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ENDOSCOPE ASSEMBLY AND ENDOSCOPE SYSTEM HAVING THE SAME

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ABSTRACT

ENDOSCOPE ASSEMBLY AND ENDOSCOPE SYSTEM HAVING THE SAME

An endoscope assembly (1) includes a base module (20), an injection needle (10), and an image sensing unit (21). The base module (20) includes an illumination input end (22). The injection needle (10) is tubular, is connected to the base module (20), and has a needle shaft (12). The needle shaft (12) has a bevel surface (121) that is formed on a distal end thereof. The image sensing unit (21) includes a tube portion (213) that extends inside the needle shaft (12), and an image sensor (211) that is connected to a distal end of the tube portion (213) and that is adjacent to the bevel surface (121) of the needle shaft (12). Additionally, a passage (40) is formed between the tube portion (213) and an inner surface of the needle shaft (12).

#FIG. 1

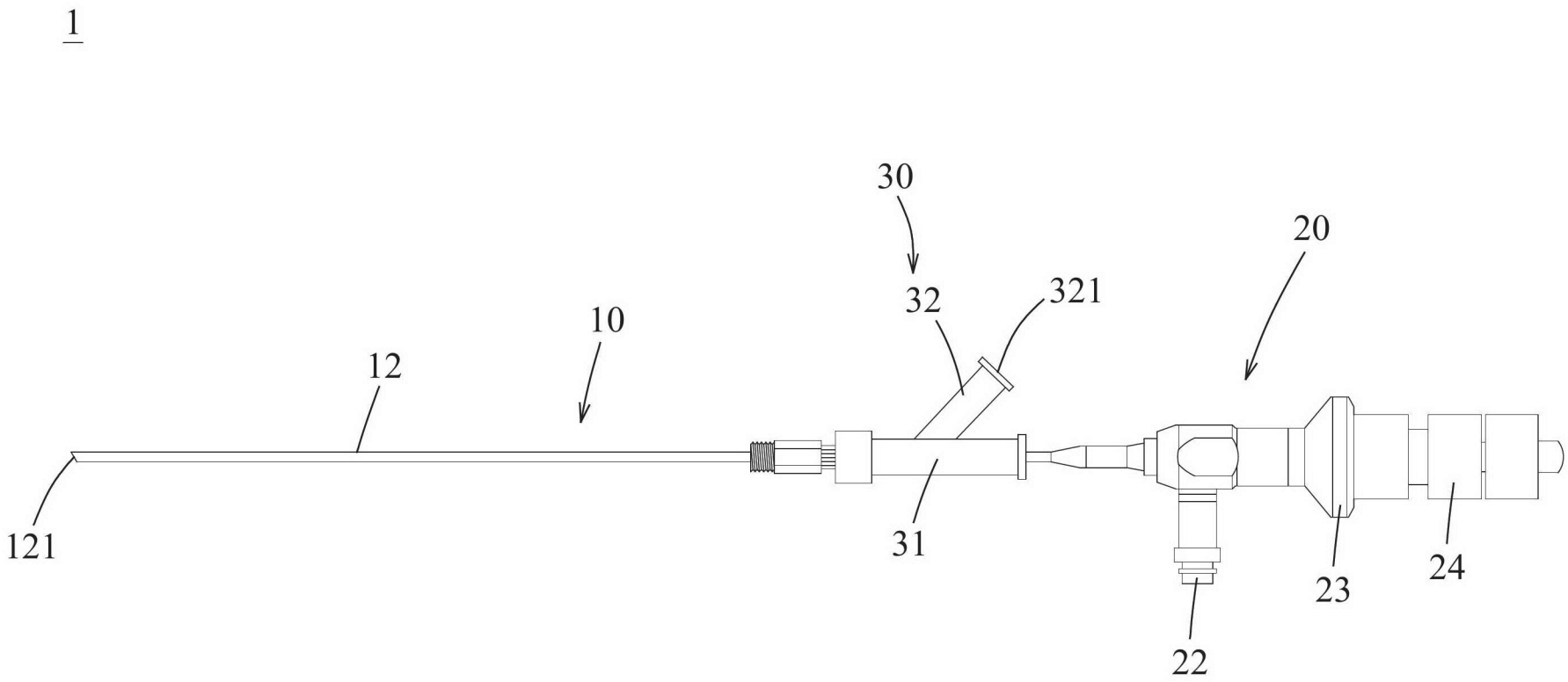

FIG. 1

ENDOSCOPE ASSEMBLY AND ENDOSCOPE SYSTEM HAVING THE SAME

The disclosure relates to an endoscope, and more particularly to an endoscope assembly and an endoscope system using the endoscope assembly.

Conventional medical endoscopic devices are fitted with various tools and used to examine the interior of a patient's body. A variety of endoscopic devices have been developed according to the requirements of various medical procedures such as thoracoscopy, laparoscopy, laparoscopic bile duct surgery, and pelvic laparoscopy. The conventional endoscope has an image sensor attached to either a soft tube or a rigid pipe and is inserted into the body cavity of the patient during a medical examination. A light source is provided through the endoscope to illuminate an area around the image sensor so that image data may be captured and transmitted directly to the observer or transmitted to an electronic device that is used by a doctor for making a diagnosis. When the diagnosis is made by the doctor, the conventional endoscope is extended into the patient's body cavity by making an incision on the patient, and the conventional endoscope is used to locate a surgical area for a surgeon to perform a surgical operation based on the diagnosis. Next, the conventional endoscope is secured in a position where it can continuously monitor the surgical area, and an injection needle or other surgical instrument is

extended to the surgical area alongside the conventional endoscope to perform surgical operations based on the doctor's diagnosis. The operation may be a medical injection, cauterization, or surgical resection etc. However, due to the limited size of the incision and the limited space of the patient's body cavity, the other surgical instruments may interfere with the endoscope, and the endoscope may be displaced from monitoring the surgical area when operating the other surgical instruments, thereby causing the surgeon to lose sight of the surgical area and having to reposition the endoscope. On the other hand, the other surgical instruments or injection needles required for the surgical operation must be inserted into the patient's body cavity in some way, and will either need to be inserted via the same incision as the endoscope and thereby making the incision larger, or by making a new incision on the patient; the enlarged incisions will most likely require sutures to close, and an increase in the size and number of incisions increases the length of the patient's postoperative recovery period.

