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## Datasheet for the decision of 3 May 2021

**Case Number:** T 2412/17 - 3.2.05

**Application Number:** 09716483.4

**Publication Number:** 2257724

**IPC:** F16K37/00

**Language of the proceedings:** EN

**Title of invention:**
Diagnostic Method for Detecting Control Valve Component Failure

**Patent Proprietor:**
Fisher Controls International LLC

**Opponent:**
Samson AG

**Relevant legal provisions:**
EPC Art. 54(1), 56

**Keyword:**
Novelty (yes)
Inventive step (no)


This datasheet is not part of the Decision.
It can be changed at any time and without notice.

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**Case Number: T 2412/17 - 3.2.05**

# D E C I S I O N
## of Technical Board of Appeal 3.2.05
## of 3 May 2021

| | |
|---|---|
| **Appellant:** (Opponent) | Samson AG<br>Weismüllerstrasse 3<br>D-60314 Frankfurt (DE) |
| **Representative:** | Nils T.F. Schmid<br>Boehmert & Boehmert<br>Anwaltspartnerschaft mbB<br>Pettenkoferstrasse 22<br>80336 München (DE) |
| **Respondent:** (Patent Proprietor) | Fisher Controls International LLC<br>205 South Center St.<br>Marshalltown, IA 50158 (US) |
| **Representative:** | Johannes Bohnenberger<br>Meissner Bolte Patentanwälte<br>Rechtsanwälte Partnerschaft mbB<br>Postfach 86 06 24<br>81633 München (DE) |
| **Decision under appeal:** | **Interlocutory decision of the Opposition Division of the European Patent Office posted on 25 August 2017 concerning maintenance of the European Patent No. 2257724 in amended form.** |

**Composition of the Board:**

| | |
|---|---|
| **Chairman** | P. Lanz |
| **Members:** | O. Randl |
| | C. Brandt |

## Summary of Facts and Submissions

I. The opponent appealed against the decision of the opposition division on the version in which patent No. 2 257 724 ("the patent") could be maintained in amended form.

II. Among the documents cited by the opposition division, the following are particularly relevant to the appeal proceedings:

D3: DE 296 12 346 U1
D4: WO 99/05576 A2
D5: WO 2004/074947 A2
D6: Extract from H. Braun et al, "Fachkunde Metall", 53rd edition, Verlag Europa-Lehrmittel, 1999, pages 398 and 399

III. The oral proceedings before the board of appeal took place on 3 May 2021. As announced in a letter dated 12 March 2021, the respondent was not represented. The proceedings were continued without it in accordance with Rule 115(2) EPC and Article 15(3) RPBA 2020.

IV. The appellant requested that the decision under appeal be set aside and the patent revoked.

The respondent had requested in writing that the appeal be dismissed.

V. Claims 1, 2, 6 and 10 of the request found allowable by the opposition division read (for claim 1, the feature references used by the board are indicated in square brackets):

"1. [**1.1**] A method of detecting a spring failure in a pneumatic control valve actuator comprising:
[**1.2**] determining an initial spring constant value ($K_{initial}$) of a set of springs of an actuator in a control valve during a first period of operation;
[**1.3**] storing the initial spring constant value and
[**1.4**] a predetermined threshold in a memory;
[**1.5**] sensing a travel distance (ΔT) of an actuator rod coupled to the actuator;
[**1.6**] sensing a change in applied pressure (ΔP) to the actuator, wherein [**1.7**] the change in applied pressure corresponds to the travel (ΔT) of the valve;
[**1.8**] determining a current spring constant value ($K_{current}$) of the set of actuator springs during a second period of operation of the control valve based on the sensed travel distance (ΔT) and corresponding sensed pressure difference (ΔP); and
[**1.9**] generating an indication of a spring defect if the current spring constant value ($K_{current}$) is different from the initial spring constant value ($K_{initial}$) by more than the predetermined threshold."

"2. The method of claim 1, wherein determining the current spring constant comprises calculating a spring constant value using the equation:

$\Delta \mathrm{P} A = \Delta T \mathrm{K}$, wherein $A$ is an effective area of a diaphragm of the actuator."

