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(54) **Analyser for optical analysis of a biological specimen**

Analysator zur optischen Analyse einer biologischen Probe

Analyseur pour l'analyse optique d'un spécimen biologique

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- **Segersten, Ragnar**
262 57 Ängelholm (SE)
- **Gillström, Conny**
691 52 Karlskoga (SE)

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(74) Representative: **Milanov, Nina Vendela Maria**
Awapatent AB
P.O. Box 5117
200 71 Malmö (SE)

(73) Proprietor: **Cellavision AB**
223 70 Lund (SE)

(72) Inventors:

- **Nilsson, Jan**
224 66 Lund (SE)
- **Bengtsson, Hans**
241 31 Eslöv (SE)

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Description

Technical field

[0001] The present invention relates to an analyser for optical analysis of a biological specimen, comprising a robot for transporting a slide with a sample to be analysed.

Background art

[0002] Computer aided image analysis of biological material has become increasingly popular during the last years. For instance computer-aided processes for counting and classifying white blood cells in blood smears and body fluids have been developed. These types of analyses constitute an important step in diagnosing infections, allergies, or blood cancers.

[0003] Another example of a field of application is semiconductors, such as the microscope disclosed in US 2002/0131166 which discloses a microscope for inspecting a semiconductor wafer having a stage moving unit for moving the wafer in the x-, y-, and z-directions.

[0004] In microscopic analyses of various medical preparations, for instance the analysis of a blood sample, a cytology sample, or a pathology sample, it is possible to use automatic scanning microscope systems. One example of such a microscope system is CellaVision DM 96 from CellaVision AB, which is used for localisation and pre-classification of the various types of white blood cells in peripheral blood smears. This system also pre-characterises parts of the red morphology and provides functionality for platelet estimation. The system scans a blood sample which is smeared onto a microscope slide. During scanning, the microscope system is making controlled positioning movements of the microscope slide in two directions, which can be referred to as directions in the x,y-plane. The microscope slide is placed on a table that moves in the two directions by means of two rails and a ball screw per direction.

[0005] A crucial part of such a system is to have a controlled handling of the sample. The sample, which is placed on a microscope slide, is to be transported from a cassette to the microscope where a coarse adjustment as well as a fine adjustment of focus is made to achieve a satisfying image of the blood sample. Several devices for loading slides from a cassette onto a stage of a microscope are known.

[0006] WO 96/12170 describes an apparatus comprising a slide handling mechanism which has a rack for supporting the slide. A screw is rotated in order to vertically move the rack upwardly and downwardly in a general vertical direction when the screw rotates.

[0007] US 2006/0228107 discloses a slide photograph data creation system. The system comprises a preparate holding hand which is movable in three dimensions. Guide frames and movable frames are coupled to different stationary step motors which provide the movement

of the preparate holding hand. The movement is realized by rotationally driving the drive shaft of the step motors so that the movable frames move following the guide frames.

[0008] US-6,847,481 discloses an automated slide loader cassette for a microscope. The automated slide loader comprises a slide cassette indexer for containing a plurality of microscope slides, a slide exchange arm for gripping a microscope slide within the indexer and for transporting the slide to a microscope for observation and then back to the indexer, and an x,y-stage for moving the slide exchange arm between the indexer and the microscope and positioning the slide for analysis.

[0009] US 2008/0020128 describes an apparatus for automated blood cell analysis. The apparatus comprises two motors for movement in both the x- and y-directions and acts as a carriage for the transportation of microscopic slides. Attached to one of the motors is a gripper for acquiring a microscopic slide from a slide carousel. The motors travel along a center rail and at least one linear bearing.

[0010] In the above described documents there are problems associated with assuring that any guiding parts are perfectly parallel, and if they are not, the device handling the slide will not be able to move properly.

Summary of the invention

[0011] It is an object of the present invention to provide an improvement of the above techniques and prior art. More particularly, it is an object of the present invention to provide an analyser having a robot for transporting a slide with a sample to be analysed that is movable in three dimensions and can be used to obtain focus of the sample without moving the optics in the analyser.

[0012] These and other objects as well as advantages that will be apparent from the following description of the present invention are achieved by an analyser comprising a robot according to the independent claim.

[0013] An analyser is provided for optical analysis of a biological specimen, comprising a robot for transporting a slide with a sample to be analysed. The robot is controlled by at least three motors, to allow movement of the robot in three dimensions, wherein the robot comprises a handling device configured to grip the slide. A guide rail guides the movement of the robot. The analyser is characterised in that at least two of said motors may be arranged to move along a respective screw, and in that the screw may be fixedly arranged in one of its ends and freely arranged in its other end. This is advantageous in that the robot may move the slide in three dimensions, e.g., from a magazine to a microscope.

[0014] Also, with a suitable choice of motors and screws, the robot is in itself able to execute both coarse adjustments and fine adjustment, e.g., for focusing to achieve a satisfying image of the sample. Further, possible defects in the orientation of the screws in the x,y-plane effects the movement in the z-plane at the smallest

extent. Due to the non-fixed arrangement of one end of the screw, the screw will not compete with a guide rail guiding the movement of the robot, and therefore, absolute parallelism between the screw and the guide rail need not be achieved when manufacturing the analyser.

[0015] The screw may be stationary, which is advantageous in that the risk of obtaining a critical number of revolutions is eliminated. Also, the moment of inertia radically decreases.

[0016] The freely arranged end of the screw may be the one closest to where the optical analysis is performed. This is advantageous in that it is most important to have proper fine motor ability where the optical analysis is performed.

