenschlauch. Sobald die Einatmung beendet ist und damit der Unterdruck im Lungenautomaten aufhört, bewegt sich die Membran unter dem durch die Hebel übertragenen Druck der Schließfeder wieder nach rechts. Dabei drückt die Schließfeder **8** über den Unterhebel **7** gleichzeitig wieder den Schließbolzen **6** auf den Ventilsitz. Damit hört die Luftzufuhr auf.

Bei der Ausatmung strömt die Ausatemluft durch den Faltenschlauch **11** zurück in den Lungenautomaten. Durch den entstehenden Überdruck öffnet sich das federbelastete Ventil **12** und die Ausatemluft strömt ins Wasser aus.



1 Preßluftflasche
2 Flaschenventil
3 Anschlußstutzen
4 Handrad
5 Dichtring
6 Schließbolzen
7 Unterhebel
8 Schließfeder
9 Oberhebel
10 Membran
11 Faltenschlauch
12 Ausatemventil
13 Haltering

Abb. 3 Schematische Darstellung des Lungenautomaten

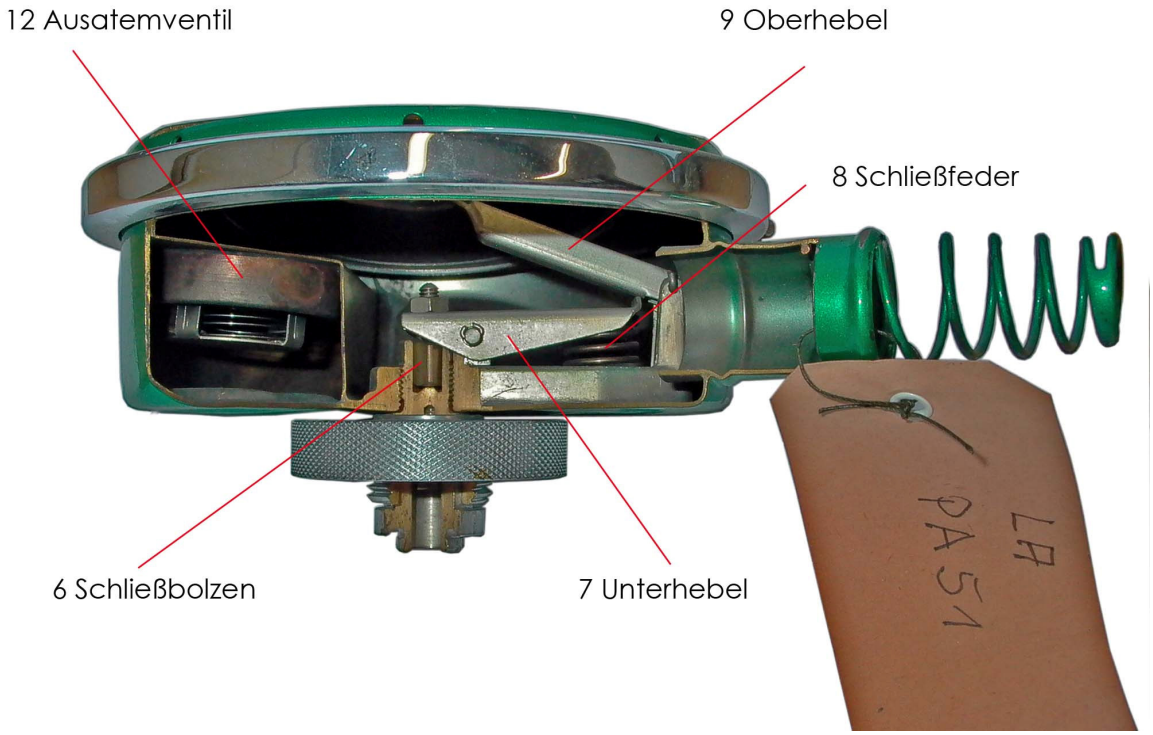
Dräger Instructions from 1961 carried sectional drawing and an explanation of how the regulator worked: Key: **1** Bottle of compressed air; **2** Cylinder valve; **3** Connection piece; **4** Wheel; **5** Seal; **6** Lockbolt; **7** Lever Action; **8** Closing spring; **9** Upper lever; **10** Diaphragm; **11** Corrugated hose; **12** Exhalation valve; **13** Retaining ring.