"6. A device for detecting spring failure in a pneumatic control valve actuator comprising:
a first input for receiving data on a pressure applied to a diaphragm of a pneumatic actuator in the control valve;

a second input for receiving data on a travel distance of an actuator rod of a control valve;
a processor and a memory operatively coupled to the processor, wherein the processor is programmed to:
calculate a spring constant based on the pressure data and travel data, determine a spring failure event in the pneumatic control valve based on the sensor data, and
generate an indication when a spring failure event occurs,
wherein the memory stores an initial value of the spring constant and a threshold."

"10. A system for detecting spring failure in a pneumatic control valve actuator comprising:
a process control system including a workstation,
a process controller, and a plurality of field devices, wherein the workstation, process controller, and the plurality of field devices are communicatively connected to each other;
a control valve including an actuator, an actuator diaphragm, and an actuator spring for biasing the actuator diaphragm, wherein at least one field device is adapted to measure the pressure applied to the diaphragm and at least one field device is adapted to measure a travel distance of an actuator rod coupled to the actuator diaphragm; and
a detection device adapted to receive data on the measured actuator pressure and actuator rod travel distance, to access a stored initial spring constant value, and to generate an alert when a difference between a calculated spring constant value and the initial spring constant value exceeds a threshold."

VI. The parties' arguments regarding novelty and inventive step of the claimed subject-matter can be summarised as follows:

(a) Interpretation of claim 1

(i) Appellant (opponent)

Claim 1 is not limited to the formula $\Delta P A = \Delta T K$. On the contrary, any initial spring constant value and any current spring constant value to be determined in accordance with any formula not further defined under claim 1 is encompassed. For the skilled person, the "spring constant value" used here is not equivalent to the understanding of the term "spring constant" generally used in mechanics. The patent, e.g. in paragraph [0022] and claim 2, describes the calculation of a spring constant in accordance with its proper mechanical meaning, which can optionally be used as "a spring constant value". However, the features of paragraph [0022] of the description are not expressed in the wording of claim 1.

(ii) Respondent (patent proprietor)

The skilled person is familiar with the concept of a spring constant. A spring range is not a spring constant.

(b) Novelty over document D3

(i) Appellant (opponent)

Document D3 discloses all the features of claim 1, including features 1.2 and 1.8.

Paragraph [0083] of the patent expressly teaches that the individual parameter values, including the spring constant values, can be read by the user from a screen or the like ("... *the detection module 70 may provide parameter values to the abnormal situation prevention system (235). Thus, an operator may view the values* ..."). It may therefore be left to the user to read the parameter values, i.e. in particular the "initial spring constant value" and the "predetermined threshold value" and the "current spring constant value". The wording of claim 1 makes no distinction with regard to the presentation of the parameter values, i.e. the "initial spring constant value" and the "current spring constant value". According to the wording of the claim, it does not matter whether the value is presented e.g. as a numerical value or, for example, in graphic form by an oblique (rising) line representing the spring constant value. Document D3 explicitly reveals the graphical representation of spring constant values in the form of a pressure-position curve (paragraph bridging pages 7 and 8). A first curve, i.e. an initial spring constant value, is recorded during initialisation (p. 7, lines 11 to 19). At a later point in time corresponding curves are recorded again, i.e. current spring constant values are determined (p. 8, lines 5 to 8). This corresponds precisely to the procedure described in paragraph [0029] and Fig. 4b of the patent, according to which first an initial spring constant value and later a current spring constant value is to be recorded in accordance with the procedure disclosed in paragraphs [0027] to [0028]. Contrary to the opinion of the opposition division expressed in section 6.3 of the reasons for the decision under appeal, it is not necessary to determine the effective area of the pneumatic actuator to obtain the spring constant.

The effective area of the actuator is a constant. The skilled person would have been aware that the precise value of this constant is irrelevant. Considering the method step described in paragraphs [0065] and [0066] of the patent, according to which a current spring constant value can be compared with an initial spring constant value by taking into account a permissible percentage deviation "α", it would have been obvious to the skilled person to completely deduce the size of the effective area of the pneumatic actuator from the equation. The subject-matter of claim 1 lacks novelty in view of document D3. This also applies to the subject-matter of independent claims 6 and 10.

