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(54) **MICROSCOPE OBJECTIVE**

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(58) **Field of Classification Search** 359/656, 359/657, 658, 659, 660, 661
See application file for complete search history.

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(57)   **ABSTRACT**

The invention is directed to an objective, particularly for telescope-type stereomicroscopes. The objective comprises two lens groups, a first lens group and a second lens group. The first lens group, which faces the object plane, has a positive refractive power and comprises a plurality of lenses of which at least two form a cemented component. The second lens group, which is on the image side, has a negative refractive power and comprises a collecting cemented component and a diverging lens. The objective is characterized in that the following conditions B_1 and B_2 are met: where D_{AP} represents the diameter of the exit pupil of the objective and ω_1 represents the maximum field angle.

15 Claims, 6 Drawing Sheets
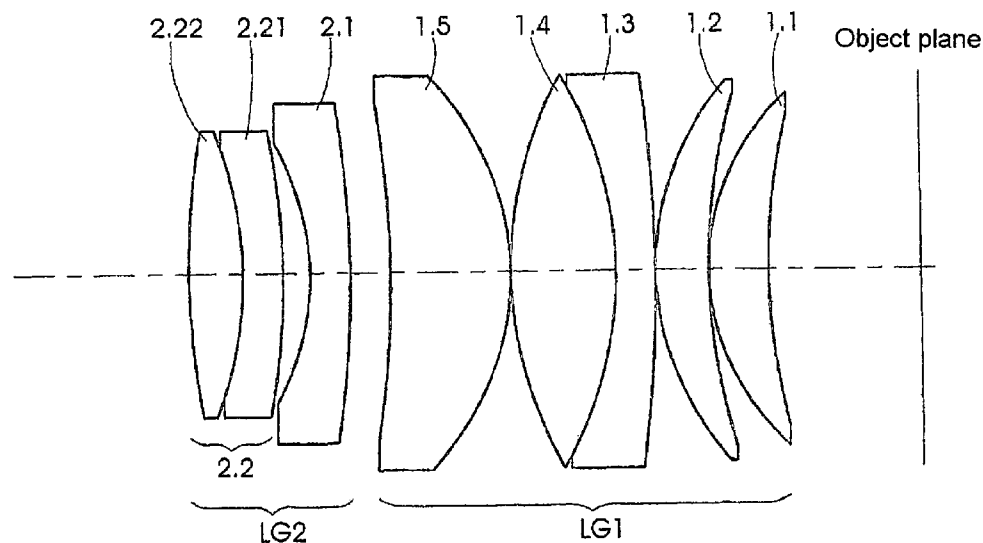
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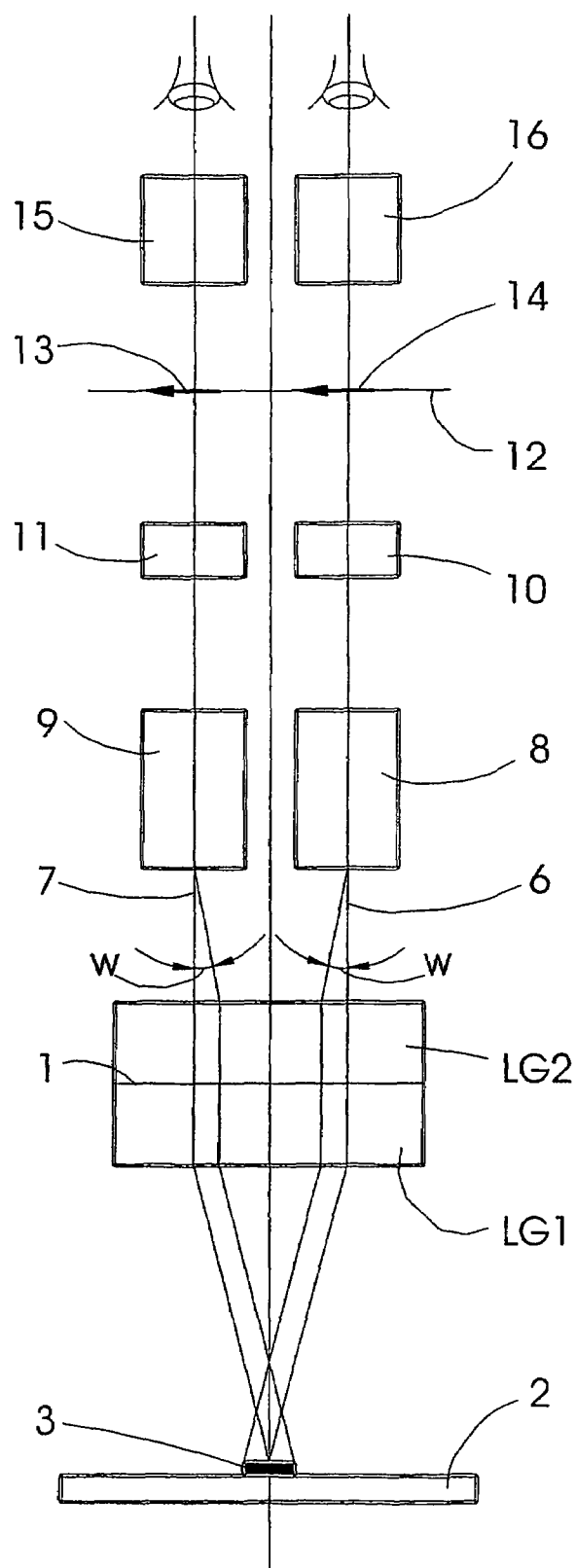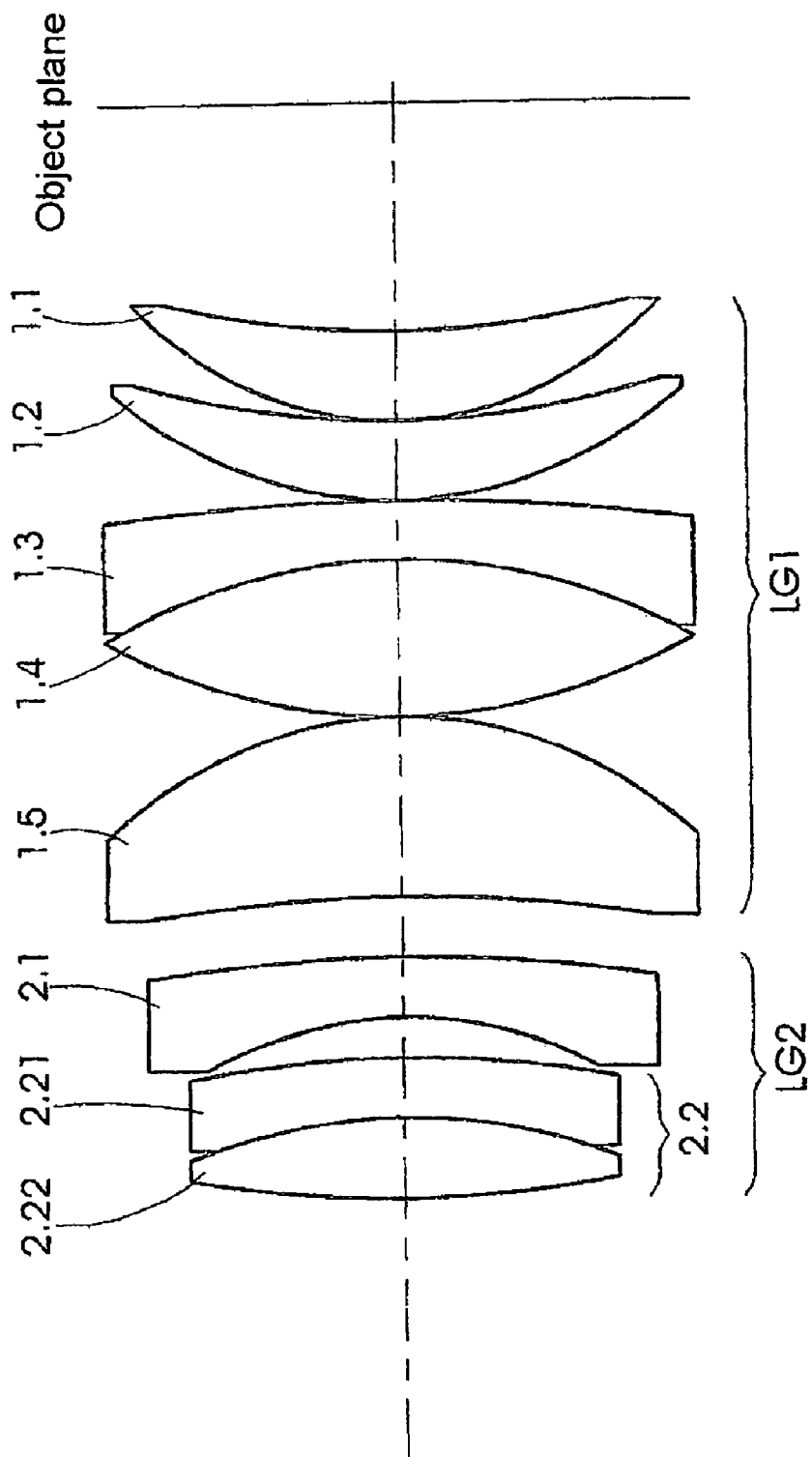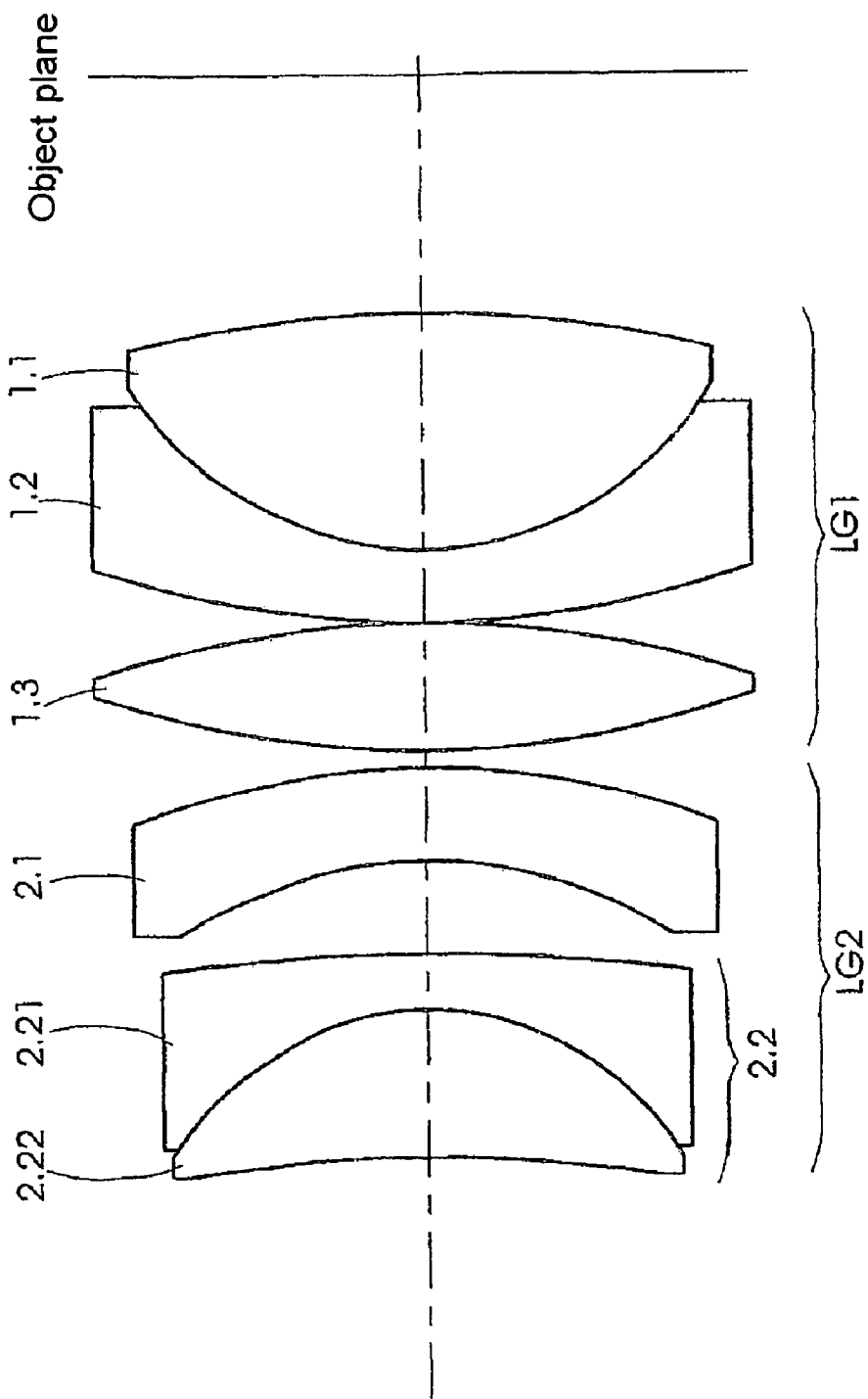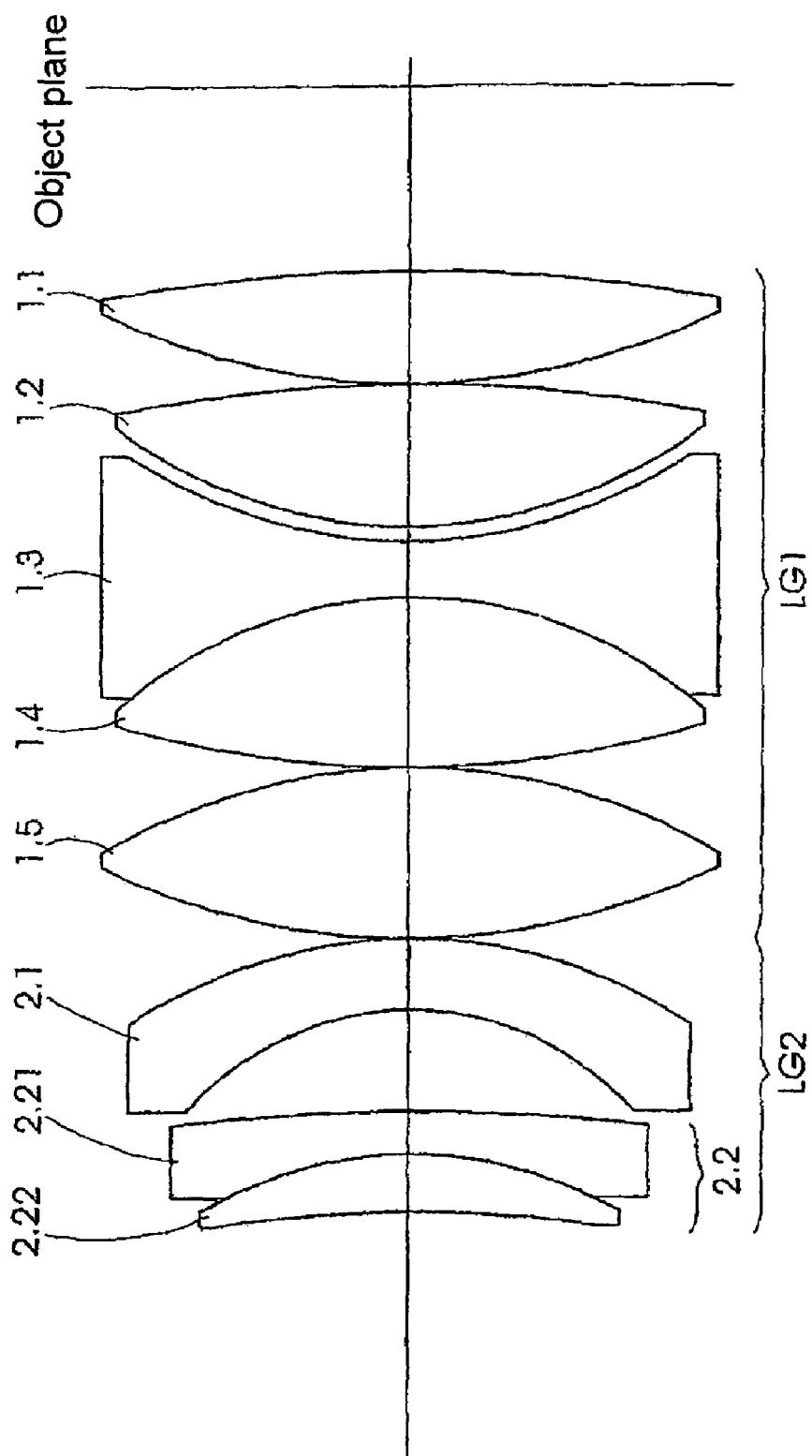
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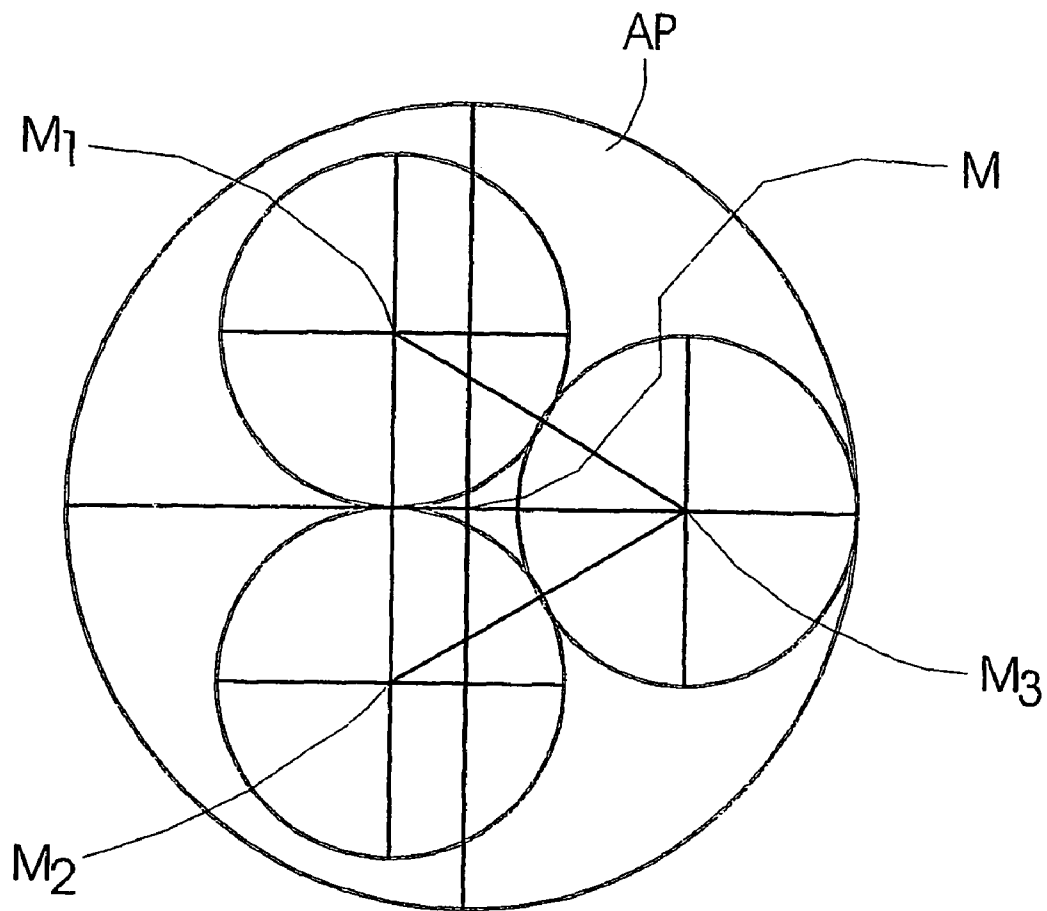
Fig.1
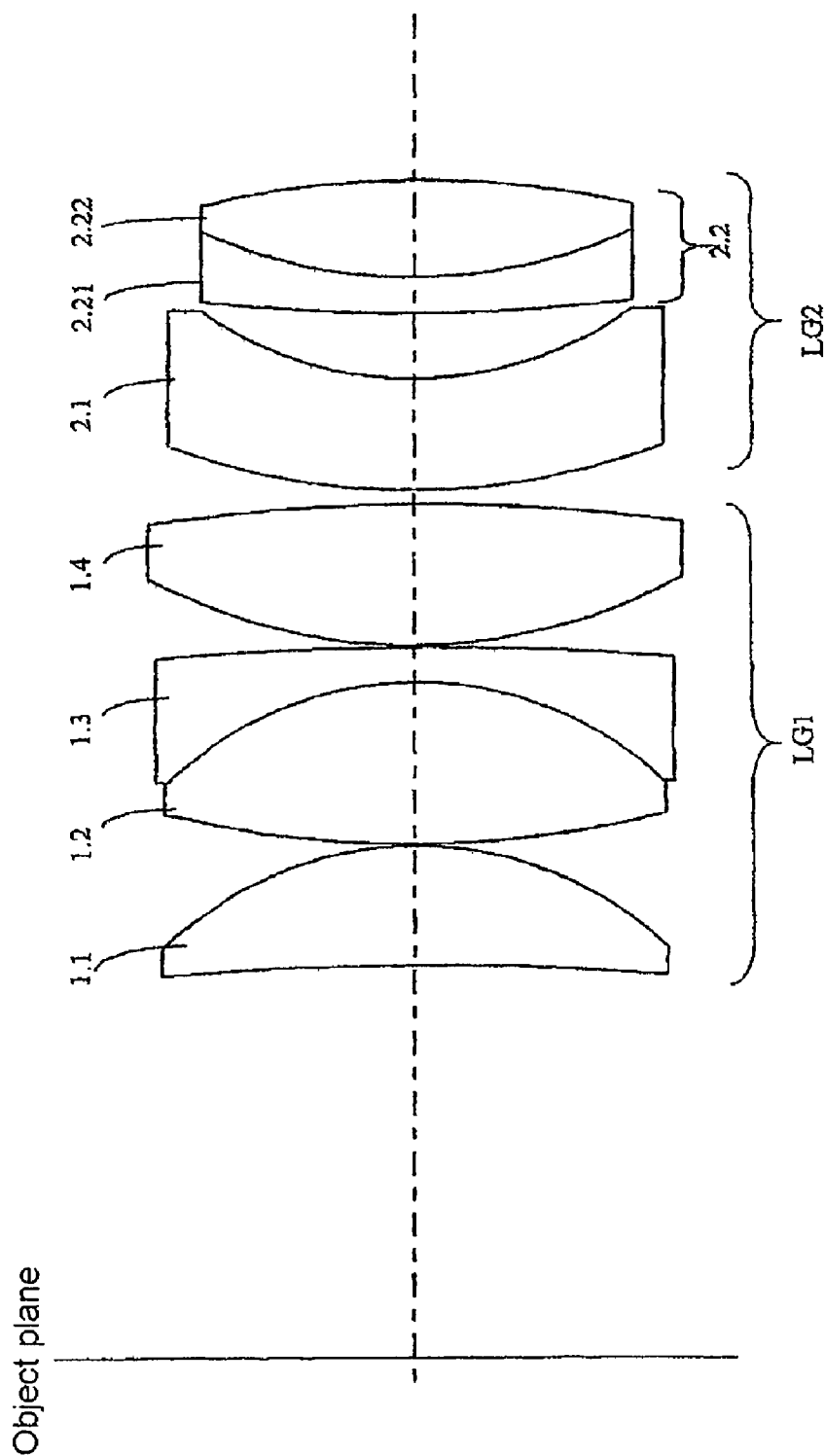
Fig.2