Mode of action

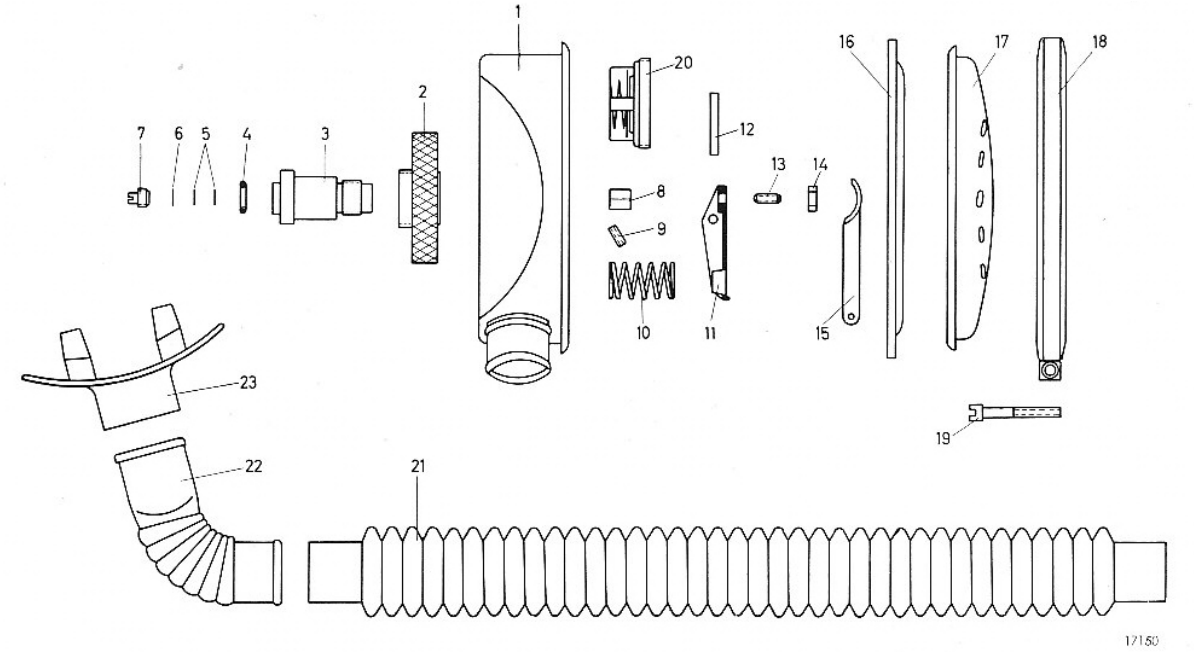
The charge of compressed air stored in the bottle 1 flows, when the bottle valve 2 is opened, to connection piece 3 and lockbolt 6 of the lung machines. During inhalation the diaphragm 10 lifts away from the corrugated hose 11 leaving a a small negative pressure in the space. The diaphragm 10 bulges under this action to the left. It acts on the upper lever 9 whose movement transfers the action of the closing spring 8 to the lever 7 wherein the pressure the lockbolt screw 6 eases, and square lockbolt 6 can be now be raised by the pressure in front of the valve seat, The compressed air now flows past the lockbolt into the regulator and the corrugated hose. Once the inhalation is complete and thus the negative pressure closes regulator, the diaphragm moves under the influence of the pressure transmitted by the closing lever to the right. Here, the closing spring 8 pushes via the lever 7 to return the lockbolt 6 on the valve seat. Thus stopping the air supply.

