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D E C I S I O N
of 4 September 1997

Case Number: T 0442/97 - 3.2.4

Application Number: 92301717.2

Publication Number: 0557631

IPC: F02C1/10

Language of the proceedings: EN

Title of invention:
Maximum ambient cycle

Applicant:
Cosby, Thomas L.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 83

Keyword:
"Disclosure - sufficiency - (No)"

Decisions cited:
-

Catchword:
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Case Number: T 0442/97 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 4 September 1997

Appellant:
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 12 December 1996 refusing European patent application No. 92 301 717.2 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: C. A. J. Andries
Members: H. A. Berger
J. P. B. Seitz

Summary of Facts and Submissions

I. The appellant (applicant) has lodged an appeal against the Examining Division's decision of 12 December 1996 to refuse European patent application No. 92 301 717.2 for failure to disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art (Article 83 EPC). The appeal was received on 7 February 1997 and the appeal fee was paid on 12 February 1997. The statement of the grounds of appeal was received on 22 April 1997.

II. The independent claims under consideration are worded as follows:

Main request:
"1. A fluid circuit for producing work comprising: a turbine for producing a work output, said turbine having means for causing expansion of a working fluid at an incoming temperature and pressure and exhausting working fluid at a first temperature and pressure below said incoming temperature and pressure; a compressor downstream of the turbine; first means for effecting heat exchange between the fluid from said turbine that is exhausted at said first temperature and the compressor so that the fluid in the compressor is cooled and the exhaust fluid from the turbine is heated by the compressor through heat exchange therewith to a temperature above said first temperature; a reservoir for fluid from said turbine heated by the compressor; means for delivering fluid heated by the compressor to the reservoir; means for delivering fluid from the reservoir to the compressor for compression thereby; a second reservoir; means for delivering fluid compressed by the compressor to the second reservoir; and means for delivering fluid from said second reservoir to said turbine."

"6. A method of operating on a fluid to produce work in a system having a compressor and a turbine comprising the steps of: delivering operating fluid to the turbine at an incoming pressure and temperature to develop a work output and produce exhaust fluid at a temperature and pressure below the incoming pressure and temperature; cooling the compressor with exhaust fluid from the turbine; delivering operating fluid that has exhausted from the turbine and exchange heat with said compressor to a fluid inlet on the compressor for compression thereby; compressing operating fluid delivered through the compressor inlet in the compressor; delivering operating fluid compressed by the compressor to said turbine; and introducing additional energy, as necessary, to the system to permit the system to operate continuously."

"12. A method of operating on a working fluid to produce work comprising the steps of: providing a fluid compressor and a turbine with the fluid inlet; increasing the pressure of the working fluid in the compressor from a first pressure; expanding working fluid in the turbine to produce a work output and to reduce the pressure and temperature of working fluid coming into the turbine to a pressure and temperature for fluid exhausted by the turbine below the incoming fluid temperature and pressure; maintaining the temperature of the working fluid substantially constant in the compressor as the pressure of the working fluid is increased by the compressor by using the fluid exhausted from the turbine to cool the compressor through heat exchange; heating the fluid from the turbine by heat exchange with the compressor; delivering fluid from the turbine heated by the compressor to the turbine inlet; and introducing additional energy, as necessary, to the system to permit the system to operate continuously."

Auxiliary Request:

"1. A fluid circuit for producing work comprising: a turbine for producing a work output, said turbine having means for causing expansion of a working fluid at an incoming temperature and pressure and exhausting working fluid at a first temperature and pressure below said incoming temperature and pressure; a compressor downstream of the turbine; first means for effecting heat exchange between the fluid from said turbine that is exhausted at said first temperature and the compressor so that the fluid in the compressor is cooled and the exhaust fluid from the turbine is heated by the compressor through heat exchange therewith to a temperature above said first temperature; a reservoir for fluid from said turbine heated by the compressor; means for delivering fluid heated by the compressor to the reservoir; means for delivering fluid from the reservoir to the compressor for compression thereby; a second reservoir; means for delivering fluid compressed by the compressor to the second reservoir; means for delivering fluid from said second reservoir to said turbine; and means for introducing additional energy, as necessary, to the circuit to permit the circuit to operate continuously."

- followed by independent claims 6 and 12 as per the main request.