The proprietor's assertion that it is clear from paragraph [0083] of the patent that an indication should only be given after a fault has been detected is incorrect. This understanding is manifestly contrary to the designation "abnormal situation prevention system 235". A system designed for fault prevention or avoidance requires a functionality operating even before faults occur, for example to present values that indicate whether the system is within a safe normal range or whether deviations or a deviation trend can be detected. Moreover, it is not apparent from the example in paragraph [0083] that only a retrospective fault representation is given. This passage describes a use of a Rosemount 3051S field device which "may" perform the fault representation, for example ("e.g.") after the occurrence of a fault. This is one alternative among many. The skilled person would have understood that the Rosemount 3051S field device is capable of producing a corresponding display at any other point in time, namely if no component error has yet occurred.

(ii) Respondent (patent proprietor)

The appellant's argument that features 1.2 and 1.8 are not restricted to determination in accordance with the formula provided but instead may be determined via any formula or, in fact, read off a screen, relies on cherry-picked quotes. The full text of paragraph [0083] of the patent teaches that the detection module, which detects faults (based on the initial and current spring constants) and provides fault indications, may provide the values after the fault has been generated. Thus an operator may view the values. The paragraph explicitly shares that such an instance may occur "when a component fault has been detected". Unless time can move backwards as well as forwards, which might allow a person to program a device with the displayed initial and current spring values after the device has used those values to determine that a fault exists, the appellant's arguments would seem to lack merit.

(c) Novelty over document D4

(i) Appellant (opponent)

Document D4 discloses all the features of claim 1, including features 1.2 and 1.8. The conclusion of the opposition division is based on too narrow an understanding of the subject-matter of claim 1, based on the embodiments disclosed rather than on the wording of the claim. Claim 1 does not mention any specific definition of the criteria to be applied to the spring constant value. According to document D4, page 16, lines 12 ff., spring constant values are calculated by determining two points (0% and 100% position) of the travel of a spring and the corresponding travel back

("two pressure vs. position data sets"). The spring constant value obtained is called "spring range".
The determination of a spring constant value based on two pressure measurements at two specific spring positions in accordance with document D4 corresponds to the teaching of paragraphs [0027] to [0029] of the patent, in particular column 7, lines 24 to 28, lines 31 to 33 and lines 38 to 41. Thus feature 1.2 is disclosed in document D4. Moreover, on page 19, lines 2 to 24, and in particular lines 2 to 4 and 12 to 14, document D4 discloses the determination of a current spring constant value in steps 364 and 378, respectively. A first current spring constant value ("pressure versus position data set - increasing") and a second current spring constant value ("pressure versus position data set - decreasing") are recorded in accordance with the procedure disclosed in the patent (paragraphs [0027] to [0028], in particular column 7, lines 24 to 28). Thus feature 1.8 is also known from document D4. The subject-matter of claim 1 lacks novelty. This also applies to the subject-matter of independent claims 6 and 10.

(ii) Respondent (patent proprietor)

Document D4 never discloses the determination of spring constants: the appellant mischaracterises the teaching of D4 in this respect. Specifically, the appellant argues that D4 teaches that "*spring constant values are calculated with the determination of two points of the operating displacement of a spring and the corresponding return operating displacement*". While document D4 does state that the spring range is determined by calculating two pressure vs. position sets and fitting the data to straight lines, that, in and of itself, is not the same as determining a spring constant. It might be argued that the slope of a line fitted to one of the sets of pressure vs. position data is a spring constant. However, nowhere does D4 teach finding the slope of the straight lines, comparing the slopes of the two lines, or using the comparison to determine a spring failure. On the contrary, document D4 teaches averaging the two lines to determine the spring range. Thus, instead of spring range being "different nomenclature", as the appellant alleges, spring range is instead an average of two pressure vs. position data sets, which no skilled person would have confused with a spring constant.

(d) Novelty over document D5

(i) Appellant (opponent)

Document D5 discloses all the features of claim 1, including features 1.2 and 1.8. The opposition division's conclusion to the contrary is based on the respondent's assertion that the realisation of the subject-matter of claim 1 would require knowledge of the exact dimensions of the effective area of the pneumatic actuator. However, the allegedly distinctive feature is not part of the claim. Features 1.2 and 1.8 merely require that "an" initial spring constant value or "a" current spring constant value be determined. The effective area of the pneumatic actuator is not relevant for considering "a" spring constant value. Furthermore, the effective area of the pneumatic actuator itself is immaterial to the concrete spring constant value described in paragraph [0022] of the patent, because for the procedure described in the claims, in particular the comparison of the initial spring constant value with the current spring constant value, a numerical definition of an exact effective area of the pneumatic actuator is immaterial, if only because the effective area is constant and thus completely irrelevant with regard to differentiation between the two spring constant values.

