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(54) **OPTICAL SCOPE FOR IMAGING OF AN OBJECT**

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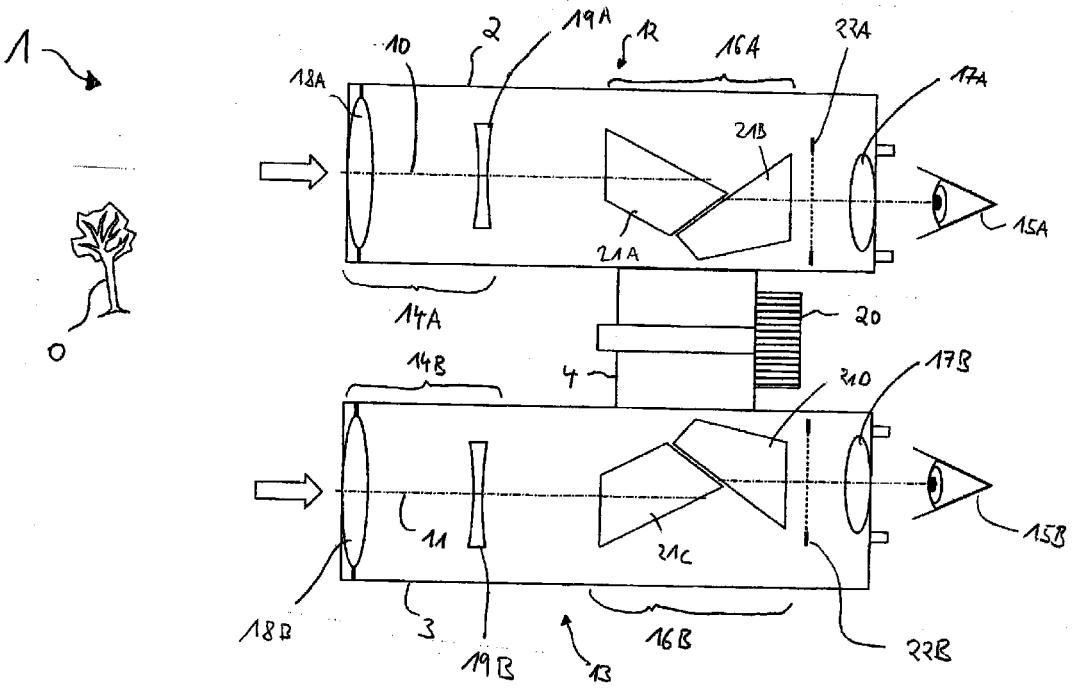
(57) **ABSTRACT**

An optical scope has at least one optical element which is used to image an object. An optical element is, for example, understood to mean a lens unit, a prism, or a prism system composed of multiple prisms. A lens unit is, for example, understood to mean one single lens or a unit which is composed of at least two lenses. It is now provided to make the optical element of glass, namely of at least one of the following glasses (glass types): N-BK7HT, N-SK2HT, F2HT, N-LASF45HT, SF6HT, N-SF6HTultra, N-SF6HT, SF57HTultra, N-SF57HTultra, N-SF57HT, as well as N-LASF9HT. The above-named glasses are glasses of the SCHOTT corporation.



