A method for producing an endoscope that comprises an endoscope head and an optic tube, comprises the steps of providing the endoscope head, providing the optic tube, and pushing a proximal end area of the optic tube into a distal end area of the endoscope head. The distal end area of the endoscope head is press-fitted with the proximal end area of the optic tube.
METHOD FOR PRODUCING AN ENDOSCOPE, AND SUCH AN ENDOSCOPE

CROSS REFERENCE TO FOREIGN APPLICATION

[0001] The present application claims priority of German patent application No. 10 2006 030 521.3 filed on Jul. 1, 2006.

BACKGROUND OF THE INVENTION

[0002] The invention relates to a method for producing an endoscope, comprising an endoscope head and an optic tube.

[0003] Such a method, and an endoscope produced by this method, are generally known.

[0004] Endoscopes are mainly used in minimally invasive surgery in order to examine body cavities or hollow organs. For this purpose, an endoscope comprises an endoscope head, on whose distal end an elongate endoscope shaft is mounted that comprises an optic tube. Connector pieces, for an external lighting source and irrigation/suction lines, and an eyepiece can be provided on the endoscope head. By way of the connector piece for the lighting source, light is coupled into an optical waveguide system extending through the endoscope head and the endoscope shaft and is guided to the distal end of the endoscope shaft. The endoscope also comprises an optics system for imaging purposes. The imaging optics can be made from optical fibres, rod lenses or the like, but can also include an image sensor with electrical signal transmission.

[0005] Depending on the material of the endoscope shaft, endoscopes can be made rigid or flexible. A rigid endoscope has a shaft made from a non-flexible material, for example stainless steel or metal.

[0006] To examine a cavity of the body, a distal end area of the endoscope is introduced into the latter, while the endoscope head, and the part of the endoscope shaft not inserted into the body cavity, remain outside the body.

[0007] The production of an endoscope comprises, among other things, connecting a proximal end area of the shaft to a distal end area of the endoscope head.

[0008] Known methods involve preparing the endoscope head and the optic tube of the endoscope and pushing the two parts into one another in such a way that the optic tube is received with its proximal end area in the distal end area of the endoscope head. The contact surfaces of both end areas are connected to one another by soldering, welding or adhesive bonding.

[0009] A disadvantage of these known methods is that connecting the endoscope head and the optic tube is technically very complicated. In the endoscope production process, suitable machines have to be provided that permit welding, soldering or adhesive bonding of the contact surfaces of the endoscope head and of the optic tube. Moreover, these known methods of connecting the endoscope head to the optic tube require a great deal of time. In particular, when bonding the two endoscope parts to one another, care must be taken to ensure that the optic tube and the endoscope head are held in a fixed position until the adhesive has dried.

[0010] Another disadvantage of these methods is the difficulty in keeping the optic tube and the endoscope head exactly positioned relative to one another during the production process, such that the length of the endoscope is reproducible. If the resulting overall length of the produced endoscope deviates just slightly from the desired length, this difference in length has to be taken into account in the design of the optical waveguide system and the imaging optics.

[0011] In the known production methods by means of welding and soldering, a further disadvantage is that, during the production process, heat develops in the area of the connecting site between the two endoscope parts. The heating of the material of the optic tube can cause said material to become brittle, thus reducing the strength of the optic tube in the area where it is affected by heat, with the result that the optic tube may already break under the effect of slight flexural stresses.

[0012] A further disadvantage is that, in endoscopes that are produced by the known methods, the connection between the endoscope head and the optic tube is not stable. If, during an operation, the optic tube is subjected to a considerable leverage on account of a flexural stress, it is possible that the endoscope will break at the connecting site, i.e. the welding, soldering or adhesive bonding site, between the endoscope head and the optic tube.

SUMMARY OF THE INVENTION

[0013] It is therefore an object of the present invention to remedy this situation and to make available a method that is of the type mentioned at the outset and that permits a technically simple and stable connection between the endoscope head and the optic tube.