[0017] The handling device may be configured to open by means of a motor and to close by means of a spring. This is advantageous in that in case of a power failure, the handling device will not drop the slide, since a spring is holding the slide in place. Also, the handling device can handle variations in the thickness of the glass of the slide.

[0018] The handling device may comprise a sensor which is arranged to alert if the handling device is completely closed. This is advantageous in that the sensor will alert the operator if the handling device is completely closed and accordingly not carrying a slide.

[0019] The analyser may further comprise optics comprising a camera, intermediate optics and front optics, wherein the intermediate optics is movably arranged and the front optics is fixedly arranged. This is advantageous in that a number of different magnification factors can be achieved. Further, with some choices of objectives, the intermediate optics may be less sensitive to faults in the positioning than the front optics, thereby making it advantageous to arrange the front optics fixed.

[0020] The optics may comprise one or more movably arranged light sources. Since the light source is movable, it can be moved when the slide is removed from the microscope, thereby making it possible to move the slide far enough away from the front optics to release optical oil placed on the slide from the front optics. Otherwise, there is a risk that optical oil from the slide soils the light source.

[0021] The light source may be an LED. An LED requires less power than a regular light bulb and also enables pulsing of the light, thus reducing the power consumption further.

[0022] The camera may be movably arranged, which is advantageous in that the same camera may be used with all possible optical configurations. This makes manufacture less expensive.

[0023] The intermediate optics may comprise at least two intermediate objectives.

[0024] The intermediate objectives may have a magnification factor chosen from the group comprising of 0.33, 0.5, 0.66 and 1.

[0025] The front optics may comprise at least two end objectives.

[0026] The end objectives may have a magnification factor chosen from the group comprising of 10, 20, 40, 50, 63 and 100.

[0027] With a suitable choice of intermediate objectives and end objectives an appropriate number of different magnification factors can be achieved for the task for which the analyser is to be used. The combination of intermediate objectives and end objectives makes it possible to use widely used objectives, thus making manufacture less expensive.

[0028] The analyser may comprise a focusing lens for focusing the light from the light source.

[0029] The focusing lens may have two end portions refracting the light and an intermediate portion there between providing total reflection of the light. With such a focusing lens, sufficient illumination and appropriate numerical aperture may be achieved in a highly economical way. Sufficient illumination and appropriate numerical aperture are important for achieving good resolution and high shutter speeds.

[0030] The focusing lens may be essentially circular cylindrical and the end portions may essentially have the shape of spherical segments.

[0031] The movement of the robot may be configured to be executed by means of linear actuators.

[0032] The movement of the movable parts of the optics is preferably configured to be executed by means of linear actuators.

[0033] Linear actuators provide a practical way of achieving the desired movements.

Brief description of the drawings

[0034] The above, as well as additional objectives, features and advantages of the present invention will be better understood through the following illustrative and non limiting detailed description of embodiments of the present invention, with reference to the appended drawings.

[0035] Fig 1 is a perspective view of an analyser for optical analysis of a biological specimen.

[0036] Fig 2 is a perspective front view of the analyser with the cover removed.

[0037] Fig 3 is a perspective rear view of the analyser showing a robot transporting a slide with a smear to be analysed.

[0038] Fig 4 is a perspective view of a magazine for holding the slides.

[0039] Fig 5 is a front view of a focusing lens that may be used in the analyser of Figs. 1-3.

Detailed description of preferred embodiments of the invention

[0040] An analyser 1 for optical analysis of a biological specimen is illustrated in Fig. 1. The analyser 1 has cavities 2 where a magazine containing slides can be placed. Each magazine contains a plurality of slides. The ana-

lyser 1 may have several cavities 2 to place more than one magazine at a time in the analyser 1. In the embodiment illustrated in Fig. 1, the analyser has eight cavities 2.

[0041] In Fig. 2, the analyser 1 is illustrated with a robot 3. The robot 3 is movably arranged so that it can move along the x-, the y-, and the z-axis. The robot comprises a handling device 4 to grip the slide 5 to be analysed. The handling device 4 is opened by means of a motor and closed by means of a spring. Also, the handling device 4 is equipped with a sensor which alerts if the handling device 4 is completely closed.

[0042] The optics 6 in the analyser 1 comprises a camera 7, intermediate optics 8 and front optics 9. The camera 7 is movably arranged so that it can move along the x-axis (double arrow X in Fig. 2) by means of a motor 18 moving along a screw 19 (see Fig. 3). The intermediate optics 8 is movably arranged so that it can move along the x-axis. The movement of the camera 7 as well as the intermediate optics 8 is executed by means of a linear actuator. The intermediate optics 8 comprises two objectives 10. In the example shown, the intermediate objectives have magnification factors 0.5 and 1, respectively. The front optics 9 is fixedly arranged. In the embodiment illustrated in Fig. 2, the front optics has three objectives 11 with magnification factors 10, 40 and 100, respectively. This combination of objectives makes it possible to achieve magnifications of 5, 10, 20, 40, 50 and 100 times, respectively.

[0043] In connection with each end objective 11, there is an LED (not shown) for illuminating the smear that is being analysed. The LEDs are movable along the z-axis in order to be able to move them out of the way when a slide 5 that has been analysed is to be removed from the optics 6. In this manner it is possible to avoid that any oil on the slide spills onto the LEDs.