Fig.3

Fig. 4

AP

M₁

M

M₃

M₂

Fig.5

Fig.6

MICROSCOPE OBJECTIVE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority of International Application No. PCT/EP2005/010473, filed Sep. 28, 2005, German Application No. 10 2004 048 299.3, filed Oct. 1, 2004 and German Application No. 10 2005 046 476.9, filed Sep. 26, 2005, the complete disclosures of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

a) Field of the Invention

The invention is directed to a microscope objective, particularly for stereomicroscopes, which has a large pupil diameter and is used with incident brightfield illumination.

b) Description of the Related Art

In telescope-type stereomicroscopes, two separate light channels are guided through one and the same objective in order to achieve a stereoscopic impression. As a result, the dimensions of an objective of this kind, especially with regard to the lens diameter, are significantly larger than those of objectives for conventional microscopes or in Greenough-type stereomicroscopes. In addition, requirements for microscope objectives with regard to the correction of the chromatic aberration, field flattening and prevention of distortion are increasingly demanding.

The objectives are usually used in connection with a focal magnification changers and exchangeable tubes. In order to make it possible to use the microscope at magnifications which allow overview imaging of an object as well as detailed viewing without having to change objectives, objectives are required in which there is more space available for suitable magnification changers in the post-magnification area and which also offer a larger usable aperture in the object space.

The use of fluorescence in stereomicroscopes with incident brightfield illumination places new demands on the design of the objectives. Accordingly, with regard to the devices, it is necessary to separate the beam paths of the excitation of the fluorescence and of the observation in the entrance aperture from the device in the objective. This leads to large apertures. Requirements regarding correction are demanding in objectives of this kind for telescope-type stereomicroscopes. In addition, because of the fluorescence excitation the selection of material is limited with respect to transparency and self-fluorescence of the materials which are employed.

EP 1 369 729 A2 describes an objective for telescope-type stereomicroscopes which comprises three optical lens groups. The first lens group is arranged toward the object side and the third lens group is arranged toward a magnification changer. This objective satisfies certain conditions with resect to the diameter of the entrance pupil of the magnification changer arranged downstream of the objective and of the maximum field angle of the objective at low magnification.

JP 2001-147378 describes an objective which is suitable for use in telescope-type stereomicroscopes. Viewed from the direction of the microscope body, they comprise a first lens group with positive refractive power, a second lens group containing at least one cemented triplet, and a third lens group with positive refractive power. These lens groups can also comprise individual lenses in addition to the cemented components or combinations of individual lenses and cemented components.

JP 2001-221955 describes another objective for telescope-type stereomicroscopes. Viewed from the direction of the

microscope body, the objective comprises two lens groups of which a first lens group with positive refractive power contains a biconvex cemented component and a second lens group contains at least two cemented components. In addition to the cemented components, the lens groups can also comprise individual lenses as well as combinations of individual lenses and cemented components.

U.S. Pat. No. 6,271,971 describes an objective for telescope-type stereomicroscopes with the primary aim of optimizing the ratio of mounting space to the objective focal length.