Therefore, an object of the disclosure is to provide an endoscope assembly that can alleviate at least one of the drawbacks of the prior art.

An additional or alternative object of the invention is to at least provide the public with a useful choice.

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According to a first aspect of the invention, there is provided an endoscope assembly comprising: a base module including an illumination input end; an injection needle being tubular, being connected to said base module, and having a needle shaft, said needle shaft having a bevel surface that is formed on a distal end thereof; and an image sensing unit including a tube portion that extends inside said needle shaft, and an image sensor that is connected to a distal end of said tube portion and that is adjacent to said bevel surface of said needle shaft, a passage being formed between said tube portion and an inner surface of said needle shaft; wherein said image sensor has an end surface that is perpendicular to an axis of said needle shaft; wherein said bevel surface of said needle shaft is inclined relative to said end surface of said image sensor; wherein said injection needle further includes an optical component that is made from a transparent material, that is mounted in said needle shaft in front of said image sensor, and that has a light incident side mounted adjacent to and being parallel to said bevel surface of said needle shaft, and adapted to guide light into said optical component, and a light emergent side parallel to and facing said end surface of said image sensor, and adapted to guide light from said light incident side toward said image sensor; wherein said light incident side and said light emergent side form

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an acute angle therebetween; wherein said optical component is structurally hollow, and has an inner space between said light incident side and said light emergent side; and wherein said light emergent side is adapted to guide light that is incident on said light incident side and that is refracted by said inner space to be substantially perpendicular to said end surface of said image sensor.

Another object of the disclosure is to provide an endoscope system having the abovementioned endoscope assembly.

According to a second aspect of the invention, there is provided an endoscope system comprising: said endoscope assembly as disclosed in the first aspect, wherein said base module further having an output end; and an output unit connected to said output end of said base module of said endoscope assembly, and having a bus that is connected to said image sensing unit via a data connection, a processor that is connected to said bus via a data connection, and a display panel that is electrically connected to said processor; said bus being disposed for transmitting an image signal captured by said image sensor, said processor being disposed for receiving the image signal transmitted by said bus and for processing the image signal, said display panel being disposed for displaying the image signal processed by said processor.

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Reference may be made in the description to subject matter which is not in the scope of the appended claims. That subject matter should be readily identifiable by a person skilled in the art and may assist putting into practice the invention as defined in the appended claims.

Other features and advantages of the disclosure will become apparent in the following detailed description of the embodiments with reference to the accompanying drawings, of which:

Figure 1 is a schematic side view illustrating an endoscope assembly of an embodiment of an endoscope system according to the present disclosure;

Figure 2 is an enlarged fragmentary schematic and perspective view showing an injection needle of the endoscope assembly of the embodiment in a penetration mode;

Figure 3 is an enlarged fragmentary schematic and perspective view showing the injection needle of the endoscope assembly of the embodiment in an injection mode;

Figure 4A is an enlarged fragmentary sectional view of the injection needle of the endoscope assembly of the embodiment;

Figure 4B is a view similar to Figure 4A, but showing a variation of the injection needle of the endoscope assembly of the embodiment;

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Figures 5A, 5B and 5C show variations of the configuration of a light source conductor; and

Figure 6 is a schematic block diagram illustrating image capture and display process of the embodiment.

Before the disclosure is described in greater detail, it should be noted that where considered appropriate, reference numerals or terminal portions of reference numerals have been repeated among the figures to indicate corresponding or analogous elements, which may optionally have similar characteristics.

Referring to Figures 1 to 3, and Figure 6, showing an embodiment of an endoscope system according to the present disclosure. The endoscope system includes an endoscope assembly 1, an output unit 231, an image reader 232, and a graphics processor 233 (see Figure 6). The endoscope assembly 1 includes a base module 20, an injection needle 10, and an image sensing unit 21 that includes an image sensor 211.

Referring to Figures 1, and 2, the base module 20 includes an illumination input end 22, an output end 23 connected to the illumination input end 22, and a relay mechanism 24 connected to the output end 23. The output unit 231 is connected to the output end 23 of the base module 40 of the endoscope device 20. The illumination input end 22 is adapted to receive a light source conductor 101 that extends towards the image sensor 211. In this embodiment, the relay mechanism 24

is configured as one of an optical fiber light concentrator, a multimedia interface, and an LED light power source. Additionally, the output unit 231 can be connected to the output end 23 of the base module 20 via a wireless connection. In this case, the relay mechanism 24 can have a wireless communication module attached, or in cases where wireless connection is not required a traditional wired communication module may be substituted. The output unit 231, image reader 232, and graphics processor 233 can be connected to the output end 23 via the relay mechanism 24. However, the relay mechanism 24 can also be omitted in some embodiments. For example, the output unit 231 can be a head-mounted display (HMD), so that an operating surgeon may be provided with a live feed video captured by the image sensing unit 21.