[0044] Fig 5. discloses a focusing lens 25 arranged to focus the light from the LEDs onto the slide, in order to achieve a satisfactory illumination and an appropriate numerical aperture. The focusing lens 25 has an essentially circular cylindrical intermediate portion 26. At each end of the intermediate portion 26 there is an end portion 27, which has the shape of a spherical segment. The light from the LED enters the focusing lens 25 and is refracted by the first end portion 27a. In the intermediate portion 26, the light is totally reflected in the outer surfaces. Before the light exits the focusing lens, it is once again refracted by the second end portion 27b.

[0045] Fig. 3 illustrates the robot 3 which is controlled by three motors 12, 13, 14, two of which 12, 13 are moving along a screw 15, 16, and the third motor 14 moving the slide 5 by means of the screw 17 to achieve movement in three dimensions. To achieve movement along the x-axis the robot has the motor 12 which moves along the screw 15. To achieve movement along the y-axis the robot has the motor 13 (indicated in Fig. 3, but obscured behind motor 14) which moves along the screw 16. To achieve movement of the slide 5 along the z-axis the

robot has the motor 14 which moves the slide 5 along the screw 17. Each screw 15, 16, 17, is fixedly arranged in one end and freely arranged in the other end. The freely arranged end of each screw 15, 16, 17, is the one closest to where the optical analysis is performed, i.e. closest to the optics 6. The screws are stationary, which implies that they do not rotate. Every screw 15, 16, 17, is a linear actuator, thus the motors 12, 13, 14, move and the screws 15, 16, 17 are fixed.

[0046] Halfway along the length of each screw 15, 16, 17 there is a position sensor (not shown) for ascertaining the position of the robot 3. Similarly, there is a position sensor at the centre of the screws along which the camera 7 and the intermediate optics move. This placement of the sensors in the middle reduces the required number of sensors as compared to arranging one sensor at each end of each screw.

[0047] On the analyser 1, a disposable oil bag or oil pack 22 is arranged, containing optical oil. When the oil pack 22 is empty, it may easily be removed and replaced with a new, full oil pack. In order to ensure that each slide is provided with a drop of oil and that the oil pack is not empty, a fork is arranged for sensing drops passing from the oil pack to the slide. A squeegee 23 or sponge may be arranged for removing oil from the slide once it has been analysed before it is returned to the magazine.

[0048] In Fig. 4 a magazine 20 for use in the analyser 1 is shown. The magazine has slots 21 for twelve slides arranged in a stack. In each slot 21, there are springs maintaining the slide in position. Thereby, it can be assured that slides do not fall out of the magazine 20, should it be accidentally knocked over or dropped. A correct positioning of the slide in the magazine also makes it easier for the robot 3 to grip the slide.

[0049] When analysing a sample in the form of a smear on a slide 5 with the analyser 1, the slide 5, which is stored in the magazine 20 is at first gripped by the handling device 4 and pulled out a bit from the magazine 20. A bar code reader 24 arranged on the main structure beam 28 of the analyser reads a bar code (not shown) on the slide 5 to retrieve information concerning the slide 5. If the slide 5 is to be analysed, the handling device 4 takes a better grip of the slide 5 and the robot 3 transports it to the optics 6 for analysing. By using the objectives 10 in the intermediate optics 8 combined with the objectives 11 in the front optics 9, a number of different magnification factors can be used to create a satisfying image for the operator. Coarse adjustments as well as fine adjustments of the movement of the slide 5, including focus, are executed by means of the robot 3. The camera 7 can take a picture of the smear on the slide 5 and send it to a computer (not shown) where an operator is able to watch the image of the smear on the slide 5. After the analysis, the robot 3 lowers the slide 5 in order to release optical oil placed on the slide from the end objective 11 in order to avoid spilling oil. The LED is also lowered in order to avoid interfering with the downward movement of the slide 5. The robot 3 then transports the slide 5 back to

the magazine 20 and puts the slide back in the same slot 21 from where it was pulled out.

[0050] The analyser 1 can be used for analysing blood samples, but also for other samples. In general, the analyser 1 is suitable for scanning of all kinds of biological specimens, including, but not limited to blood and bone marrow smears, cytological samples, such as Pap smears, and histopathological tissue sections.

[0051] The skilled person realises that a number of modifications of the embodiments described herein are possible without departing from the scope of the invention, which is defined in the appended claims.

[0052] For instance, the intermediate optics may also have other magnification factors than the ones described above. Usually, the magnification factors will be chosen from the group consisting of 0.33, 0.5, 0.66 and 1, but other magnification factors are also possible.

[0053] Similarly, the front optics may have other magnification factors. The front optics will in most cases have at least two objectives 11 with a magnification factor chosen from the group comprised of 10, 20, 40, 50, 63 and 100. Other magnification factors are also possible. In the embodiment shown, the front optics has three objectives, but it could for instance have only two objectives. These could in such case have magnification factors 20 and 100, respectively.

[0054] In the embodiment described above, illumination of the sample is achieved by means of LEDs. In connection with the focusing lens 25 described above, LEDs are the preferred light source. However, in general, other light sources may also be used, such as light bulbs.

[0055] An additional slot (not shown) in addition to the slots 2 on the front of the analyser may be used as a reserve slot for receiving single slides that are not placed in a magazine. This is convenient if an emergency sample needs to be analysed. Such a reserve slot also enables a continuous flow in case a robot is used for transferring a slide from, e.g., a smearing device to the analyser without using a magazine. Additionally, the reserve slot can be used as a discharge opening in case of power failure. If a power failure has reset the analyser 1 with the robot 3 holding a slide 5, the robot 3 will not know in which slot 21 in the magazine 20 to return the slide 5 and can instead discharge the slide 5 through the reserve slot.