OBJECT AND SUMMARY OF THE INVENTION

Accordingly, it is the primary object of the invention to provide an objective for telescope-type stereomicroscopes in a simple compact construction which satisfies requirements regarding the correction of the chromatic aberration and distortion while meeting the demands for more space for magnification changers and for a larger useful aperture in the object space and which realizes a large working distance and a flat visual field.

This object is met in an objective with two lens groups comprising individual lenses and, in each instance, at least one cemented component, where the conditions

$$46.5 < D_{AP} \le 60 \text{ and} \qquad\qquad B_1$$

$$0.16 \le \tan \omega_1 \qquad\qquad B_2$$

are met, D_{AP} represents the exit diameter of the objective and ω_1 represents the angle of the maximum field.

The lens groups can comprise individual lenses, at least one cemented component, or a combination of individual lenses and cemented components.

An advantageous objective has a focal length $f' \ge 40$ mm and ≤ 200 mm.

It is advantageous when the illumination beam path is coupled into the exit pupil of the objective.

In particular, it is advantageous when the center points of the entrance pupil of the illumination beam path and the center points of the two beam paths of the objective form an isosceles triangle inside the exit pupil of the objective, the center point of the exit pupil lying inside this triangle.

With respect to the exit pupil of the objective, it is advantageous when the following conditions are met:

$$0.25 \le a_1/D_{AP} \le 0.5$$

$$0.25 \le a_2/D_{AP} \le 0.5$$

$$0.25 \le a_3/D_{AP} \le 0.5,$$

where a_1 and a_2 are the distances of the center points M_1 and M_2 of the two beam paths of the objective from the center point M of the exit pupil of the objective, and a_3 is the distance of the center point M_3 of the entrance pupil of the illumination beam path from the center point M of the exit pupil of the objective.

Accordingly, it is also advantageous when the focal length of this second lens group satisfies the following condition:

$$-0.0668*f'^2+7.4933*f'-460 \le f'_2 \le -0.0668f'^2+ 7.4933*f'-400,$$

where f'_2 is the focal length of the second lens group and f' is the total focal length of the objective.

An advantageous objective is also provided when the second lens group comprises a cemented component and an individual lens, and the cemented component is arranged next

to the magnification changer and when the focal length of this second lens group satisfies the following condition:

$$-0.0668*f'^2+7.4933*f'-460 \leq f'_2 \leq -0.0668f'^2+ 7.4933*f'-400,$$

where f'_2 is the focal length of the second lens group and f' is the total focal length of the objective. The individual lens is preferably constructed as a meniscus with the convex side facing the object.

It is also advantageous when the cemented component of the second lens group meets the condition:

$$10^{-8}*f'^2+9*10^{-8}*f'-10^{-4} \leq 1/f_1/v_{e1}+ 1/f_2/v_{e2} \leq 10^{-8}*f'^2+9*10^{-8}*f'-10^{-4},$$

and lens **2.1** of this lens group meets the condition $v_{e3} \leq 55$, where f'_1 is the focal length of lenses **2.22**, f'_2 is the focal length of lenses **2.21**, f' is the total focal length of the objective, v_{e1} and v_{e2} are the Abbe numbers of lenses **2.22** and **2.21**, and v_{e3} is the Abbe number of lens **2.1**.

In the inventive construction, the first lens group has a positive refractive power and comprises a plurality of lenses of which at least two form a cemented component. The second lens group has a negative refractive power and comprises a collecting cemented component and a diverging lens.

An advantageous first construction of the objective with a focal length $f'=50$ mm, an entrance aperture of 55 mm and an aperture ratio of 1:0.9 is realized by the constructional data indicated in claim **10**. This first construction comprises two lens groups, wherein considered from the object space, a first lens group with positive refractive power comprises two individual lenses with positive refractive power and a cemented group comprising two lenses, followed by an individual lens with positive refractive power and a second lens group with negative refractive power comprising another individual lens with negative refractive power and a cemented group with positive refractive power comprising two lenses.

An advantageous second construction of the objective with a focal length $f'=100$ mm, an entrance aperture of 55 mm and an aperture ratio of 1:1.8 is realized by the constructional data indicated in claim **11**. This second construction likewise comprises two lens groups, wherein, considered from the object space, a first lens group with positive refractive power comprises a cemented group comprising two lenses and an individual lens with positive refractive power and a second lens group with negative refractive power comprising an individual lens with negative refractive power and a cemented group with positive refractive power comprising two lenses.

A third construction of the objective with a focal length $f'=80$ mm, an entrance aperture of 55 mm and an aperture ratio of 1:1.45 can be produced by the constructional data indicated in claim **12**. This third construction likewise comprises two lens groups, wherein, considered from the object space, a first lens group with positive refractive power comprises two individual lenses with positive refractive power, a cemented group comprising two lenses and another individual lens with positive refractive power, and a second lens group with negative refractive power comprising an individual lens with negative refractive power and a cemented group with positive refractive power comprising two lenses.

An advantageous fourth construction of the objective with a focal length $f'=65.59$ mm, an entrance aperture of 53.5 mm and an aperture ratio of 1:1.23 can be produced by the constructional data indicated in claim **13**. This fourth construction likewise comprises two lens groups, wherein, considered from the object space, a first lens group with positive refractive power comprises two individual lenses with positive

refractive power, a cemented group comprising two lenses, and another individual lens with positive refractive power, and a second lens group with negative refractive power comprising an individual lens with negative refractive power and a cemented group with positive refractive power comprising two lenses.

An objective which is advantageously applicable in fluorescence stereomicroscopes is achieved when the condition $\tau(350; 5)_j \geq 0.8$ is met, where $\tau(350; 5)_j$ is the medium-internal transmission at a wavelength of the light of 350 nm and a substrate thickness of 5 mm, and an index $j=1, 2, \ldots$ stands for all optical media of the objective.

The microscope objective that is provided in this way is particularly suited for use in fluorescence stereomicroscopy with incident brightfield illumination and, above all, offers advantages in this regard over known objectives. Further, there are advantages with respect to the correction of the chromatic aberration, field flattening and distortion as well as with respect to the demand for larger spaces for the magnification changers arranged downstream of the objective and for a larger useful aperture in the object space.