The injection needle 10 is tubular, is connected to the base module 20, and has a needle shaft 12; the injection needle 10 further includes a Y-connector 30, and the needle shaft 12 is connected to the Y-connector 30 at an end of the Y-connector 30 that is distal from the base module 20. In this embodiment, the Y-connector 30 is removably connected to the base module 20 so that the injection needle 10 is replaceable; the injection needle 10 is therefore disposable and sterilizing the injection needle 10 after use will be unnecessary. However, it should be mentioned that the above

mentioned configuration is not a limitation of this disclosure, and in other embodiments the injection needle 10 may be removably connected to the Y-connector 30 instead.

The injection needle 10 further includes a filler member 102. A passage 40 is formed between the tube portion 213 and an inner surface of the needle shaft 12. The Y-connector 30 includes a first branch tube 31, and a second branch tube 32 communicating with the first branch tube 31. The first branch tube 31 has two opposite ends that are respectively connected to the base module 20 and the needle shaft 12, and that fluidly communicate with the passage 40. The first branch tube 31 guides the light source conductor 101 from the output end 22 towards the image sensing unit 21 inside the needle shaft 12. The second branch tube 32 has an injection port 321 that is adapted for inlet of a pharmaceutical therethrough into the passage 40.

The needle shaft 12 of the injection needle 10 has a bevel surface 121 that is formed on a distal end thereof, and an end hole 122 that is formed in the bevel surface 121. The pharmaceutical that was inlet into the passage 40 is outlet through the end hole 122. In this embodiment, the image sensor 211 has an end surface that is perpendicular to an axis of the injection needle 10. The bevel surface 121 of the needle shaft 12 is inclined relative to the end surface of the image sensor 211,

and forms a sharp tip 120 that can easily puncture a patient's skin. With the sharp tip 120 the injection needle 12 only makes a small wound when puncturing the patient, and the small wound facilitates postoperative recovery and will not require sutures to close. For example, the needle shaft 12 may be made of a stainless steel material and the outer diameter may range from 1.0 millimeters to 2.5 millimeters, so that the wound on the patient will be no larger than 2.5 millimeters, which will not require sutures to close and thereby facilitate the patient's recovery. The length of the injection needle 10 is in a range from 40 millimeters to 450 millimeters, and more optimally in a range from 60 millimeters to 300 millimeters.

Referring to Figures 2 and 3, the image sensing unit 21 includes a tube portion 213 that extends inside the needle shaft 12, and the image sensor 211 is connected to a distal end of the tube portion 213 and is adjacent to the bevel surface 121 of the needle shaft 12. In this embodiment, the image sensor 211 may be a traditional optical camera used with a fiberscope, a charge-coupled device (CCD) image sensor, or a complementary metal-oxide semiconductor (CMOS) image sensor, but are not limited to these examples. The image sensor 211 may includes a processor (not shown) to process the image data before sending the image data to the output end 23.

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Referring to Figures 1 to 3, the injection needle 10 is convertible between a penetration mode where the filler member 102 extends into the passage 40, and an injection mode where the filler member 102 is removed from the passage 40. When the injection needle 10 punctures the patient's skin it in the penetration mode, the patient's tissue is prevented from clogging the end hole 122 of the injection needle 10, and causing an uneven wound on the patient that is difficult to heal. Additionally it should be noted that if such clogging where to occur, it may prevent the outlet of the pharmaceutical from the end hole 122. On the other hand, when the injection needle 10 is in the injection mode it can be used to inject the pharmaceutical onto a surgical area, where the pharmaceutical will outlet from the end hole 122 of the injection needle 10. However, in other embodiments of the endoscope assembly 1, a soft tube (not shown) can be extended through the passage 40 and out of the end hole 122, so that surgical irrigation fluid (such as saline) may be used to irrigate the surgical area. Likewise the soft tube may also be used as a surgical drain to drain out the irrigation fluid and other bodily fluids. Additionally a second soft tube (not shown) may be extended through the passage 40 so that the surgical area may be drained as it is irrigated. Alternatively, other surgical instruments and devices necessary for a variety of

surgical operation may be extended via the passage 40.

Referring to Figures 2, 4A, and 4B, the injection needle 10 further includes an optical component 214 mounted in the needle shaft 12 in front of the image sensor 211, under the sharp tip 120 and adjacent to the end hole 122. The optical component 214 is used to help the image sensor 211 resolve the surgical area. The optical component 214 is mounted under the sharp tip 120 so that it is sheathed away from directly impacting body tissue when the injection needle 24 is puncturing the patient's skin, which will prevent tearing of the patient's tissue. The wound on the patient will therefore be more even and the healing of the wound will be comparatively quicker than an uneven puncture wound. Additionally, this helps prevent tissue from building up in front of the image sensor 211 during the puncturing and will help to maintain a clear image of the surgical area. The optical component 214 is made from a transparent material (such as glass or plastics), and has a light incident side 131 mounted adjacent to and parallel to the bevel surface 121 of the needle shaft 12, and is adapted to guide light into the optical component 214. The optical component 214 further has a light emergent side 132 parallel to and facing the end surface of the image sensor 211 and adapted to guide light from the light incident side 131 toward the image sensor 211. In more detail, the optical component 214

is in a beveled frustoconical shape that is beveled at the same incline as the bevel surface 121 (as shown in Figures 4A, 4B). In this embodiment, the light incident side 131 and the light emergent side 132 of the optical component 214 forms an acute angle therebetween.

In this embodiment, the optical component 214 is structurally hollow, and has an inner space 134 between the light incident side 131 and the light emergent side 132. The light emergent side 132 is adapted to guide light that is incident on the light incident side 131 and that is refracted by the inner space 134 to be substantially perpendicular to the end surface of the image sensor 211. Specifically, the hollow structure of the optical component 214 generates minimal interference with light passing through the optical component 214 and refracted by the inner space 134.