III. In reply to the first instance's argument that the described cycle (hereinafter MAC-1) is not a workproducing cycle but instead it is a work-consuming, refrigerating one, the appellant states that since no attempt is made to move heat from a low temperature zone to a high temperature zone this is not the case; the cycle is used to perform work. The appellant states that the essential cycle of the invention transforms heat absorbed from the environment into usable external work and that no infringement of the second law of thermodynamics is involved since the necessary temperature differential is indeed present. The higher temperature reservoir or source is made up by the environment and the lower temperature reservoir or sink is created internally in the form of the lower-than-ambient-temperature exhaust fluid from the turbine. With regard to the first instance's questioning of the attainability of a 'linear' run of the MAC-1 isothermal compression step, the appellant notes that this step is not comparable to the corresponding step of the Carnot cycle. In the Carnot cycle isothermal compression involves application of compression work. Seen on an infinitesimal scale this results in a saw tooth isothermal compression line. In the MAC-1 isothermal compression step heat is removed by means of the cool turbine exhaust fluid to such an extent that the total mechanical compression work becomes less than the work output from the turbine. Thus, MAC-1 delivers a net work output.

The appellant asserts that the thermodynamic cycle and the fluid circuit for realising the same in effect result in the production of external energy and that this mainly is due to the fact that the necessary work of compression in the compressor is reduced to be less than the work output generated by expansion in the turbine. Such reduction is made possible by carrying out compression in an ideal isothermal manner by utilising the cool exhaust fluid of the turbine to absorb the heat of the compressor to be rejected during the isothermal compression step. This heat exchange takes place internally thereby doing away with the need for an external heat sink in the traditional sense of the second law of thermodynamics.

For these reasons the appellant considers the requirements of Articles 52, 83 and 84 EPC to be met.

IV. On 11 July 1997 the Board dispatched the summons to oral proceedings with an annexed communication pursuant to Article 11(2) of the Rules of Procedure stating why, in the provisional opinion of the Board, the application did not seem to meet the requirements of Article 83 EPC. In response to this communication the appellant filed with a letter dated 29 August 1997 further arguments to explain the cycle and circuit of the invention as well as a copy of an article by the inventor "A 'NEW' ENERGY SOURCE", published in "TESLA: A Journal of Modern Science - 2nd Quarter 1997". Nothing new of substance has been identified by the Board in these submissions.

With this letter the Board was also informed that neither the appellant nor the representative would attend the oral proceedings.

V. The oral proceedings were held on 4 September 1997 in accordance with Rule 71(2) EPC in the absence of the appellant.

VI. Requests

The appellant requests that the contested decision be set aside and a European patent be granted on the basis of the originally filed claims with the amendments as filed with the letter dated 25 April 1995 (main request) **or** on the basis of those same documents albeit with the amended claim 1 as submitted at the oral proceedings before the Examining Division on 15 October 1996 (auxiliary request).

Reasons for the Decision

1. The appeal is admissible.

2. *Problem as described in the Application*

As can be understood from the description of the application the aim is to produce a net work output by means of a thermodynamic cycle of high efficiency.

3. *Disclosure of the invention (Article 83 EPC)*

3.1 As far as the application can be understood it is proposed to produce external work by a thermodynamic cycle which comprises an internal heat sink as well as an internal heat source (cooling of the compressor by the low temperature exhaust fluid of the turbine). Although the circuit does exhibit external heat exchangers with the ambient air at the respective reservoirs these only serve to correct minor temperature deviations. This is supported by the fact that in one embodiment the low pressure heat exchanger has been removed from the circuit.

3.2 According to the second law of thermodynamics, it is not possible to produce a net work output without a heat flow between an external heat source and an external heat sink.

3.3 Whereas a compression process may be carried out in a more work efficient way by doing it in isothermal rather than in an isentropic manner, such a change of process alone cannot result in the production of a net work output, merely in a reduction of the necessary mechanical work input. Moreover, a truly isothermal compression cannot be realized in practice, not even with the proposed, well known cooling flights. No features which in practice could lead to such an ideal isothermal compression are hinted at or disclosed in the application.

3.4 According to the amended claims (claims 6 and 12 of both the main and auxiliary requests, and claim 1 of the auxiliary request) additional energy may, as necessary, be introduced to the system to permit the system to operate continuously. However, no clear information is given as to where in the system this additional energy is to be introduced or as to which circumstances could lead to such a situation. If external work must be introduced, for instance, to run the compressor, then a refrigeration cycle in principle is the result. However, such a cycle does not produce net external work but in fact consumes external work. In the present case, the surroundings may be marginally and locally cooled due to heat exchange in the low pressure reservoir and may be marginally and locally heated due to heat exchange in the high pressure reservoir. Nevertheless, the work output can never exceed the external work input.

3.5 For a thermodynamic process to make sense in a **work** producing context (as presently claimed in all the independent claims) it must predominantly rely on a **transformation** of energy from **heat**. To produce a net **work** output based on **work** input would merely amount to a **transport** of energy which would make little sense because of the inevitable (energy) losses incurred by any real-life construction.

3.6 The disputed application is stated to pertain to a **work producing cycle** in a high efficiency system. Thus - with reference to the above - the process cycle must predominantly rely on **heat energy** input to be of any practical use.

