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**D E C I S I O N**  
**of 11 January 1996**

**Case Number:** T 0574/94 - 3.2.1

**Application Number:** 86111176.3

**Publication Number:** 0215296

**IPC:** F15B 1/047

**Language of the proceedings:** EN

**Title of invention:**  
Helium charged hydraulic accumulators

**Patentee:**  
Rockwell International Corporation

**Opponent:**  
Integral Hydraulik & Co

**Headword:**  
-

**Relevant legal provisions:**  
EPC Art. 56

**Keyword:**  
"Inventive step (no)"

**Decisions cited:**  
-

**Catchword:**  
-



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Boards of Appeal

Chambres de recours

Case Number: T 0574/94 - 3.2.1

**D E C I S I O N**  
of the Technical Board of Appeal 3.2.1  
of 11 January 1996

**Appellant:**  
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**Representative:** Wagner, Karl H.  
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**Respondent:**  
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**Decision under appeal:** Decision of the Opposition Division of the  
European Patent Office posted 3 May 1994 revoking  
European patent No. 0 215 296 pursuant to  
Article 102(1) EPC.

**Composition of the Board:**

**Chairman:** F. Gumbel  
**Members:** S. Crane  
G. Davies

Summary of Facts and Submissions

I. European patent No. 0 215 296 was granted on 27 December 1989 on the basis of European patent application No. 86 111 176.3.

Claim 1 of the granted patent reads as follows:

"An accumulator (10) for use in high pressure hydraulic fluid systems, of the type having a housing (12), a chamber (14) within said housing (12), said chamber (14) sealingly containing a gas under pressure (16), and means (20) for allowing expansion of said gas in said chamber (14) in order to transmit the force of said gas under pressure to the hydraulic fluid (22) to displace a desired volume of hydraulic fluid in the system from said housing (12), said means for allowing expansion of said gas to transmit the force of said gas comprising a metal bellows (20) mounted in said chamber (14), characterized by providing said gas under pressure (16) in excess of approximately 3,000 psi (210 bar) throughout an entire operative range of operating temperatures and pressures, the size of said chamber being substantially in accord with the equation:

$$V_a = V_o \left[ 1 + \frac{\left(\frac{P_6}{P_2}\right) \left(\frac{Z_6}{Z_2}\right) \left(\frac{T_6}{T_2}\right)}{\left(\frac{P_2}{P_3}\right) \left(\frac{Z_3}{Z_2}\right) \left(\frac{T_3}{T_2}\right) - 1} \right]$$

where

V<sub>a</sub> = accumulator volume = oil (hydraulic fluid) volume plus gas volume in the accumulator,

$V_o$  = hydraulic oil (fluid) required to power a given device,  
 $T_2$  = lowest accumulator gas temperature before oil discharge,  
 $P_2$  = accumulator gas pressure at  $T_2$ ,  
 $Z_2$  = compressibility factor, a function of  $T_2$  and  $P_2$ ,  
 $T_3$  = accumulator gas temperature after oil discharge,  
 $P_3$  = accumulator gas pressure at  $T_3$ ,  
 $Z_3$  = compressibility factor, a function of  $T_3$  and  $P_3$ ,  
 $T_6$  = highest accumulator gas temperature before oil discharge,  
 $P_6$  = accumulator gas pressure at  $T_6$ ,  
 $Z_6$  = compressibility factor, a function of  $T_6$  and  $P_6$

said gas, including the precharge gas, being helium."

Dependent claims 2 and 3 relate to preferred embodiments of the accumulator according to claim 1.

II. An opposition against the granted patent was filed by the present respondent on the grounds, inter alia, that its subject-matter lacked an inventive step. As state of the art the respondents relied upon the following documents:

D1: R. Gangnath et al, "Optimization of Hydraulic Accumulators for Low Temperature Applications", Society of Automotive Engineers, International Summer Meeting, Montreal, 10 to 14 June 1963,

D2: DE-A-2 103 552,

D3: DE-A-2 824 979.

III. Oral proceedings before the Opposition Division were held on 3 December 1992. The respondents did not attend. At the oral proceedings the present appellants

(proprietors of the patent) submitted a new single claim which was directed to "a method for determining the optimum volume of an accumulator".

After deliberation the Opposition Division set a four-month time limit for the appellants to submit a revised description, which was to be adapted to the terms of the new claim and to include an acknowledgement of the most relevant state of the art, and for the respondents to comment on the new claim. The minutes of the oral proceedings were posted on 16 December 1992.

