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**Datasheet for the decision
of 23 January 2019**

Case Number: T 1917/15 - 3.4.02

Application Number: 06713513.7

Publication Number: 1860477

IPC: G02B17/06, G03F7/20, H01L21/027

Language of the proceedings: EN

Title of invention:

PROJECTION OPTICAL SYSTEM, EXPOSURE EQUIPMENT AND DEVICE
MANUFACTURING METHOD

Patent Proprietor:

Nikon Corporation

Relevant legal provisions:

EPC 1973 Art. 54(1), 54(4), 56, 100(b), 100(c)
EPC Art. 54(3)

Keyword:

Sufficiency of disclosure (yes)
Novelty: main and first auxiliary request (no), second
auxiliary request (yes)
Inventive step: second auxiliary request (yes)



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Case Number: T 1917/15 - 3.4.02

D E C I S I O N
of Technical Board of Appeal 3.4.02
of 23 January 2019

Appellant: Nikon Corporation
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Decision under appeal: **Interlocutory decision of the Opposition
Division of the European Patent Office posted on
29 July 2015 concerning maintenance of the
European Patent No. 1860477 in amended form.**

Composition of the Board:

Chairman B. Müller
Members: F. J. Narganes-Quijano
H. von Gronau

Summary of Facts and Submissions

- I. The patent proprietor lodged an appeal against the decision of the opposition division maintaining European patent No. 1860477 in amended form on the basis of auxiliary request 4 submitted by the patent proprietor during the oral proceedings before the opposition division.

The first-instance opposition proceedings were based on the grounds for opposition of

- lack of sufficiency of disclosure (Article 100 (b) EPC), and
- lack of novelty and lack of inventive step (Article 100 (a) EPC, together with Articles 54(1) and 56 EPC).

- II. Among the documents considered during the first-instance proceedings, the following have been considered during the appeal proceedings:

- D1: WO 2006 069 725 A
- D2: US 6 556 648 B1
- D3: "Next-Generation Extreme Ultraviolet Lithographic Projection Systems", M. F. Bal; PhD Thesis, Technische Universiteit Delft (NL), 2003; pages 1 to 139
- D4: US 6 172 825 B1
- D5: US 6 710 917 B2
- D9: US 2002 0129 328 A1.

The patent proprietor also referred to the declaration of Y. Kawabe, filed with the letter dated 7 December 2015.

In its decision the opposition division held with regard to the main request and auxiliary requests 1 to 4 then on file that

- the ground for opposition raised under Article 100(b) EPC was not persuasive;

- the ten-mirror variant of the optical system defined in claim 1 of the main request was not novel over document D1 representing state of the art within the meaning of Article 54(3) EPC, and the eight-mirror variant of the mentioned optical system was not novel over the disclosure of any of documents D2 and D3;

- independent claim 7 of auxiliary request 1 contravened the requirements of Articles 84 and 123(2) EPC;

- the optical system defined in claim 1 of auxiliary request 2 was not novel over document D1;

- the exposure apparatus defined in independent claim 20 of auxiliary request 3 did not involve an inventive step over document D2; and

- the patent as amended according to auxiliary request 4 satisfied the requirements of the EPC within the meaning of Article 101(3)(a) EPC.

III. With the statement setting out the grounds of appeal dated 7 December 2015 the patent proprietor submitted *inter alia* a set of claims 1 to 23 as a main request, and a set of claims 1 to 13 as a second auxiliary request.

IV. In reply to a communication annexed to the summons to oral proceedings and in which the board gave a preliminary assessment of the case, the patent proprietor, with the letter dated 21 December 2018, *inter alia* submitted a set of claims 1 to 22 as a first auxiliary request, and the following document:

A1: "Catadioptric Lens design: The Breakthrough to Hyper-NA Optics", B. Kneer *et al.*; Optical Microlithography XIX, Proc. of SPIE, Vol. 6154 (2006); pages 615420-1 to 615420-10.

V. Oral proceedings before the board were held on 23 January 2019.

At the beginning of the oral proceedings, the then opponent withdrew its appeal filed against the decision under consideration, and also withdrew the opposition.