Document D5 directly and unambiguously discloses the determination of an initial spring constant value and a current spring constant value (see page 7, first paragraph, and the procedure described in Figs. 4a and 4b). Document D5 also describes in paragraphs [0019], [0027], [0029] and [0032] position data and pressure data with regard to several adjustment points to determine the spring constant values of the valve, referred to as "spring ranges". Initialization procedures and steps involving the control of a spring constant are shown in Figure 3. Thus feature 1.2 is clearly disclosed.

Furthermore, D5 reveals the determination of a current spring constant value based on position and pressure values (see paragraphs [0026], [0029] and [0045], and claims 1 and 2). Thus current information is used to calculate the spring constant value "spring range" on the basis of this current position data and pressure data. This is identical to the procedure described in paragraphs [0027] and [0028] of the patent, in particular column 7, lines 24 to 28. Consequently, feature 1.8 is also disclosed in document D5. The subject-matter of claim 1 thus lacks novelty over this prior art. These reasons also apply to the subject-matter of independent claims 6 and 10.

(ii) Respondent (patent proprietor)

The expression "spring range" has a well-defined and well-understood meaning to a person of ordinary skill in the art (see e.g. US Patent No. 2,248,076). The spring range of a pneumatic actuator is the air pressure required to produce a full stroke of the actuator with no external load. It has a relationship to the spring constant only in that the spring constant, operating through the springs, plays a role in determining the spring range, as do other factors such as friction, see also document D5, paragraph [0027]. It is precisely the fact that spring range is affected by factors other than spring constant (e.g. friction) that proves that determining the spring range is not the same as determining the spring constant. However, throughout the analysis of document D5, the appellant erroneously relies on the description of spring range as being equivalent to determining a spring constant.

(e) Inventive step

(i) Appellant (opponent)

Starting from document D3

Document D3 relates to the detection of spring failure. This involves the determination of a characteristic spring parameter. Although its unit is not N/m, this parameter is characteristic of the spring behaviour. In its description of the state of the art, document D3 mentions both the direct measurement of the spring force to diagnose the spring condition and the comparison of a measured pressure/displacement characteristic with a reference characteristic (see second paragraph on page 4). Such characteristics are known to the skilled person, as can be seen from document D6, in which the spring-force-to-spring-displacement ratio is referred to as "spring rate" (*Federrate*).

Even if the effective area is assumed to constitute a distinguishing feature, it does not have a technical effect going beyond what is known from the state of the art.

The patent itself contains relevant passages in paragraphs [0068] ("*In another embodiment, an initial spring constant value may be given (e.g., provided by a manufacturer for a particular pneumatic control valve) and this initial spring constant may be stored as a trained value without computing or verifying an initial spring constant.*") and [0084] ("*For instance, one or more of the blocks of detection module 70 may have user configurable parameters (e.g., initial actuator spring constant to be provided by a manufacturer or plant database) ...*"). This means that it is not necessary to calculate a parameter of the dimension N/m, but that the value can be determined in other ways.

The "current spring value" is disclosed in paragraph [0028] without any reference to the area:

> "*In block 413, a current spring constant of the actuator spring may be determined. For example, at a particular period of time, a valve travel distance may be measured with a corresponding pressure change. In an embodiment, a first position of the valve at a first time may be recorded and a second position of the valve at a second time may be recorded, where the difference between the first position and second position may be calculated as the valve travel distance* $\Delta T$*. During the valve travel, a corresponding change in applied actuator*

> *pressure may occur. This actuator pressure change may be measured by recording the actuator pressure at the first time when the valve is in the first position and then recording the actuator pressure at the second time when the valve reaches the second position. The difference in the two pressure readings may then be used as the change in pressure ΔP.*"

This way of proceeding - very similar to what is disclosed in document D3 - makes it possible to determine the spring constant. The effective area is mentioned only once, in paragraphs [0022] and [0023], disclosing one particular option ("... may be used ...") for calculating the spring constant.

Assuming that the reference to the area constitutes the only distinguishing feature, it should be noted that this amounts to a mere calculation rule (*Rechenregel*) that has no technical effect.