During exhalation, the exhaled air flows through the corrugated hose 11 back into the regulator. Due to the resulting overpressure, the spring-loaded valve 12 opens and the exhaled air flows out into the water.

Please enlarge so that the text can be read easily. Left and right display can also be shown in a column above each other, then the subscription form above.



Sectional model Dräger “Delphin”. Key: **6** square closing bolt; **7** lower lever; **8** spring or “closing” spring; **9** upper lever; **10** diaphragm; **12** exhalation valve.



Lfd. Nr.	Bezeichnung	Bestell-Zeichen	Preis
	Preßlufttauchgerät „Delphin II" vollst. mit 4-Ltr.-Flasche	R 16375	
	bestehend aus:		
	4-Liter-Preßluftflasche mit Ventil, 200 at gefüllt	B 2481	
	Tragegurt vollst.	R 16376	
	Lungenautomat „Delphin II" vollst.	R 16360	
	Preßlufttauchgerät „Delphin II" vollst. mit 5-Ltr.-Flasche	R 16350	
	bestehend aus:		
	5-Ltr.-Preßluftflasche mit Ventil, 200 at gefüllt	B 2521	
	Tragegurt vollst.	R 16378	
	Lungenautomat „Delphin II" vollst.	R 16360	
	Einzelteile für Lungenautomat „Delphin II"		
1	Bodenschale	R 16358	
2	Handrad	R 16345	
3	Anschlußstutzen	R 16353	

Lfd. Nr.	Bezeichnung	Bestell-Zeichen	Preis
4	Dichtring	R 16346	
5	Sieb	D 5304	
6	Gleitring	D 4766	
7	Siebschraube	R 3707	
8	Schließbolzen	R 16369	
9	Gewindestift (nichtrost. Stahl)	M 3x8 DIN 553	
10	Druckfeder	R 16355	
11	Hebel	R 16344	
12	Stift	R 16356	
13	Druckschraube	R 16357	
14	Sechskantmutter (Messing, vernickelt)	M 4 DIN 934	
15	Hebel	R 15953	
16	Membran	R 15950	
17	Deckel	R 16374	
18	Spannring	R 15937	
19	Schraube	R 16354	
20	Ausatemventil	R 16365	
21	Faltenschlauch	R 16371	
22	Mundstück-Krümmer	R 16623	
23	Gummi-Mundstück	R 16636	
	Perlonschnur 0,7 ∅ zum Einbinden des Faltenschlauches		

Dräger "Delphin II" Item List July 1956. The numbering is different from the two pictures above. The machine was constructed from only 23 parts. The single-stage regulator models "PA61 / 1" and "Monomat" are made up from twice as many parts.

Various Mouthpieces

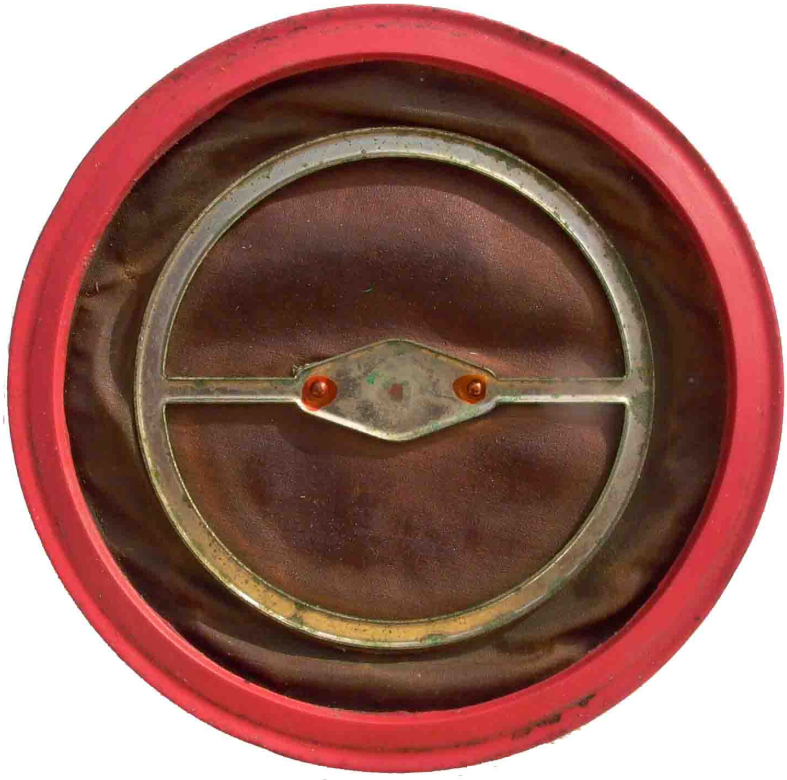
The standard mouthpiece of the “Delphin” with corrugated tube at an angle. Corrugated hose and mouthpiece were fixed by binding or whipping. The same mouthpiece was used in other Dräger breathing apparatus, plus a nose clip was attached to the eyelet on the front.