[0014] It is also an object of the present invention to make available an endoscope of the type mentioned at the outset, in which the endoscope head is of a simple construction and is connected in a stable manner to the optic tube.

[0015] According to an aspect of the invention, a method for producing an endoscope, comprising an endoscope head and an optic tube, is provided, the method comprising the steps of providing the endoscope head, providing the optic tube, pushing a proximal end area of the optic tube into a distal end area of the endoscope head, and press-fitting the distal end area of the endoscope head with the proximal end area of the optic tube.

[0016] According to another aspect of the invention, an endoscope is provided, comprising an endoscope head and an optic tube, wherein a proximal end area of the optic tube is press-fitted with a distal end area of the endoscope head.

[0017] The method according to the invention and the endoscope according to the invention permit a technically very simple connection between the endoscope head and the optic tube. Press-fitting the two endoscope parts together advantageously requires no further auxiliaries, for example soldering pin or adhesive. Moreover, the method according to the invention can be carried out in less time than soldering, welding or adhesive bonding of the endoscope head to the optic tube. Therefore, during production of the endoscope, it is possible to omit process steps such as cooling or drying of the connecting site between the endoscope head and the optic tube.
Also, by press-fitting the optic tube with the endoscope head, which pressing operation can be carried out cold and without heating, no material weakness is caused by the effect of heat, as does occur in the case of welding or soldering.

A further advantage of the method according to the invention compared to the known methods is the fact that the connection between the optic tube and the endoscope head is stable, and remains so over the course of time. Since the two endoscope parts are pressed together, the endoscope is not sensitive to external influences, such as water. Consequently, the optic tube does not come loose, not even after a large number of cleaning processes of the endoscope, with the result that expensive repair work is avoided.

The pressing together of the endoscope head and optic tube also permits a stable connection between both parts. In this way, the endoscope advantageously withstands even considerable flexural stresses of the optic tube that generate a considerable leverage on the optic tube.

In a preferred embodiment, the proximal end area of the optic tube is press-fitted by axial compressing.

This measure represents a constructionally simple pressing of the optic tube onto the endoscope head. Since the wall thickness of the optic tube is smaller than that of the endoscope head, the optic tube is more suitable for an axial compressing process than is the endoscope head for a crimping process.

In another preferred embodiment, the optic tube is held in an axially fixed position during the pressing operation, and an axial force in the direction of a distal end area of the optic tube is exerted on the proximal end area of the optic tube.

This measure has the advantage that the press-fitting of the optic tube with the endoscope head is achieved in a simple manner in that the inserted optic tube is held at the distal end of the endoscope head and an axial force, which acts in the direction of the distal end of the optic tube, is exerted on it at the same time. The proximal end area of the optic tube is thereby axially compressed and press-fitted with the endoscope head.

In another preferred embodiment, the axial force is provided by a pressing tool, in particular a mandrel.

This measure represents a technically simple possibility of generating the axial force acting on the optic tube. In contrast to the known methods, the outlay in terms of tools is much less.

In another preferred embodiment, the distal end area of the endoscope head is provided on its inside with a circumferential recess into which material of the optic tube flows with a form fit during the pressing operation.

This measure has the advantage that the optic tube is held in an axially particularly secured position in the endoscope head, because material of the optic tube engages in the recess of the endoscope head. Tensile forces and pressure forces on the optic tube in the axial direction do not lead to a change in position of the optic tube relative to the endoscope head.

In another preferred embodiment, the circumferential recess is provided as a groove extending about the full circumference.

This measure has the advantage that, because of this design of the recess, a particularly large amount of material can engage in the recess. The connection of the endoscope head to the optic tube is therefore particularly stable.

In another preferred embodiment, the distal end area of the endoscope head is provided with at least one circumferentially limited cavity into which material of the optic tube flows with a form fit during the pressing operation.

This measure has the advantage that the material pushed into the circumferentially limited cavity ensures that the optic tube cannot turn relative to the endoscope head about its longitudinal axis. In this way, the optic tube is secured against rotation in a simple manner.

In another preferred embodiment, a proximal end of the optic tube is additionally widened in a trumpet shape.

