United States Patent

[11] 3,557,780

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a corporation of Japan

[32] Priority **Apr. 20, 1967, Feb. 26, 1968, Mar. 11, 1968**
[33] **Japan**
[31] **42/24827/1967, 43/11793/1968 and 43/18522/1968**

[54] **MECHANISM FOR CONTROLLING FLEXURE OF ENDOSCOPE**
10 Claims, 39 Drawing Figs.

[52] **U.S. Cl.** **128/4,** 356/241
[51] **Int. Cl.** **A61b 1/00**
[50] **Field of Search** ..... 128/4, 6, 5, 7, 8, 9; 138/120; 356/241, 259(Inquired), 256(Inquired); 95/11, 281(Inquired)

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Primary Examiner—Adele M. Eager
Assistant Examiner—G. F. Dunne
Attorney—Kurt Kelman

ABSTRACT: Mechanism for controlling flexture of an endoscope which comprises at least two flexible portions each including a plurality of tubular short articulated segments having their faces tapered to form diametrically extending pivot ridges and flexibly connected to and in alignment with each other by means of wires extending through said ridges with the ridge of one segment bearing against the opposite ridge of the next segment, at least two sets of tension wires extending through said segments to a control portion of the endoscope through a connecting portion connecting said controllable flexible portion to said control portion so as to be connected to an operating mechanism therein, the forward ends of each of said sets of tension wires being secured to the forward ends of the respective flexible portions thereby permitting each of the flexible portions to be bent by activating the set of tension wires secured thereto by means of said operating mechanism separately from other flexible portion(s).

Brake means are provided to releasably maintain the flexible portions in their controlled position.