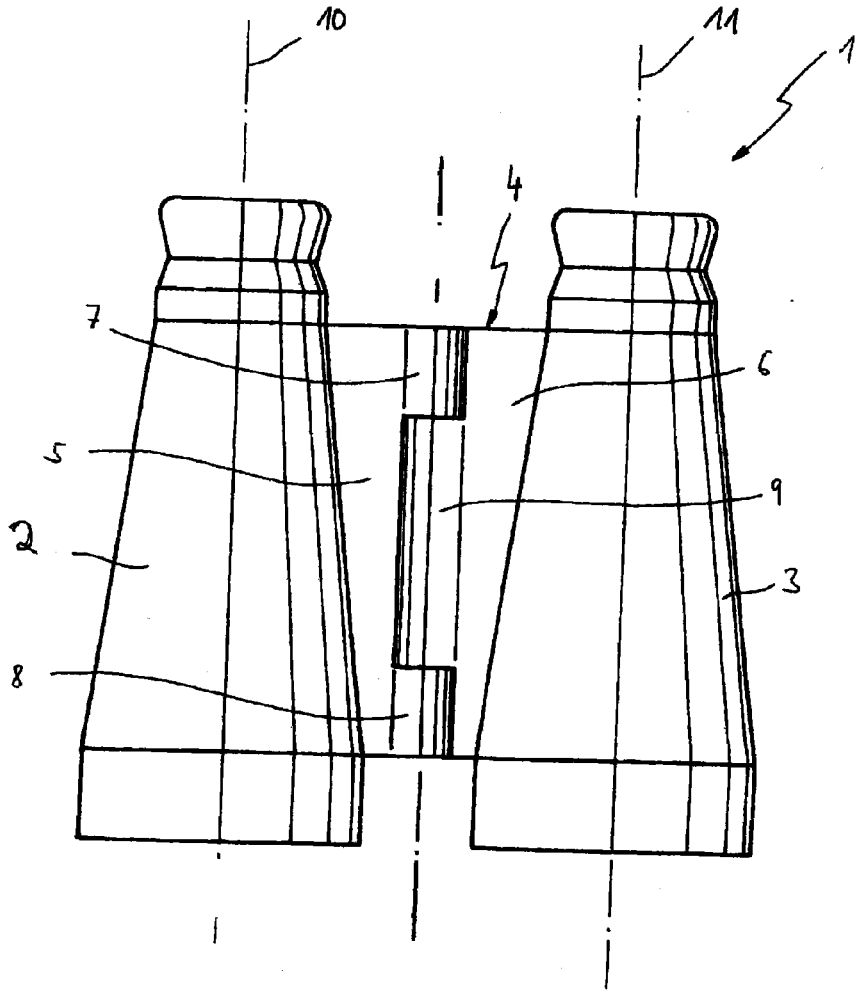


Fig. 1

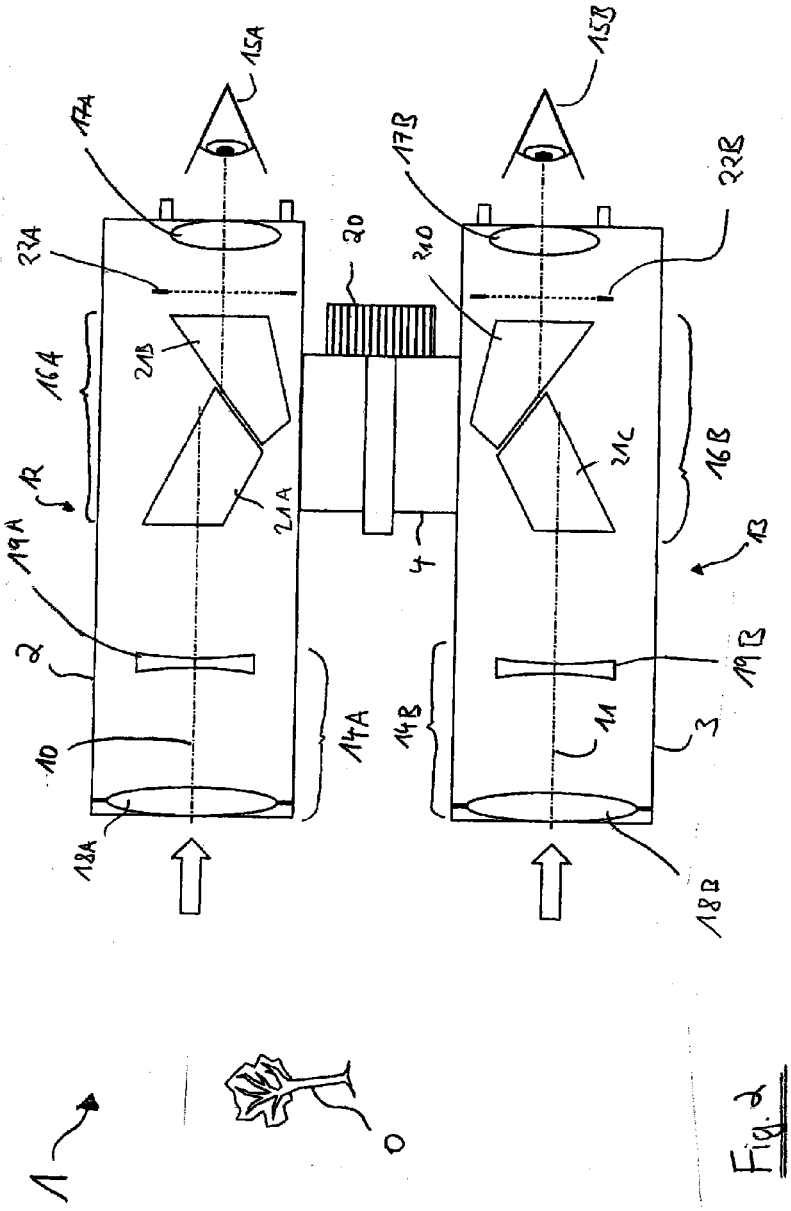

15A
15B
17A
17B
22A
22B
20
21A
21B
21C
16A
16B
R
19A
19B
2
10
14A
14B
11
3
4
18A
18B
1
O

Fig. 2

OPTICAL SCOPE FOR IMAGING OF AN OBJECT

[0001] The invention relates to an optical scope for imaging an object, e.g., on an image detection unit. An optical scope is, for example, understood to mean a monocular, a binocular, a telescope, or a spotting scope. Furthermore, an image detection unit is, for example, understood to mean a human eye or, for example, a digital recording medium. A CCD is in particular suitable as the digital recording medium.

[0002] Optical scopes of the above-named type are known from the prior art. The known optical scopes usually have at least one optical unit which is used to image an object. For example, the optical unit is designed as an objective lens, as an ocular, or as a prism system.

[0003] Each of the optical units in turn has at least one optical element or at least two optical elements. A single lens or a plurality of lenses, e.g., a lens component, is provided as the optical element, for example. In a prism system, the optical element is designed as a prism. Each optical element has imaging properties which are determined by the transmission of the light incident onto the optical element, among other things. The transmission is the permeability of the medium of which the optical element is composed. Depending on the property of the medium, the light incident onto the optical element is reflected on at least one boundary surface of the optical element or is partially absorbed when it passes through the optical element. A certain portion of the incident light which is not reflected and not absorbed again exits the optical element. This portion of light is called the transmitted light.

[0004] A variable which describes the transmission is the transmittance $T(\lambda)$. The latter is a function of the wavelength and is defined as the ratio of a light intensity transmitted through an optical element to a light intensity incident onto the optical element. A wavelength-based weighting provides a transmission number which also describes the property of the transmission of the optical element. In particular, sensitivity curves $V(\lambda)$ of the bright-adapted human eye and $V'(\lambda)$ of the dark-adapted human eye are used as weighting factors. The following equation applies:

$$T = \int_{-\infty}^{+\infty} T(\lambda) \cdot V(\lambda) d\lambda$$