- IV. With a letter dated 25 January 1993 the respondents argued that the formula contained in the claim could be derived in a simple manner either from first principles or from the equivalent formula given in document D1.
- V. With letters dated 22 April, 28 June and 26 August 1993 the appellants requested three extensions of the time limit. The first two of these were granted fully, the third partially, so that in all the time limit was extended by nine months.

Finally, on 26 October 1993, the appellants filed a substantive reply to the submissions of the respondents in their letter of 25 January 1993. In the last sentence of their letter they requested continuation of the oral proceedings should the Opposition Division "disagree with the applicant's position". A revised description was not filed.

- VI. With its decision dated 3 May 1994 the Opposition Division revoked the patent.

The reasons given for the decision were that the patent specification, in the absence of a revised description, did not meet the requirements of the EPC, in particular

Rule 27. Since the patent could not therefore be maintained in the requested amended form it had to be revoked.

- VII. An appeal against this decision was filed on 13 July 1994 and the appeal fee paid on the same day.

With the statement of grounds of appeal, filed on 13 September 1994, the appellants submitted a revised description and a modified single claim 1, and requested that the patent be maintained in amended form on the basis of these together with the drawings as granted. The new claim was substantially equivalent to the claim filed at the oral proceedings before the Opposition Division.

The appellants argued that since the grounds for revocation of the patent had been removed the appeal should be allowed and the patent maintained in amended form. As the substantive issues had already been dealt with it would now be unfair to remit the case to the Opposition Division. The appellants commented that the course taken by the Opposition Division had been extreme. It would have been more in line with the normal practice of the EPO if after receipt of their letter of 25 October 1993 they had been informed that certain amendments or formalities were still outstanding. The last sentence of their letter could be interpreted as meaning exactly that.

- VIII. With a letter dated 28 September 1994 the respondent commented on the substantive merits of the case. They argued that the subject-matter of the claim lacked inventive step since the use of helium at high pressure had been proposed in document D2 and the formula used for "optimising" the volume of the accumulator was equivalent to the one found in document D1.

IX. In a communication dated 25 September 1995, the Board indicated that it intended to deal itself with the questions of whether the amended documents conformed with Articles 123(2) and (3) EPC and whether the claimed subject-matter was patentable, rather than remit the case to the Opposition Division. It stated that in its opinion the then valid single claim was unallowable having regard to Article 123(3) EPC and also expressed its reservations as to whether the subject-matter of the claim constituted more than a mathematical method as such, excluded from patentability by Article 52(2) EPC.

X. Oral proceedings before the Board were held on 11 January 1996. The respondents, who had already indicated their intention not to attend in a letter dated 2 January 1996, were not present.

At the oral proceedings the appellants requested that the patent be maintained on the basis of the granted claims with the description to be amended if this were necessary.

In support of this request the appellants argued substantially as follows:

Although the use of helium as a pressurizing gas for a hydraulic accumulator was proposed in document D2 there was no suggestion there that it would be beneficial to use it with an accumulator of the metal bellow type.

Similarly, there was nothing in document D1 to suggest that the formula proposed there for calculating the required volume of the accumulator was particularly applicable to an accumulator of this type or when the accumulator was filled with helium. In any case this formula was not identical to that found in claim 1 of the granted patent since the latter included the terms

$P_2$  and  $P_3$  thus enabling the person skilled in the art readily to determine the required accumulator volume to give chosen pressures at the start and end of accumulator discharge.

### Reasons for the Decision

1. The appeal complies with the formal requirements of Articles 106 to 108 and Rules 1(1) and 64 EPC. It is therefore admissible.
2. *Procedural questions*

Once the appellants had submitted a new single claim at the oral proceedings before the Opposition Division, the claims being directed to a "method for determining the optimum volume of an accumulator" rather than to an accumulator per se as was granted Claim 1, it was evident that the description of the patent specification would also require amendment. The amendments considered necessary by the Opposition Division (adaptation to the terms of the claim, acknowledgement of prior art) are set out in point 15 of the minutes of the oral proceedings. The Opposition Division set a time limit for the filing of suitable amendments, which was extended several times. The required amendments were however not filed by the appellants.

Now, according to Article 102(3) EPC the Opposition Division shall decide to maintain the patent amended if, taking into consideration the amendments made during the opposition proceedings, the patent and the invention to which it relates meet the requirements of the EPC. For the reasons given in the contested decision, with which the Board fully agrees, this was not the case here. Since the appellants had been clearly told what the

deficiencies in the patent specification were, and although they had been given more than adequate time to rectify them but had not done so, the Opposition Division was therefore justified in revoking the patent when they did.