This measure has the advantage that the proximal end of the optic tube points outwards and away from the longitudinal axis of the optic tube. If, during subsequent assembly work, optical fibres are introduced through the optic tube and the endoscope head, these are advantageously prevented from damage, for example from kinking or breaking.

In another preferred embodiment, the distal end area of the endoscope head is adhesively bonded to the proximal end area of the optic tube after the pressing operation.

This measure has the advantage that the endoscope is sealed against external influences, for example water. However, in contrast to the known methods, the adhesive does not have to apply the adhesion force for the secure connection between optic tube and endoscope head, such that the adhesion site does not represent a predetermined break point.

Further advantages and features will become clear from the following description and from the attached drawing.

It will be appreciated that the aforementioned features and those still to be explained below can be used not only in the cited combinations, but also in other combinations or singly, without departing from the scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is described and explained in more detail below on the basis of a number of selected illustrative embodiments and with reference to the attached drawing, in which:

FIG. 1 shows a side view of an endoscope;

FIG. 2 shows an optic tube (in cutaway view) and an endoscope head in longitudinal section at the start of a method for producing the endoscope;

FIG. 3 shows the optic tube and the endoscope head from FIG. 2 in a further method step of the production method;

FIG. 4 shows the endoscope head and the optic tube from FIG. 3 with a pressing tool in a further method step of the production method;
FIG. 5 shows the endoscope head, the optic tube and the pressing tool from FIG. 4 in a further method step of the production method;

FIG. 6 shows the endoscope head, the optic tube and the pressing tool from FIG. 5 in a further method step of the production method;

FIG. 7 shows the endoscope head and the optic tube from FIG. 6 and a further pressing tool in a further method step of the production method;

FIG. 8 shows the endoscope head, the optic tube and the further pressing tool from FIG. 7 in a further method step of the production method; and

FIG. 9 shows the endoscope head in a cross section along the line I-I in FIG. 8.

DETAILED DESCRIPTION OF PREFERRED EXEMPLARY EMBODIMENTS

An endoscope designated by the general reference number 10 is shown in FIG. 1. The endoscope 10 comprises an endoscope head 12 and an endoscope shaft 14.

Such an endoscope 10 is used, for example, in minimally invasive surgery for examining body cavities or hollow organs. The distal end of the endoscope 10 is introduced into an opening in the body, such that at least the endoscope head 12 remains outside the body.

The endoscope shaft 14 comprises an elongate optic tube 16 whose proximal end area 18 is connected to a distal end area 20 of the endoscope head 12. The optic tube 16 is preferably designed as a cylinder-shaped hollow cylinder with a thin wall.

A connector piece 22, for an external lighting source, and an eyepiece 24 are arranged on the endoscope head 12. The endoscope 10 also accommodates an optical waveguide system that extends from the connector piece 22 to a distal end area 26 of the optic tube 16 and is made up of optical fibres. The optical waveguide system is used to illuminate an operating site within the opening in the body. The endoscope 10 also accommodates an imaging system that extends from the eyepiece 24 to the distal end area 26 of the optic tube 16. The imaging system can comprise optical fibres, rod lenses, or also an image sensor with electrical signal transmission.

The endoscope 10 is preferably rigid, the optic tube 16 being made from non-flexible materials, for example steel or metal.

In a method for producing the endoscope 10, the optic tube 16 and the endoscope head 12 are provided in a first method step (see FIG. 2). At its distal end area 20, the endoscope head 12 has a circumferential recess 28 on its inside, and at least one circumferentially limited cavity 30.

The recess 28 is preferably designed as a groove 32 that extends about the full circumference in the distal end area 20 of the endoscope head 12. The cavity 30 can either be arranged directly on a part of the recess 28 or can be arranged spatially separate from the latter in the distal end area 20 of the endoscope head 12. Moreover, the cavity 30 can be set deeper in relation to the recess 28, as seen in the radial direction of the distal end area 20 of the endoscope head 12.