The patent proprietor submitted claims 1 to 14 and page 3A of the description as a new second auxiliary request.

The patent proprietor requested that the decision under appeal be set aside and the patent be maintained in amended form on the basis of

- claims 1 to 23 of the main request file with the letter dated 7 December 2015,

- claims 1 to 22 of the first auxiliary request filed with the letter dated 21 December 2018,

- claims 1 to 14 and description page 3A filed during the oral proceedings of 23 January 2019, description pages 2, 3, 3B, 3C, 4 to 23 and figures 1 to 13 attached to the decision under appeal, all documents pertaining to the second auxiliary request, or

- claims 1 to 13 of the third auxiliary request filed as second auxiliary request with the letter dated 7 December 2015.

At the end of the oral proceedings the chairman announced the decision of the board.

VI. Claim 1 of the main request reads as follows:

"An X-ray projection optical system of the three times image forming type for a scanning type exposure apparatus for projecting a reduced image of a first surface (4) on a second surface (7); the projection optical system is nearly telecentric on the second surface (7) side and consists of ten reflecting mirrors, which have convex or concave mirror shape and are arranged between the first surface (4) and the second surface (7); the projection optical system comprising: a first reflecting image forming optical system (G1) for forming a first intermediate image of the first surface (4) based on light from the first surface (4), a second reflecting image forming optical system (G2) for forming a second intermediate image of the first surface (4) based on light from the first intermediate image, and a third reflecting image forming optical system (G3) for forming the reduced image of the first surface (4) on the second surface (7) based on light from the second intermediate image, wherein the number of reflecting mirrors which the third reflecting image forming optical system (G3) comprises is greater than the number of reflecting mirrors which the first reflecting image forming optical system (G1) comprises and is greater than or equal to the number of reflecting mirrors which the second reflecting image forming optical system (G2) comprises."

The wording of claim 1 of the first auxiliary request differs from that of claim 1 of the main request in that the expression "for forming the reduced image of the first surface (4) on the second surface (7)" has been replaced by "for forming a third and final image

as the reduced image of the first surface (4) on the second surface (7)".

Claim 1 of the second auxiliary request reads as follows:

"An X-ray projection optical system for a scanning type exposure apparatus for projecting a reduced image of a first surface (4) on a second surface (7); the projection optical system is nearly telecentric on the second surface (7) side and consists of eight reflecting mirrors being in order of the incidence of light from the first surface (4), a first reflecting mirror (M1), a second reflecting mirror (M2), a third reflecting mirror (M3), a fourth reflecting mirror (M4), a fifth reflecting mirror (M5), a sixth reflecting mirror (M6), a seventh reflecting mirror (M7) and an eighth reflecting mirror (M8), which have convex or concave mirror shape and are arranged between the first surface (4) and the second surface (7); the projection optical system comprising: a first reflecting image forming optical system (G1) for forming a first intermediate image of the first surface (4) based on light from the first surface (4), a second reflecting image forming optical system (G2) for forming a second intermediate image of the first surface (4) based on light from the first intermediate image, and a third reflecting image forming optical system (G3) for forming the reduced image of the first surface (4) on the second surface (7) based on light from the second intermediate image, wherein the number of reflecting mirrors which the third reflecting image forming optical system (G3) comprises is greater than the number of reflecting mirrors which the first reflecting image forming optical system (G1) comprises and is greater than the number of reflecting mirrors

which the second reflecting image forming optical system (G2) comprises, wherein the third reflecting mirror (M3) and the eighth reflecting mirror (M8) are positioned between the fourth reflecting mirror (M4) and the sixth reflecting mirror (M6), seen along the optical axis."

The set of claims of the second auxiliary request in addition comprises claims 2 to 14 all referring back to claim 1.

Reasons for the Decision

1. The appeal of the patent proprietor is admissible.

During the oral proceedings held before the board the sole opponent withdrew its appeal filed against the decision under consideration and also withdrew the opposition. Upon withdrawal of the opposition, the opponent ceased to be a party to the present proceedings.