$$T' = \int_{-\infty}^{+\infty} T(\lambda) \cdot V'(\lambda) d\lambda$$

[0005] T is identified as the transmission number for the day transmission. T' is identified as the transmission for the night transmission.

[0006] The transmission of an optical system (system transmission) is determined by the transmission of its individual optical elements. It is known to indicate the system transmission by a value so that the image quality of the optical system is recognized.

[0007] It is furthermore known that the transmission is reduced in optical scopes from the prior art with an increasing number of optical elements installed in the optical scope, since incident light is reflected on an increasing number of optical elements.

[0008] Furthermore, environmental conditions exist which exacerbate or render impossible the observation of an object using a known optical scope. For example, it is difficult to observe an object using the known optical scopes at dawn or during the night. Due to the little light incidence and due to the little transmission of the light incident into the known optical scope it is difficult to obtain a good quality image.

[0009] Reference is additionally made to WO 2004/061487 A2 and US 2006/0238732 A1.

[0010] It is desirable that the optical scope (and thus also the optical units or optical elements forming the optical scope), using which an observation of an object is carried out, has the highest transmission possible. The invention is based on the object of providing an optical scope which has a high transmission.

[0011] This object is achieved according to the invention by an optical scope having the features of claim **1**. Further features of the invention result from the description that follows, the appended claims, and/or the appended figures.

[0012] According to the invention, the optical scope is designed to image an object. It has at least one optical element which is used to image the object. Here, an optical element is, for example, understood to mean a lens unit, a prism, or a prism system composed of multiple prisms. A lens unit is, for example, understood to mean one single lens or a unit which is composed of at least two lenses.

[0013] It is now provided to make the optical element of glass, namely of at least one of the following glasses (glass types): N-BK7HT, N-SK2HT, F2HT, N-LASF45HT, SF6HT, N-SF6HTultra, N-SF6HT, SF57HTultra, N-SF57HTultra, N-SF57HT, as well as N-LASF9HT. The above-named glasses are glasses of the SCHOTT corporation.