Referring to Figure 4B, showing another embodiment of the endoscope assembly 1 according to this disclosure. In this embodiment, the light incident side 131 is stepped, and has a plurality of spaced-apart first incident surfaces 135 that are parallel to the end surface of the image sensor 211 and and that are arranged in a direction parallel to the bevel surface 121 of the needle shaft 12. Each of the first incident surfaces 135 has a length that is not larger than one micrometer. In this embodiment, because the first incident surfaces 135 are micron sized in scale and

arranged in a direction parallel to the bevel surface 121, a significant portion of incident light passes perpendicularly through the light incident side 131, the light emergent side 132 and onto the image sensor 211, and thereby reducing distortion of the image due to refraction.

Referring to Figures 2 and, the light source conductor 101 conducts the light source provided from the illumination input end 22. In this embodiment the light source conductor 101 is configured as a plurality of optical fiber strands that are arranged in a circle around a periphery of the image sensor 211. The optical fiber strands may be arranged in a full circle around the image sensor 211 as shown in Figure 5C or arranged to be partially concentrated around one portion of the image sensor 211 as shown in Figures 5A and 5B. In other embodiments, the light source conductor 101 may be an LED light source (not shown) disposed adjacent to the bevel surface 121 of the needle shaft 12; in these embodiments, electrical wires running through the needle shaft 12 are used to power the LED light (not shown).

Referring to Figures 1 to 6, the output unit 231 has a bus 2311 that is connected to the image sensing unit 21 via a data connection, a processor 2312 that is connected to the bus 2311 via a data connection, and a display panel 2313 that is electrically connected to

the processor 2312. The bus 2311 is disposed for transmitting an image signal captured by the image sensor 211, the processor 2312 is disposed for receiving the image signal transmitted by the bus 2311 and for processing the image signal, and the display device 2313 is disposed for displaying the image signal processed by the processor 2312. For example an image of the patient's internal body cavity may be captured by the image sensor 211, and then transmitted via the bus 2311 to be displayed on the display panel 2313 for examination by the doctor so that a diagnosis can be made. In this embodiment, the output unit 231 is wirelessly connected to the output end 23, for example, via blue tooth, ZigBee, Wi-Fi, or RF etc. Additionally, the output unit 231 may be a display device, a portable electronic device or virtual reality headset. For example, the surgeon may wear a virtual reality headset as the output unit 231 to view images captured by the image sensor 211, however this is not a limitation on the type of the display device 2313 that may be employed.

The image reader 232 is connected to the output end 23, is electrically connected to the image sensor 211, and is used to read the captured image signal from the image sensor 211. The graphics processor 233 is connected to the output end 23 and has a signal amplifier 2331 and an image filter 2332 that are used to process the captured image signal.

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In summary of the above, by virtue of the endoscope assembly 1 including the injection needle 10 and the image sensing unit 21, the endoscope assembly 1 can monitor the surgical area while directly performing an injection at the surgical area. The endoscope assembly 1 is therefore convenient to use. Additionally, by the injection needle 10 being in the penetration mode, a clean and even puncture wound can be made on the patient; by the injection needle 10 being in the injection mode a surgical instrument may be extended to the surgical area via the passage 40, thereby obviating the need for a second incision to be made or enlargement of the original incision; by making less and smaller incisions, the length of the patient's postoperative recovery period may be shortened, and the object of this invention has been satisfied.

For the purpose of this specification, it will be clearly understood that the word "comprising" means "including but not limited to," and that the word "comprises" has a corresponding meaning.

It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the common general knowledge in the art, in Australia or any other country.

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The Claims defining the invention are as follows:

1. An endoscope assembly comprising:

a base module including an illumination input end;

an injection needle being tubular, being connected to said base module, and having a needle shaft, said needle shaft having a bevel surface that is formed on a distal end thereof; and

an image sensing unit including a tube portion that extends inside said needle shaft, and an image sensor that is connected to a distal end of said tube portion and that is adjacent to said bevel surface of said needle shaft, a passage being formed between said tube portion and an inner surface of said needle shaft;

wherein said image sensor has an end surface that is perpendicular to an axis of said needle shaft;

wherein said bevel surface of said needle shaft is inclined relative to said end surface of said image sensor;

wherein said injection needle further includes an optical component that is made from a transparent material, that is mounted in said needle shaft in front of said image sensor, and that has

a light incident side mounted adjacent to and being parallel to said bevel surface of said needle shaft, and adapted to guide light into said optical component, and

a light emergent side parallel to and facing said

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end surface of said image sensor, and adapted to guide light from said light incident side toward said image sensor;

wherein said light incident side and said light emergent side form an acute angle therebetween;

wherein said optical component is structurally hollow, and has an inner space between said light incident side and said light emergent side; and

wherein said light emergent side is adapted to guide light that is incident on said light incident side and that is refracted by said inner space to be substantially perpendicular to said end surface of said image sensor.

2. The endoscope assembly as claimed in Claim 1, wherein:

said needle shaft of said injection needle further has an end hole formed in said bevel surface;

said injection needle further includes a filler member; and

said injection needle is convertible between a penetration mode where said filler member extends into said passage, and an injection mode where said filler member is removed from said passage.

3. The endoscope assembly as claimed in any one of Claims 1 and 2, wherein said injection needle further includes

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a Y-connector that includes:

a first branch tube having two opposite ends that are respectively connected to said base module and said needle shaft, and that fluidly communicate with said passage; and

a second branch tube communicating with said first branch tube, and having an injection port that is adapted for inlet of a pharmaceutical therethrough into said passage and outlet of the pharmaceutical from said end hole.