2. *Main request - Novelty of claim 1*

- 2.1 Document D1 discloses with reference to Fig. 12 an optical system (see page 91, line 1 to page 93, line 16). The document constitutes the publication of an international application on which the European patent application Nr. 05819425.9 was subsequently based, and the document was published on 6 July 2006, i.e. after the priority dates (15 February 2005 and 4 November 2005) of the patent in suit. It has been undisputed during the proceedings that the disclosure

of document D1 relating to Fig. 12 is supported by the first of the priorities mentioned in the document and dated 23 December 2004, and that consequently the mentioned disclosure constitutes prior art within the meaning of Article 54(3) EPC, together with Article 54(4) EPC 1973 applicable in the present case, for the contracting states (DE, FR, GB, IT and NL) validly designated in both the European patent application corresponding to document D1 and the present patent.

2.2 It has also been undisputed during the proceedings that the optical system disclosed in document D1 with reference to Fig. 12 constitutes an X-ray projection optical system for a scanning type exposure apparatus for projecting a reduced image of a first surface on a second surface, the optical system being telecentric on the second surface side and consisting of ten reflector mirrors having a convex or concave shape (see in particular Table 12 on page 92, together with page 91, lines 1 to 3, and page 4, lines 22 and 23). In addition, the optical system is constituted by four optical subsystems, namely

- a first subsystem of two mirrors (mirrors S10 and S20 in Fig. 12) forming a first intermediate image (image Z3) of the first surface (surface 10),

- a second subsystem of four mirrors (mirrors S50, S70, S80, and the first of the two mirrors designated in Fig. 12 as "S60" and disposed close to mirror S70) forming a second intermediate image (Fig. 12),

- a third subsystem of two mirrors (mirror S30 and the second of the two mirrors designated in the figure as "S60" and disposed close to the mirror S80, i.e. the mirror designated as "S40" in the corresponding description, see page 92, line 6) forming a third intermediate image, and

- a fourth subsystem of two mirrors (SK1 and SK2) forming the final, reduced image on the second surface (surface 20 in Fig. 12).

Claim 1 corresponds to claim 1 of auxiliary request 1 underlying the decision under appeal, and in the decision the opposition division concluded that the subject-matter of claim 1 was anticipated by the disclosure of document D1 relating to Fig. 12 because

- the first and the second optical subsystems of the optical system of Fig. 12 of document D1 constituted, respectively, a first and a second reflecting image forming optical system as claimed, and

- the third and the fourth optical subsystems of the optical system of Fig. 12 constituted together a third reflecting image forming optical system as claimed, wherein

- the number of mirrors of the third reflecting image forming optical system (i.e. four) was greater than the number of mirrors of the first reflecting image forming optical system (i.e. two) and equal to the number of mirrors of the second reflecting image forming optical system (i.e. four) as required by the claimed subject-matter, and

- the first, second and third reflecting image forming optical systems respectively formed a first intermediate image, a second intermediate image, and the final image, so that the optical system was of the three times image forming type as claimed.

2.3 The appellant has contested the opposition division's finding in this respect, and has submitted that the optical system of Fig. 12 of document D1 was constituted by four reflecting image forming optical systems of mirrors each forming an image and each comprising, respectively, 2, 4, 2 and 2 mirrors, and

not by three reflecting image forming optical systems each forming an image and satisfying the claimed conditions relating to the number of mirrors within each system.

In the board's opinion, however, the mirrors of an optical system comprising a plurality of mirrors can conceptually be grouped into systems of mirrors in an arbitrary way, and the technical significance of a predetermined grouping of the mirrors into systems depends on the technical features of these systems. In the present case, the fact that the claimed optical system comprises a first, a second and a third reflecting image forming optical system of mirrors as claimed does not determine any technical feature of the optical systems of mirrors other than the features mentioned in the claim. In particular, none of these features exclude the formation of an additional intermediate image within one of the optical systems of mirrors, and in particular within the claimed third optical system, and the question of whether such an optical system of mirrors having an intermediate image formed therein can still be considered an optical system or - as submitted by the patent proprietor - should be considered as two optical systems each forming an intermediate image constitutes, in the absence of any other technical consideration, a pure conceptual question without technical pertinence.