Optionally, there was also a removable mouthpiece. It consisted of the connector with retaining screw and insert holding a mouthpiece also a tightly-bound rubber mouthpiece. Photo: Jean Christophe Depoorter.

The corrugated hoses in these two pictures are of different shapes. In the top illustration the hose is angular, in the lower representation it is rounded at the outer circumference. In the top illustration the corrugations of the hose are angular, in the lower representation they are rounded at the outer circumference.

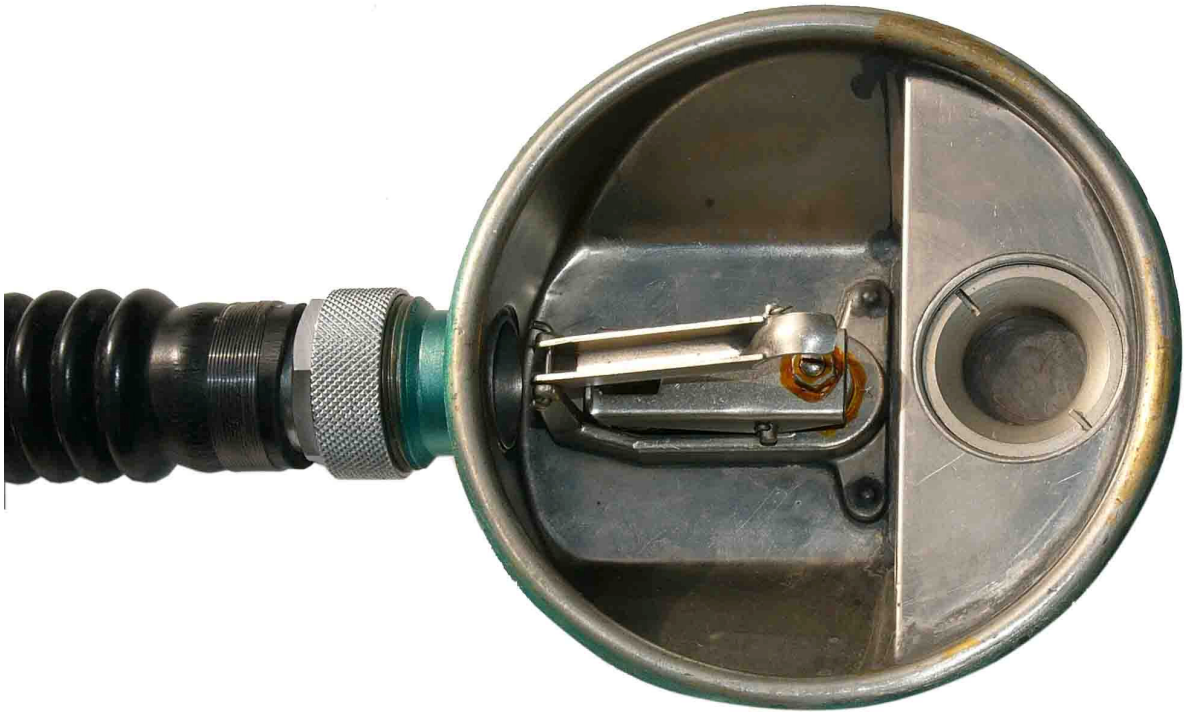
The mouthpiece can be rotated or removed if the knurled screw underneath is loosened. Photo: Jean Christophe Depoorter.