Document D3 does not teach away from the invention. On the contrary, it explicitly points out to the skilled person that "*by comparing a measured pressure/ displacement characteristic with a reference characteristic, a poor condition of the springs can be recognised*", which essentially anticipates the teaching of the independent claims of the patent. The invention disclosed in document D3 does not require a pressure sensor either. The fact that the respondent considers a solution with a pressure sensor - which document D3 describes as disadvantageous - to be desirable brings foreseeable disadvantages due to the additional complexity, but does not entail any unexpected technical advantage and therefore cannot justify an inventive step over document D3 (see "Guidelines for Examination in the EPO", G-VI 10.1).

Starting from document D4

The situation is similar to the one described for document D3. The valve actuator signature procedure disclosed in document D4 can identify problems such as a broken spring (page 14, lines 21 to 24): details are given on page 16, lines 13 ff. At step 234, the data is analyzed by calculating the spring range by fitting the two pressure vs. position data sets with straight lines and calculating where they cross the 0% and 100% position. The spring range is the average of the values determined from the two lines. This amounts to determining a spring characteristic whose slope relates to the spring constant.

Again, assuming that the area constitutes the sole distinguishing feature, it has to be noted that this amounts to a mere calculation step requiring additional information but providing no advantage to the user. The respondent has not cited any such advantage.

Obviousness

In the absence of any advantage, it is not possible to carry out a meaningful problem-solution analysis, and evaluation of inventive step has to stop.

If the objective technical problem is seen as finding an alternative parameter for detecting a spring failure in a pneumatic control valve actuator, its solution is obvious because the spring constant is a well-known parameter.

It is true that document D3 refers to this particular approach as being laborious because pressure measurements are needed. However, the methods disclosed in documents D4 and D5 do make use of pressure measurements. Consequently, the skilled person would not be deterred from using pressure measurements by this statement of document D3.

Document D3, on page 2, starting at line 21, discloses that simple pneumatic actuators usually have several springs which provide the counter-force to the pneumatic actuator force required to reset the actuator. The skilled person, in view of the fact that pressures are being measured and that the forces in play are relevant, would be aware that the effective area has to be taken into account. Thus document D3 itself leads the skilled person to the subject-matter of claim 1.

Document D4 discloses (see page 7, from line 28 onwards) that many forces act on the valve stem and plug, including for example spring forces from the actuator, fluid forces and frictional forces, it being understood that valves and their associated forces are well known in the art. Thus the transition from pressures to forces (via the effective areas) is something that the skilled person is familiar with.

Document D5 also deals with spring failures (see paragraph [0002]). Paragraph [0027] states that if the spring range of the valve is known, each of the samples of position versus pressure can be projected onto the pressure axis using the slope of the spring range line. The spring range corresponds to the actuator pressures that cause the valve to be in the closed position and in the open position. These pressures are known as spring range because they are largely determined by the springs inside the actuator. Thus the slope of a curve is being examined. The skilled person would have realised that this slope (unit: $N/m^3$) relates to the spring constant (unit: N/m) via a surface (unit: $m^2$), namely the effective surface of the diaphragm.

In view of the above, the subject-matter of claim 1 lacks inventive step. This also applies to the subject-matter of independent claims 6 and 10.

If the invention were a computer-implemented invention, the question would arise which of the technical and non-technical features involves an inventive step. In this case it is the surface that arguably constitutes the sole distinguishing feature. However, this feature makes no technical contribution because it amounts to a mere non-technical calculation rule. If it is assumed that there is a technical contribution, it should be taken into account when defining the objective technical problem. The problem would then be to find out, taking account of the valve displacement and the corresponding pressure values, whether the spring constant has changed. The solution to this problem is obvious - it is contained in the problem.

(ii) Respondent (patent proprietor)

Document D3 explicitly teaches away from the invention. It discloses that "comparing a measured pressure/travel characteristic curve with a reference curve" would require "a pressure sensor and an evaluation unit with an extra analog input". Document D3 explicitly states that, in accordance with the invention disclosed, no force or pressure sensor is necessary. Instead, D3 teaches evaluation of a reaction time, not a spring

constant, to attempt to detect spring failure.
It cannot anticipate or render obvious the subject-matter of claim 1.