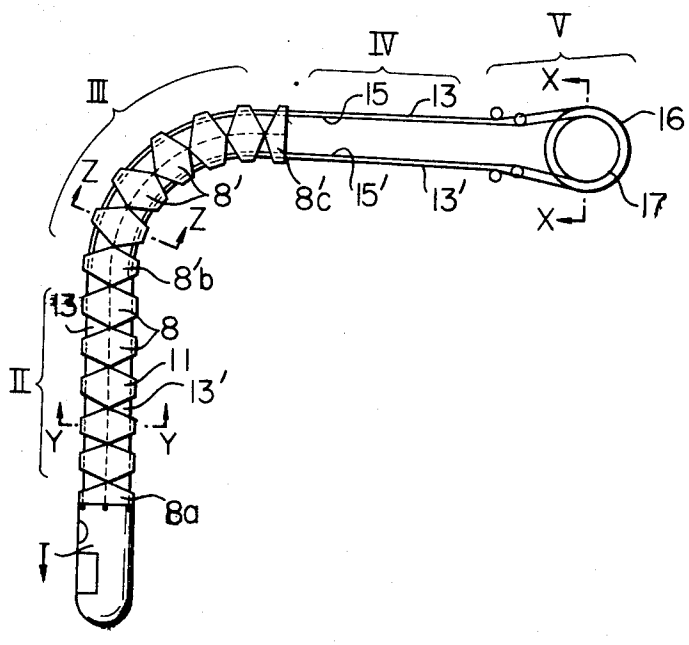

Fig. 1

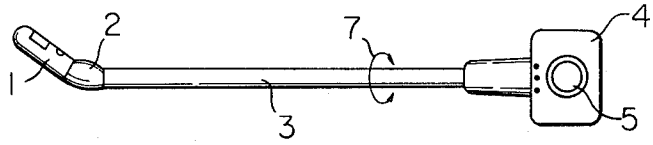

Fig. 2

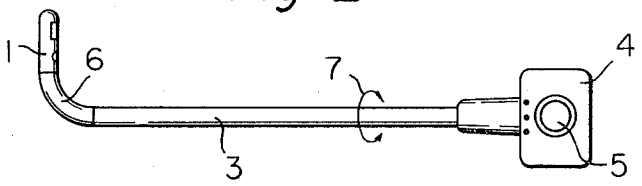

Fig. 3

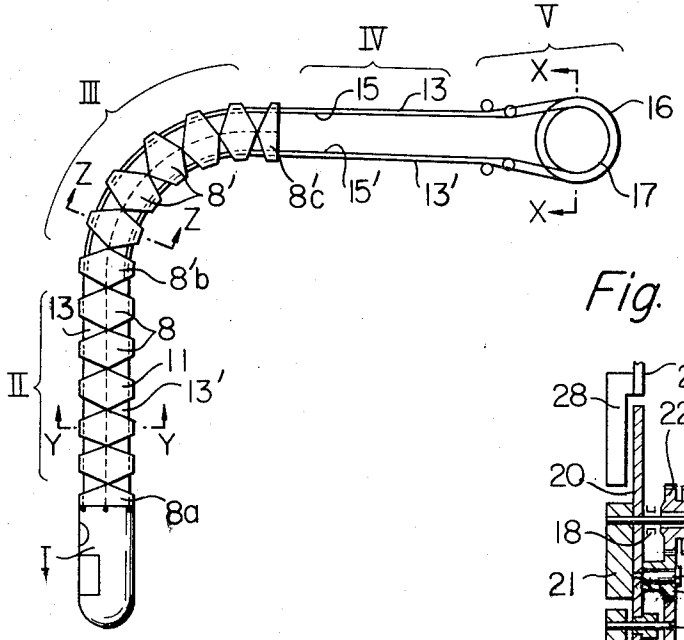

Fig. 4

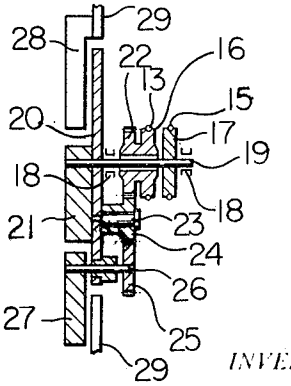

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Fig. 5A

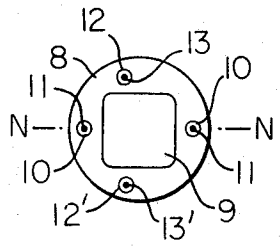

Fig. 5B

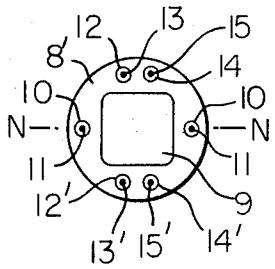

Fig. 6

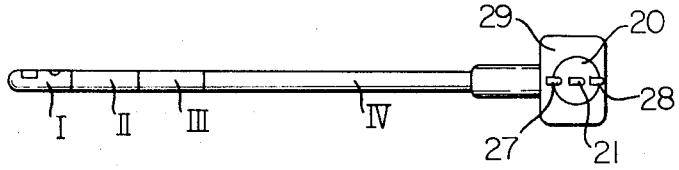

Fig. 7

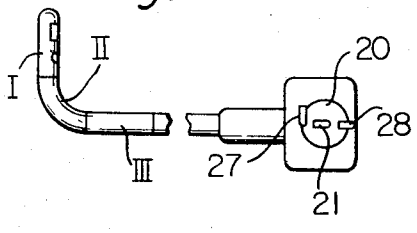

Fig. 8

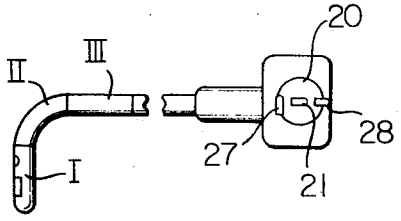

Fig. 9

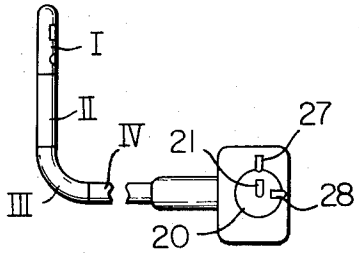