In the 1950s, the regulators were used by several people in diving associations, therefore a personalised mouthpiece made sense for reasons of hygiene. Why the corrugated hose was not interchangeable for the same reason, is unknown. This only became possible with a later variant.



Membrane of the "Delphin" of rubberized fabric with riveted annular metal reinforcement. The central horizontal bar was aligned parallel to the upper lever during assembly. Outside is the red rubber sealing edge.

View into the open controller housing: The breathing tube was slanted at an angle to the lever mechanism leading into the housing. To the right is a separate chamber with the screwed-in exhalation valve. It is believed that the chamber also serves to reduce the dead space.



Interior view of a second version with removable corrugated hose. On the left can be seen the threaded connection with union nut. This was offset laterally and was soldered in line with the lever mechanism and exhalation valve. The detachable hose permits easier cleaning inside the controller housing; it can dry out better without the hose. The outer curved bead is no longer on the top edge as in the above variant. The black corrugated hose in this image is not original.

The exhalation valve

The exhalation valve comprises a circular flat mica disc which is pressed by a compression spring on a sealing seat. Washer and spring are mounted in a demountable round capsule. Exhalation valves that seal completely are not possible in a regulator. The pressure of the spring would have to be very heavy to really seal, much too large to exhale against. So with each exhalation a few drops of water enter the controller housing and accumulate therein. Even small amounts of water can be sucked into the housing. Initially, these are unnoticed when diving because the water remains below normal swimming position in the housing. If one is floating upside down in the water, the accumulated water will run into the breathing tube and you get a water-air mixture in the mouth. This cannot be avoided due to the pendulum action of the "Delphin" with its lack of direction valves. A real diver would not be panicked by such a trifle of course.

Housing back with exhalation valve (left) and cylinder handwheel connector (middle).

The Handwheel Connector

At that time - we can hardly imagine it today - the supply of compressed air could be a big problem. In the *Drägerheft* no. 223 1953 we read

'While high-pressure oxygen is widely available, oil-free compressed air at 200 is available only in oxygen production plants. Whoever purchases an SCBA can consequently not do without an adequate cylinder park, especially since there are no small cheap compressors'. (2)

This was certainly one reason why regulators for swim-divers were constructed to be easily removable with hand wheel or yoke connectors. Thus they could be connected to full air cylinders easily and quickly. The system has been proven to date.

The patented low pressure warning

A pressure gauge or "Finimeter" was not fitted to the "Delphin II" for cost reasons. Flexible high pressure lines were labourious to produce and therefore expensive at that time.

Dräger solved the problem in a different way. In single-stage regulators the inhalation resistance increases slightly with decreasing cylinder pressure. Dräger turned this drawback into a virtue by dimensioning the nozzle of the pressure reducer so that breathing resistance increased markedly at 15 bar. The diver was thus warned that it was time to ascend. This low pressure warning required no additional parts, like the usual reserve circuit or a pressure gauge. It was thus a very simple and cheap solution, see: "D instructions for use 6 in the catalogue of 1953.

(The patent can be downloaded as a PDF file at the German Patent Office: http://www.dpma.de/english/index.html Click the links above for 'DEPATISnet', select Search mode 'Beginners' and enter in the line 'publication number' the patent number DE 974814B.)

The reserve valve of the "Delphin III" acted on only one of the two air cylinders, kicking in when about 40 bar was reached. The bottle without a reserve could then be breathed-down until the pressure reached 15 bar and breathing resistance increased as described above; it was time to pull the reserve and release the remaining 40 bar. This equalised pressure between the cylinders and breathing again became easy, until the residual pressure of 15 bar was reached again. It was then high time to surface.