[0056] Another way of solving the problem of handling slides 5 that are held by the robot when there is a power failure is to program the analyser 1 such that the robot 3 remembers where to go with slide 5 and such that, when power is returned, the robot 3 resumes its work where it was interrupted.

[0057] In the embodiment shown, the screws along which the motors move are fixedly arranged in the end farthest from the optics and freely arranged in the end closest to the optics. Another way of achieving a freedom of movement near the point of analysis, i.e. near the optics, could be to use a longer screw which is fixed at both ends and to arrange it such that the optics is placed close to the centre of the screw.

[0058] In the case of an analyser 1 with only one slot 2 for magazines 20, the bar code reader 24 may be fixedly arranged on the main structure beam 28 of the analyser 1. In the case of an analyser 1 with more than one slot 2 for magazines, such as the embodiment described above, the robot 3 may be arranged to catch the bar code reader 24, such that it slides along the main structure beam 28 accompanying the robot 3 as it moves to the current magazine 24. As the robot 3 moves the slide into the area of analysis, below the optics 6, the bar code reader 24 is left at the first magazine slot 2.

Claims

1. Analyser (1) for optical analysis of a biological specimen, comprising
a robot (3) for transporting a sample on a slide (5) to be analysed, wherein the robot (3) is controlled by at least three motors (12, 13, 14) to allow movement of the robot (3) in three dimensions, wherein the robot (3) comprises a handling device (4) configured to grip the slide (5), and
a guide rail guiding the movement of said robot (3),
characterised in that at least two of said motors (12, 13) are arranged to move along a respective screw (15, 16), and
at least one screw (15, 16, 17) is fixedly arranged in one of its ends and freely arranged in its other end.
2. Analyser (1) according to claim 1, wherein at least one screw (15, 16, 17) is stationary.
3. Analyser (1) according to claim 1, wherein the freely arranged end of the screw (15, 16, 17), is the one closest to where the optical analysis is performed.
4. Analyser (1) according to any one of claims 1-3, wherein the handling device (4) is configured to open by means of a motor and to close by means of a spring.
5. Analyser (1) according to any one of claims 1-4, wherein the handling device (4) comprises a sensor which is arranged to alert if the handling device (4) is completely closed.
6. Analyser (1) according to any one of claims 1-5, further comprising optics (6) comprising a camera (7), intermediate optics (8) and front optics (9), wherein the intermediate optics (8) is movably arranged and the front optics (9) is fixedly arranged.
7. Analyser (1) according to claim 6, wherein the optics (6) comprises at least one light source.
8. Analyser (1) according to claim 7, wherein said at least one light source is a light emitting diode.

9. Analyser (1) according to any one of the claims 6-8, wherein the camera (7) is movably arranged.
10. Analyser (1) according to any one of claims 6-9, wherein the intermediate optics (8) comprises at least two intermediate objectives (10).
11. Analyser (1) according to claim 10, wherein the intermediate objectives have magnification factors chosen from the group comprised of 0.33, 0.5, 0.66 and 1.
12. Analyser (1) according to any one of claims 8-11, wherein the front optics (9) comprises at least two end objectives (11).
13. Analyser (1) according to claim 12, wherein the end objectives have magnification factors chosen from the group comprised of 10, 20, 40, 50, 63 and 100.
14. Analyser (1) according to any one of claims 8-13, further comprising a focusing lens (25) for focusing the light from the light source.
15. Analyser (1) according to claim 14, wherein said focusing lens (25) has two end portions (27) refracting the light and an intermediate portion (26) there between providing total reflection of the light.
16. Analyser (1) according to claim 15, wherein said focusing lens (25) is essentially circular cylindrical and wherein said end portions (27) essentially have the shape of spherical segments.
17. Analyser (1) according to any one of claims 1-16, wherein the movement of the robot (3) in at least one of the dimensions is configured to be executed by means of a linear actuator.
18. Analyser (1) according to any one of the claims 6-17, wherein the movement of the movable parts of the optics (6) is configured to be executed by means of a linear actuator.

Patentansprüche

1. Analysator (1) zur optischen Analyse einer biologischen Probe, Folgendes umfassend:

einen Automaten (3) zum Transportieren einer zu analysierenden Probe auf einem Objektträger (5), wobei der Automat (3) von mindestens drei Motoren (12, 13, 14) gesteuert wird, um die Bewegung des Automaten (3) in drei Richtungen zu ermöglichen, wobei der Automat (3) eine Transportvorrichtung (4) umfasst, die dafür eingerichtet ist, den Objektträger (5) zu ergreifen,

und eine Führungsschiene, welche die Bewegung des Automaten (3) führt, **dadurch gekennzeichnet, dass** mindestens zwei der Motoren (12, 13) dafür angeordnet sind, sich an einer entsprechenden Schraube (15, 16) entlang zu bewegen, und dass mindestens eine Schraube (15, 16, 17) an einem ihrer Enden fixiert und an ihrem anderen Ende frei angeordnet ist.

