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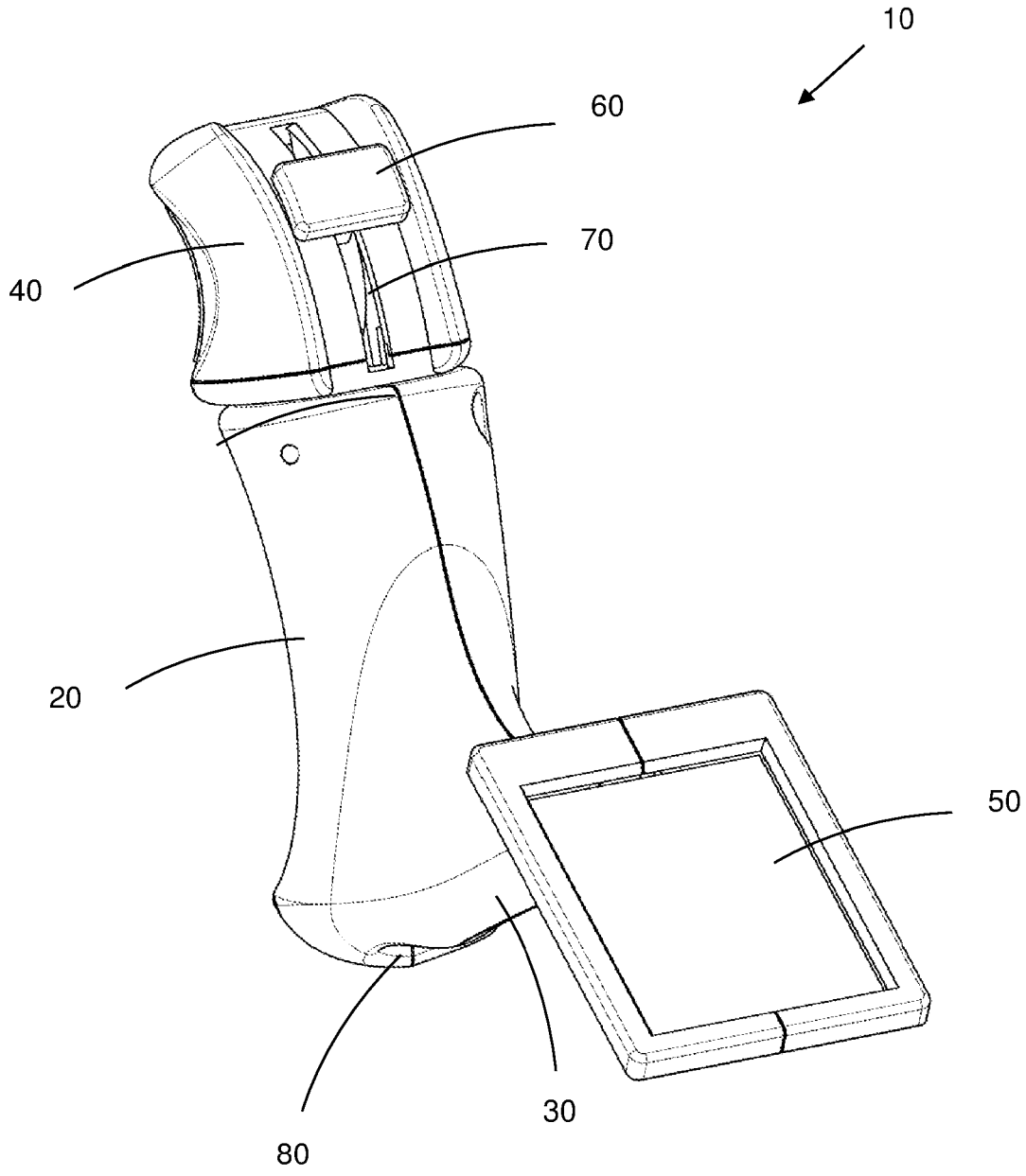
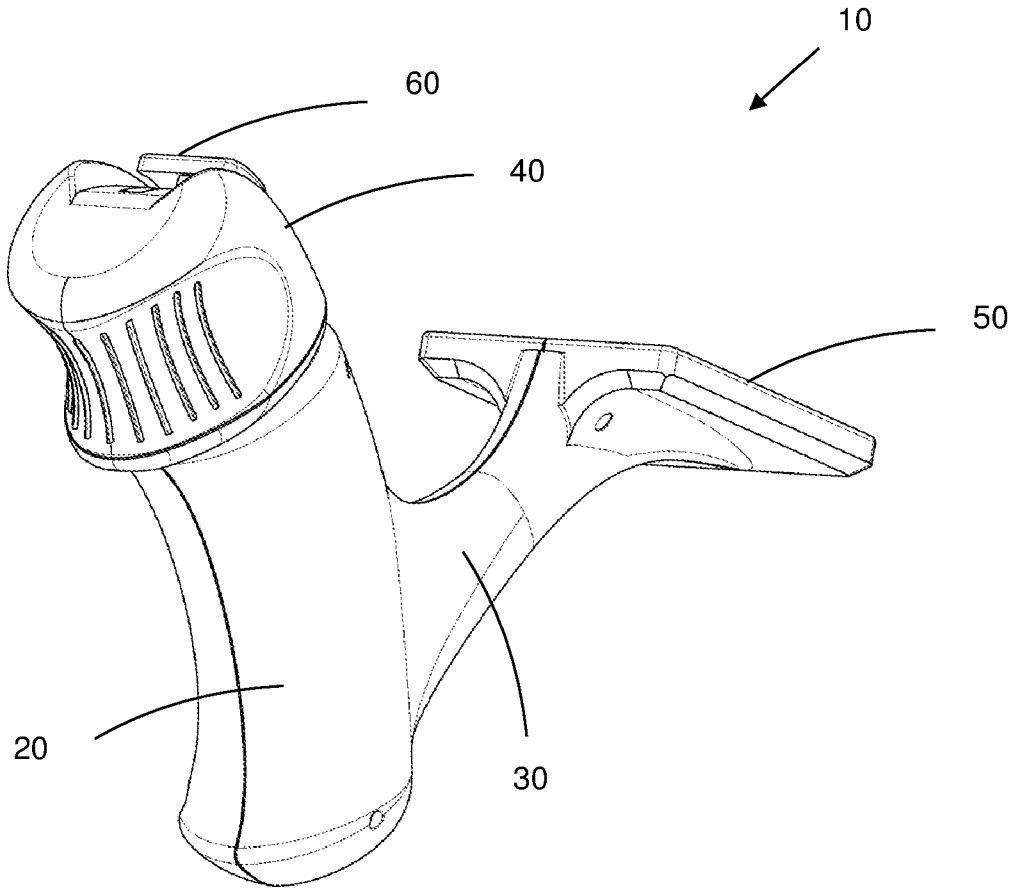
Figure 1