The dead space and its pitfalls

The "pendulum" operation of the "Delphin" had a dead space of half a litre. This was made up from the volume of the corrugated hose, the mouthpiece and the regulator box and corresponded approximately to the volume of one breath at rest!

It was not possible to use directional valves in the mouthpiece to discriminate between inhalation and exhalation, two corrugated tubes would be necessary. With every breath you inhaled a proportion would contain carbon dioxide and water vapor from the previously exhalation before fresh, unused air followed. While exhaling, fresh air was blown out that was then remained in the controller housing and hose

before inhaling again.

Alexander Busch, System Engineer at Dräger Tauchtechnik explained this as follows: For every litre of external dead space, an increase of ventilation by almost 60% is necessary so that the carbon dioxide load remains within physiologically acceptable limits. This increases the rate of breathing and thus the work of breathing. In the case of the "Delphin" we are therefore expecting an average of 30% higher breathing rate and correspondingly a greater work of breathing can be assumed.

"External" dead space means the dead space of the machine. There are the "inner" dead spaces in the airways of the lung of about 140ml. This is a constant even during free breathing.
How do these relationships affect diving? Dr. Lothar Hassling, a member of the Historical Diving Society eV, is a diving medic and sees this increased carbon dioxide content as being problematic on longer, deeper dives.

Pendulum breathing may lead to an additive effect on nitrogen narcosis and DCI (decompression illness). An elevated carbon dioxide level in the blood leads to vaso-dilation and thus to increased blood circulation in the brain. Nitrogen is also increasingly blamed as the "culprit" in depth narcosis as well as decompression sickness. Furthermore, the carbon dioxide levels in the blood act as a major respiratory irritant and thus increase the breathing rate. This of course means an increase in nitrogen uptake. Other effects of a rising carbon dioxide tension in the blood are discomfort, palpitations, headache, ringing in the ears and sweating. These are all "stressors" that help promote nitrogen narcosis.

In the early 1950s there was hardly any protection against cold for Scuba divers, the dives were usually short and not too deep. However, the "Delphin III", with its two four-litre bottle volume and a rubber suit, allowed longer and deeper dives to be possible. It was therefore given a maximum depth limit of 25m.

The "Delphin" was thirteen years on the market, so it can be concluded that it was effective, at least for Scuba diving with short times and low diving depths, despite the above-mentioned problems.

Variants and Accessories

The following variants are known and are summarized here once again:

"Delphin" Regulators

Regulator housing:
- Hose entering at an angle to lever mechanism standing
- Hose in line with the lever mechanism and screw
- Housing with yellow stickers

Corrugated hose:
- Rounded shape
- Squared shape
- Hose protection with binding
- Clamp made of yellow plastic

Mouthpieces:
- Corrugated tube with loop
- Corrugated tube without eye
- Removable mouthpiece

Handwheel Connector

- Knurled on the outer circumference, O-ring seal.
- With four holes for studs using a key, nylon gasket.

When these variants were each introduced is unknown.

Compressed air diving apparatus:
"Delphin II / 800" with 4L cylinder 1953 - 1966
"Delphin II / 1000" with 5L cylinder 1953 - 1966
"Delphin III / 1600" with two 4L cylinder in 1955 - 1966. With and without reserve circuit.

Regulator housing with yellow stickers and knurled handwheel.
Photo: Sven Erik Jørgensen

Wooden case for the “Delphin” from the Dräger catalogue of 1957. The case is of high quality, has dovetailed corners, a lock box and a nice leather handle. The lid contains space for the manual.

Diving practice with the "Delphin II" Scuba cylinders.