The invention will be described more fully in the following with reference to embodiment examples shown in the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. **1** shows the construction of a telescope-type stereomicroscope in a highly simplified manner;

FIG. **2** shows a first embodiment example of an objective;

FIG. **3** shows a second embodiment example of an objective;

FIG. **4** shows a third embodiment example of an objective; and

FIG. **5** shows the arrangement of the different pupils in the objective pupil; and

FIG. **6** shows a fourth embodiment example of an objective.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The construction of a telescope-type stereomicroscope is shown as a block diagram in FIG. **1** for purposes of illustration. The stereomicroscope comprises an objective **1** which, according to the invention, comprises a first lens group LG1 and a second lens group LG2 considered from the object **3** being observed which is arranged in an object plane **2**. Toward the image side, a magnification changer **8** and **9** and tube lenses **10** and **11**, in that sequence, are arranged downstream of the objective **1** in two separate beam paths **6** and **7**. The object **3** is imaged in the image plane **12** of the respective beam path **7** and **8** as a real intermediate image **13** and **14**. An eyepiece **15** and **16** is provided for observing the intermediate images **13** and **14** in each beam path **6**, **7**.

As is conventional in stereomicroscopes of the type mentioned above, the two tube systems take two parallel partial bundles from the parallel beam bundles offered by the objective **1**. In so doing, an off-axis object point is introduced through the objective into downstream optics, e.g., a magnification changer, into their entrance pupil at an angle ω.

In the embodiment example shown in FIG. **2**, the objective comprises, considered from the object plane in direction of the image plane **12**, a first lens group LG1 followed by a second lens group LG2. Lens group LG1 in its entirety has a

positive refractive power and lens group LG2 in its entirety has a negative refractive power.

As can further be seen from FIG. 2, the first lens group LG1 comprises five lenses 1.1 to 1.5 of which lenses 1.3 and 1.4 are cemented together to form a cemented component. Lens group LG2 comprises a lens 2.1 with negative refractive power and a cemented component 2.2 with positive refractive power. The cemented group 2.2 comprises another lens 2.21 and a lens 2.22 with positive refractive power. This microscope objective has the following constructional data showing radii r in mm, distances d in mm, refractive indices n_e, and Abbe numbers v_e:

Lens	Radius mm	Distance d mm	n_e	v_e
	object plane	33.23399		
	−143.28340			
1.1		12.70000	1.498450	81.30
	−45.64480			
		0.20000		
	−156.22550			
1.2		10.00000	1.498450	81.30
	−61.77000			
		0.20000		
	487.02500			
1.3		9.00000	1.747940	44.60
	86.59320			
1.4		21.20000	1.498450	81.30
	−86.59320			
		0.20000		
	65.55050			
1.5		22.70000	1.498450	81.30
	334.94300			
		6.71704		
	172.77720			
2.1		9.40000	1.584820	40.56
	48.69730			
		7.59559		
	193.86600			
2.21		6.00000	1.607180	37.76
	79.72170			
2.22		8.80000	1.498450	81.30
	−258.51300			

This objective 1 has a focal length of 50 mm, an entrance aperture of 55 mm, and an aperture ratio of 1:0.9.

FIG. 3 shows an example for a second construction of an objective according to the invention. This objective likewise has two lens groups LG1 and LG2. The first, object-side, lens group LG1 has three lenses 1.1 to 1.3 of which lenses 1.1 and 1.2 are cemented together. Lens group LG2 comprises a lens 2.1 with negative refractive power and a cemented component 2.2 with positive refractive power which comprises lenses 2.21 and 2.22.

This microscope objective has the following constructional data showing radii r in mm, distances d in mm, refractive indices n_e and Abbe numbers v_e:

Lens	Radius mm	Distance d mm	n_e	v_e
	object plane	81.08262		
	109.02830			
1.1		27.00000	1.498450	81.05
	−45.97500			
1.2		9.70000	1.758440	52.09
	−133.35410			
		0.15000		
	101.08200			

-continued

Lens	Radius mm	Distance d mm	n_e	v_e
1.3		14.70000	1.498450	81.05
	−128.62950			
		1.91858		
	120.58530			
2.1		8.70000	1.616640	44.27
	45.64480			
		11.20295		
	152.25440			
2.21		7.80000	1.518720	63.96
	41.86920			
2.22		14.00000	1.622470	63.19
	613.12200			

This objective 1 has a focal length of 100 mm, an entrance aperture of 55 mm, and an aperture ratio of 1:1.8.

FIG. 4 shows another objective according to the invention. This third construction of the objective with a focal length f′=80 mm, an entrance aperture of 55 mm and an aperture ratio of 1:1.45 likewise comprises two lens groups LG1 and LG2, wherein, considered from the object space, the first lens group LG1 with positive refractive power comprises two individual lenses 1.1 and 1.2, each with positive refractive power, a cemented group comprising two lenses 1.2 and 1.4, and another lens 1.5 with positive refractive power, and a second lens group LG2 with negative refractive power comprising a lens 2.1 with negative refractive power and a cemented group 2.2 comprising two lenses 2.21 and 2.22.

This microscope objective which is shown in FIG. 4 has the following constructional data showing radii r in mm, distances d in mm, refractive indices n_e and Abbe numbers v_e:

Lens	Radius mm	Distance d mm	n_e	v_e
	object plane	61.00000		
	330.28404			
1.1		11.10000	1.530190	67.58
	−87.89693			
		0.15000		
	179.10180			
1.2		13.50000	1.530190	67.58
	−81.26925			
		2.04381		
	−76.62790			
1.3		7.00000	1.758440	52.10
	56.32682			
1.4		18.70000	1.487940	80.07
	−160.14134			
		0.15000		
	78.20610			
1.5		17.40000	1.530190	67.58
	−121.89972			
		0.15000		
	82.85538			
2.1		7.0000	1.758440	52.10
	49.22050			
		10.76007		
	214.01477			
2.21		7.0000	1.510450	60.98
	65.99372			
2.22		7.65175	1.622860	60.08
	276.92831			

This objective 1 has a focal length of 80 mm, an entrance aperture of 55 mm, and an aperture ratio of 1:1.45.

FIG. **5** shows the position of the different pupils in the exit pupil AP. These are the pupils having center points M_1 and M_2 of the two observation beam paths of the stereomicroscope and the entrance pupil M_3 of the illumination beam path which is coupled into the exit pupil AP of the objective **1**. These three pupils, whose center points are designated by M_1, M_2 and M_3, are arranged in the exit pupil AP in such a way that their center points M_1, M_2 and M_3 form an isosceles triangle, and center point M of the exit pupil AP lies within this triangle, where the following conditions must be met:

$$0.25 \leq a_1/D_{AP} \leq 0.5$$

$$0.25 \leq a_2/D_{AP} \leq 0.5.$$

$$0.25 \leq a_3/D_{AP} \leq 0.5,$$

where a_1 and a_2 are the distances of the center points M_1 and M_2 of the two beam paths of the objective **1** from the center point M of the exit pupil AP of the objective **1**, and a_3 is the distance of the center point M_3 of the entrance pupil of the illumination beam path from the center point M of the exit pupil AP of the objective **1**.