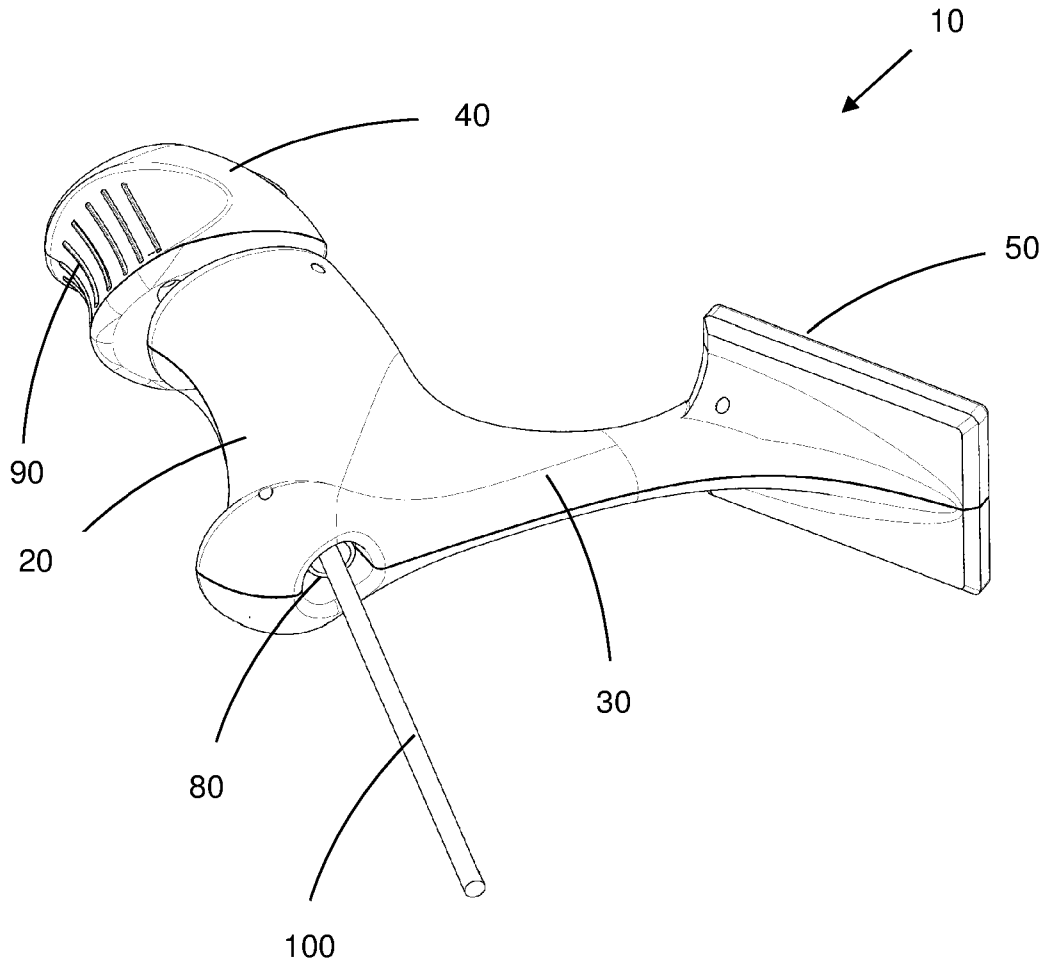
16 12 20

Figure 2



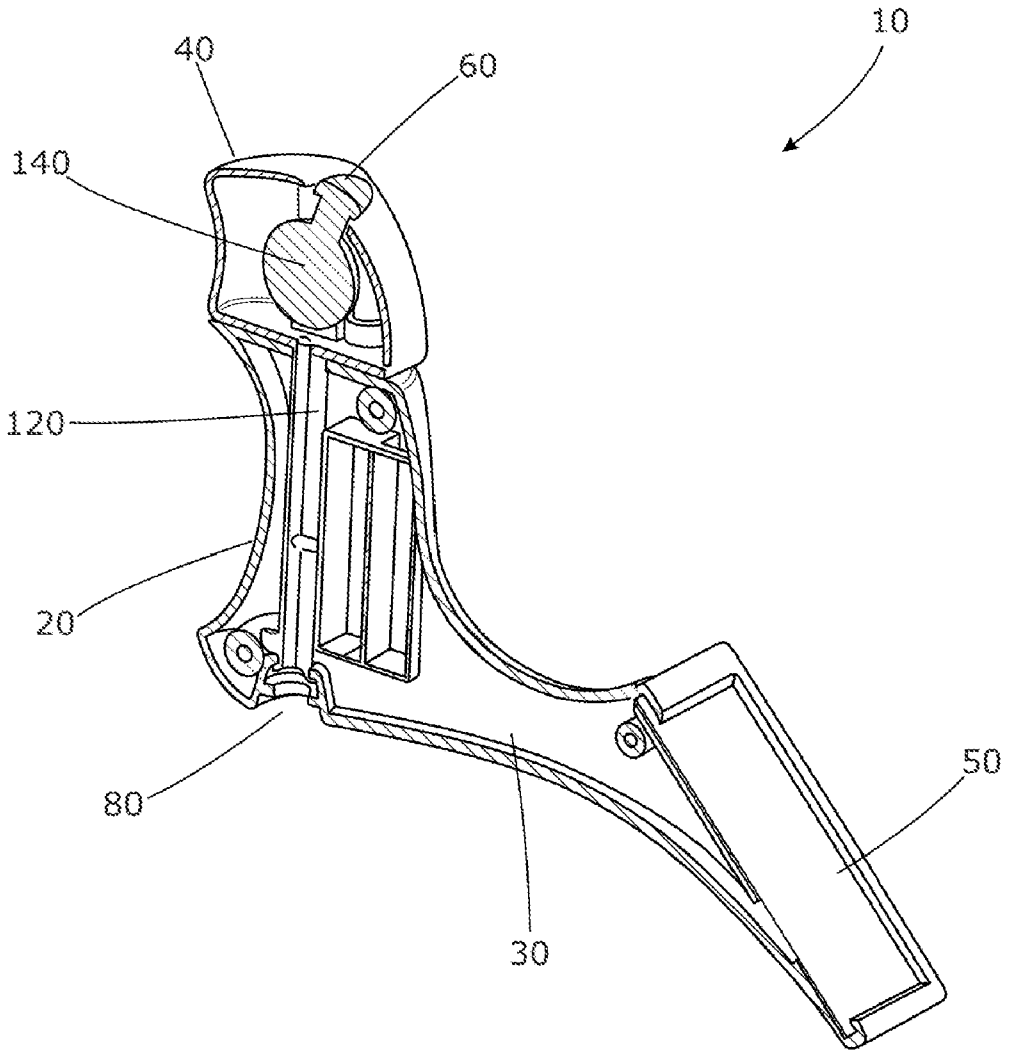
16 12 20

Figure 3



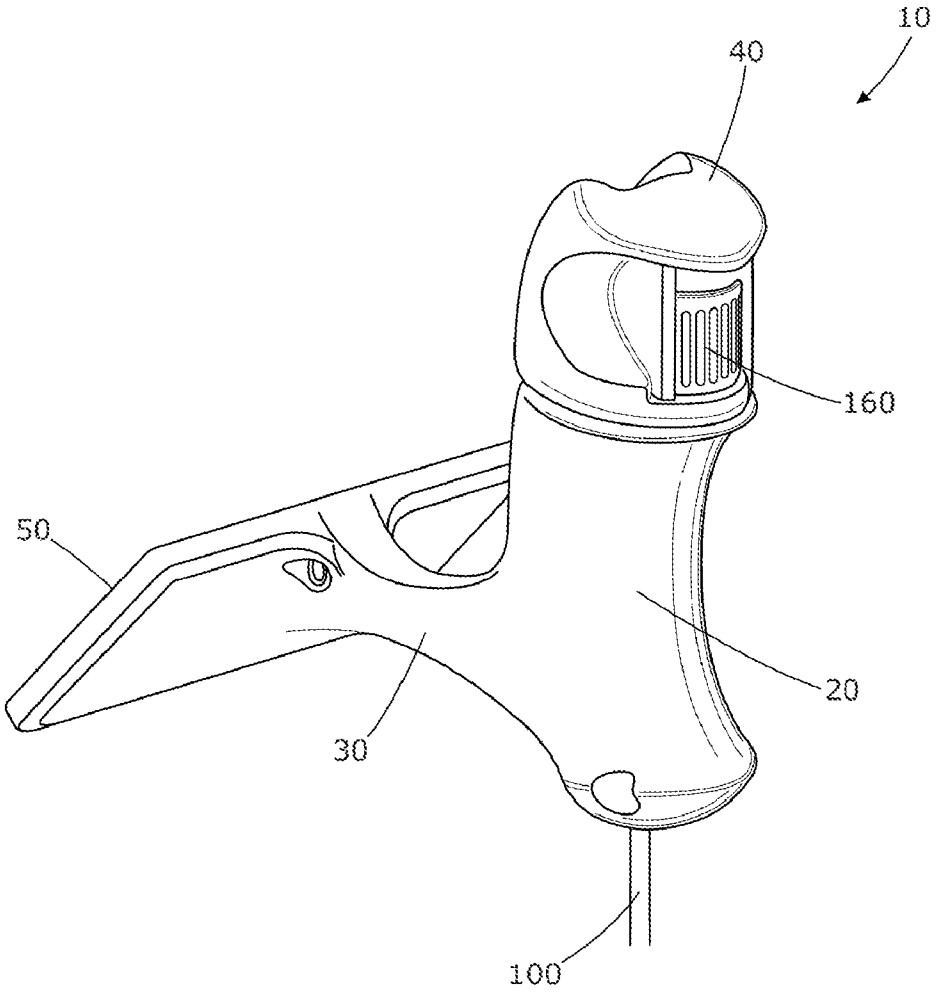
16 12 20

Figure 4



16 12 20

Figure 5



16 12 20

TITLE – Endoscope

The present invention relates to an endoscope, and more particularly to a flexible endoscope for aiding intubation.

Endoscopes are devices for examining the interior of a hollow organ or cavity of the body. Endoscopes typically comprise a handle, an operative member, which may be rigid or flexible, and means for transmitting an image from the distal end of the operative member, situated within a patient's body during use, to an eyepiece or display outside the body. Examples of flexible endoscopes include fiberscopes and videoscopes. Fiberscopes typically comprise a bundle of optical fibres within the operative member for transmitting an image from a lens to an eyepiece. As a result of the optical fibres, in particular, fiberscopes are both fragile and expensive. Videoscopes include a camera in the operative member and a connected video display. Videoscopes require a longer setup time, and take up more space.

Recently, endoscopes have also been specifically configured to aid intubation. Intubation is the process of inserting an endotracheal tube through the mouth and into the trachea of a patient. This allows the patient to be connected to a ventilator to assist with respiration. This may be because the patient is unable to breathe without assistance, for example during anaesthesia, or because the patient is unable to maintain their airway.

A stylet is an example of a conventional device for aiding intubation. A stylet is a malleable device that is inserted into an endotracheal tube prior to insertion of the endotracheal tube into the trachea of a patient. The malleable nature of the stylet allows a user to pre-form the stylet, which then maintains the surrounding endotracheal tube in a desired shape prior to insertion into the trachea. The endotracheal