In the case of the optical system represented in Fig. 12 of document D1, the mirror S30 and the second of the two mirrors designated in the figure as "S60" and disposed close to the mirror S80 form an intermediate image, and this intermediate image is imaged onto a final image by mirrors SK1 and SK2. Therefore, these four mirrors can be considered to constitute - as

submitted by the patent proprietor - two different optical systems of mirrors (S30 and S60, and SK1 and SK2), but they can also be considered to constitute a single optical system of mirrors (S30, S60, SK1 and SK2) forming a final image as it is the case with the third of the optical systems of mirrors defined in claim 1. In addition, the number (namely 4) of mirrors in this third optical system of mirrors (S30, S60, SK1 and SK2) satisfies the claimed requirements relating to the number of mirrors in the different optical systems of mirrors constituting the claimed projection optical system.

- 2.4 The appellant has also submitted that three intermediate images and a final image, i.e. four images, were formed in the optical system represented in Fig. 12 of document D1, and that for this reason this system did not anticipate the claimed optical system which was required to be of a specific type, namely "of the three times image forming type".

However, the expression "of the three times image forming type" can be interpreted - as submitted by the patent proprietor - as referring to a class or category of optical systems in which three, and only three images (i.e. only two intermediate images, and a final image) are formed, but it can also generically be interpreted as held by the opposition division as referring to an optical system in which at least three images are formed, i.e. at least two intermediate images and a final image, the two intermediate images constituting main intermediate images in the sense that they serve a particular technical purpose (for instance, for receiving therein optical elements such as apertures, filters, etc.), and wherein the (accidental, or possibly also purposive) formation of

additional intermediate images is not necessarily excluded.

In addition, none of the features of claim 1 endows the mentioned expression with a technical meaning that would exclude the formation of more than two intermediate images, and in particular the formation of an additional intermediate image within the third of the three optical systems of mirrors of the claimed projection optical system. More particularly, the claimed third optical system of mirrors is required to have a number of mirrors satisfying the claimed condition and to form the final, reduced image, but the claim is silent as to any other restriction to the optical characteristics of the third optical system that would exclude that a third intermediate image is formed within the third optical system of mirrors.

The appellant has further submitted that - in agreement with the declaration by Y. Kawabe - the mentioned expression had a very specific and well established meaning in the field of lithography, and that the skilled person working in this field would interpret the mentioned expression as excluding a fourth image. In support of this submission, the appellant has referred to document D2 (see title), document D3 (title), and to the post-published document A1 (see abstract), all pertaining to the technical field of lithography. According to these documents, the magnification of a projection optical system constituted by a predetermined number of mirrors was positive or negative depending on whether the number of intermediate images formed within the optical system was odd or even (document D2, column 12, lines 40 to 43; document D3, section 3.7, last paragraph on page 49; and document A1, section 4 and Fig. 4).

The board agrees with the appellant that the sign (positive or negative) of the magnification of the final image formed by a projection optical system constituted by mirrors depends on the parity (odd or even) of the number of intermediate images formed within the optical system, with the consequence that, as also submitted by the appellant, when the projection optical system is used in a lithographic scanning exposure apparatus for scanningly projecting a mask on a wafer, the mask and the wafer are to be moved in the same or in opposite directions depending on the parity of the number of intermediate images formed within the projection optical system, thus imposing restrictions on the type of projection optical systems that can be used in a predetermined lithographic scanning exposure apparatus for scanningly projecting a mask on a wafer. However, in the board's view these considerations are not sufficient to conclude that the expression "of the three times image forming type" has a specific and well established technical meaning in the specific technical field considered in documents D2, D3 and A1, or that the expression would necessarily be interpreted by the skilled person in this specific technical field as referring to a specific class or category of projection optical systems comprising two, and only two intermediate images in the projection optical system.

In addition, claim 1 defines an X-ray projection optical system for a scanning type exposure apparatus for projecting a reduced image, and the claim is not restricted to lithographic scanning exposure techniques for scanningly projecting a mask on a wafer, let alone restricted to projection optical systems compatible with lithographic scanning exposure arrangements in which the mask and the wafer are moved in the same, or

in the opposite direction. Consequently, the claimed subject-matter pertains to a more general technical field than the specific technical field to which documents D2, D3 and A1 pertain, and there is no evidence that in the more general technical field to which the claimed subject-matter pertains the expression "of the three times image forming type" would have a clear and established technical meaning excluding additional intermediate images in the projection optical system.