4. The endoscope assembly as claimed in any one of Claims 1 to 3, wherein said injection needle is removably connected to said base module so that said injection needle is replaceable.

5. The endoscope assembly as claimed in any one of Claims 1 to 4, wherein said light incident side is stepped, and has a plurality of spaced-apart first incident surfaces that are parallel to said end surface of said image sensor and that are arranged in a direction parallel to said bevel surface of said needle shaft, each of said first incident surfaces having a length that is not larger than one micrometer.

6. The endoscope assembly as claimed in any one of Claims 1 to 5, wherein said base module further includes a relay

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mechanism that is configured as one of an optical fiber light concentrator, a multimedia interface, and an LED light power source.

7. An endoscope system comprising:

said endoscope assembly as claimed in any one of Claims 1 to 6, wherein said base module further having an output end; and

an output unit connected to said output end of said base module of said endoscope assembly, and having a bus that is connected to said image sensing unit via a data connection, a processor that is connected to said bus via a data connection, and a display panel that is electrically connected to said processor;

said bus being disposed for transmitting an image signal captured by said image sensor, said processor being disposed for receiving the image signal transmitted by said bus and for processing the image signal, said display panel being disposed for displaying the image signal processed by said processor.

8. The endoscope system as claimed in Claim 7, wherein said output unit is connected to said output end of said base module of said endoscope assembly via a wireless connection.

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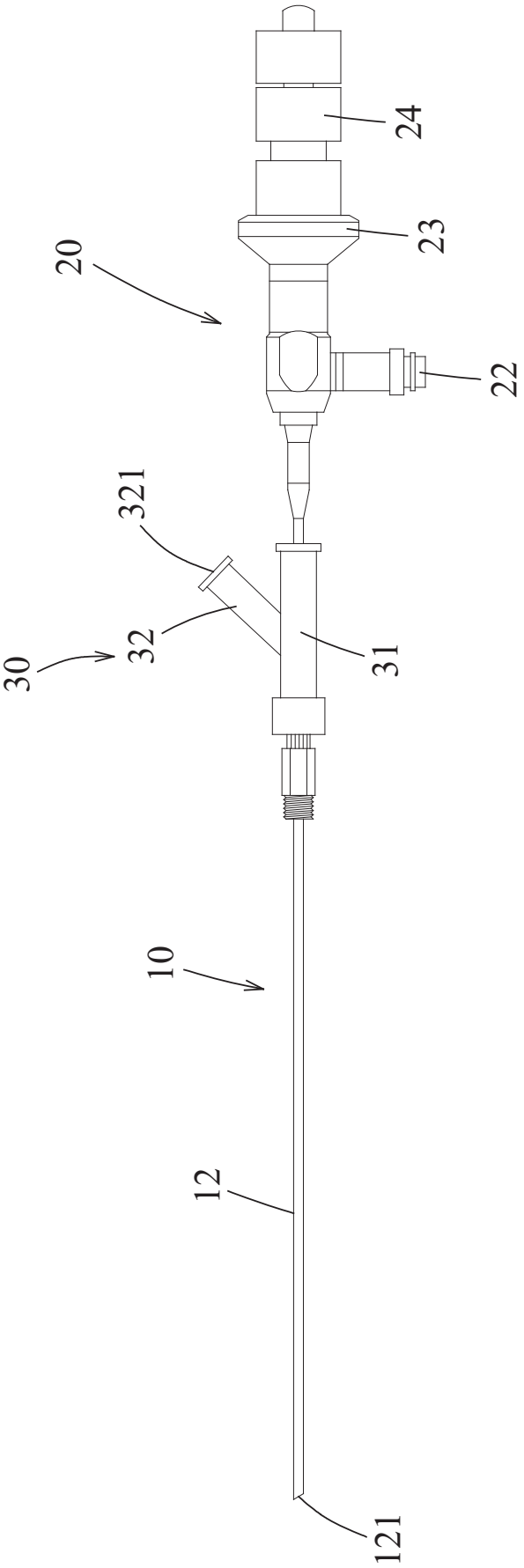