tube is then introduced into the trachea using a laryngoscope, such that a distal end of the endotracheal tube is located within the trachea, and a proximal end of the endotracheal tube projects from the patient's mouth. Once the distal end of the endotracheal tube is appropriately positioned within the trachea, the stylet is withdrawn, along with the laryngoscope.

A bougie is another example of a conventional device for aiding intubation. A bougie is a flexible device that is used to provide a positive position within the trachea for guiding an endotracheal tube into the trachea. A bougie is typically introduced into the trachea such that a distal end is located within the trachea and a proximal end projects from the patient's mouth. An endotracheal tube is then "railroaded" over the bougie, which involves inserting the proximal end of the bougie into a distal end of the endotracheal tube, and sliding the endotracheal tube over, and along, the external surface of the bougie until the distal end of the endotracheal tube is appropriately positioned within the trachea. The bougie therefore acts as a guide for placement of the endotracheal tube. The bougie is then removed from the endotracheal tube and the patient.

Endoscopes enable the user to see images within the body, eg near the tip of the endotracheal tube whilst inserting an endotracheal tube into the trachea, for example by those methods described above or otherwise. Flexible endoscopes generally work in one of two ways, dependent on their length. Longer endoscopes are used to pre-load an endotracheal tube which is retained at the proximal end of the operative member, and then advanced over the operative member once the distal end of the operative member is correctly located within the trachea of a patient. Shorter endoscopes are used only to visualise the vocal chords of the patient whilst an endotracheal tube is introduced into the trachea, so that the placement of the endotracheal tube can be guided and adjusted accordingly.