Heinz-Dieter Seiffert, former chairman of the DUC Berlin and a member of the Historical Diving Society eV has written an account of his first experiences in 1955 with the "Delphin II":

The extremely strong influence from the reports and books by Hans Hass was the reason I sought a diving club in Berlin where I could be trained in the use of this diving apparatus with which to explore this unknown world under water myself. In May 1955 I, with friends found our way to the DUC Berlin and again in July, where we had the opportunity to participate in a training course with different diving equipment.

After several hours, and after extensive theoretical explanations about the devices we began the practical part of the training in the diving pool of the Berlin Olympic Swimming Stadium. We used Scuba cylinders of the "Delphin II" type and also Dräger oxygen diving apparatus type "138" for this course.

For me, to breathe independently from an aqualung under water was an overwhelming moment that left a lasting positive impression on me. Our instructors, especially Hans Joachim Kloss, familiarised us with the safe handling of the "Delphin II" compressed air device. We did various exercises to gain familiarity with the device; among others, to place the device on the bottom of the pool - "Take out the mouthpiece while always lower than the regulator! "- Then to dive back down to the device to put it on again properly.

We had an extended training in the use of this regulator; not only in a warm indoor pool, but also in colder open waters in Autumn. We never experienced problems with the pendulum breathing, but we were constantly reminded to take the mouthpiece out of the mouth occasionally while diving and induce an air by holding it slightly higher than the regulator (diaphragm). By this means the regulator could be "flushed" out, while dive time was barely reduced. The dead-space problem was also easier to solve: by breathing in through our mouth, and exhaling through our nose. Even during the occasional deeper dives while on vacation, we have met no problems while using the "Delphin".

Heinz Dieter Seiffert in 1955 with the "Delphin II" in the Berlin Olympic swimming pool.

Open water dives with the "Delphin II" in June 1959. HD Seiffert as an instructor on the left. A cavalier is helping the young lady with the diving apparatus.

Before a dive in a Berlin waters, November 1956

Heinz-Dieter Seiffert, equipped with a "Delphin II on the jetty. On the right next to the open water diver's helmet is a "Delphin" regulator connected to a twin cylinder diving apparatus and, on the left, a Dräger oxygen rebreather "Model 138" in action. Admired by spectators from the area, a club member is working the lever pump (third from the left on the dock). The safety line for the helmet diver, a reporter from the SFB (Sender Freies Berlin), is held by the trio behind HD Seiffert. Press Photo DUC Berlin, 1957

In Conclusion

This article on the "Delphin" has become longer than I expected at first. The more intensively I dealt with various aspects of the regulator and its use, the more questions arose. The research was extensive, though there is much that I have learned.
It seemed to me I should also include something of those times with their particular circumstances. So a little about the history of the beginnings of sport-diving in Germany has come to the fore. In summary, it should be noted that the "Delphin" is not simply a rarity, it also has character! It would be a shame to leave it on the shelf so, being well aware of its pitfalls in use, I will make use of it for the occasional dive.

Notes.

* "Pendulum breathing" refers to a system where the diver breathes in and out through a single hose, usually (though not exclusively) in a closed-circuit apparatus. Clearly there is considerable "dead-space" in the system.

** "Swim (or swimming) divers" is a common German term. It is used to distinguish divers using mask and fins with a breathing apparatus from those using helmet and weighted boots. Hans Hass is recognised as the inventor of this diving method. Swim or swimming divers need regulators which automatically supply breathing gas in all conceivable body positions: horizontal, head up, head down. . .

References:

1) Phil Nuytten, *Emile Gagnan and the Aqua-Lung, Part 1: 1948-1958*, Historical Diving Society, Canada 2004

2) Dr. Ing. Franz Hollmann "SCBA" in *Drägerheft*, No. 223, March/December 1953

All images by the author except those especially identified.

This article was first published in the HDS Germany's *TauchHistorie, Zeitschift der Historischen Tauchergesellschaft e.v.* Issue, Nr 3./February 2015

Note: *Drägerheft* are a series of magazines published by Dräger from the beginning of the 20th century. Today they represent a valuable source of information.