FIG. 1

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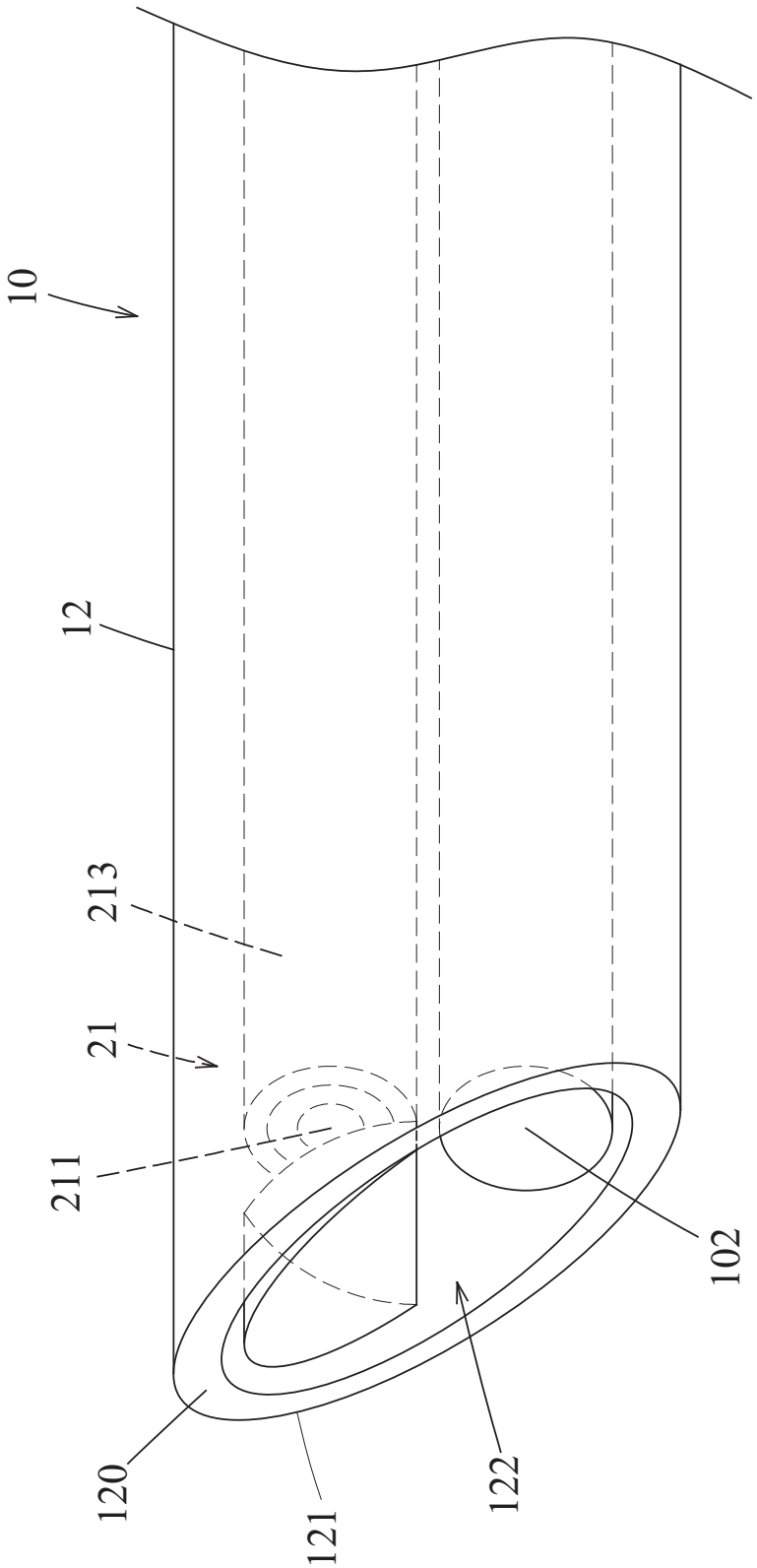

FIG. 2

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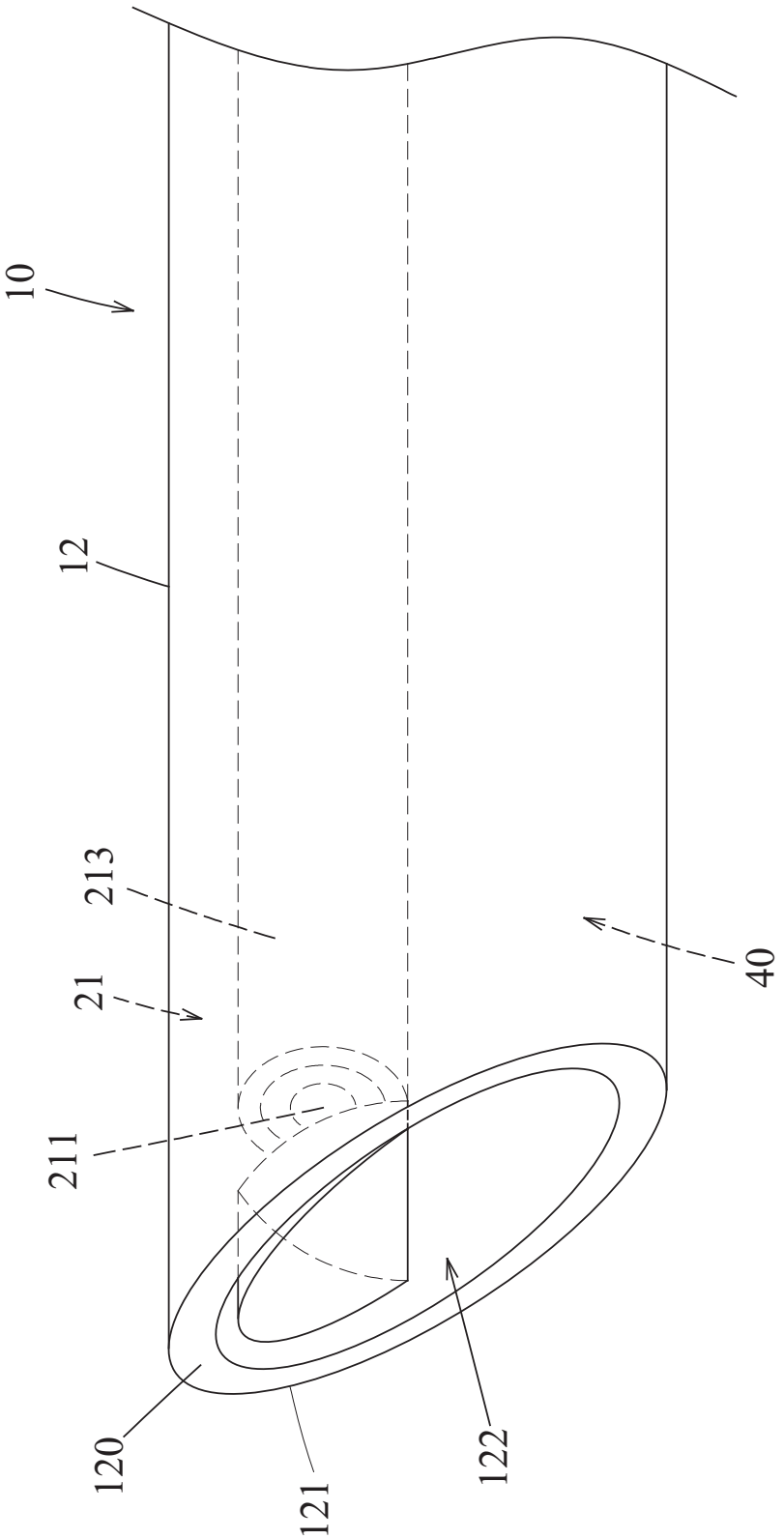

