COMPENSATOR FOR SUBMARINE PRESSURES

by ERIC PELLERIN

This apparatus is used for maintaining, inside submerged measuring instruments, a pressure as near as possible to that which it resists exteriorly. This enables recording apparatuses to be used on land, and in general delicate apparatuses which sea water deteriorates or which, when working, would be upset by immersion.

This apparatus is based on the following principe: to replace the fluid filling the ordinary compensator bellows by a much less compressible fluid which allows the apparatus to be immersed to depths where the fluid is less compressible.

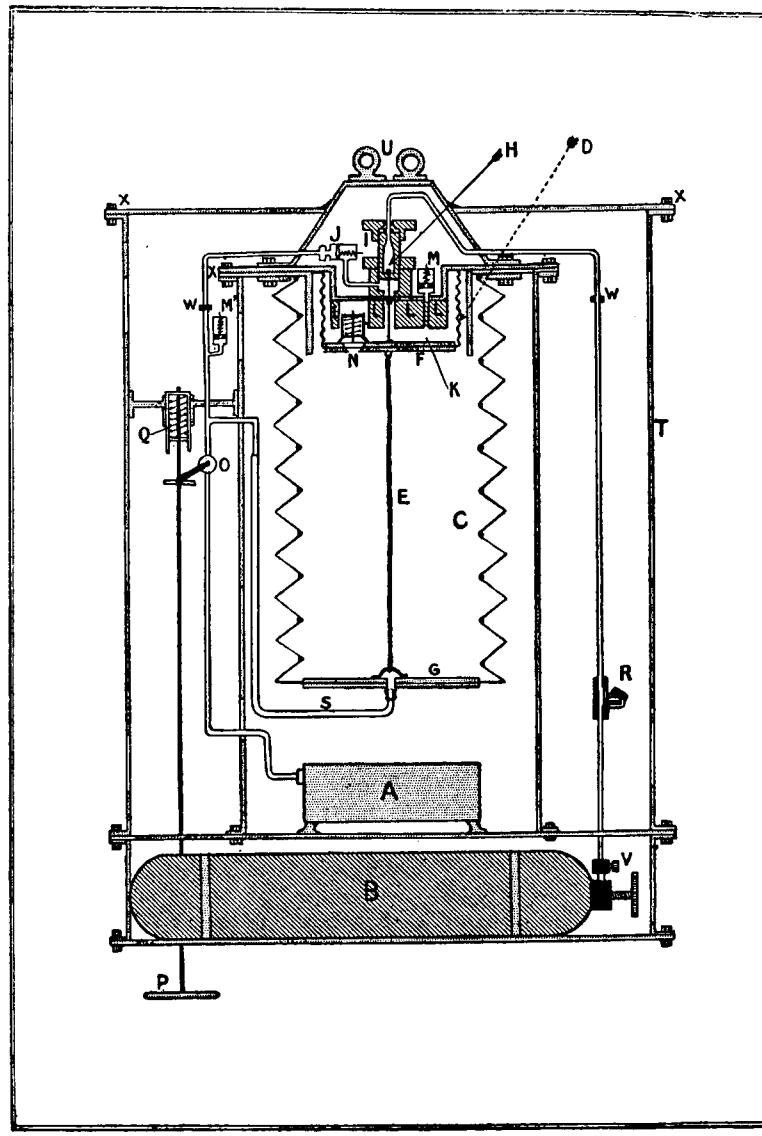
Our apparatus uses air as fluid (or any other gas difficult to liquify) compressed to high pressure in steel bottles; a suitable device maintains, during the descent, the rubber bellows at their initial volume, untill reaching the depth (depending on the ratio of the volume of the bottles and bellows, as well as on the pressure in the bottles) so that the pressure in the bellows is equal to the pressure in the bottles. From that moment the apparatus compensates the pressures by diminution of the volume of the bellows, which, filled with air (or the gas used) to a much higher pressure than the atmosphere, needs to be submitted to much higher pressures for reducing its volume by the same quantity by which it would have been diminished if it had compensated the pressure by diminution of the volume from the surface.

A simple calculation shows that much greater oceanic depths can be attained without using, for the air bottles, pressures greater than that actually used in industry.