2. Analysator (1) nach Anspruch 1, wobei mindestens eine Schraube (15, 16, 17) feststehend ist.
3. Analysator (1) nach Anspruch 1, wobei das frei angeordnete Ende der Schraube (15, 16, 17) dasjenige ist, das der Stelle, an der die optische Analyse durchgeführt wird, am nächsten liegt.
4. Analysator (1) nach einem der Ansprüche 1 bis 3, wobei die Transportvorrichtung (4) dafür eingerichtet ist, sich mit Hilfe eines Motors zu öffnen und sich mit Hilfe einer Feder zu schließen.
5. Analysator (1) nach einem der Ansprüche 1 bis 4, wobei die Transportvorrichtung (4) einen Sensor umfasst, der dafür angeordnet ist, einen Alarm auszulösen, wenn die Transportvorrichtung (4) vollständig geschlossen ist.
6. Analysator (1) nach einem der Ansprüche 1 bis 5, ferner eine Optik (6) umfassend, die eine Kamera (7), eine Zwischenoptik (8) und eine Vorderoptik (9) umfasst, wobei die Zwischenoptik (8) beweglich und die Vorderoptik (9) feststehend angeordnet ist.
7. Analysator (1) nach Anspruch 6, wobei die Optik (6) mindestens eine Lichtquelle umfasst.
8. Analysator (1) nach Anspruch 7, wobei die mindestens eine Lichtquelle eine Leuchtdiode ist.
9. Analysator (1) nach einem der Ansprüche 6 bis 8, wobei die Kamera (7) beweglich angeordnet ist.
10. Analysator (1) nach einem der Ansprüche 6 bis 9, wobei die Zwischenoptik (8) mindestens zwei Zwischenobjektive (10) umfasst.
11. Analysator (1) nach Anspruch 10, wobei die Zwischenobjektive Vergrößerungsfaktoren aufweisen, die aus der Gruppe ausgewählt sind, die 0,33, 0,5, 0,66 und 1 umfasst.
12. Analysator (1) nach einem der Ansprüche 8 bis 11, wobei die Vorderoptik (9) mindestens zwei Endobjektive (11) umfasst.

13. Analysator (1) nach Anspruch 12, wobei die Endobjektive Vergrößerungsfaktoren aufweisen, die aus der Gruppe ausgewählt sind, die 10, 20, 40, 50, 63 und 100 umfasst.

14. Analysator (1) nach einem der Ansprüche 8 bis 13, ferner eine Fokussierlinse (25) umfassend, um das Licht von der Lichtquelle zu bündeln.

15. Analysator (1) nach Anspruch 14, wobei die Fokussierlinse (25) zwei Endabschnitte (27) aufweist, die das Licht brechen, und dazwischen einen Zwischenabschnitt (26), der die Totalreflektion des Lichts bereitstellt.

16. Analysator (1) nach Anspruch 15, wobei die Fokussierlinse (25) im Wesentlichen kreisförmig zylindrisch ist und wobei die Endabschnitte (27) im Wesentlichen die Form kugelförmiger Segmente aufweisen.

17. Analysator (1) nach einem der Ansprüche 1 bis 16, wobei die Bewegung des Automaten (3) in mindestens einer der Richtungen dafür eingerichtet ist, mit Hilfe eines Linearaktors ausgeführt zu werden.

18. Analysator (1) nach einem der Ansprüche 6 bis 17, wobei die Bewegung der beweglichen Teile der Optik (6) dafür eingerichtet ist, mit Hilfe eines Linearaktors ausgeführt zu werden.

Revendications

1. Analyseur (1) pour analyse optique d'un spécimen biologique, comprenant un robot (3) pour transporter un échantillon sur une lame (5) à analyser, le robot (3) étant commandé par au moins trois moteurs (12, 13, 14) pour permettre le mouvement du robot (3) dans trois dimensions, le robot (3) comprenant un dispositif de manutention (4) conçu pour saisir la lame (5) et un rail de guidage guidant le mouvement dudit robot (3),

caractérisé en ce qu'au moins deux desdits moteurs (12, 13) sont conçus pour se déplacer le long d'une vis respective (15, 16) et qu'au moins une vis (15, 16, 17) est disposée fixement dans une de ses extrémités et librement disposée dans son autre extrémité.

2. Analyseur (1) selon la revendication 1, dans lequel au moins une vis (15, 16, 17) est stationnaire.

3. Analyseur (1) selon la revendication 1, dans lequel l'extrémité librement disposée de la vis (15, 16, 17) est celle la plus proche de l'endroit où l'analyse optique est réalisée.

4. Analyseur (1) selon l'une quelconque des revendications 1 à 3, dans lequel le dispositif de manutention (4) est conçu pour s'ouvrir au moyen d'un moteur et pour se fermer au moyen d'un ressort.

5. Analyseur (1) selon l'une quelconque des revendications 1 à 4, dans lequel le dispositif de manutention (4) comprend un capteur qui est conçu pour émettre une alerte si le dispositif de manutention (4) est complètement fermé.

6. Analyseur (1) selon l'une quelconque des revendications 1 à 5, comprenant en outre une optique (6) comportant une caméra (7), une optique intermédiaire (8) et une optique frontale (9), l'optique intermédiaire (8) étant disposée de manière mobile et l'optique frontale (9) étant disposée de manière fixe.

7. Analyseur (1) selon la revendication 6, dans lequel l'optique (6) comprend au moins une source lumineuse.

8. Analyseur (1) selon la revendication 7, dans lequel ladite au moins une source lumineuse est une diode électroluminescente.

9. Analyseur (1) selon l'une quelconque des revendications 6 à 8, dans lequel la caméra (7) est disposée de manière mobile.

10. Analyseur (1) selon l'une quelconque des revendications 6 à 9, dans lequel l'optique intermédiaire (8) comprend au moins deux objectifs intermédiaires (10).