Fig. 10

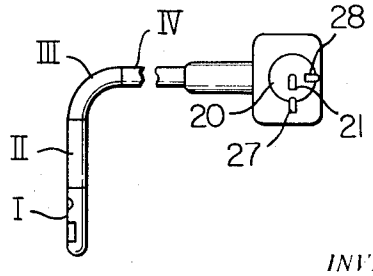

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Fig. 11

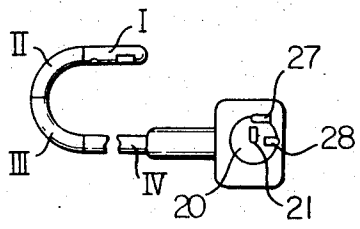


Fig. 12

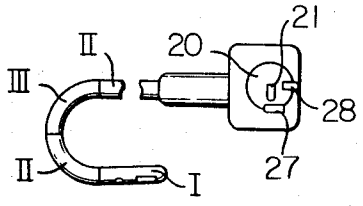


Fig. 13

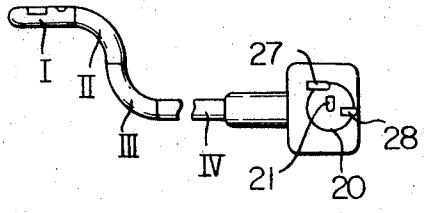
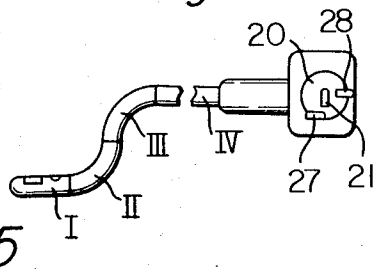


Fig. 14



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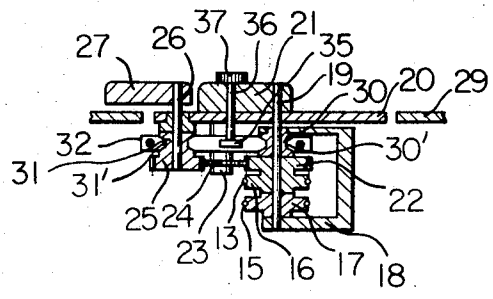

Fig. 16

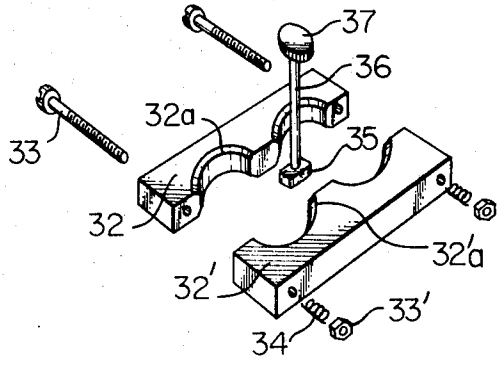

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Fig. 17A

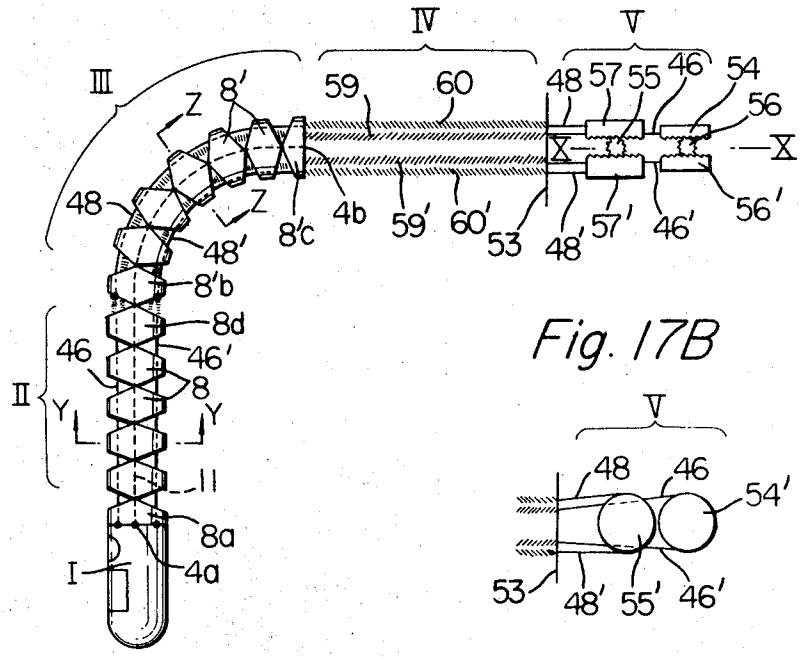
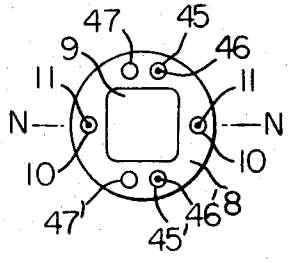