## Reasons for the Decision

1. Claim interpretation

1.1 "Spring constant value"

The expression "spring constant value" is not defined in the patent. The board understands it to designate the (numerical) value of the spring constant, the latter being a concept well familiar to the skilled person having a basic knowledge of mechanics. According to Hooke's law, the force F needed to extend or compress a spring by some distance x is directly proportional to that distance:

$$F = k \cdot x,$$

k being the so-called "spring constant". In other words, the value of the spring constant expresses the amount of force needed to compress or extend a spring (or, by extension, a piece of elastic material) by a given distance. The use of the expression in the patent is in line with this understanding based on general principles.

It was argued that this interpretation was too narrow and that the expression "spring constant" could mean that any spring constant value to be determined via any formula not further defined under claim 1 was encompassed. The fact that the conventional formula was recited in dependent claim 2 was cited as evidence that claim 1 was meant to have a broader scope. Although this argument is not without merit, it is not decisive, for several reasons. First, the board is not aware - nor has the appellant provided evidence - that any spring parameter other than the conventional spring constant is referred to by that expression in the technical field under consideration. Second, it is not unheard of that dependent claims add features already implicit in the claim on which they depend. Third, claim 1 is clear in itself in this respect and does not require any interpretive effort based on the rest of the claims and the description.

1.2 "determining a ... spring constant value" (features 1.2 and 1.8)

The patent contains no special definition of what is meant by "determining", so the common general meaning of the term applies. According to the Oxford English Dictionary, the verb "determine" means "to ascertain definitely by observation, examination, calculation, etc. (a point previously unknown or uncertain); to fix as known". This corresponds to the way in which the verb is used in the patent, and especially in paragraph [0028], where one particular way of determining the spring constant (via the measurement of a travel distance and a pressure change) is disclosed. However, it is true that claim 1 is not limited to this particular way. What claim 1 requires is that the initial and the current spring constant values be determined (in whatever way) and compared so as to generate an indication of a spring defect under certain circumstances.

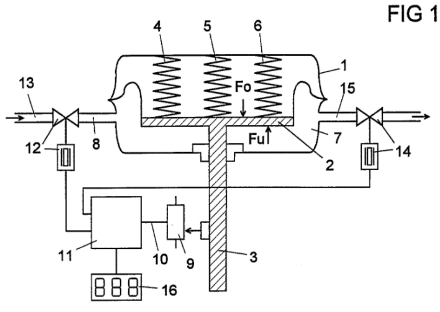
According to paragraph [0083] of the patent, the detection module may provide information to the abnormal situation prevention system. An example is mentioned in which the information is provided in the form of parameter values that can be viewed by an operator, for instance when a component fault has been detected. However, this disclosure relates to the way in which an operator is informed once an abnormal situation has been detected. It does not describe the steps leading to the detection of the spring failure.

2. Novelty

2.1 Lack of novelty over document D3

Document D3 discloses a device for the self-testing of pneumatic drives. This device comprises a drive housing 1, a diaphragm plate 2 connected to a push rod 3 for a control valve and which can be acted upon at least on one side by an adjustable air pressure. Springs 4 to 6 act on plate 2 against the action of the air pressure. The device also comprises a position transmitter 9 which detects the position of plate 2. Valves 12 and 14 are provided for adjusting the air pressure on plate 2 by supplying or discharging compressed air. Moreover, the device comprises a device 11 for measuring the reaction time of plate 2 to a valve actuation, and an evaluation device 11 with which the measured reaction time can be compared with a reference value to determine a deviation.

FIG 1



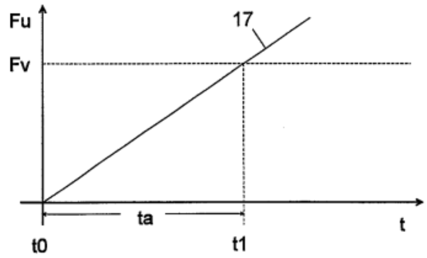
The opposition division dealt with the objection in point 4 of the reasons of the decision under appeal. This passage contains the following statement:

> "*... the opposition division does not share the opponent's opinion according to which a pressure-position curve can be regarded as the disclosure of a spring constant value. The opposition division follows the proprietor who argued that a spring constant value might be determinable from such a graph but is nevertheless not disclosed in D3. Therefore at least the features 1.2 and 1.8 are not known from D3.*"

Thus the question of novelty boils down to whether document D3 discloses the steps of determining an initial and a current spring constant value of a set of actuator springs in a control valve.