3.7 Analysis of the closed-cycle process of the present application shows that the proposed cycle might be comparable to a modified so-called constant pressure cycle, ie a cycle in which the fluid is constantly maintained under pressure. From the thermodynamic data of the present case example it is clear that the cycle is fully located in the superheated region of the working fluid (Freon 22). This means that the cycle involves no phase transitions of the working fluid. A known constant pressure cycle includes isentropic compression, isobaric cooling, isentropic expansion and isobaric heating, and relies on mechanical work input to the compressor to create a heat flow for refrigerating processes, see for example: "Lehrbuch der Kältetechnik", by H.L. von Cube, Volume 1, 3th edition, 1981, Verlag C.F. Müller Karlsruhe, pages 222-224.

3.8 It is an object of the application under consideration to minimise the compression work of the cycle. With reference to the known process this can be seen as being obtained by substituting the known isentropic compression step of the constant pressure cycle with an isothermal one. As is well known, isothermal compression necessitates simultaneous rejection of heat energy corresponding to the work energy input and such compression requires less work than isentropic compression between the same pressure levels. It is noted that the concept of substituting isentropic compression with isothermal compression in the superheated region is not new, see for example: "Principles of refrigeration" by W.B. Gosney, Cambridge University Press, 1982, pages 224 and 490. A comparison between the known process and the present one (although these are stated to serve different purposes) shows an important difference to lie in the way cooling is carried out. The known concept (implicitly) relies on an **external** heat sink for the heat to be rejected under isothermal compression and a different, **external** heat source for the heat to be absorbed during the isobaric heating. This maintains the full energy transforming (here: refrigerating) potential of the process.

3.9 The solution proposed in claim 1 (main request) of the present application does not comprise an external heat source and an external heat sink, but seems to rely on using the working fluid both as an **internal** heat sink **and** as an **internal** heat source (see page 4, lines 32 and 33 of the present application: "... exchanges no heat outside of the internal counterflowing streams..."). Consequently no heat flow vis-a-vis an external system takes place. The effect of such internal 'short-circuiting' is that the energy transforming potential of the cycle is **internally exhausted** thereby effectively preventing the cycle from serving any useful workproducing purpose. A claim to be able to produce net work in these circumstances thus amounts to an infringement of the first law of thermodynamics which in one formulation states that: Energy cannot emerge or disappear - it can merely migrate between interacting thermodynamic systems. When no heat flow involving external systems is present as an energy source, work cannot be produced in a meaningful manner. Thus the skilled man cannot on the basis of the disclosure of the invention produce a fluid circuit resulting in the production of net work, and the requirements of Article 83 EPC are therefore not met.

3.10 It is noted that the application mentions "additional means" (45 or 54) for providing the system with work or heat required to keep the system in continuous operation.

3.11 The suggested application of heat seems to be limited to one of the reservoir heat exchangers since no heat is exchanged "... outside of the internal counterflowing streams..." of the turbine exhaust fluid and the fluid under compression, see above. Both these heat exchangers are however explicitly stated to be in heat exchanging relationship with the ambient air. Not only will the addition of heat here thus go against the explicit teaching of the application, in the present circumstances the ambient air can only be considered to represent one single external system, ie the heat source or the heat sink, but not both. Therefore, the necessary external heat flow (specified by the second law of thermodynamics) is missing.

3.12 With regard to the suggested additional work input, it is noted that if the process is unable to run continuously without extra work input to the compressor or elsewhere in the circuit, then a situation exists where it would be more efficient to make direct use of such work energy instead of first directing it through a loss-incurring thermodynamic process.

3.13 Hence, it is fully unclear where and under which circumstances additional heat or work are to be applied, and the vague possibility of doing so does not change the above conclusion concerning the unfeasibility of the disclosed process.

3.14 In conclusion, the essential circuit of the invention relies on a process cycle infringing on natural laws, namely the first and second laws of thermodynamics.

3.15 Pursuant to Article 83 EPC an invention must be disclosed sufficiently clearly to allow the skilled person to carry out the invention. Since the very process cycle on which the subject-matter of the independent claims is implicitly based does not obey the laws of nature, it is not possible for a person skilled in the art to carry out the invention with the help of the teaching disclosed in the present application and produce net external work. Therefore, the requirements of Article 83 EPC are not met.

3.16 It is noted that the process data appearing on the drawing accompanying the appellant's submissions in the letter dated 29 August 1997 and serving to illustrate the MAC-1 circuit and process merely reflect a theoretical approach and do not reflect the result of a running process. With reference to the above and since the submissions would not cause the Board to change its provisional opinion, it was possible for the Board to take a final decision at the end of the oral procedings.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:	The Chairman:
N. Maslin	C. Andries