- 2.5 In view of these considerations, the board sees no reason to depart from the opposition division's view that the optical system defined in claim 1 is anticipated by the disclosure of document D1 relating to Fig. 12 and that, consequently, the claimed subject-matter is not new within the meaning of Article 52(1) EPC 1973 together with Article 54(3) EPC (together with Article 54(4) EPC 1973).

3. *First auxiliary request - Novelty of claim 1*

Claim 1 of the first auxiliary request differs from claim 1 of the main request only in that the expression "for forming the reduced image of the first surface (4) on the second surface" of claim 1 of the main request has been replaced by "for forming a third and final image as the reduced image of the first surface (4) on the second surface (7)".

The appellant has submitted that the expression "forming a third and final image" related to a sequence of images, and constituted the definition of the last of the images in a sequence of images, and it excluded further images, and in particular a fourth image constituted by an additional intermediate image.

However, in the board's view the mentioned modification has no incidence in the claimed subject-matter. Claim 1 of the main request already makes clear that the image formed by the third reflecting image forming optical system is the reduced image formed by the projection optical system, and that it therefore constitutes the "final" image. In addition, this final image can be labelled as "a third", or as the third image implied by the expression "of the three times image forming type", without however necessarily excluding that additional intermediate images (which could then be labelled as "a fourth image", etc.) are formed within the projection optical system, and in particular within the claimed third reflecting image forming optical system.

Consequently, in the board's view the mentioned amendment does not restrict the claimed subject-matter to projection optical systems comprising a final image and two, and only two, intermediate images. Therefore, claim 1 is not new over the disclosure of document D1 relating to Fig. 12 for the same reasons as given in point 2 above in respect of claim 1 of the main request (Article 52(1) EPC 1973, together with Article 54(3) EPC, and Article 54(4) EPC 1973).

4. *Second auxiliary request*

4.1 Amendments

Claim 1 of the second auxiliary request results from the combination of the first of the variants of the projection optical system defined in claim 1 as granted relating to the system consisting of eight reflecting mirrors, with the features of dependent claim 7 as granted, together with the disclosure in the

application as originally filed relating to the use of the claimed optical system in a scanning type exposure apparatus (see last sentence of paragraph [0013] of the publication of the application as originally filed).

Claim 1 has been further amended to specify that the third and the eighth reflecting mirrors are positioned between the fourth and the sixth reflecting mirrors. This feature is disclosed in paragraphs [0035] and [0037] of the publication of the application as originally filed, the feature being disclosed in these two paragraphs as an underlying assumption independent of the specific relationships between distances disclosed in the mentioned paragraphs. In addition, according to the criteria conventionally used in this technical field and also used in the application as originally filed (see for instance paragraphs [0034] to [0037], and paragraph [0061] together with Tables (1) to (5) of the publication of the application as originally filed), the spatial position of the mirrors is defined as the spatial position of the geometrical vertices of the mirrors or, in the event that, in practice, only an off-axis segment of some of the mirrors is present in the optical system, as the spatial position of the geometrical vertex of the geometrical prolongation of the off-axis segment of the corresponding mirror. Therefore, the claimed feature according to which the relative position of the third, fourth, sixth and eighth mirrors defined in claim 1 is as "seen along the optical axis" is clear in the technical context of the claim (Article 84 EPC 1973) and based on the content of the application as originally filed (Article 123(2) EPC).

Claims 2 to 14 of the second auxiliary request are based on claims 8 to 17 and 20 to 22 as granted, respectively.

The amendments to the description relate to the adaptation of its content to the invention as defined in the present claims (Article 84 and Rule 27(1)(c) EPC 1973).

The board is therefore satisfied that the amendments to the patent as granted comply with the requirements of Article 84 EPC 1973 and Articles 123(2) and (3) EPC.

4.2 Sufficiency of disclosure

The grounds for opposition under Article 100(b) EPC 1973 concerned the features of dependent claims 9, 10 and 18 to 21 as granted.

