Zusatzinformationen

Dräger PA 60/2
Der erste zweistufige Zweischlauchregler von Dräger für Sporttaucher
Von Franz Rothbrust

Dräger-Prospekt PA 60/2 von Mai 1956 in Deutsch

Dräger-Prospekt PA 60/2 von Juli 1956 in Englisch

Dräger-Gebrauchsanweisung PA 60/2 von Januar 1958 in Deutsch

Englischer Original-Text
der Erläuterungen von Peter Jackson (HDS UK), ehemaliger Ingenieur bei Siebe Gorman:

The clip is obviously intended to be part of the assembly as it is shown in the manufacturer's exploded drawing (7). Its function may not appear obvious but it has an important part to play. In the event of high flows of air through the regulator, pressure under the first stage diaphragm may fall low enough to cause the diaphragm to move inwards far enough for its metal hub (13) to bottom in the housing, effectively cutting off the flow. This unfortunate characteristic of the regulator was no doubt discovered after it went into production, so the addition of the clip was, in effect, an afterthought. A better engineered solution would have been to castellate the face of the diaphragm hub. The regulator should not be used without the clip in place.
The condition that I have described is a dynamic one. When high flows of air are demanded from the regulator, it is possible that the pressure under the diaphragm could fall to a low enough level to allow the diaphragm hub to make contact with the housing. It is true that air is entering the diaphragm hub from the cylinder, but it may not always enter fast enough to maintain the required secondary pressure. There are many factors influencing the rate of flow into the hub, including the combined resistance of all the passageways through the cylinder valve, the manifold (if a multi-cylinder apparatus), the filter and the first stage valve itself.

Combined with this is the drag effect of high flow, which tries to pull an upstream type of valve towards the closed position as the air passes through it. This is particularly relevant at depth, as the density of the flowing air increases as its pressure increases and so it applies an increasing closing force to the valve. This, of course, is because the first stage delivery pressure increases with depth - 1 bar higher for each 10 metres of depth.

There is yet another potential restriction to flow into the diaphragm hub that can be seen in the sectional view of the regulator (PA 60 SDS KOM). Assuming the drawing to be to scale proportionally, it looks as though, with the diaphragm moved in as far as it can go (ie. with the hub touching the housing – no clip), then the conical end face of the valve plunger (12) will be very close to the back opening of the valve jet. This could also present a significant restriction to high flow into the diaphragm hub.

A further limitation to this design of regulator is the fact that the air passes out through the second stage valve directly from the area under the diaphragm, which includes the area inside the hub. As the face of the hub approaches the inside of the housing at high flows, the diaphragm becomes affected by an increasingly divided area of downstream pressure. Air enters the area inside the hub, but leaves from the area outside the hub. If these two areas are not constantly maintained at the same (identical) pressure, regardless of flow, then correct regulation of second stage supply pressure under all conditions will not be possible. If the face of the hub moves close enough to the face of the housing, the

resulting resistance to flow can cause the pressure under the outer area of the diaphragm to decline with increasing flow. The end result could quite possibly be that the face of the hub then closes against the housing. This, in turn will not only cause a severe loss of airflow to the diver, but will subsequently delay restoration of the correct second stage pressure as pressure inside the hub will have to increase to a significantly higher level in order to push it away from the housing and allow pressure to act on the outer area of the diaphragm as well.

The resulting rapid fluctuations in delivery pressure might well also cause “hammering” of the first stage as it struggles to maintain a consistent position, particularly as the design has no inherent damping other than that provided by having two diaphragm biasing springs with distinctly different characteristics. No doubt the reason for the regulator having both springs is to reduce the incidence of oscillation, which can also arise from turbulence in the flow out of the first stage, particularly when the air is taken directly from the area where it acts upon the diaphragm to oppose the spring(s) and thus regulate the pressure. When the regulator is not in use, the face of the hub is closed against the housing so that, when high pressure air is admitted by opening the cylinder valve, once again the pressure under the hub will rise to a level substantially above the designed second stage delivery pressure, with a corresponding instantaneous lack of proper regulation.

So, you see, it is necessary to prevent the face of the diaphragm hub from making close contact with the housing and that is what the little wire clip does!

I hope this has not been too tedious.

Best wishes,
Peter