[0014] The optical scope according to the invention is based on the surprising finding that the transmission of the optical scope is significantly improved compared to the prior art, if at least one optical element, which is situated in an optical scope, is made of at least one of the above-mentioned glasses. In particular, it is possible to use the optical scope to observe and image an object at unfavorable environmental conditions, e.g., at dawn or at night.

[0015] If the optical scope according to the invention has multiple optical elements, the invention provides that at least one of these multiple optical elements is made of at least one of the above-named glasses. The invention does not necessarily provide that all of the multiple optical elements are made of at least one of the above-named glasses. However, one embodiment of the invention does provide that multiple or even each of the multiple optical elements are/is made of at least one of the above-named glasses. In one exemplary embodiment of the optical scope according to the invention, it is provided that the optical scope has at least one first optical element and at least one second optical element, the first optical element being made of at least one of the above-named glass types and the second optical element being made of at least one of the above-named glass types.

[0016] In one exemplary embodiment of the optical scope according to the invention, it is additionally or alternatively provided that the optical scope has at least one objective lens which includes the optical element. In another exemplary embodiment, it is additionally or alternatively provided that the optical scope has an ocular which has the optical element.

[0017] In yet another exemplary embodiment of the optical scope according to the invention, it is alternatively or additionally provided that an image detection unit is provided which is, for example, designed as a digital recording medium, in particular as a CCD.

[0018] As already mentioned above, the optical element is designed as a lens unit, for example. In another exemplary embodiment, it is additionally or alternatively provided that the optical scope has at least one first lens unit and at least one second lens unit. In this exemplary embodiment, it is provided that the first lens unit is made of at least one of the above-named glasses and that the second lens unit is made of at least one of the above-named glasses.

[0019] In yet another exemplary embodiment of the optical scope according to the invention, the optical element is designed as a prism. In another exemplary embodiment of the optical scope according to the invention, the optical scope has multiple prisms which are situated in the optical scope as optical elements.

[0020] In another exemplary embodiment of the optical scope according to the invention, the optical scope is designed as a monocular, a binocular, a telescope, or a spotting scope. The invention, is, however, not limited to the above-named exemplary embodiments.

[0021] The invention is now elucidated in greater detail with the aid of the figures with reference to one exemplary embodiment.

[0022] FIG. **1** shows a first schematic view of an optical scope; and

[0023] FIG. **2** shows a second schematic view of the optical scope according to FIG. **1**.

[0024] The invention is discussed in the following with reference to an optical system in the form of a binocular **1** (referred to in the following only as optical scope **1**). It is explicitly pointed out that the invention is not limited to a binocular. The invention is rather suitable for every optical system, for example, also for a monocular, a telescope, or a spotting scope.

[0025] FIG. **1** shows a first schematic view of the optical scope **1** which has a tube-shaped first housing part **2** and a tube-shaped second housing part **3**. A first optical axis **10** runs through the first housing part **2**. In contrast, a second optical axis **11** runs through the second housing part **3**. The first housing part **2** is connected to the second housing part **3** via a folding bridge **4**. The folding bridge **4** has a first hinge part **5** which is integrally connected to the first housing part **2**. Furthermore, the folding bridge **4** has a second hinge part **6** which is situated on the second housing part **3**. The first hinge part **5** has a first receptacle part **7** and a second receptacle part **8** between which a third receptacle part **9** of the second hinge part **6** is situated. An axle bolt (not illustrated) runs through the first receptacle part **7**, the second receptacle part **8**, and the third receptacle part **9**, so that the relative position of the first housing part **2** and the second housing part **3** may be attuned to one another. In this way, it is possible to attune the first housing part **2** and the second housing part **3** to the interocular distance of a user, so that, on the one hand, the first housing part **2** is situated on the one of the two eyes of the user and, on the other hand, so that the second housing part **3** is situated on the other one of the two eyes of the user.

[0026] FIG. **2** shows another view of the optical scope **1**. The first housing part **2** has a first optical subsystem **12**. The first optical subsystem **12** is provided with a first objective lens **14**A, with a first prism system **16**A, and with a first ocular **17**A. On the first ocular **17**A, a first eye **15**A of a user may be situated to observe an object O. The first optical axis **10** of the first optical subsystem **12** is slightly offset laterally due to the first prism system **16**A, so that the first optical axis **10** consequently has a stepped design.

[0027] In this exemplary embodiment, the first objective lens **14**A includes a first front unit **18**A and a first focusing unit **19**A. Other embodiments of the first objective lens **14**A provide a different number of individual lenses or lens components made of lenses. For the purpose of focusing the object O observed through the optical scope **1**, either the first ocular **17**A or the first focusing unit **19**A may be axially displaced along the first optical axis **10**.