There has now been devised an improved endoscope, which overcomes or substantially mitigates disadvantages associated with the prior art.

According to a first aspect of the invention, there is provided an endoscope for use in intubation, the endoscope comprising a housing, a display device having a display screen, and an operative member extending from the housing, the operative member being configured to be inserted into a patient's airway and to transmit images to the display screen, the housing comprising an actuator coupled to the operative member and a retainer coupled to the display screen, the housing

having a handle portion comprising at least the actuator, and the actuator being single-handedly rotatable by an operator relative to the retainer, such that the operative member is rotatable relative to the display screen.

The present invention is advantageous principally because the housing of the endoscope comprises an actuator coupled to the operative member and a retainer coupled to the display screen, and the actuator is single-handedly rotatable by an operator relative to the retainer, such that the operative member is rotatable relative to the display screen. This enables an endoscope to have a display screen that is mounted to, or integral with, the housing of the endoscope, without the display screen rotating relative to the operator when the operative member is rotated.

This is in contrast to a display screen mounted on to an endoscope known in the art, since those endoscopes are rotated by a user rotating the housing with their hand, with which the mounted display would also rotate.

According to a further aspect of the present invention there is provided a method of manufacturing an endoscope as defined above, the method comprising the steps of:

(i) providing a housing, a display device having a display screen, and an operative member extending from the housing, the operative member being configured to be inserted into a patient's airway and to transmit images to the display screen, and the housing comprising an actuator coupled to the operative member and a retainer coupled to the display screen, and

(ii) arranging the housing to have a handle portion comprising at least the actuator, and the actuator to be single-handedly rotatable by an operator relative to the retainer, such that the operative member is rotatable relative to the display screen.

The actuator and the retainer may be arranged such that they are engageable by first and second parts of the operator's body, the first and second parts of the operator's body being capable of movement relative to each other. The first part of the operator's body may be a part of a first hand and associated fingers and thumb

of the operator. The second part of the operator's body may be a different part of the first hand and associated fingers and thumb of the operator. Alternatively, the second part of the operator's body may be another part of the body of the operator.

The handle portion may comprise the actuator and the retainer. That is, the actuator and the retainer may be parts of the handle portion. In this arrangement, the actuator may be arranged such that it is engageable by at least one finger or thumb of the operator, and the retainer may be arranged such that it is engageable by at least one different finger or thumb of the same hand of the operator. The actuator may be movable through at least a first movement path. The first movement path may be an arcuate movement path. The operator may be able to effect rotation of the actuator and the retainer relative to each other through relative movement of the fingers of a first hand, or through the relative movement of a finger and the thumb of the first hand. For example, the actuator may be positioned towards the top end of the handle portion when held by the operator in use, such that the actuator is arranged to be engageable by the first finger of the operator, ie the finger closest to the operator's thumb, or the thumb of the operator, and the retainer may be the remainder of the handle portion, such that the retainer is engageable by the remainder of the operator's hand. Thus, when the operator moves their first finger or thumb relative to the rest of their hand, the actuator will rotate relative to the retainer, causing rotation of the operative member whilst maintaining the position of the display screen relative to the operator.

Alternatively, the handle portion may comprise the actuator, but not the retainer. That is, the retainer may be positioned remote from the handle portion. In this arrangement, the actuator may be arranged to be engaged by a hand and associated fingers of the operator, and the retainer may be arranged to be engaged by a different part of the operator's body. The operator may be able to effect rotation of the actuating portions relative to each other through movement of their hand relative to the different part of their body. For example, the retainer may extend from the handle portion so as to engage, eg rest upon, with the operator's

wrist or arm, the wrist or arm being for the hand engaging the actuator. Thus, when the operator moves their fingers or hand relative to their wrist or arm, the actuator will be rotated relative to the retainer, causing rotation of the operative member whilst maintaining the position of the display screen relative to the operator.

The actuator and the retainer may be rotatable relative to each other about a longitudinal axis of the operative member. The actuator and the retainer may be rotatable relative to each other about a longitudinal axis of the handle portion. The operative member may extend from the housing substantially parallel to the longitudinal axis of the handle portion.

The operative member may be rotatable relative to at least part of the handle portion of the housing, eg relative to the part of the handle portion upon which the palm of the operator's hand is located. The actuator may comprise a first actuator member for controlling rotation of the operative member relative to the handle portion, ie about a longitudinal axis of the handle portion and/or the operative member.

This is advantageous in that the operative member may be controlled without having to move or rotate at least part of the handle portion of the housing, eg that part of the handle portion upon which the palm of the operator's hand is located, which provides improved control during use. This is particularly beneficial since in use the endoscope is held high, eg above the head of the operator, in order to introduce the operative member into the airway of a patient, making rotation of the part of the handle portion upon which the palm of the operator's hand is located difficult.

The first actuator member may be mechanical in form. Where the first actuator member is mechanical in form, the first actuator member may include a moveable member, which may be operated by a user's finger, for example. The first actuator may be arranged at the opposite end of the housing relative to the end from which the operative member extends. The first actuator member may be arranged for

pivoting or rotational movement. The first actuator member may have the form of an arm. Alternatively, the first actuator member may comprise a wheel, the wheel being rotatable within the housing. The wheel may be positioned within a slot in the housing. The wheel may be arranged at the opposite end of the housing relative to the end from which the operative member extends. The wheel may be mechanically coupled to the operative member such that rotation of the wheel causes rotation of the operative member. The wheel may be rotatable in a first direction to rotate the operative member in a first direction relative to the handle portion. The wheel may be rotatable in a second direction to rotate the operative member in a second direction relative to the handle portion. The first and second directions may be rotationally opposite directions. The wheel may be operable by a user's finger.

Alternatively, the actuator may be formed by a head portion of the housing, which is rotatable relative to the remainder of the handle portion and the display screen device. The handle portion and the display screen device may be fixed relative to each other. The rotatable head portion may be arranged at the opposite end of the housing relative to the end from which the operative member extends. The rotatable head portion may be arranged relative to the handle portion of the housing such that it may be rotated by the index finger and/or thumb of the user.

A distal tip portion of the operative member may be movable relative to a main body of the operative member, and this movement of the distal tip portion of the operative member may be controllable by the user from the housing of the endoscope. This controlled movement of the distal tip portion of the operative member facilitates both the viewing of the interior of the patient's body and the guiding of the endotracheal tube during intubation.