11. Analyseur (1) selon la revendication 10, dans lequel les objectifs intermédiaires ont des facteurs de grossissement sélectionnés parmi le groupe composé de 0,33, 0,5, 0,66 et 1.

12. Analyseur (1) selon l'une quelconque des revendications 8 à 11, dans lequel l'optique frontale (9) comprend au moins deux objectifs terminaux (11).

13. Analyseur (1) selon la revendication 12, dans lequel les objectifs terminaux ont des facteurs de grossissement sélectionnés parmi le groupe composé de 10, 20, 40, 50, 63 et 100.

14. Analyseur (1) selon l'une quelconque des revendications 8 à 13, comprenant en outre une lentille de focalisation (25) pour focaliser la lumière de la source lumineuse.

15. Analyseur (1) selon la revendication 14, dans lequel ladite lentille de focalisation (25) a deux sections terminales (27) réfractant la lumière et une section intermédiaire (26) entre elles permettant une réflexion

totale de la lumière.

16. Analyseur (1) selon la revendication 15, dans lequel ladite lentille de focalisation (25) est sensiblement cylindrique et circulaire et lesdites sections terminales (27) ont sensiblement la forme de segments sphériques. 5
17. Analyseur (1) selon l'une quelconque des revendications 1 à 16, dans lequel le mouvement du robot (3) dans au moins une des dimensions est conçu pour être exécuté au moyen d'un actionneur linéaire. 10
18. Analyseur (1) selon l'une quelconque des revendications 6 à 17, dans lequel le mouvement des pièces mobiles de l'optique (6) est conçu pour être exécuté au moyen d'un actionneur linéaire. 15

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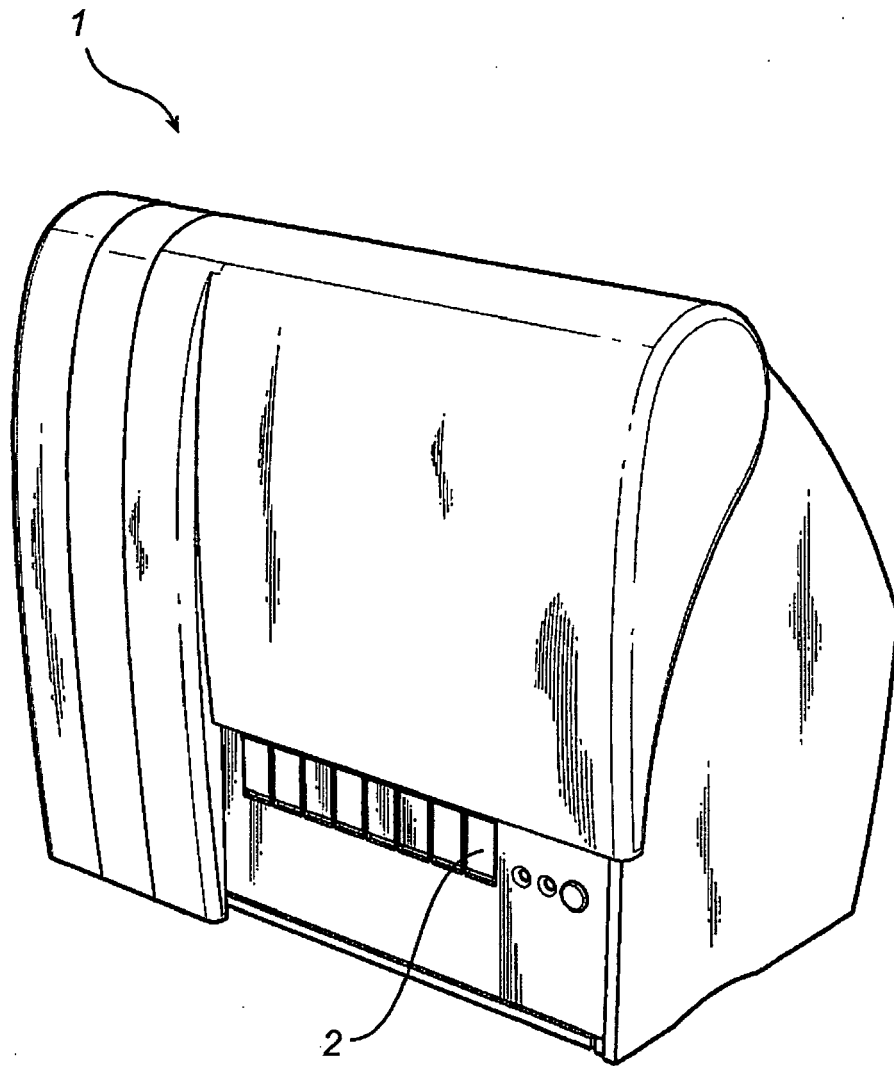
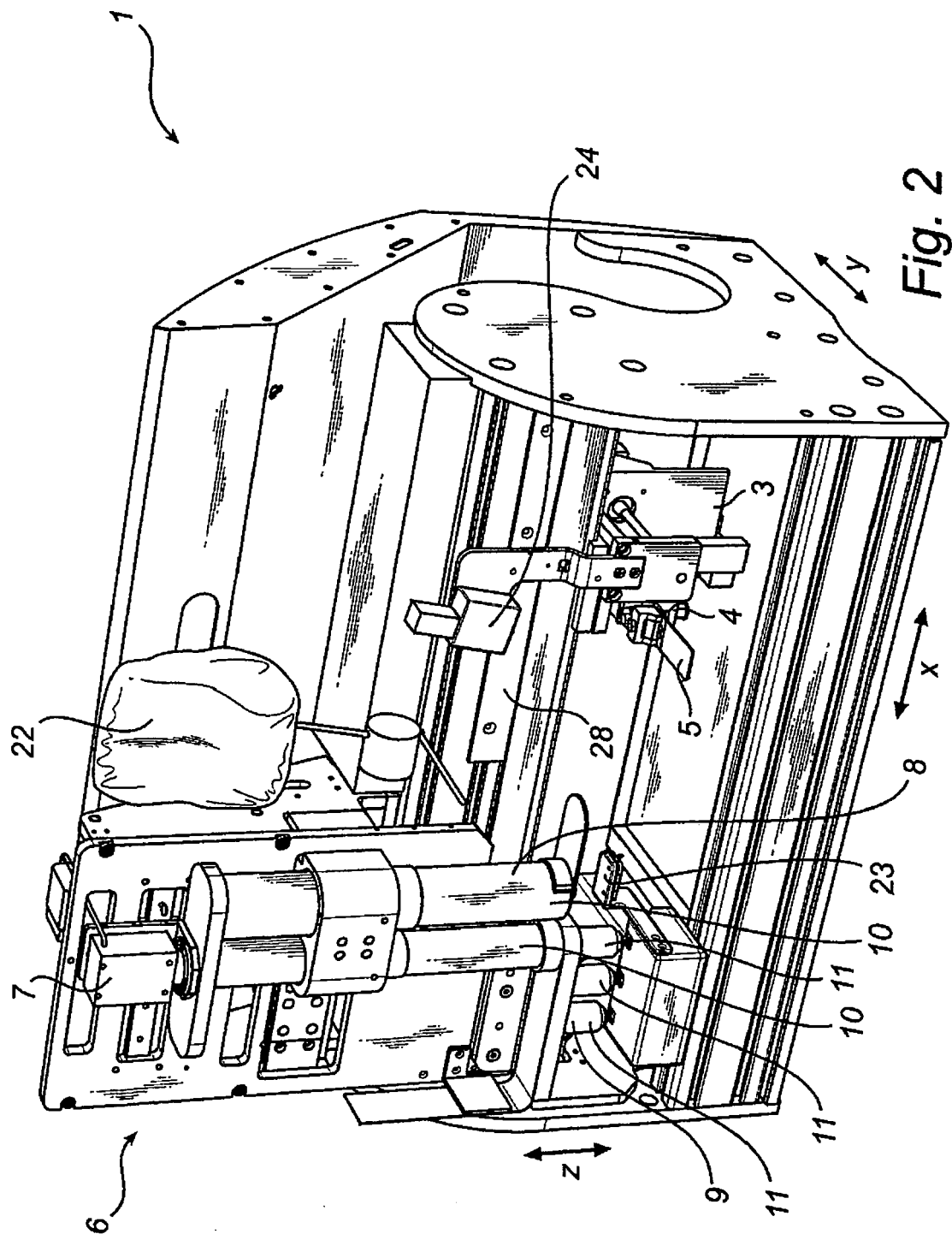