[0028] The second housing part **3** has a second optical subsystem **13**. The second optical subsystem **13** is provided with a second objective lens **14**B, with a second prism system **16**B, and with a second ocular **17**B. On the second ocular **17**B, a second eye **15**B of the user may be situated to observe the object O. The second optical axis **11** of the second optical subsystem **13** is slightly offset laterally due to the second prism system **16**B, so that the second optical axis **11** consequently has a stepped design.

[0029] In this exemplary embodiment, the second objective lens **14**B includes a second front unit **18**B and a second focusing unit **19**B. Other embodiments of the second objective lens **14**B provide a different number of individual lenses or lens components made of lenses. For the purpose of focusing the object O observed through the optical scope **1**, either the second ocular **17**B or the second focusing unit **19**B may be axially displaced along the second optical axis **11**.

[0030] In both above-described optical subsystems **12**, **13**, the beam direction of the light beams incident into the optical subsystem **12**, **13** is as follows: object O—objective lens **14**A, **14**B—prism system **16**A, **16**B—ocular **17**A, **17**B—eye **15**A, **15**B.

[0031] In the exemplary embodiment described here, an adjusting knob **20** is situated for focusing purposes on the folding bridge **4**, this adjusting knob allowing the first focusing unit **19**A and the second focusing unit **19**B to be jointly displaced along the optical axes **10** and **11**.

[0032] In the exemplary embodiment described here, both the first objective lens **14**A and the second objective lens **14**B generate a real image, which is inverted in relation to the observed object O, in an image plane associated with the particular objective lens **14**A, **14**B. The first prism system **16**A associated with the first objective lens **14**A as well as the second prism system **16**B associated with the second objective lens **14**B are used for image erection. In this way, the inverted image is erected and is imaged in a new image plane, the left-hand intermediate image plane **22**A and the right-hand intermediate image plane **22**B. The first prism system **16**A and the second prism system **16**B may be constructed as an Abbe-König prism system, Schmidt-Pechan prism system, Uppendahl prism system, Porro prism system, or any other prism system variant.

[0033] A first field stop which sharply defines the field of view is, for example, situated in the left-hand intermediate image plane **22**A. Furthermore, a second field stop which sharply defines the field of view may be situated in the right-hand intermediate image plane **22**B.

[0034] The first ocular **17**A is used to image the image of the left-hand intermediate image plane **22**A at any desired distance, e.g., ad infinitum or at another distance. Furthermore, the second ocular **17**B is used to image the image of the right-hand intermediate image plane **22**B at any desired distance, e.g., ad infinitum or at another distance.

[0035] The aperture of the first optical subsystem **12** and the second optical subsystem **13** (not illustrated) may either be formed by a mount of an optical element of the correspond-

ing optical subsystems **12** and **13** or by a separate aperture. It may be imaged in the beam direction by the corresponding optical subsystems **12** and **13** in a plane which is situated in the beam direction behind the corresponding ocular **17**A or **17**B and is typically spaced at 5 mm to 25 mm therefrom. This plane is referred to as the plane of the exit pupil.

[0036] The optical scope **1** illustrated in FIGS. **1** and **2** has multiple optical units, namely the first objective lens **14**A, the second objective lens **14**B, the first prism system **16**A, the second prism system **16**B, the first ocular **17**A, as well as the second ocular **17**B. The first objective lens **14**A is composed of multiple optical elements, namely the first front unit **18**A and the first focusing unit **19**A. The second objective lens **14**B also has multiple optical elements, namely the second front unit **18**B and the second focusing unit **19**B. The first prism system **16**A is composed of optical elements in the form of a first prism **21**A and a second prism **21**B. The second prism system **16**B is composed of a third prism **21**C and a fourth prism **21**D. In this exemplary embodiment, the first ocular **17**A as well as the second ocular **17**B are each formed by a single optical element, namely a single lens unit.

[0037] At least one of the optical elements of the optical scope **1** is made of at least one of the following glasses (glass types): N-BK7HT, N-SK2HT, F2HT, N-LASF45HT, SF6HT, N-SF6HTultra, N-SF6HT, SF57HTultra, N-SF57HTultra, N-SF57HT, as well as N-LASF9HT. In particular, it is provided to make at least two or each of the above-named optical elements of at least one of the above-named glasses. The above-named glasses are glasses of the SCHOTT corporation.