FIG. 3

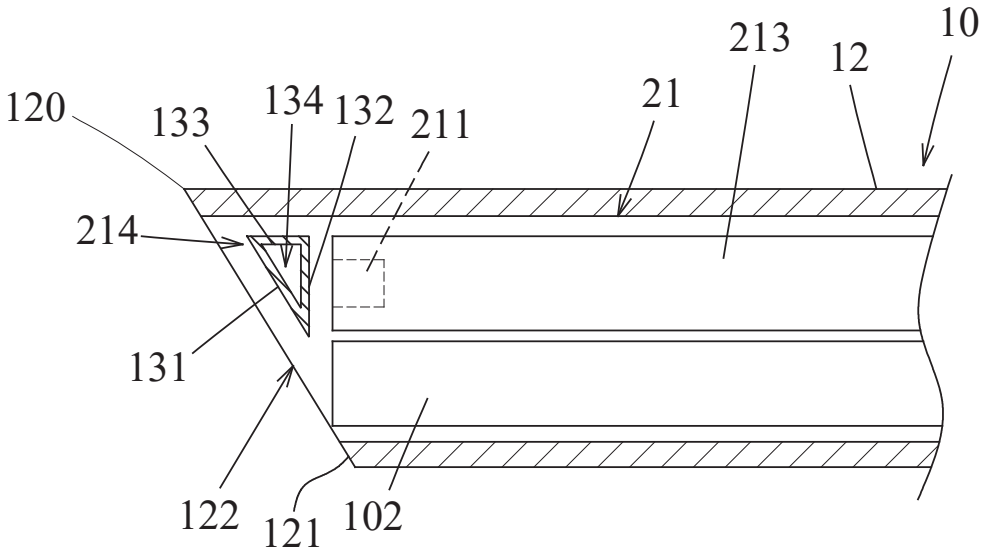

FIG. 4A

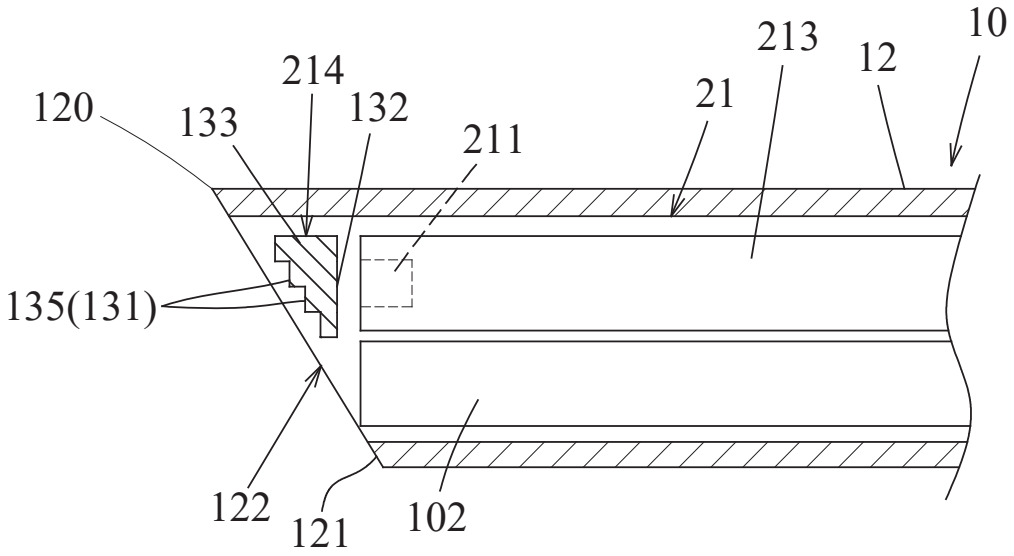

FIG. 4B

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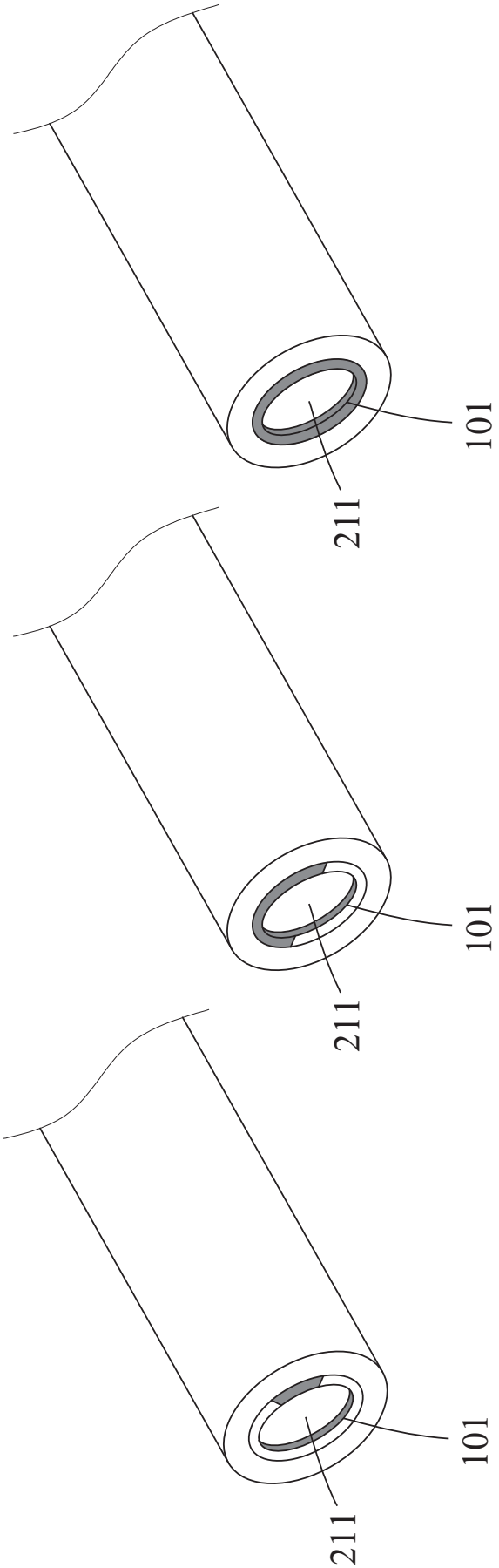

FIG. 5A FIG. 5B FIG. 5C