It was argued that features 1.2 and 1.8 had been disclosed on page 7, lines 11 to 19, and page 8, lines 5 to 8, of document D3. These passages refer to Fig. 2 of document D3, which illustrates the measurement of a start-up time ta. Valve 14 (see Fig. 1 above) is closed and valve 12 is opened (time t0). Consequently, gas flows into the pressure chamber 7. As can be seen in Figure 2, the pressure in the pressure chamber 7 and hence the force Fu acting on the underside of the diaphragm plate 2 increases essentially linearly (curve 17).

FIG 2




The duration between the opening of valve 12 at time t0 and the beginning of the movement of the push rod 3 at time t1 is evaluated as the start-up time (*Anlaufzeit*) ta and stored in a memory within the positioner 11. Start-up times measured during subsequent operation of the pneumatic actuator are compared with this stored reference value and monitored. Thus impermissible deviations can be detected. If the start-up time has decreased considerably compared with the reference value, this is an indication of corroded or broken springs in the actuator. Thus document D3 teaches that start-up times may be stored and compared to detect spring failures, but it does not teach that spring constants are determined. The start-up times may relate to the spring constant values, and the comparison of the curves 17 at different times may allow detection of variations in the spring constant value. However, there is no direct and unambiguous disclosure in document D3 that these values could or should be determined.

Consequently, the board endorses the opposition division's finding that document D3 does not disclose features 1.2 and 1.8.

2.2 Lack of novelty over document D4

Document D4 discloses an intelligent positioner system for controlling a fluid control valve and a method for diagnosing such a valve (see page 18, line 17 ff.).

The document teaches that a "valve signature" can be determined by measuring the valve position and associated actuator pressure during the opening ("pressure vs. position data set - increasing", see page 15, line 30) and closing of the valve ("pressure vs. position data set - decreasing", see page 16, line 9). The two data sets are fitted with straight lines, and the latter are extrapolated to 0% (valve shut) and 100% (valve completely open) positions. This allows the result to be obtained without relying on the position feedback signal and makes the method more accurate. The "spring range" is defined as the average of the values obtained for the two lines (page 16, lines 13 to 16).

The opposition division dealt with the alleged lack of novelty over document D4 in point 5 of the reasons for the decision under appeal. It found features 1.2 and 1.8 not to be disclosed:

> "*At least the determination of a spring constant value (see features 1.2 and 1.8) is not known from D4. The opponent pointed to the text passage starting at line 12 on page 16 describing the calculation of a spring range which according to him is the same as a spring constant value. This argumentation cannot be followed. As the proprietor pointed out the document D5 defines the spring range as the actuator pressures at the closed and*

> *at the open valve position, which seems to be the correct explanation of the spring range.*"

It was argued that the "spring range" of document D4 is nothing but another expression of the spring constant. The board cannot accept this argument based on a broad interpretation of the expression "spring constant" for the reasons set out in point 1.1 above.
The situation is similar to the one described above for document D3: the diagnosis is based on values relating to the spring constants, but not on the spring constants as such. In document D3, the start-up time is monitored, whereas in document D4 the spring range (i.e. an averaged pressure difference) is considered.

Therefore the subject-matter of claim 1 is also new over the disclosure of document D4.

2.3 Lack of novelty over document D5

Document D5 discloses a method and system for performing online valve diagnostics. The method disclosed is similar to the one described in document D4. Again, valve information (including position and pressure data) is obtained during valve operation.
The spring range (i.e. the actuator pressures that cause the valve to be in the closed and in the open position, see paragraph [0027]) is obtained by fitting a line through the data points (see Fig. 5 and paragraph [0047]).