Fig. 17B

Fig. 18



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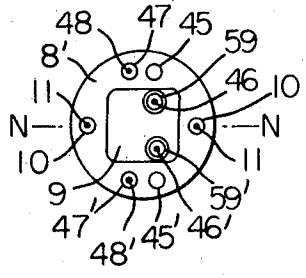

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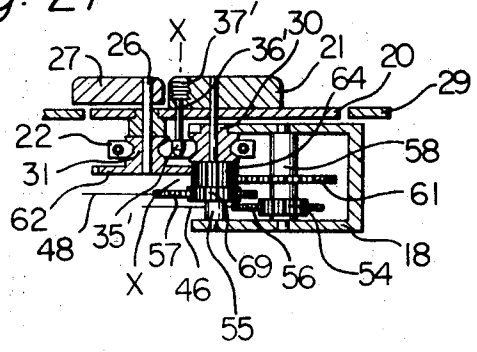

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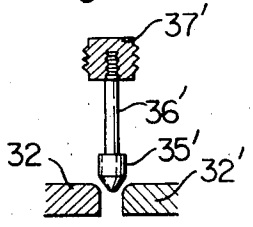

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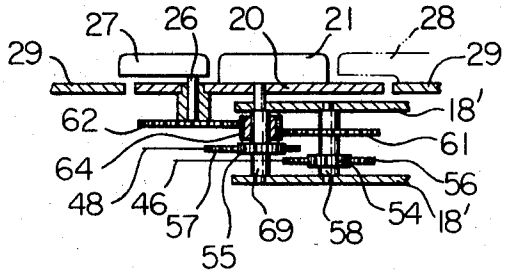
Fig. 20



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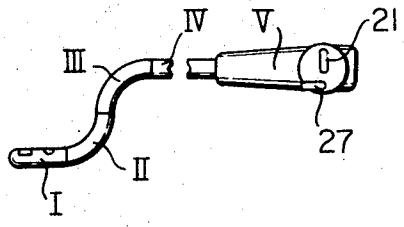

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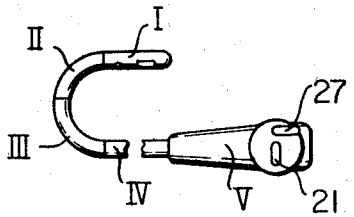

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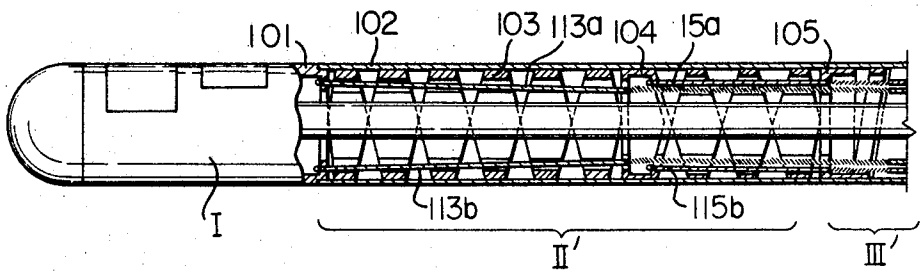
Fig. 25