The features of dependent claims 9, 10, 20 and 21 as granted are now defined in dependent claims 3, 4, 12 and 13 of the present second auxiliary request, respectively. In its decision the opposition division held that the patent specification described embodiments falling within the ranges specified in dependent claims 9, 10, 20 and 21 as granted, and that it was not apparent why the skilled person, using normal optical design methods, would not be able to conceive embodiments at the limit values of the ranges specified in these claims. The board sees no reason to question the opposition division's finding in this respect, and concludes that the patent specification discloses the invention defined in dependent claims 3, 4, 12 and 13 of the present second auxiliary request in a manner sufficiently clear and complete for it to be carried out by the person skilled in the art.

The features of dependent claims 18 and 19 as granted are no longer present in the claims of the present second auxiliary request.

Therefore, the grounds for opposition under Article 100(b) EPC 1973 do not prejudice the maintenance of the patent as amended according to the present second auxiliary request.

4.3 Novelty - Claim 1

4.3.1 Document D2 discloses a projection optical system (column 1, lines 9 to 11, and Fig. 1 and 18, together with the corresponding description) for projecting a reduced image of an object on an image surface with radiation of 5 nm (column 6, lines 12 to 18), the optical system being telecentric on the image surface (column 12, lines 5 to 8) and being constituted by eight reflecting mirrors, each mirror having a concave or a convex shape (Fig. 18, column 30, lines 31 to 35, and Table 13 in column 33). Furthermore, the optical system forms two - and only two - intermediate images, and the sequence of eight mirrors constitutes, when seen in order of the incidence of light from the object, a mirror system of the type 2-2-4, i.e. a system comprising a first subsystem of two mirrors (M1 and M2 in Fig. 18) forming the first intermediate image, followed by a second subsystem of two mirrors (M3 and M4) forming the second intermediate image, and by a third subsystem of four mirrors (M5 to M8) forming the final, reduced image. In addition, the number of mirrors (four) in the third subsystem is greater than the number of mirrors (two) in each of the first and the second subsystems.

While claim 1 requires that the third and the eighth mirrors of the claimed optical system are arranged between the fourth mirror and the sixth mirror when seen along the optical axis, in the optical system of document D2 the third and the eighth mirrors are arranged on the image side of both the fourth and the sixth mirrors (see Fig. 18 and Table 13).

In the decision under appeal the opposition division held that the optical system of document D2 was disclosed for use in a scanning type exposure apparatus (see document D2, column 7, lines 46 to 64) and that, consequently, the optical system was also suitable for use in a scanning type exposure apparatus as required by claim 1. During the appeal proceedings the appellant has disputed the opposition division's finding in this respect. In particular, the patent proprietor has submitted that the disclosure of document D2 relating to the use of the optical systems in a scanning type exposure apparatus did not represent an enabling disclosure in respect of the optical system of Fig. 18 because, due to the close proximity of the mirror M7 of Fig. 18 to the image plane, it was practically impossible in a lithographic apparatus incorporating the optical system of Fig. 18 to completely scan a shot area without the wafer hitting mirror M7 as shown in the results of simulations presented by the patent proprietor during the appeal proceedings. However, in view of the distinguishing feature already identified in the preceding paragraph, and also in view of the considerations and conclusions in point 4.4.1 below which are independent of the question of whether or not the optical system of Fig. 18 of document D2 is suitable for use in a scanning type exposure apparatus within the meaning of the claimed subject-matter, there is no need for the board to decide on this issue.

- 4.3.2 Document D3 discloses the same optical system as the one disclosed in document D2 and referred to in point 4.3.1 above (see Fig. (6.13), together with the corresponding disclosure).
- 4.3.3 Document D4 discloses a projection optical system (abstract and Fig. 4 together with the corresponding description) for a scanning type exposure apparatus for projecting a reduced image of an object on an image surface (Fig. 2, and column 6, lines 13 to 39), the optical system being telecentric on the image surface (column 13, lines 26 to 32) and being constituted by reflecting mirrors having a concave or a convex shape.