[0038] If at least one of the optical elements of the optical scope **1** is made of at least one of the above-named glasses, a greater transmission of the optical scope **1** is achieved compared to comparable optical systems from the prior art. In particular, it is possible to use the optical scope **1** to observe and image an object at unfavorable environmental conditions, e.g., at dawn or at night.

[0039] Properties of the above-named glasses are indicated in the table below. The properties are quoted from a publication of the SCHOTT corporation.

glass	n_d	v_d	Tau
N-BK7HT	1.51680	64.17	0.998
N-SK2HT	1.60738	56.65	0.996
F2HT	1.62004	36.37	0.996
N-LASF45HT	1.80107	34.97	0.886
SF6HT	1.80518	25.43	0.941
N-SF6HTultra	1.80518	25.36	0.887
N-SF6HT	1.80518	25.36	0.877
SF57HTultra	1.84666	23.83	0.924
N-SF57HTultra	1.84666	23.78	0.830
N-SF57HT	1.84666	23.78	0.793
N-LASF9HT	1.85025	32.17	0.843

[0040] In the table, the individual glass types are indicated, the notation of the glass types referring to the glass types of the SCHOTT corporation. Moreover, the refractive index is denoted with the reference symbol n_d and the Abbe number is denoted with the reference symbol v_d in the table. Furthermore, the transmittance, i.e., the ratio of the light incident onto the optical element to the transmitted light, is indicated with the reference symbol Tau_i. The values indicated in the above-named table refer to an optical element of 10 mm thickness and at an incident light having a wavelength of 400 nm.

[0041] In another exemplary embodiment, it is provided to use in the optical scope **1** at least one optical element which is made of at least one of the above-named glass types. Additionally, this glass type may be lead-containing. This glass type has an absorption edge which is shifted into the short-wave spectrum. Additionally or alternatively, it is provided to use in the optical scope **1** an additional optical element which is made of lead-containing glass.

LIST OF REFERENCE NUMERALS

[0042] **1** optical scope
[0043] **2** first housing part
[0044] **3** second housing part
[0045] **4** folding bridge
[0046] **5** first hinge part
[0047] **6** second hinge part
[0048] **7** first receptacle part
[0049] **8** second receptacle part
[0050] **9** third receptacle part
[0051] **10** first optical axis
[0052] **11** second optical axis
[0053] **12** first optical subsystem
[0054] **13** second optical subsystem
[0055] **14**A first objective lens
[0056] **14**B second objective lens
[0057] **15**A first eye
[0058] **15**B second eye
[0059] **16**A first prism system
[0060] **16**B second prism system
[0061] **17**A first ocular
[0062] **17**B second ocular
[0063] **18**A first front unit
[0064] **18**B second front unit
[0065] **19**A first focusing unit
[0066] **19**B second focusing unit
[0067] **20** adjusting knob
[0068] **21**A first prism
[0069] **21**B second prism
[0070] **21**C third prism
[0071] **21**D fourth prism
[0072] **22**A left-hand intermediate image plane
[0073] **22**B right-hand intermediate image plane
[0074] O object

1. An optical scope for imaging an object, comprising:
at least one optical element made of glass, wherein the optical element is made of at least one of the following glass types:
N-BK7HT, N-SK2HT, F2HT, N-LASF45HT, SF6HT, N-SF6HTultra, N-SF6HT, SF57HTultra, N-SF57HTultra, N-SF57HT, or N-LASF9HT.

2. The optical scope as recited in claim **1**, further comprising:
at least one objective lens which includes the optical element.

3. The optical scope as recited in claim **1**, further comprising:
at least one ocular which includes the optical element.

4. The optical scope as recited in claim **1**, further comprising:
an image detection unit which includes a digital recording medium.

5. The optical scope as recited in claim **1**, wherein the optical element includes a lens unit.

6. The optical scope as recited in claim **5**,

wherein the lens unit is a first lens unit,

and wherein the optical scope further comprises:

at least one second lens unit made of at least one of the following glass types: N-BK7HT, N-SK2HT, F2HT, N-LASF45HT, SF6HT, N-SF6HTultra, N-SF6HT, SF57HTultra, N-SF57HTultra, N-SF57HT, or N-LASF9HT.

7. The optical scope as recited in claim **1**, wherein the optical element includes a prism.

8. The optical scope as recited in claim **1**, wherein the optical scope is at least one of: a monocular, a binocular, a telescope, or a spotting scope.

* * * * *