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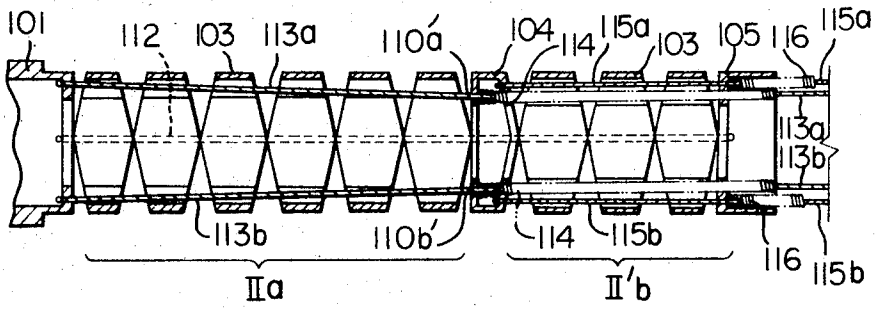

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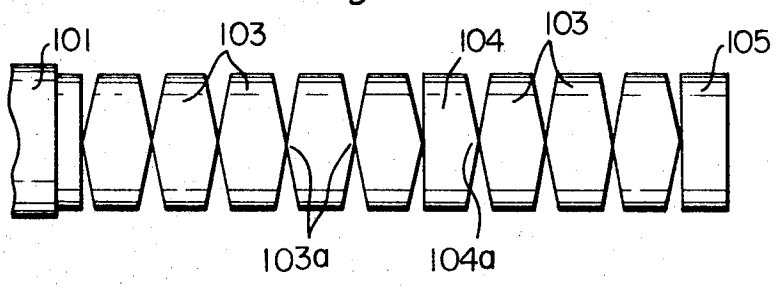

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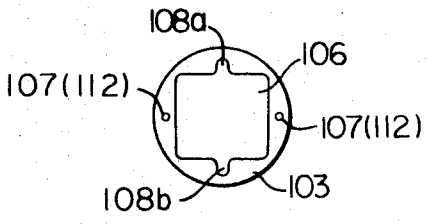

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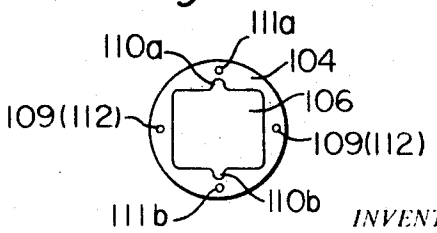

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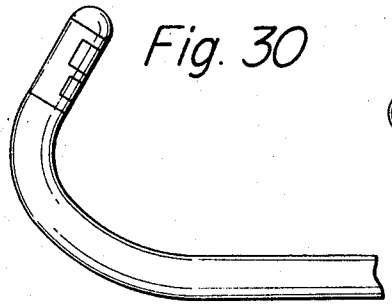

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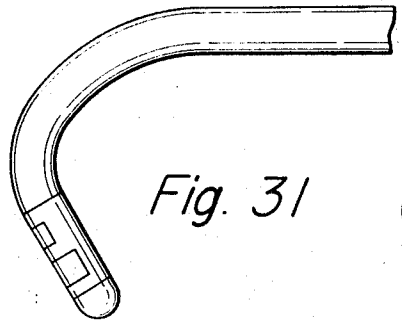

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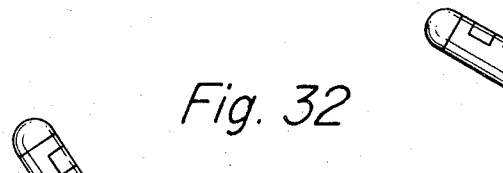

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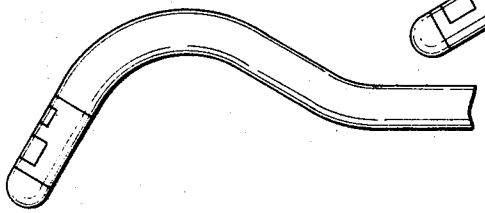