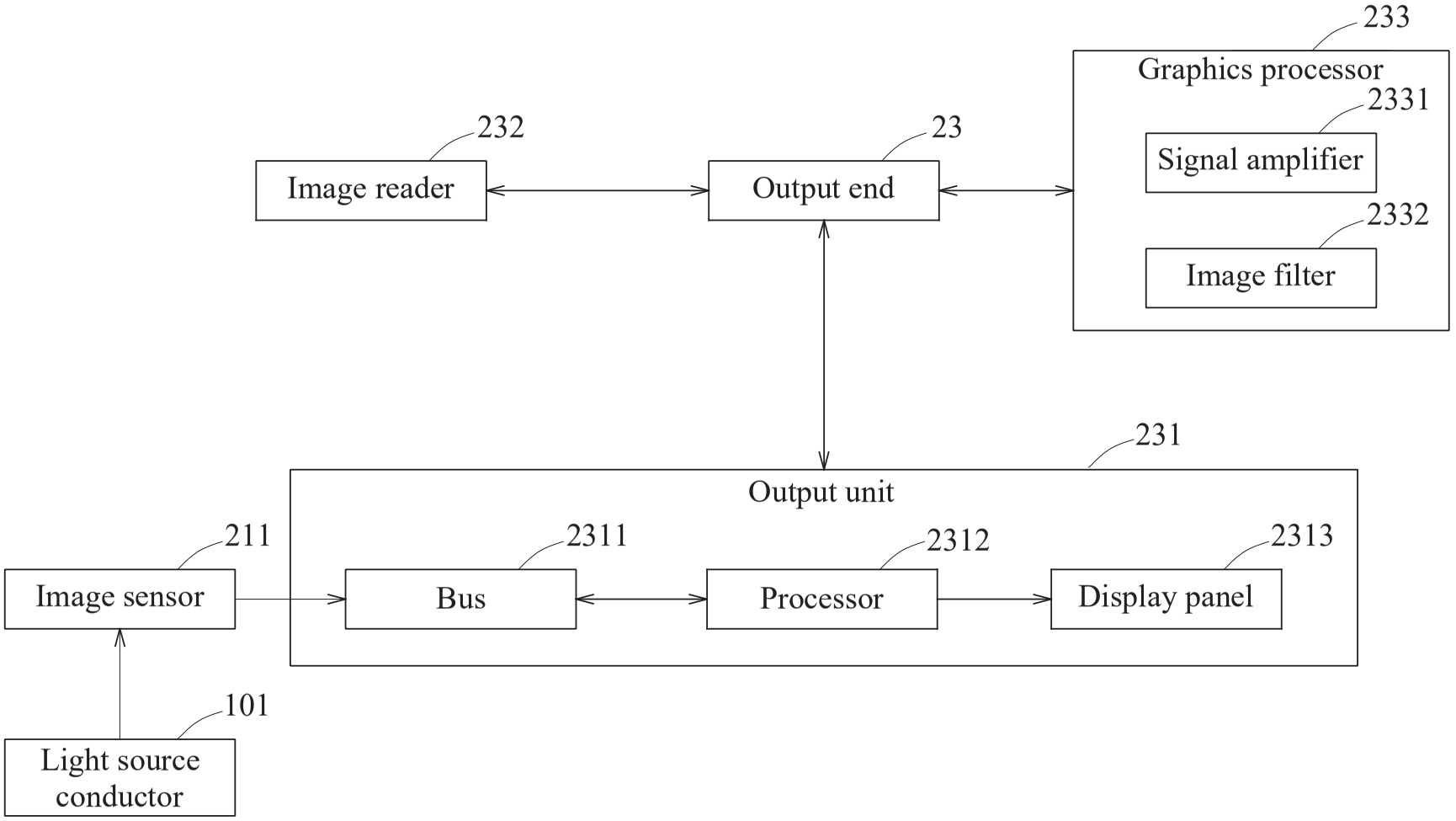
233
Graphics processor
2331
Signal amplifier
2332
Image filter
232
Image reader
23
Output end
231
Output unit
211
Image sensor
2311
Bus
2312
Processor
2313
Display panel
101
Light source conductor

FIG. 6