The movement of the distal tip portion may comprise variation of the angle of orientation of the distal tip portion relative to the main body portion of the operative member, eg about a hinge or pivot portion, or about a bending portion. The distal tip portion may therefore be angled, ie non-parallel, relative to a main body portion of the operative member, and may for example, be obliquely angled relative to the

main body portion. Alternatively, the distal tip portion may be angled as much as 180 degrees relative to the main body portion of the operative member. The shape of the distal tip portion may remain substantially constant during this movement.

The housing may comprise a second actuator for controlling movement of the distal tip portion of the operative member, ie to vary the angle of orientation of the distal tip portion of the operative member relative to the main body of the operative member, eg within the plane in which the central longitudinal axes of the operative member and the housing lie, which may be the median plane of the patient's body, in use.

The second actuator, herein referred to as a distal tip portion actuator, may be mechanical in form. The distal tip portion actuator may have an engagement portion, the engagement portion being operable by a user. Where the distal tip portion actuator is mechanical in form, the engagement portion may be a moveable arm, which may be operated by a user's thumb, for example. The engagement portion may be movable through at least a second movement path. The second movement path may reside substantially in a single plane. The second movement path may be substantially arcuate. In this arrangement, the distal tip portion actuator may be moveable by a user relative to a longitudinal axis of the housing, eg either linearly or by rotation through an arc. For example, the engagement portion may comprise a lever projecting from a slot in the housing, within which the lever is movable relative to a longitudinal axis of the housing. Where the engagement portion is a lever, the second movement path is preferably arcuate. The distal tip portion actuator may be moveable relative to a longitudinal axis of the housing in a first actuator member direction to move and/or vary the orientation of the distal tip portion in a first operative direction, and the distal tip portion actuator may be moveable relative to a longitudinal axis of the housing in a second actuator direction to move and/or vary the orientation of the distal tip portion in a second operative direction. The first and second actuator directions may be opposite directions, either rotationally through an arc or linearly, and the first and second operative directions may be opposite directions, either rotationally through an arc or linearly.

This is advantageous in that it allows an operator to control movement of the operative member single-handedly.

The second actuator, eg the distal tip portion actuator, may be disposed on a first surface of the housing, the first surface being on the same side of the housing as the display screen. Where the housing includes a head portion arranged at the opposite end of the housing relative to the end of the housing from which the operative member extends, a second actuator, eg the distal tip portion actuator, may be disposed on a first surface of the head portion of the housing, the first surface being on the same side of the housing as the display screen, such that the actuator may be operated by the user's thumb. The first actuator member described above may be disposed on a second surface of the head portion of the housing, the second surface being on the opposite surface of the housing as the distal tip portion actuator and the display screen, such that the first actuator member may be operated by a user's first finger.

The provision of a first rotation actuator formed on or by a head portion of the housing, and the head portion including a distal tip portion actuator, allows movement of the operative member to be controlled single-handedly.

In an alternative arrangement, the housing may comprise a single actuator for controlling rotation of the operative member relative to the handle portion and for controlling movement (ie articulation) of the distal tip portion of the operative member. The single actuator may be movable through at least two paths. The two paths may each extend between two end points. The two paths may be different paths. The two paths may be different in that they each have two differing end points, ie the two paths do not share any end points. The single actuator may be movable through at least a first movement path to control rotation of the operative member relative to the handle portion. The first movement path may be substantially arcuate, for example. The single actuator may be movable through at least a second movement path to control articulation of the distal tip portion of the operative member. The second movement path may be substantially linear, for

example. The single actuator may be movable through the first movement path to control rotation of the operative member relative to the handle portion, and at any point along that first movement path may be moveable along at least one further movement path to control articulation of the distal tip portion of the operative member.

The single actuator may comprise an engagement portion, engageable by an operator. The engagement portion may protrude from the housing, such that it is engageable by at least one finger or thumb of the operator. The engagement portion may include a movable member. The movable member may be arranged for linear and/or pivoting and/or rotational movement. The movable member may have the form of an arm. The movable member may be movable in all directions within a geometric surface, within boundaries defined by the actuator, for example about a ball joint. That is, the geometric surface may be a curved geometric surface. The single actuator may be a joystick, for example.

The housing may further comprise a grip portion, for engagement by at least the index finger of the user. The grip portion may be disposed on a second surface of the housing, the second surface being on the opposite side of the housing to the display screen. Where the housing includes a head portion arranged at the opposite end of the housing relative to the end of the housing from which the operative member extends, the grip portion may be disposed on a second surface of the head portion of the housing, the second surface being on the opposite side of the housing to the display screen, such that the grip portion may be engaged by at least the user's index finger.

According to a further aspect of the invention, there is provided an endoscope for use in intubation, the endoscope comprising a housing including a handle portion and a display screen portion, the display screen portion having a display screen, and an operative member extending from the housing, the operative member being configured to be inserted into a patient's airway and to transmit images to the display device, wherein the operative member extends from a first end of the housing and the display screen portion extends from the first end of the housing,

such that the display screen is spatially separated from the handle portion and a user's wrist is positionable between the display screen and the end of the housing from which the operative member extends.

This is advantageous in that the display screen is easily visible to an operator in use, regardless of whether the endoscope is at the commencement of insertion into the patient's airway, eg when the operator's arm is fully raised, or the endoscope is fully inserted into the patient's airway, eg when the operator's arm is lower. It is also advantageous in that the positioning of the display screen ensures that it is not obscured by the operator's wrist in use.

According to a further aspect of the present invention there is provided a method of manufacturing an endoscope as defined above, the method comprising: providing a housing including a handle portion and a display screen portion, the display screen portion having a display screen, and an operative member extending from the housing, the operative member being configured to be inserted into a patient's airway and to transmit images to the display device, the operative member and the display screen portion extending from a first end of the housing such that the display screen is spatially separated from the handle portion and a user's wrist is positionable between the display screen and the end of the housing from which the operative member extends.

The display screen portion may include the window through which the display screen is viewable. The display screen portion may have a generally cuboidal portion within which the display device is accommodated. The display screen may be spatially separated from the handle portion of the housing, such that the user's wrist is positionable between the display screen and the end of the housing from which the operative member extends. The housing may therefore include an arm portion that extends between the handle portion of the housing and the display screen portion of the housing.

The display screen portion may extend from the end of the housing from which the operative member extends. Where the display screen is spatially separated from

the handle portion of the housing by an arm portion, the arm portion may extend from the end of the housing from which the operative member extends. In this arrangement, the arm portion may be arranged to rest against the inside of a user's wrist.