Fig. 1



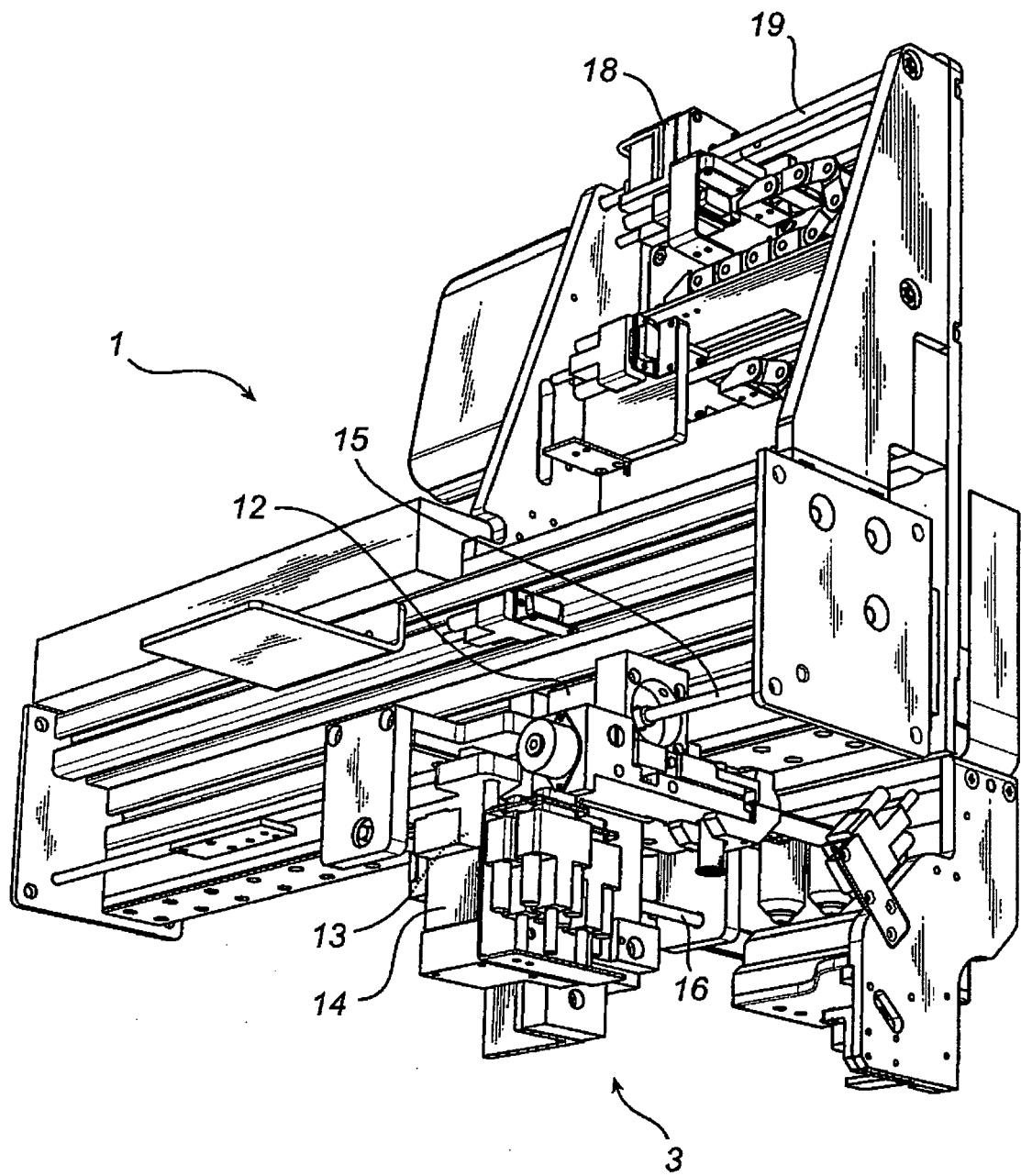
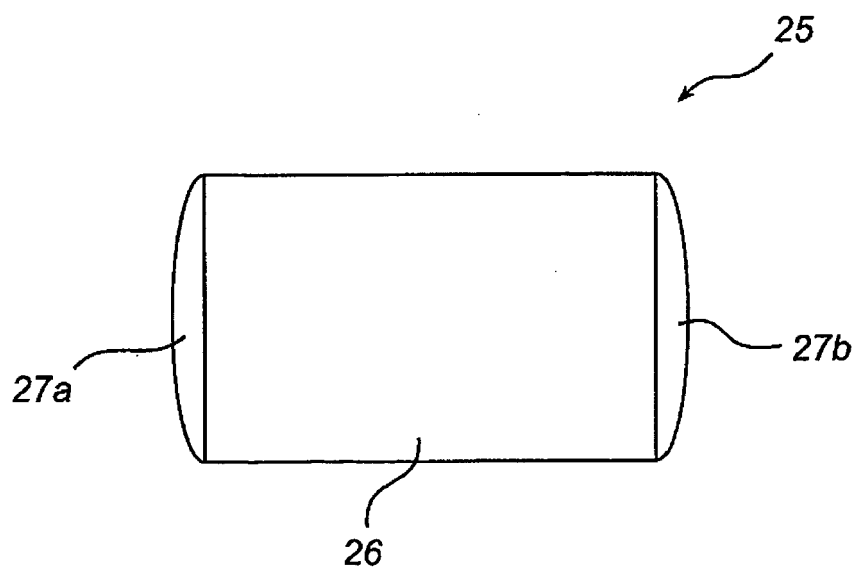
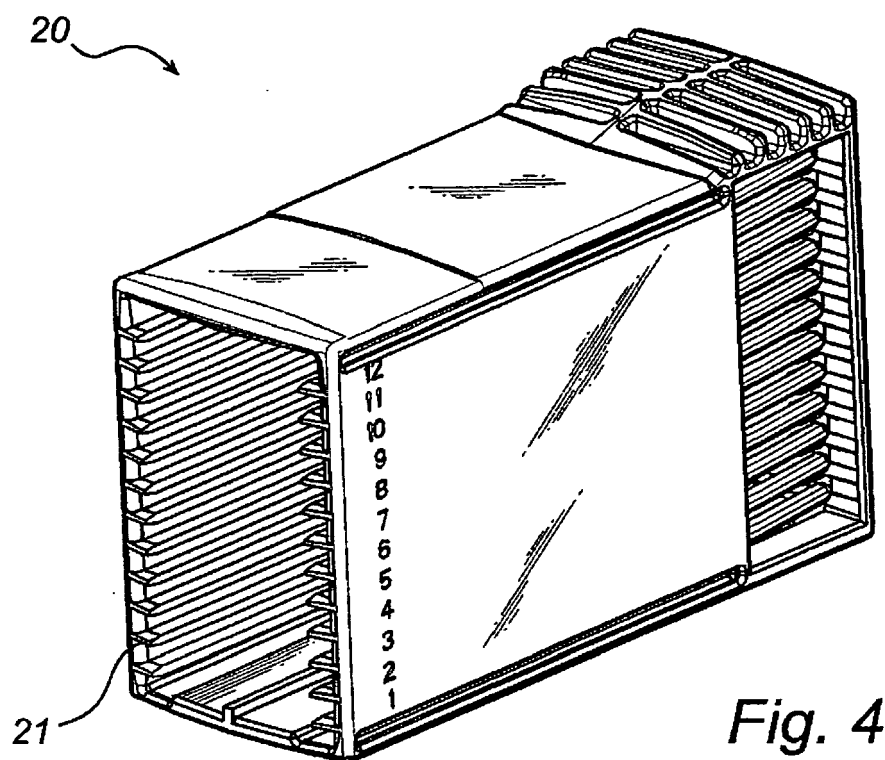


Fig. 3



REFERENCES CITED IN THE DESCRIPTION

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