An external diameter 34 of the optic tube 16 is dimensioned such that it is slightly smaller than an internal diameter 36 of the distal end area 20 of the endoscope head 12.

In a further method step, as is shown in FIG. 3, the proximal end area 18 of the optic tube 16 is pushed in a direction of an arrow 38 into the distal end area 20 of the endoscope head 12. In doing so, an outer surface 40 of the optic tube 16 touches an inner surface 42 of the endoscope head 12, or the outer surface 40 of the optic tube 16 is spaced slightly apart from the inner surface 42 of the distal end area 20 of the endoscope head 12. Moreover, the proximal end area 18 of the optic tube 16 is pushed so far into the distal end area 20 of the endoscope head 12 that at least a proximal end 44 of the optic tube 16 extends past the recess 28 and the cavity 30.

FIGS. 4-8 show the distal end area 20 of the endoscope head 12 and the proximal end area 18 of the optic tube 16 being pressed together.

The optic tube 16, whose proximal end area 18 is pushed into the distal end area 20 of the endoscope head 12, is held in an axially fixed position in respect of tensile forces and pressure forces acting in the axial direction of the optic tube 16 (see FIG. 4). For this purpose, the optic tube 16 is clamped in a holding device 46. Such a holding device 46 can, for example, have two jaws 48, 50, which engage on the outer surface 40 of the inserted optic tube 16 distally of the distal end area 20 of the endoscope head 12. The two jaws 48, 50 either touch the distal end area 20 of the endoscope head 12 or are spaced slightly apart from it. The jaws 48, 50 of the holding device 46 are shown in FIG. 4, whereas, for reasons of clarity, they are not shown in FIGS. 5-8.

An axial force is exerted on the proximal end area 18 of the optic tube 16 in the direction of an arrow 52. The axial force is generated by means of a pressing tool 54, which is guided from the proximal direction through the endoscope head 12 into the optic tube 16.

The pressing tool 54 can preferably be designed as a cylindrical mandrel 56. The pressing tool 54 narrows in a step shape at a distal end 58, such that an external diameter 60 of the distal end 58 of the pressing tool 54 is slightly smaller than an internal diameter 62 of the optic tube 16.

Moreover, in the area of the step-shaped narrowing, the pressing tool 54 has a plane surface 64 that preferably extends about its full circumference and that is transverse to a longitudinal axis 66 of the pressing tool 54, and on which the proximal end 44 of the optic tube 16 comes to lie on the full circumference. The distal end 58 of the pressing tool 54 is preferably of such a length that the pressing tool 54 extends past the recess 28 and the bulge 30 when in a fully inserted state, i.e. when the plane surface 64 touches the proximal end 44 of the optic tube 16.

As is shown in FIG. 5, the proximal end area 18 of the optic tube 16 is axially compressed by the axial force in such a way that axially compressed material is forced radially outwards. This is especially the case when the distal end 58 of the pressing tool 54 extends past the recess 28 and the cavity 30 and thus prevents a radially inwardly directed movement of the buckled material. Material of the proximal end area 18 of the optic tube 16 thus engages with a form fit in the recess 28 while the optic tube 16 is press-fitted with
the endoscope head 12. The engagement of the material of the optic tube 16 into the recess 28 permits a secure axial positioning of the optic tube 16 relative to the endoscope head 12.

[0063] The pressing action also causes material of the optic tube 16 to engage in the cavity 30 (see FIG. 6). This ensures that the optic tube 16 is not able to turn relative to the endoscope head 12 about its longitudinal axis.

[0064] As is shown in FIG. 7, the proximal end 44 of the optic tube 16 is also widened in a trumpet shape, such that the external diameter 34 of the optic tube 16 increases at this location. The proximal end 44 of the optic tube 16 points outwards and away from a longitudinal axis of the optic tube 16. For this purpose, the pressing tool 54 is removed from the optic tube 16 and from the endoscope head 12. A further pressing tool 68 is pushed, in the direction of the arrow 52, through the endoscope head 12 and into the pressed-on optic tube 16, and it exerts an axial force on the proximal end area 18 of the optic tube 16.