In this context the Board cannot endorse the suggestion of the appellants that the proper approach would have been for the Opposition Division to remind them, after the receipt of their substantive response of 25 October 1993, of the need to file a revised description. Such an approach would not have been, in the opinion of the Board, clearly compatible with the requirement that the Opposition Division adopt an essentially neutral stance between the two parties involved. The respondents had a legitimate expectation that the procedure would be brought to a close within a reasonable time following the oral proceedings on 3 December 1992. The setting of a further time limit for filing the revised description, with possibly further requests for extension, would clearly not have been in their interest nor in the interest of procedural economy.

The request for continuation of the oral proceedings contained in the appellants' letter of 25 October 1993 is clearly restricted in its terms to the situation where the Opposition Division might consider revising its opinion on the substantive issues dealt with in that letter. As this was not the case, the Opposition Division was correct in not acceding to this request.

Since the amended description submitted with the statement of grounds of appeal effectively removed the grounds which led to revocation of the patent by the Opposition Division, the Board could in principle have remitted the case to the Opposition Division for it to take a decision on the outstanding formal and substantive issues. However, as the appellants themselves argued, that course of action would have led to an unjustifiable lengthening of the procedure. In the particular circumstances of this case, the Board therefore decided, for reasons of procedural economy, to make use of its power under Article 111 EPC to decide on these issues itself.

3. *Novelty and inventive step*

A hydraulic accumulator is an energy storage device for supplying quick response hydraulic power during for example peak transient loads. The accumulator essentially comprises a housing divided by a partition into two chambers of variable volume. One chamber contains gas under high pressure, the other chamber contains hydraulic fluid which is delivered on demand under the pressure of the gas. Traditionally nitrogen is used as the pressurizing gas. Three basic types of partition are known in the prior art: a floating piston, a flexible diaphragm and a metal bellows. An example of an accumulator of the latter type is disclosed in GB-A-1 047 983 (document D0), which is mentioned in the introductory description of the patent specification and on which the preamble of granted claim 1 is based.

The subject-matter of claim 1 is distinguished from the state of the art known from document D0 in that the gas in the accumulator is helium under a pressure in excess of approximately 3000psi (210 bar) throughout the entire operating range of the accumulator and that the volume

of the accumulator is determined by the formula stated in the claim. An accumulator having all the features set out in claim 1 is not disclosed in the cited state of the art and is therefore novel. Since this has not been in dispute, further detailed explanations are unnecessary.

The technical problem to which the claimed invention is directed is the provision of an accumulator which is of the minimum size and weight compatible with the use to which it is to be put. In particular, the claimed invention is concerned with an accumulator in which the gas charge is at high pressure, i.e. more than 3000 psi (210 bar), and which is to be used over a wide range of temperatures, such as experienced by an aircraft in operation.

The problem with the traditional filling gas, nitrogen, is that at high pressures, and in particular at the low temperatures experienced for example by an aircraft flying in the stratosphere, its properties deviate significantly from those of an ideal gas. The real gas effects significantly influence the performance of the accumulator, see document D1, page 2, right-hand column and document D2, page 3, paragraphs 3 and 4. In the left hand column of page 3 of document D1 mention is made of helium as possible filling gas as it allows a weight reduction of 85% based on nitrogen and its adiabatic exponent, "K", of 1.67 may be better than the effective "K" of nitrogen. It is however indicated that diffusion of helium through many engineering materials will present problems. Document D2 specifically proposes the use of helium as a filling gas at pressure above 300 bar to avoid the real gas effects experienced with nitrogen. In the specific example described on pages 10 and 11 the helium-filled accumulator operates at pressures between 600 and 400 bar. In paragraph 2, page 13, of this

document it is indicated that the volume of an accumulator using nitrogen needs to be of the order of 50% greater than when helium is used, for the same amount of energy stored.

Thus it is clear from the teachings of documents D1 and D2 that considerable benefits are associated with the use of helium as a filling gas at high pressures. A potential problem is however containing the helium adequately. However, it is apparent that the best containment offered by the known accumulator types is given by the use of a metal bellows, as disclosed in document D0, since here there are no leakage paths past a moving piston or the like and the diffusion of helium through the metal wall of the bellows can be expected to be less than that through a flexible, e.g. polymeric, diaphragm. Thus the Board comes to the conclusion that the use of helium as a filling gas, at pressures in excess of 3000 psi (210 bar), in an accumulator of the metal bellows type, was an obvious measure.