The handle portion may be substantially cylindrical. The handle portion may be of a length and/or circumference similar to that of the average grip size of a human hand. The handle portion may have a central longitudinal axis that is curved.

The arm portion of the housing may have a cross-sectional width that is less than the cross-sectional width of the display screen portion of the housing. The arm portion may have a cross-sectional width that is less than the cross-sectional width of the handle portion. The arm portion may extend substantially perpendicularly from the handle portion, eg at an angle of 70-120^0 thereto. The display screen may be positioned at the opposite end of the arm portion relative to the handle portion, ie the distal end of the arm portion.

The display screen may be an LCD screen. This is advantageous in that the display screen is inexpensive to produce, reducing the overall manufacture cost of the endoscope and allowing it to be implemented as a single-use endoscope. Alternatively, the display may be an OLED screen.

The central viewing axis of the display screen may be obliquely angled relative to the longitudinal axis of the arm portion, eg upwardly towards the eyes of the user, and the central viewing axis of the display screen may be obliquely angled relative to the central longitudinal axis of the handle portion. Specifically, the top edge of the display screen may be tilted towards the handle portion. The display screen may be substantially square or substantially rectangular in shape.

The operative member may extend from an end of the housing. The operative member may extend from the housing in a direction that is substantially perpendicular to the arm portion of the housing, eg at an angle of 70-120^0. This is advantageous in that it enables that the position of the display screen to be above

the operative member, in use, such that the display screen can be easily viewed regardless of whether the operative member is partially inserted into a patient's mouth or fully inserted into the patient's trachea.

The housing may further comprise a head portion. The head portion of the housing may be substantially cylindrical. The head portion of the housing may be of a similar diameter to the handle portion. The arm portion of the housing may extend from a first end of the handle portion. The head portion may extend from a second end of the handle portion. The first end and the second end may be opposite ends. The operative member may be substantially greater in length than it is in diameter. The operative member may be of a length at least substantially similar to the distance between the mouth and trachea of an adult or infant human. However, preferably the operative member is of a length substantially greater than the distance between the mouth and trachea of an adult or infant human, which allows an endotracheal tube to be loaded and then advanced over the endoscope once the distal end of the operative member is correctly located within the trachea of a patient The operative member may be of a diameter substantially less than the average diameter of a human's trachea. The operative member may be of a diameter substantially less than the average diameter of an endotracheal tube.

The operative member may be configured to be received within an endotracheal tube. The operative member may be shaped and/or dimensioned to be received within an endotracheal tube. The operative member may be substantially elongate in form. The operative member may have a diameter, for example an outer diameter, of between 1.0mm and 10.0mm. The operative member may have a diameter of between 2.0mm and 5.0mm. The operative member may have a length between 100mm and 1000 mm. The operative member may have a length between 200mm and 700mm.

The distal end of the operative member may comprise a rounded tip. By distal end is meant an end of the operative member that enters the trachea of a patient first during use. The rounded tip may comprise a circular cross-section and/or may comprise a substantially hemi-spherical global form.

The operative member may comprise a light source for illuminating an interior surface of the body, from which the images transmitted to the display device are obtained. The light source may be positioned at the distal tip of the operative member. The light source may be an LED.

Alternatively, the light source may comprise one or more light guides, eg optical fibres, that extend from a lamp in the housing to the distal end of the operative member. The lamp in the housing may be an LED. The operative member may be configured to receive light at its distal end, eg light from the light source that is reflected by the interior surface of the body being imaged, to form the images that are transmitted to the display device. The light may be received through an aperture and/or a lens at the distal end of the operative member.

The endoscope may comprise a device for converting the images into electronic format, eg an image sensor. The display device may receive the images in electronic format, eg a conventional image or video format. The image sensor may be adapted to capture still images and/or video sequence images.

The image sensor may be disposed at the distal end of the operative member. In this arrangement, the images may be transmitted in electronic format to the display device, for example by a wired connection though the operative member and the housing to the display device. Alternatively, the light forming the images may be transmitted to an image sensor accommodated by the housing, at the proximal end of the operative member. In this arrangement, the operative member may comprise one or more light guides, eg optical fibres, that extend from the distal end of the operative member to the image sensor in the housing.

The images may be instantaneous images. That is, in use, the display screen may display real-time images of the patient's trachea. The images may be single images. This is advantageous in that it allows a user to view adjustments to the positioning of the endotracheal tube within the trachea in real time. Alternatively, the images may be video images.

The operative member may comprise a channel therethrough. The channel may extend parallel to the longitudinal axis of the operative member. The channel may comprise an opening at proximal and distal ends of the operative member. Where the operative member comprises such a channel, the housing may comprise an aperture leading to the opening at the proximal end of the operative member, such that the channel is accessible through the housing. The channel may be used to insert or withdraw fluid from a patient's trachea in use.

According to a further aspect of the invention, there is provided an endoscope for use in intubation, the endoscope comprising a housing including a handle portion, a display device having a display screen, and an operative member extending from the housing, the operative member being configured to be inserted into a patient's airway and to transmit images to the display device, wherein the housing accommodates the display device, and the display screen is viewable through a window in the housing.

This aspect of the present invention is advantageous principally because the housing accommodates the display device, and the display screen is viewable through a window in the housing. This enables the endoscope, including the display device, to be provided as an integrated device, and hence enables the display device and the operative member of the endoscope to be packaged together in a sterile environment, eg as a single-use, disposable device, thereby reducing the risk of the spread of infection. On the contrary, video displays that are connected to videoscopes are used for multiple operations over a long period of time in order to justify their cost, and therefore require repeated sterilisation so as to reduce the risk of spread of infection.

The present invention also provides significant manufacturing advantages, such as reducing manufacturing costs.

The endoscope according to this aspect of the invention may therefore comprise a single-use, disposable device, which is provided in a single sterile package. The

housing, including the display device accommodated therewithin, may be provided to the user as a single item, which does not require assembly by the end user. The housing may therefore be devoid of output connections to an external display device.

The display device may be accommodated within a display screen portion of the housing that is formed integrally with at least a handle portion of the housing. The display screen portion of the housing and/or the display device may be non-removable from the remainder of the housing of the endoscope, eg without disassembling or breaking the housing of the endoscope. The housing of the endoscope may comprise at least one housing component that defines a portion of the handle housing portion and the display screen housing portion.

The operative member may be connected to the housing of the endoscope via a connector. The operative member may be releasably attached to the connector, and therefore detachable from, and re-attachable to, the housing of the endoscope. Alternatively, the operative member may be permanently attached to the housing of the endoscope via the connector, ie not detachable, for example formed integrally therewith.