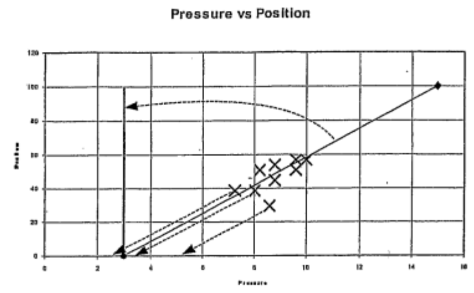



FIG. 5A

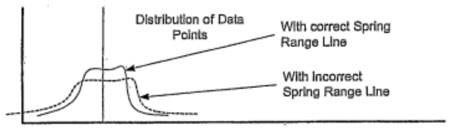



FIG. 5B

The opposition division considered the objection of lack of novelty over document D5 in point 6 of the reasons of the decision under appeal. It wrote:

> "*With respect to D5 the opponent referred to figure 4A which in his* [sic] *opinion is a visual representation of a spring constant and he [sic] further referred to figure 4B allegedly showing a computed graph wherein the effect of the spring constant is compensated for. In his* [sic] *opinion this would have required the calculation of a spring constant.*
>
> *The opposition division does not share this opinion as D5 only discloses a spring range which according to the first paragraph on page 7 is defined as the actuator pressures of a valve at the closed and at the open position. A spring constant could possibly be determined from the curve in fig. 4A provided that the surface area of the actuator piston is known, however this is not disclosed in D5. Therefore at least features 1.2 and 1.8 are not known from D5.*"

It was argued that both allegedly distinguishing features merely require that "an" initial spring constant value or "a" current spring constant value be determined, and that the effective area of the pneumatic actuator is not important for the consideration of "a" spring constant value. However, the effective area comes into play because Hooke's law (and the definition of the spring constant derived from it, see point 1.1 above) relates a force to a distance, whereas the measurements involved in methods such as that of document D5 relate to pressures (i.e. forces per area) rather than forces. Thus the determination of the spring constant based on pressure measurements requires knowledge of the effective area.

It was also argued that the effective area is constant and thus identical for determination of both spring constant values, and that consequently it is completely irrelevant with regard to differentiation between the two spring constant values. The board agrees that the data shown in document D5 would allow determination of relative changes of the spring constant and, provided that the effective area was known, even determination of the absolute value of the spring constant. However, this possibility is not mentioned in document D5. As a consequence, it cannot be said that document D5 directly and unambiguously discloses the determination of an initial and a current spring constant as required by features 1.2 and 1.8. The spring range determined in document D5 relates to the spring constant, but it is not the spring constant as understood by the board (see point 1.1 above).

Thus the subject-matter of claim 1 is also new over the disclosure of document D5.

2.4 Conclusion on novelty

The subject-matter of claim 1 is new over the disclosure of documents D3, D4 and D5 (Article 54(1) and (2) EPC).

The same conclusion applies to the subject-matter of independent claims 6 and 10.

3. Inventive step

3.1 Starting point

The opposition division considered documents D3, D4 and D5 as relevant starting points for examining inventive step.

3.2 Difference

As stated above (see points 2.1 to 2.3), claim 1 differs from the disclosure of documents D3, D4 and D5 in features 1.2 and 1.8 because none of these documents discloses the determination of spring constant values as such, but detects spring failures by examining parameters such as the start-up time (document D3) or the so-called "spring range" (documents D4 and D5), both of which are correlated with but not identical to the spring constant.

3.3 Objective technical problem

The board is not aware of any technical advantage obtained by using the spring constants rather than correlated parameters to detect spring failure. Nor has the respondent provided any information in this respect. In the absence of any established technical advantage, the problem solved by the subject-matter of claim 1 is formulated as providing an alternative parameter on which the detection of spring failure in a pneumatic control valve actuator can be based.

3.4 Obviousness

The skilled person is aware that, apart from factors (such as the effective spring area) that are constant for a given spring arrangement, the parameters used to detect spring failure in the various methods of the state of the art are correlated with the spring constant. Therefore monitoring the spring constant as such for the detection is an obvious alternative to the use of a pressure/displacement characteristic (state of the art cited in document D3), the start-up time (document D3) or the spring range (documents D4 and D5), and cannot confer an inventive step.

Consequently, the subject-matter of claim 1 does not involve an inventive step.

The same conclusion applies to the subject-matter of independent claims 6 and 10.

3.5 Conclusion regarding inventive step

The subject-matter of claims 1, 6 and 10 lacks inventive step over the disclosure of documents D3, D4 and D5 (Article 56 EPC).

4. Overall conclusion

In view of the finding that the subject-matter of claims 1, 6 and 10 lacks inventive step, the respondent's request has to be dismissed.

As this is the sole request on file, the patent has to be revoked. It is not necessary for the board to decide on the other objections raised against this request.

**Order**

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

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

N. Schneider P. Lanz

Decision electronically authenticated