It is therefore necessary to consider the significance of the formula given in claim 1. This formula relates to the total volume of the accumulator ( $V_a$ ) to the quantity of hydraulic fluid ( $V_o$ ) which is required to be delivered and various other parameters, in particular the temperatures experienced by the accumulator in service.

As technical background it needs to be explained that as the accumulator is subjected to lower ambient temperatures the volume of the gas charge will tend to decrease. The oil charge is therefore automatically "topped off" to maintain the original predetermined filling pressure of the gas. This conventional procedure, see page 2, left-hand column, of document D1, is not mentioned in the patent specification but is

implicit in the fact that the pressure of the gas charge prior to use stays constant over the temperature range i.e.  $P_2 = P_4 = P_6$ , see Figure 2. Furthermore, it is to be noted that the gas expansion to discharge hydraulic fluid is essentially an adiabatic process, so that on expansion of the gas charge its temperature drops (eg. from  $T_2$  to  $T_3$ ). Taking account of these factors it is therefore necessary to determine the minimum volume of the gas chamber necessary to provide the required volume of hydraulic fluid at the minimum acceptable service pressure ( $P_3$ ) over the whole range of temperatures of the gas charge i.e. due to changes in ambient temperature ( $T_2$  to  $T_6$ ) and adiabatic expansion.

Since, as mentioned above,  $P_2 = P_6$  the term

$$\frac{P_2}{P_6}$$

equals one and can thus be eliminated from the formula given in the claim, which thus reduces to

$$V_a = V_o \left[ 1 + \frac{\left(\frac{Z_6}{Z_2}\right) \left(\frac{T_6}{T_2}\right)}{\left(\frac{P_2}{P_3}\right) \left(\frac{Z_3}{Z_2}\right) \left(\frac{T_3}{T_2}\right) - 1} \right]$$

In document D1, starting on page 5, at the bottom of the left-hand column a formula for the total accumulator volume is derived which appears in the middle of the left-hand column of page 7 and which, using the parameters of the patent specification, is as follows:

$$V_a = V_o \left[ 1 + \left( \frac{Z_6}{Z_2} \right) \left( \frac{V_2}{V_o} \right) \left( \frac{T_6}{T_2} \right) \right]$$

By making use of the relationships  $V_0 = V_3 - V_2$  and

$$V_x = \frac{R \cdot Z_x \cdot T_x}{P_x}$$

the respondents have demonstrated by appropriate substitution and manipulation that

$$\frac{V_2}{V_o} = \frac{1}{\left( \frac{P_2}{P_3} \right) \left( \frac{Z_3}{Z_2} \right) \left( \frac{T_3}{T_2} \right) - 1}$$

and thus that the formulae contained in present claim 1 and document D1 are equivalent. The correctness of their demonstration was not disputed by the appellants.

The formula given in document D1 is generally applicable to all types of accumulator and filling gases. The person skilled in the art using this formula to calculate the required total volume of an accumulator of the metal bellows type filled with high pressure helium as a gas charge will inevitably arrive at the same value, given the equivalence of the formulae, as if he were to calculate this using the formula given in claim 1. The appellants have argued that the formula of claim 1 is more convenient to use than that of document D1 since it allows the direct input of the values  $P_2$  and  $P_3$ , which are the ones most significant to the designer. Even if that were true it would be

irrelevant to the question of inventive step. The relevant feature of claim 1 is the volume of the accumulator, not how the volume is calculated. The volume calculated according to the claimed formula is not distinguished from the volume calculated according to the formula of the prior art, so that this feature can add nothing of inventive significance to the subject-matter of the claim.

**Order**

**For these reasons it is decided that:**

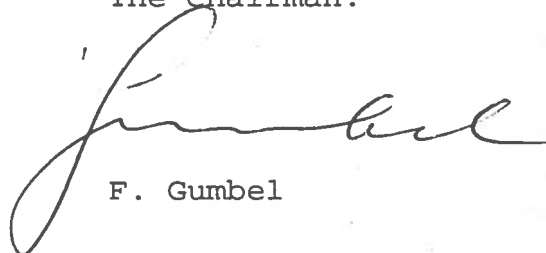
The appeal is dismissed.

The Registrar:



S. Fabiani

The Chairman:



F. Gumbel