The optical system of document D4, however, does not comprise eight mirrors as required by claim 1, but six mirrors. In addition, the optical system forms only one intermediate image and is of the type 2-4, i.e. the system comprises a first subsystem of two mirrors (M1 and M2 in Fig. 4) forming the intermediate image, followed by a second subsystem of four mirrors (M3 to M6) forming the final image.

- 4.3.4 Document D5 discloses a projection optical system (abstract and Fig. 5, together with column 1, lines 12 to 17, and the table shown in Fig. 9) for a scanning type exposure apparatus for projecting a reduced image of an object on an image surface (column 5, lines 59 to 67), the optical system being telecentric on the image surface (column 6, lines 17 to 22), and being constituted by eight reflecting mirrors having a concave or a convex shape and forming two intermediate images.

The optical system of document D5, however, is of the type 2-4-2, i.e. the system comprises a first subsystem of two mirrors (S1 and S2 in Fig. 5) forming the first intermediate image, followed by a second subsystem of four mirrors (S3 to S6) forming the second intermediate image, and by a third subsystem of two mirrors (S7 and S8) forming the final image, so that - contrary to claim 1 - the number of mirrors in the third subsystem is not greater than the number of mirrors in the first subsystem and the number of mirrors in the second subsystem. In addition, the third and the eighth mirrors of the optical system disclosed in document D5 are disposed on the image side of both the fourth and the sixth mirrors when seen along the optical axis of the optical system (see Fig. 5), and not between the fourth mirror and the sixth mirror as required by claim 1.

4.3.5 Document D9 discloses a projection optical system (abstract and Fig. 9, together with the table shown in Fig. 10, and the corresponding description) for projecting a reduced image of an object on an image surface (paragraphs [0068] and [0069]), the optical system being telecentric on the image surface (paragraph [0072]) and being constituted by eight reflecting mirrors having a concave or a convex shape (Fig. 9).

However, the optical system of document D9 forms one single intermediate image, and is of the type 4-4, i.e. the system comprises a first subsystem of four mirrors (M11 to M14 in Fig. 9) forming the intermediate image, followed by a second subsystem of four mirrors (M15 to M18) forming the final image.

4.3.6 The remaining documents considered during the first-instance opposition proceedings are less relevant for the issue of novelty.

4.3.7 It follows that the subject-matter of claim 1 is new over the disclosure of the documents considered during the proceedings (Article 54(1) EPC 1973).

4.4 Inventive step - Claim 1

4.4.1 In view of the considerations regarding the issue of novelty set out in point 4.3 above, the board considers that the closest state of the art is represented by document D2 or, alternatively, by document D3 which discloses the same optical system as document D2.

As noted in point 4.3.1 above, second paragraph, the claimed optical system differs from the optical system of document D2 in the relative position of the third, the fourth, the sixth and the eighth mirrors of the system. According to the description of the patent, the technical effect achieved by this distinguishing feature in combination with the remaining claimed features is the improvement of the compactness of the optical system in the radial direction (see paragraphs [0006], [0012] and [0013] of the patent specification), and a comparison of the compact mirror configuration of the examples of the claimed system shown in the patent specification (see Fig. 7, 9 and 11) with the relatively wide distribution in the radial direction of the mirrors of the optical system of document D2 (see Fig. 18) shows that the claimed optical system improves the compactness in the radial direction of the optical system of document D2.

None of the documents under consideration disclose or suggest improving the compactness in the radial direction of the optical system of document D2 as claimed. In particular:

- The disclosure of document D3, in this respect, does not go beyond the disclosure of document D2.