[0065] The further pressing tool 68 likewise narrows at the distal end, although the narrowing is not in the form of a step shape but instead extends over a concavely curved partial area of a distal end 70. The smallest external diameter 72 of the distal end 70 of the further pressing tool 68 is also slightly smaller than the internal diameter 62 of the optic tube 16. The narrowing distal end 70 of the further pressing tool 68 spreads the proximal end 44 of the optic tube 16 outwards in such a way that a shape of the proximal end 44 of the optic tube 16 adapts to a shape of the distal end 70 of the further pressing tool 68. The pressing tool 54 and the pressing tool 68 can also be designed as one pressing tool, with which it is possible both to axially compress the proximal end area 18 of the optic tube 16 and also to widen the proximal end 44 of the optic tube 16.

[0066] During subsequent insertion of optical fibres into the endoscope 10, the widened proximal end 44 of the optic tube 16 avoids damage to said optical fibres.

[0067] Thereafter, the further pressing tool 68 is removed from the endoscope head 12 in the direction of an arrow 74 (see FIG. 8).

[0068] After the pressing operation, the proximal end area 18 of the optic tube 16 is also adhesively bonded to the distal end area 20 of the endoscope head 12. For this purpose, an adhesive is applied to the outer surface 40 of the optic tube 16 and/or to the inner surface 42 of the distal end area 20 of the endoscope head 12. The adhesive bonding of the optic tube 16 to the endoscope head 12 serves to seal off the connecting site of the two endoscope parts from external influences, such as water.

[0069] FIG. 9 shows a cross-sectional view of the distal end area 20 of the endoscope head 12 along the line L-L in FIG. 8. The proximal end area 18 of the optic tube 16 is press-fitted with the distal end area 20 of the endoscope head 12. Material of the optic tube 16 engages with a form fit in the recess 28, formed as a groove 32 extending about the full circumference, and into the cavity 30.

What is claimed is:
1. A method for producing an endoscope, said endoscope comprising an endoscope head and an optic tube, said method comprising the steps of:
   - providing said endoscope head,
   - providing said optic tube,
   - pushing a proximal end area of said optic tube into a distal end area of said endoscope head,
   - press-fitting said distal end area of said endoscope head with said proximal end area of said optic tube.
2. The method of claim 1, wherein said proximal end area of said optic tube is press-fitted by axial compressing.
3. The method of claim 1, wherein said optic tube is held in an axially fixed position during said press-fitting, and an axial force in direction to a distal end area of said optic tube is exerted on said proximal end area of said optic tube.
4. The method of claim 3, wherein said axial force is provided by a pressing tool.
5. The method of claim 1, wherein said distal end area of said endoscope head is provided on an inside of said endoscope head with a circumferential recess into which material of said optic tube flows with a form fit during said press-fitting.
6. The method of claim 5, wherein said circumferential recess is provided as a groove extending about a full circumference of said endoscope head.
7. The method of anyone of claim 1, wherein said distal end area of said endoscope head is provided with at least one circumferentially limited cavity into which material of said optic tube flows with a form fit during said press-fitting.
8. The method claim 1, wherein a proximal end of said optic tube is additionally widened in a trumpet shape.
9. The method of claim 1, wherein said distal end area of said endoscope head is adhesively bonded to said proximal end area of said optic tube after said press-fitting.
10. An endoscope, comprising an endoscope head and an optic tube, wherein a proximal end area of said optic tube is press-fitted with a distal end area of said endoscope head.
11. The endoscope of claim 10, wherein said distal end area of said endoscope head has, on an inner side of said endoscope head, a circumferential recess into which material of said optic tube engages with a form fit.
12. The endoscope of claim 11, wherein said circumferential recess is designed as a groove extending about a full circumference of said endoscope head.
13. The endoscope of claim 10, wherein said distal end area of said endoscope head has, on an inner side of said endoscope head, at least one circumferentially limited cavity into which material of said optic tube engages with a form fit.
14. The endoscope of claim 10, wherein a proximal end area of said optic tube is widened in a trumpet shape.

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