FIG. **6** shows another objective according to the invention. This fourth construction of the objective with a focal length f'=65.59 mm, an entrance aperture of 53.5 mm and an aperture ratio of 1:1.23 likewise comprises two lens groups LG1 and LG2, wherein, considered from the object space, the first lens group LG1 with positive refractive power comprises an individual lens **1.1** with positive refractive power, a cemented group with negative refractive power comprising two lenses **1.2** and **1.3**, and another lens **1.4** with positive refractive power, and a second lens group LG2 with negative refractive power comprising a lens **2.1** with negative refractive power and a cemented group **2.2** comprising two lenses **2.21** and **2.22**.

This microscope objective which is shown in FIG. **6** has the following constructional data showing radii r in mm, distances d in mm, refractive indices n_e and Abbe numbers v_e:

Lens	Radius mm	Distance d mm	n_e	v_e
		object plane		
		49.60000		
	−378.759			
1.1		15.00000	1.4980	81:1
	−46.980			
		0.21000		
	135.296			
1.2		20.50000	1.440	94.6
	−46.308			
1.3		4.50000	1.716	53.6
	−415.764			
		0.20000		
	71.814			
1.4		17.90000	1.440	94.6
	−254.821			
		1.77000		
	89.771			
2.1		14.40000	1.489	70.2
	48.347			
		8.20000		
	237.162			
2.2		4.50000	1.716	53.6
	68.294			
2.3		12.20000	1.498	81.1
	−125.885			
		0.40000		

This objective **1** has a focal length of 65.59 mm, an entrance aperture of 53.5 mm, and an aperture ratio of 1:1.23.

In this objective, the focal length of the second lens group satisfies the following condition:

$$-0.0668*f'^2 + 7.4933*f' - 780 \leq f'_2 \leq -0.0668f'^2 + 7.4933*f' - 400,$$

where f'_2 is the focal length of the second lens group and f' is the total focal length of the objective **1**.

The cemented component of the second lens group meets the condition:

$$10^{-8}*f'^2 + 9*10^{-8}*f' - 1.8*10^{-4} \leq 1/f_1/v_{e1} + 1/f_2/v_{e2} \leq 10^{-8}*f'^2 + 9*10^{-8}*f' - 10^{-4},$$

and the lens (**2.1**) of the lens group meets the condition $v_{e3} \leq 55$, where f'_1 is the focal length of lenses **2.22**, f'_2 is the focal length of lenses **2.21**, f' is the total focal length of the objective, v_{e1} and v_{e2} are the Abbe numbers of lenses **2.22** and **2.21**, and v_{e3} is the Abbe number of lens **2.1**.

This fourth construction of the objective is distinguished above all in that it is apochromatically corrected and also has a high transmission in the near UV spectral region.

While the foregoing description and drawings represent the present invention, it will be obvious to those skilled in the art that various changes may be made therein without departing from the true spirit and scope of the present invention.

The invention claimed is:

1. An objective, particularly for telescope-type stereomicroscopes, wherein the objective comprises two lens groups of which, considered from the object plane, a first lens group with positive refractive power is next to the object plane and a second lens group with negative refractive power is next to optics arranged downstream, wherein the following conditions are met:

$$46.5 < D_{AP} \leq 60; \text{ and} \qquad B_1$$

$$0.16 \leq \tan \omega_1; \qquad B_2$$

where D_{AP} represents the diameter of the exit pupil of the objective and ω_1 represents the maximum entrance angle in the downstream optics.

2. The objective according to claim **1**; wherein the focal length of the objective is f' $\geq$ 40 mm and $\leq$ 200 mm.

3. The objective according to claim **1**; wherein the illumination beam path is coupled into the exit pupil of the objective.

4. The objective according to claim **3**; wherein the center point of the entrance pupil of the illumination beam path and the center points of the two beam paths of the objective form an isosceles triangle inside the exit pupil of the objective, the center point of the exit pupil lying inside this triangle.

5. The objective according to claim **4**; wherein the following conditions are met:

$$0.25 \leq a_1/D_{AP} \leq 0.5;$$

$$0.25 \leq a_2/D_{AP} \leq 0.5;$$

$$0.25 \leq a_3/D_{AP} \leq 0.5;$$

where a_1 and a_2 are the distances of the center points of the two beam paths of the objective from the center point of the exit pupil of the objective, and a_3 is the distance of the center point of the entrance pupil of the illumination beam path from the center point of the exit pupil of the objective.

6. The objective according to claim **1**;

wherein the focal length of this second lens group satisfies the following condition:

$$-0.0668*f'^2+7.4933*f'-460 \leq f'_2 \leq -0.0668f'^2+7.4933*f'-400,$$

where f'2 is the focal length of the second lens group and f' is the total focal length of the objective.

7. The objective according to claim **1**;

wherein the second lens group comprises a cemented component and an individual lens, and the cemented component is arranged next to the magnification changer; and

wherein the focal length of this second lens group satisfies the following condition:

$$-0.0668*f'^2+7.4933*f'-460 \leq f'_2 \leq -0.0668f'^2+7.4933*f'-400,$$

where f'2 is the focal length of the second lens group and f' is the total focal length of the objective.

8. The objective according to claim **7**;

wherein the cemented component of the second lens group meets the condition:

$$10^{-8}*f'^2+9*10^{-8}*f'-10^{-4} \leq 1/f_1/v_{e1}+1/f_2/v_{e2} \leq 10^{-8}*f'^2+9*10^{-8}*f'-10^{-4},$$

and lens (**2.1**) of this lens group meets the condition $v_{e3} \leq 55$, where f'$_1$ is the focal length of the lenses (**2.22**), f'$_2$ is the focal length of the lenses (**2.21**), f' is the total focal length of the objective, v_{e1} and v_{e2} are the Abbe numbers of the lenses (**2.22** and **2.21**), and v_{e3} is the Abbe number of the lens (**2.1**).

9. The objective according to claim **1**;

wherein the first lens group has a positive refractive power and comprises a plurality of lenses of which at least two form a cemented component; and

wherein the second lens group has a negative refractive power and comprises a collecting cemented component and a dispersing lens.

10. The microscope objective according to claim **1**;

wherein the first lens group includes lenses **1.1**, **1.2**, **1.3**, **1.4**, and **1.5** and the second lens group includes lenses **2.1**, **2.21**, and **2.22**, according to the constructional data in the following table:

Lens	Radius mm	Distance d mm	n_e	v_e
	object plane 33.23399			
	−143.28340			
1.1	−45.64480	12.70000	1.498450	81.30
	−156.22550	0.20000		
1.2	−61.77000	10.00000	1.498450	81.30
	487.02500	0.20000		
1.3	86.59320	9.00000	1.747940	44.60
1.4	−86.59320	21.20000	1.498450	81.30
	65.55050	0.20000		
1.5	334.94300	22.70000	1.498450	81.30
	172.77720	6.71704		

-continued				
Lens	Radius mm	Distance d mm	n_e	v_e
2.1	48.69730	9.40000	1.584820	40.56
	193.86600	7.59559		
2.21	79.72170	6.00000	1.607180	37.76
2.22	−258.51300	8.80000	1.498450	81.30

where d represents the distances between the lenses, n_e represents the refractive indices, and v_e represents the Abbe number of the glass; and

wherein the objective has the following performance parameters:

focal length f'=50 mm;

entrance aperture 55 mm; and

aperture ratio 1:0.9.