According to a further aspect of the present invention there is provided a method of manufacturing an endoscope as defined above, the method comprising the steps of:

(i) providing a housing including a handle portion, a display device having a display screen, and an operative member extending from the housing, the operative member being configured to be inserted into a patient's airway and to transmit images to the display device, and

(ii) assembling the housing to accommodate the display device, such that the display screen is viewable through a window in the housing.

Practicable embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, of which:

Figure 1 is a front perspective view of an endoscope;

Figure 2 is a rear perspective view of the endoscope of Figure 1;

Figure 3 is an underside perspective view of the endoscope of Figures 1 and 2 connected to an operative member;

Figure 4 is a cross-sectional perspective view through the endoscope of Figures 1-3; and

Figure 5 is a rear perspective view of an endoscope similar to that of Figures 1-3, but having an alternative actuation mechanism for rotational movement of an operative member.

Figures 1 to 3 illustrate an endoscope 10 according to the present disclosure. The endoscope 10 comprises a body portion 20 having a head portion 40 at one end. Extending from the other end of the body portion 20 is an arm portion 30. At the other end of the arm portion 30 is an integrated display portion 50 comprising a display screen. The head portion 40 comprises an actuator 60 mounted within a slot 70. The body portion 20 further comprises a port 80 configured to receive, and connect to, an operative member, the operative member being for insertion into a patient's airway in use.

The body portion 20 is a substantially cylindrical body, having a circumference and length similar to that of a user's hand grip, such that the body portion 20 can be easily held in one hand by a user. The body portion 20 has a substantially concave rear edge, such that the head portion 40 and the lower end of the body portion 20 extend further outwards at the rear of the endoscope 10, further aiding a user's grip of the endoscope 10.

The head portion 40 is also a substantially cylindrical body of a similar circumference to the body portion 20. The arm portion 30 extends substantially

perpendicularly to the body portion 20, such that the body portion 20 and the arm portion 30 form a substantially L-shaped endoscope body. The arm portion 30 is a substantially cuboidal body, with rounded edges, that is substantially less in diameter than the body portion 20 and the head portion 40.

On its front side, the head portion 40 comprises a recess, the recess having the slot 70 therein. Within the slot 70 is an actuator 60 that is vertically moveable from one end of the slot 70 to the other. The slot 70 and the actuator 60 are also positioned on the front side of the head portion 40 such that a user may operate the actuator 60 with their thumb when holding the endoscope 10 and viewing the display screen.

At the bottom end of the body portion 20, ie the surface opposite the head portion 40, is the port 80. The port 80 is substantially circular and is configured to receive, and connect to, a flexible operative member 100 (shown in Figure 3), the operative member 100 being for insertion into a patient in use.

On the opposing side of the head portion 40 to the slot 70 and the actuator 60 is a grip portion 90 (see Figure 2). The grip portion 90 is positioned on the rear side of the head portion 40 such that it may be contacted by a first finger of the user when holding the endoscope 10.

Figure 4 shows a cross-sectional view through the endoscope 10 of Figures 1-3, which illustrates the mechanics by which the head portion 40 and the actuator 60 control movement of an operative member 100 received within port 80.

The head portion 40 is rotatable relative to the body portion 20, and fixedly connected to the operative member 100 via connecting member 120. The head portion 40 and the connecting member 120 may be formed as a unitary component for insertion into a corresponding receiving channel running through the body portion 20. In use, an operative member 100 is inserted through port 80 and fixedly connected to the connecting member 120. Connecting member 120 extends between the port 80 and the head portion 40 through the body portion 20,

mechanically connecting the head portion 40 to the operative member 100 received therein.

Rotation of the head portion 40 relative to the body portion 20 therefore causes corresponding rotation of the connecting member 120 and the operative member 100 relative to the body portion 20, ie about the longitudinal axis of the operative member 100. Thus, rotation of the head portion 40 in an anticlockwise direction causes rotation of the operative member 100 in an anticlockwise direction, and rotation of the head portion 40 in a clockwise direction causes rotation of the operative member 100 in a clockwise direction.

The grip portion 90 is particularly useful for this function since it allows a user holding the endoscope to rotate the head portion 40 using only a first finger contacting the grip portion 90.

This arrangement allows a user to rotate the head portion 40, and thus rotate the operative member 100, with just a single finger, whilst keeping the body portion 20 still with the remainder of their hand. This relative movement enables the user to control the operative member 100 without changing the orientation of the display 50 relative to themselves, thus allowing them to maintain a constant view of the display, and thus the patient's trachea, in use.

The actuator 60 comprises a lever moveable within the slot 70 so as to control a movement of the operative member 100, in use. In particular, the actuator is moveable within the slot 70 so as to control the orientation of a distal tip portion of the operative member 100, such that the distal tip portion of the operative member 100 is movable to a range of oblique angles relative to a main body of the operative member 100. In use, the operative member 100 is inserted into the trachea of a patient and the distal tip portion of the operative member 100 can then be moved relative to the main body of the operative member 100. An appropriate mechanism is shown in detail in US 2018/0303317 A1.

The connecting member 120 comprises a channel, through which a pair of threads connect actuator 60 to an operative member 100 received within port 80. The actuator 60 is mechanically connected to a wheel 140, which in turn is connected to the pair of threads at a first end of each thread. The threads are connected to the operative member 100 at a second end of each thread.

As the actuator 60 is moved one way within slot 70, it will rotate the wheel 140 in an anticlockwise direction, thus tightening a first of the threads and bending the distal tip portion such that it is angled relative to the main body of the operative member 100 in a first direction. As the actuator 60 is moved in the opposite direction within slot 70, it will rotate the wheel 140 in the clockwise direction, thus tightening the second of the threads and bending the distal tip portion such that it is angled relative to the main body of the operative member 100 in a second, opposite direction. Hence, when the actuator 60 is positioned centrally within the slot 70, the distal tip portion is aligned with the main body of the operative member 100, rather than angled.

It will be appreciated that alternative known actuation mechanisms may be implemented to control both rotation of the operative member 100 and articulation of the distal tip portion of the operative member 100.

One such alternative for controlling rotation of the operative member 100 is illustrated in Figure 5. In this alternative embodiment, the endoscope 10 comprises a wheel 160 positioned within a slot on a rear face of the head portion 40. In this embodiment, the head portion 40 is fixed relative to the body portion 20, and instead the wheel 160 controls rotational movement of the operative member 100. The wheel 160 is rotatable within the head portion 40, and is therefore rotatable relative to both the head portion 40 and the body portion 20.