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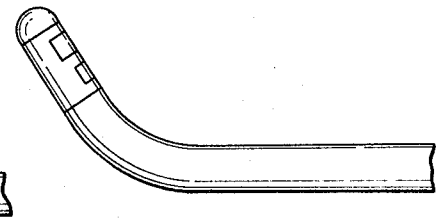

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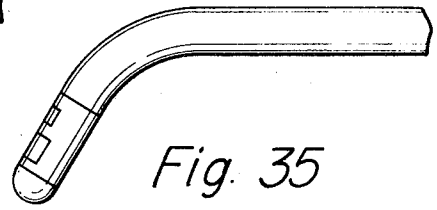
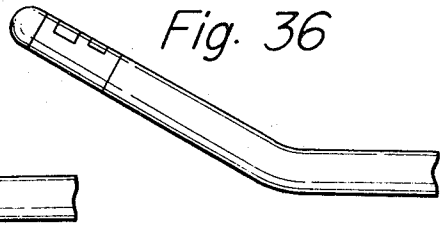


Fig. 35



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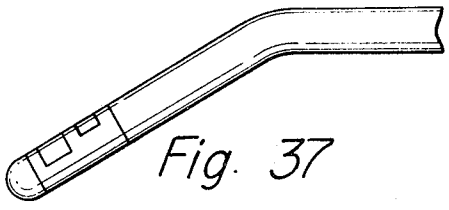

Fig. 37

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MECHANISM FOR CONTROLLING FLEXURE OF ENDOSCOPE

BACKGROUND OF THE INVENTION

The present invention relates to a control mechanism for bending the controllable flexible portion of an endoscope in desired configuration.

The prior art control mechanism for bending the controllable flexible portion of the endoscope is inconvenient in that the bent state of the controllable flexible portion of the endoscope cannot be exactly detected from the exterior when the endoscope is inserted into the hollow portion of a living body to be inspected.

The present invention avoids the above described disadvantages.

SUMMARY OF THE INVENTION

The present invention provides a novel and useful control mechanism for bending the controllable flexible portion of an endoscope in which at least two groups are provided in said flexible portion, each of which groups can be bent separately from the other group(s) in desired direction by selectively pulling wire means connected to the group in question by operating control lever means in the control portion of the endoscope to which said wire means endoscope connecting said flexible portion to the control portion.

The positions of the lever means are adapted to correspond to the bent state of the controllable flexible portion thereby permitting the bent state of the flexible portion to be exactly and conveniently detected from the exterior by the controlled position of the lever means when the endoscope is used for inspection.

Brake means are provided in the control mechanism to positively maintain the bent state of the flexible portion given by the operation of the control mechanism thereby preventing the bent state of the flexible portion from being unexpectedly changed by the external force.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1 and 2 are schematic general views of two kinds of endoscopes showing the manners how the flexible portions are bent, respectively;

FIG. 3 is a schematic view showing the principle of the control mechanism for bending the flexible portion of one embodiment of the endoscope constructed in accordance with the present invention;

FIG. 4 is a fragmentary cross-sectional view taken along line X–X in FIG. 3;

FIG. 5A is a cross-sectional view taken along line Y–Y in FIG. 3;

FIG. 5B is a cross-sectional view taken along line Z–Z in FIG. 3;

FIGS. 6 to 14 are general views of the endoscope provided with the control mechanism shown in FIGS. 3 and 4, respectively, showing the manner how the flexible portion of the endoscope is bent in accordance with the operation of the control knobs in the control mechanism;

FIG. 15 is a fragmentary cross-sectional view similar to FIG. 4 but showing the portion of the control mechanism provided with brake means constructed in accordance with the present invention;

FIG. 16 is an exploded perspective view showing the main parts of an embodiment of the brake means shown in FIG. 15;

FIG. 17A is a schematic general view similar to FIG. 3 but showing the principle of the control mechanism for bending the flexible portion of the second embodiment of the endoscope constructed in accordance with the present invention;

FIG. 17B is a fragmentary view showing the modification of the actuating means using drum means in place of pinion-rack means employed in the actuating means shown in FIG. 17A;