11. The microscope objective according claim **1**;

wherein the first lens group includes lenses **1.1**, **1.2**, and **1.3** and the second lens group includes lenses **2.1**, **2.2**, and **2.3**, according to the constructional data in the following table:

Lens	Radius mm	Distance d mm	n_e	v_e
	object plane 81.08262			
	109.02830			
1.1	−45.97500	27.00000	1.498450	81.05
1.2	−133.35410	9.70000	1.758440	52.09
	101.08200	0.15000		
1.3	−128.62950	14.70000	1.498450	81.05
	120.58530	1.91858		
2.1	45.64480	8.70000	1.616640	44.27
	152.25440	11.20295		
2.21	41.86920	7.80000	1.518720	63.96
2.22	613.12200	14.00000	1.622470	63.19

where d represents the distances between the lenses in mm, n_e represents the refractive indices, and v_e represents the Abbe number of the glass; and

wherein the objective having the following performance parameters:

focal length f'=100 mm;

entrance aperture 55 mm; and

aperture ratio 1:1.8.

12. The microscope objective according claim **1**;

wherein the first lens group includes lenses **1.1**, **1.2**, **1.3**, **1.4**, and **1.5** and the second lens group includes lenses **2.1**, **2.21**, and **2.22**, according to the constructional data in the following table:

Lens	Radius mm	Distance d mm	n_e	v_e
		object plane 61.00000		
	330.28404			
1.1		11.10000	1.530190	67.58
	−87.89693			
		0.15000		
	179.10180			
1.2		13.50000	1.530190	67.58
	−81.26925			
		2.04381		
	−76.62790			
1.3		7.00000	1.758440	52.10
	56.32682			
1.4		18.70000	1.487940	80.07
	−160.14134			
		0.15000		
	78.20610			
1.5		17.40000	1.530190	67.58
	−121.89972			
		0.15000		
	82.85538			
2.1		7.0000	1.758440	52.10
	49.22050			
		10.76007		
	214.01477			
2.21		7.0000	1.510450	60.98
	65.99372			
2.22		7.65175	1.622860	60.08
	276.92831			

where d represents the distances between the lenses in mm, n_e represents the refractive indices, and v_e represents the Abbe number of the glass;

wherein the objective having the following performance parameters:

focal length f'=80 mm;

entrance aperture 55 mm; and

aperture ratio 1:1.45.

13. The microscope objective according claim **1**;

wherein the first lens group includes lenses **1.1**, **1.2**, **1.3**, and **1.4** and the second lens group includes lenses **2.1**, **2.2**, and **2.3**, according to the constructional data in the following table:

Lens	Radius mm	Distance d mm	n_e	v_e
		object plane 49.60000		
	−378.759			
1.1		15.00000	1.4980	81.1
	−46.980			
		0.21000		
	135.29e6			
1.2		20.50000	1.440	94.6
	−46.308			
1.3		4.50000	1.716	53.6
	−415.764			
		0.20000		
	71.814			
1.4		17.90000	1.440	94.6
	−254.821			
		1.77000		
	89.771			
2.1		14.40000	1.489	70.2
	48.347			
		8.20000		
	237.162			
2.2		4.50000	1.716	53.6
	68.294			
2.3		12.20000	1.498	81.1
	−125.885			
		0.40000		

where d represents the distances between the lenses in mm, n_e represents the refractive indices, and v_e represents the Abbe number of the glass; and

wherein the objective having the following performance parameters:

focal length f'=65.59 mm;

entrance aperture 53.5 mm; and

aperture ratio 1:1.23.

14. The objective according to claim **1**, comprising its application in fluorescence stereomicroscopes.

15. An objective, particularly in fluorescence stereomicroscopes, having the condition:

$$\tau(350;5)_j \geqq 0.8;$$

where $\tau(350; 5)_j$ is the internal transmission at a wavelength of the light of 350 nm and a substrate thickness of 5 mm, and an index j=1, 2, . . . stands for all optical media of the objective.

*　*　*　*　*

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO.   : 7,643,216 B2   Page 1 of 1
APPLICATION NO. : 11/664553
DATED   : January 5, 2010
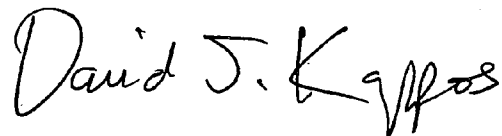INVENTOR(S)   : Johannes Winterot et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Pg Item (73):

Please correct the Assignee from "Carl Zeiss Microimaging GmbH" to --Carl Zeiss
MicroImaging GmbH--

Signed and Sealed this

Twenty-fifth Day of May, 2010

David J. Kappos
Director of the United States Patent and Trademark Office

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO.   : 7,643,216 B2
APPLICATION NO.   : 11/664553
DATED   : January 5, 2010
INVENTOR(S)   : Winterot et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page: item (30),
Foreign Application Priority Data:

      Please add the --DE 10 2004 048.299.3 Filed 10/2/2004--

Item (57); In the Abstract:

Line 10, please add

      $--B_1$: $46.5 < D_{AP} \le 60$ and--
      $--B_2$: $0.16 \le \tan \omega_1$,--

In Claim 1, Column 8:

Lines 8 to 9, please amend
      "$46.5 < D_{AP} \le 60$ and B_1:"
      "$0.16 \le \tan \omega_1$, B_2:"

To read

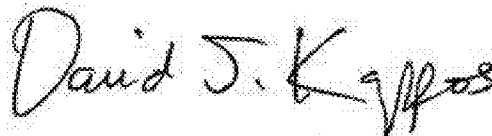 $--B_1$: $46.5 < D_{AP} \le 60$; and--
      $--B_2$: $0.16 \le \tan \omega_1$;--

In Claim 6, Column 9:

      Line 6 please amend "f2" to read $--f'_2--$

Signed and Sealed this
Eighth Day of November, 2011

David J. Kappos
Director of the United States Patent and Trademark Office

<u>In Claim 7, Column 9</u>

Lines 10 please change "f2" to read --f'$_2$--

<u>In Claim 13, Column 12</u>

In the table, it read <u>Radius mm</u> "135.29e6" should read --135.296--