Similar to the embodiment illustrated in Figure 4, the operative member 100 is inserted through port 80 and fixedly received within a channel, eg with a snap fit. The channel extends between the port 80 and the wheel 160 through the body portion 20 and the head portion 40, mechanically connecting the wheel 160 to the operative member 100 received therein. Rotation of the wheel 160 within the head

portion 40 therefore causes corresponding rotation of the channel 120 and the operative member 100 relative to the body portion 20, ie about the longitudinal axis of the operative member 100.

Thus, rotation of the wheel 160 in an anticlockwise direction causes rotation of the operative member 100 in an anticlockwise direction, and rotation of the wheel 160 in a clockwise direction causes rotation of the operative member 100 in a clockwise direction.

Similar to the embodiment described in relation to Figure 4, this arrangement allows a user to rotate the wheel 160 within the head portion 40, and thus rotate the operative member 100, without changing the orientation of the display 50, allowing them to maintain a constant view of the display, and thus the patient's trachea, in use.

Other alternative actuation mechanisms for controlling rotation of the operative member and/or articulation of the distal tip portion of the operative member may include, for example, the above-described wheel mechanism 160 housed within the body portion 20, or an additional actuating arrangement similar to the actuator 60 and slot 70 described above for use in rotation of the operative member..

The operative member 100 comprises a light source such as an LED at its distal tip, ie the end of the operative member 100 that enters the trachea of a patient first during use. The light source is used to illuminate an interior surface of the patient, from which the images transmitted to the display device are obtained. The operative member 100 comprises one or more light guides, eg optical fibres, that extend from the body portion 20 to the distal end of the operative member 100, through which the images are relayed to the display device.

The distal tip portion of the operative member 100 comprises an image sensor for converting the images into electronic format, which is disposed at the distal end of the operative member 100. The images may be in the form of single images or video. These images are relayed to, and displayed by, the display screen 50. The

images may be transmitted in electronic format to the display screen 50 by a wired connection though the operative member 100 and the body and arm portions 20,30 to the display screen 50.

The distal tip of the operative member 100 is formable, eg by bending. In particular, the distal tip of the operative member 100 is malleable, such that it may be bent relative to the main portion of the operative member 100 as described above.

The display portion 50, and the display screen therein, are substantially square shaped. The display portion 50 is tilted relative to the vertical axis of the body portion 20 such that the display screen tilts slightly upwards relative to the vertical axis of the body portion 20. This makes viewing of the display screen easier when the endoscope 10 is being used by an operator.

In use, the operative member 100 is inserted into an endotracheal tube to image the trachea. The endoscope 10 and the endotracheal tube are then introduced into the trachea, such that a distal end of the endotracheal tube is located within the trachea, and a proximal end of the endotracheal tube projects from the patient's mouth. As the operative member 100 transmits images to the display screen 50, a user can see when the endoscope 10 passes through the patient's trachea, and since the endotracheal tube is pre-loaded onto the endoscope 10, will thus know when the endotracheal tube passes through the patient's trachea. The location of the distal tip portion of the operative member 100 is controlled by the user using the actuator 60 and the rotatable head portion 40, such that the endoscope 10 and the endotracheal tube are guided appropriately, and the display screen 50 provides images of the body during insertion to facilitate this guiding of the endotracheal tube. Once the distal end of the endotracheal tube is appropriately positioned within the trachea, the operative member 100 is withdrawn, along with the laryngoscope.

Alternatively, where the endotracheal tube is not pre-loaded onto the endoscope 10, the endoscope 10 may be positioned just outside of the trachea so as to image the trachea as an endotracheal tube is inserted.

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Claims

1. An endoscope for use in intubation, the endoscope comprising:
a housing including a handle portion and a display screen portion, the display screen portion having a display screen, and
an operative member extending from the housing, the operative member being configured to be inserted into a patient's airway and to transmit images to the display device,
wherein the operative member extends from a first end of the housing and the display screen portion extends from the first end of the housing, such that the display screen is spatially separated from the handle portion and a user's wrist is positionable between the display screen and the end of the housing from which the operative member extends.

2. An endoscope according to Claim 1, the housing further comprising an arm portion that extends between the handle portion of the housing and the display screen portion of the housing.

3. An endoscope according to Claim 2, wherein the arm portion extends from the end of the handle portion from which the operative member extends.

4. An endoscope according to Claim 2 or Claim 3, wherein the arm portion is arranged to rest against the inside of an operator's wrist.

5. An endoscope according to any of Claims 2-4, wherein the arm portion extends substantially perpendicularly from the handle portion.

6. An endoscope according to any of Claims 2-5, wherein the handle portion of the housing and the arm portion of the housing form a substantially L-shaped endoscope body.

7. An endoscope according to any of Claims 2-6, wherein the display screen is positioned at the opposite end of the arm portion relative to the handle portion.

8. An endoscope according to any preceding claim, wherein the operative member extends from the housing substantially parallel to the longitudinal axis of the handle portion.

9. An endoscope according to any of Claims 2-8, wherein the operative member extends from the housing in a direction that is substantially perpendicular to the arm portion of the housing.

10. An endoscope according to any of Claims 2-9, wherein a central viewing axis of the display screen is obliquely angled relative to a longitudinal axis of the arm portion.

11. An endoscope according to Claim 10, wherein the central viewing axis of the display screen is obliquely angled upwardly towards the eyes of a user in use.

12. An endoscope according to any preceding claim, wherein a central viewing axis of the display screen is obliquely angled relative to a central longitudinal axis of the handle portion.

13. An endoscope according to Claim 12, wherein the top edge of the display screen is tilted towards the handle portion.

14. An endoscope according to Claim 12 or Claim 13, wherein the display screen portion of the housing is tilted upwards relative to the central longitudinal axis of the handle portion of the housing.

15. An endoscope according to any preceding claim, wherein the display screen portion of the housing is formed integrally with at least the handle portion of the housing.

16. An endoscope according to any preceding claim, wherein the housing of the endoscope comprises at least one housing component that defines a portion of the handle housing portion and the display screen housing portion.

17. An endoscope according to any preceding claim, wherein the endoscope comprises a single-use, disposable device, which is provided in a single sterile package.

18. A method of manufacturing an endoscope, the method comprising:

(i) providing a housing including a handle portion and a display screen portion, the display screen portion having a display screen;

(ii) providing an operative member extending from the housing, the operative member being configured to be inserted into a patient's airway and to transmit images to the display device,

(iii) arranging the housing such that the operative member and the display screen portion extend from a first end of the housing such that the display screen is spatially separated from the handle portion and a user's wrist is positionable between the display screen and the end of the housing from which the operative member extends.