- Document D4 teaches locating the fourth, or both the fourth and the fifth of the six mirrors constituting the optical system disclosed in the document (see point 4.3.3 above) between the third and the sixth of the mirrors (column 5, lines 20 to 33, and lines 37 to 48) in order to improve the overall compactness (column 5, lines 37 to 44; see also column 1, lines 57 to 62, and column 3, lines 33 to 45), and in particular the compactness in the direction of the optical axis of the optical system (column 5, lines 33 to 36). Therefore, document D4 is not specifically directed to the problem of improving the compactness in the radial direction of a mirror optical system of the type under consideration. In addition, a comparison of the imaging arrangement of the optical systems of document D2 (Fig. 18) and of document D4 (Fig. 4) shows that the first and the second mirrors of the optical system of document D2 (mirrors M1 and M2 in Fig. 18) have the same optical function as, and therefore constitute the optical counterpart of, the first and the second mirrors of the optical system of document D4 (mirrors M1 and M2 of Fig. 4), with the consequence that the third to the sixth of the mirrors of document D4 (mirrors M3 to M6 in Fig. 4) constitute the optical counterpart of the third to the eighth of the mirrors of document D2 (mirrors M3 to M8 in Fig. 18). Consequently, even assuming that the skilled person would consider the possibility of applying the teaching of document D4 to the optical system of document D2, they would then be confronted with the problem of how

the teaching of document D4 relating to the relative position of four mirrors (mirrors M3 to M6) would have to be applied to the set of eight mirrors (mirrors M3 to M8) of the optical system of document D2. For these reasons, in the board's view the teaching of document D4 does not disclose or suggest improving the compactness in the radial direction of the optical system of document D2 in a way that would result in the claimed subject-matter.

- The optical system of document D5 (see point 4.3.4 above) comprises eight mirrors and two intermediate images (column 4, lines 31 to 36), and the document addresses the problem of improving the compactness in the radial direction of the optical system (column 4, lines 36 to 42). The document, however, proposes improving the compactness in the radial direction by designing the optical system so that the second intermediate image is formed in the path of the rays between the sixth and the seventh of the mirrors (column 4, lines 36 to 42). The application of this teaching to the optical system of document D2 of the type 2-2-4 would not only not lead to the claimed optical system, but would even result in an optical system of the type 2-4-2, i.e. in an optical system presenting more differences when compared with the claimed system than the optical system of document D2.

- The optical system of document D9 comprises eight mirrors and one single intermediate image (see 4.3.5 point above) and, in the radial direction, is relatively compact (see Fig. 9). The document would therefore suggest improving the compactness of the optical system of document D2 by replacing the optical system of document D2 by that of document D4, or at least by suppressing the formation of one of the two intermediate images of the optical system of document

D2, and this approach would result in an optical system of the type 4-4, i.e. in an optical system presenting more differences when compared with the claimed system than the optical system of document D2.

- The remaining documents considered during the first-instance opposition proceedings are less pertinent.

The board concludes that the optical system defined in claim 1 is not obvious when starting with document D2 as the closest state of the art (Article 56 EPC 1973).

4.4.2 Since document D3 discloses the same optical system as disclosed in document D2, the same conclusion reached in point 4.4.1 above also applies when starting with document D3 as the closest state of the art. In addition, it is apparent from the considerations in points 4.3 and 4.4.1 above that the same conclusion would be reached when starting alternatively with any of documents D4, D5 and D9 as the closest state of the art.

4.4.3 Therefore, the subject-matter of claim 1 involves an inventive step (Article 56 EPC 1973) over the documents considered in the appeal proceedings.

4.5 Novelty and inventive step - Claims 2 to 14

Claim 11 is directed to a scanning type exposure apparatus comprising the projection optical system defined in claim 1, claim 14 is directed to a method of manufacturing a device comprising the use of the exposure apparatus defined in claim 11, dependent claims 2 to 10 refer back to claim 1, and dependent claims 12 and 13 refer back to claim 11. Therefore, the subject-matter of claims 2 to 14 is also new and

involves an inventive step (Articles 54(1) and 56 EPC 1973).

5. In view of the above considerations, the board concludes that the patent as amended according to the second auxiliary request of the appellant meets the requirements of the EPC within the meaning of Article 101(3)(a) EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the department of first instance with the order to maintain the patent as amended in the following version:
 - Claims: 1 to 14 of the second auxiliary request filed during the oral proceedings of 23 January 2019.
 - Description: Pages 2, 3, 3B, 3C, 4 to 23 attached to the decision under appeal, and page 3A filed during the oral proceedings of 23 January 2019.
 - Drawings: Figures 1 to 13 attached to the decision under appeal.

The Registrar:

The Chairman:



M. Kiehl

B. Müller

Decision electronically authenticated