When weighing the apparatus, safety valves opening towards the sea and tested to 300 grammes per square centimetre allow the excess of air to escape.

The gradual introduction of compressed air into the bellows is provided for by a special device resembling the reducing valve of industry but which works not for a constant pressure but for constant difference of pressures (between the bellows and the valve chamber).

The attached sketch, better than a long description, shows the working of the apparatus.



EXPLANATORY NOTES REFERRING TO THE SKETCH.

A. Apparatus where the pressure is compensated (tide gauge, thermograph, etc.).

B. Compressed air bottle. (For great depths several are placed side by side and connected to same pipe).

C. Rubber bellows (A rubber covered iron wire is placed at the bottom of each pleat to prevent expansion of the bellows when inside pressure is greater than outside).

D. Very thin corrugated metal cylinder.

E. *F.G.* Wire chain connecting the plates *G* and *F* which make a tight joint for bellows *C* and cylinder *D*.

H. A non return valve at the extremity of a steel rod fixed to plate *F* which, when lifting, allows compressed air contained in the body of valve *I* to penetrate into the bellow *C* after having passed valve *J*. (The aperture closed by the valve is of small section).

I. Body of the valve.
J. Valve allowing passage of gas towards the bellows only.
K. Chamber inside cylinder *D.*
L. Metallic masses for filling useless space.
M, M'. Valves tested to 300 grammes per square centimetre opening towards the outside.
N. Valve tested to 250 grammes per sqaure centimetre and opening towards the inside chamber *K.*
O. Cock shutting when plate *P* comes into contact with the bottom and opening by means of spring *Q* when the apparatus is weighed.
P. Plate for contact with the bottom, controlling cock *O.*
Q. Spring of cock *O.*
R. A non-return valve.
S. Rubber tube connecting the bellows to fixed pipes.
T. Protecting steel cover.
U. Mooring rings.
V. Filling valve of compressed air bottles.
W. Joints.

WORKING.

After having undone the screws *X* and unscrewed through the apertures of casing *T* the joints *W*, by lifting up by the mooring rings *U*, the bellows and reducing valve block are taken out together; then the apparatuses for observing are introduced into *A*; then the upper part is screwed down again after everything has been put into place.

When immersing the apparatus, valve *R* is kept shut by hand, then the hand valves of the air bottles are opened. The air has been compressed in the latter to a pressure varying with the depth desired.

The apparatus is then immersed.

Water acting on the interior face of plate *G* compresses the air contained in bellows *C*. This pressure is transmitted on to plate *F* and, by the steel rod mounted on it, to valve *H* which opens. The compressed air, lifting valve *J*, passes through rubber tube *S* and fills the bellows. When they are full, the thin chain *E*, tightening, shuts valve *H*, also shutting off the admission of compressed air.

When the pressure of bellows *C* exceeds the pressure in chamber *K* by 250 grammes per square centimetre, valve *N* opens and the equilibrium is reestablished.

As the apparatus descends, bellows *C* are thus kept full up to a certain depth to which air pressure in the bottles becomes about equal to the pressure of air in the bellows.

From this moment onwards, valve *J* preventing the readmission of air in the bottles, the apparatus works as ordinary compensator bellows, but as the gas in it is much less compressible because of the pressure, it can descend much more deeply before the bellows are completely flat.

If, by reason of too great adherence, valve *H* had remained stuck to its seat, the apparatus would have worked as ordinary compensator bellows until the stirrup of chain *E*, fixed to plate *G*, pressing on plate *F*, unsticks valve *H*; the apparatus then returns of itself to normal working conditions.

When it is desired to use the apparatus for great depths, valve *R* pre-

vents the breaking of the bottles and pipes up to valve *J*. Sea water rushes in as soon as the pressure becomes less than the external pressure. Valve *R*, being unable to reshut, prevents bursting while weighing.

Valves *M* and *M'* allow the escape of excessive air while weighing.

Cock *O*, governed by plate *P* and spring *Q*, isolates the observing apparatuses from the compensator as long as the apparatus is on the bottom.

To use less air, the tubes must be of small section and must take up as little useless space as possible in the observing apparatuses.

Above all, partial weighings when lowering, or partial lowerings when weighing must be avoided, for they would cause a useless waste of air and might even cause water to leak in .

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