FIG. 18 is a cross-sectional view taken along line Y–Y in FIG. 17A;

FIG. 19 is a cross-sectional view taken along line Z–Z in FIG. 17A;

FIG. 20 is a fragmentary cross-sectional view taken along line X–X in FIG. 17A showing the control mechanism;

FIG. 21 is a view similar to FIG. 20 but showing a modification of the control mechanism provided with brake means;

FIG. 22 is a fragmentary view showing the main parts of brake means in the control mechanism of FIG. 21;

FIGS. 23 and 24 are general views of the endoscope provided with the control mechanism as shown in FIG. 20 or 22, respectively, showing the manners how the flexible portion of the endoscope is bent in accordance with the operation of the control knobs in the control mechanism;

FIG. 25 is a fragmentary view partly in cross section of another embodiment of the endoscope constructed in accordance with the present invention;

FIG. 26 is a fragmentary cross-sectional view showing the flexible portion shown in FIG. 25;

FIG. 27 is a side view of the portion shown in FIG. 26;

FIG. 28 is a front view of the tubular segment constituting the flexible portion shown in FIG. 27;

FIG. 29 is a front view of the intermediate ring employed in the endoscope shown in FIG. 25; and

FIGS. 30 to 37 are fragmentary views of the flexible portion of the endoscope shown in FIG. 25, respectively, showing the manners how the flexible portion of the endoscope is bent in accordance with the operation of the control mechanism of the endoscope shown in FIG. 25.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Prior to the description of the present invention, operation of the prior art endoscopes will be described briefly for the better understanding of the present invention.

FIG. 1 shows one type of the prior art endoscope in which camera portion 1 is connected to one end of flexible portion 3 by articulated portion 2. The other end of flexible portion 3 is connected to control housing 4 provided with control knob 5 which actuates said articulated portion 2 through wires extending through flexible portion 3 so that camera portion 1 is bent at an angle with respect to the axis of the end of flexible portion 3 to which camera portion 1 is connected through articulated portion 2.

In order to facilitate the inspection by using the endoscope, flexible portion 3 can be rotated about its axis together with control housing 4 relative to grip means rotatably mounted on control housing 4. The grip means is provided with angular graduation cooperating with the index provided on control housing 4 so that the degree of rotation of flexible portion 3 and hence the direction of camera portion 1 can be detected by means of the graduation and the index.

FIG. 2 shows another type of the prior art endoscope, in which controllable flexible portion 6 is employed in place of articulated portion shown in FIG. 1.

In the prior art endoscopes as shown in FIGS. 1 and 2, it is difficult to exactly detect the direction of the camera portion and the degree of the bending thereof during the inspection using the endoscope, because the inspection is usually carried out in the dim place.

Now various embodiments of the present invention will be described in detail with reference to FIGS. 3—37.

Referring to FIG. 3 showing the principle of the control mechanism for bending the controllable flexible portion of the endoscope constructed in accordance with the present invention, camera portion I is connected to one end of first controllable flexible portion II, and the other end of said first controllable flexible portion II is connected to one end of second controllable flexible portion III, the other end of said second controllable flexible portion III being in turn connected to one end of flexible elongated connecting portion IV yieldingly bendable in accordance with the configuration of the path leading to the hollow space in the living body to be inspected.

The other end of said flexible elongated connecting portion IV is connected to control portion V, in which the control mechanism for actuating said first and second flexible portions II, III is provided.

As shown in FIGS. 3 and 5A, said first flexible portion II comprises a plurality of relatively short articulated tubular segments 8 all of which are of identical construction. As shown in FIG. 3, both faces of each of segments 8 are tapered to form diametrically extending pivot ridges N–N, respectively. As shown in FIGS. 3 and 5B, said second flexible portion III comprises a plurality of relatively short articulated tubular segments 8' substantially similar to segments 8. All of said segments 8' are of identical construction. Hollow space 9 is provided in each of said segments 8, 8', through which the film loaded in camera portion I and lead wires for energizing the lamp in camera portion I or a light conducting fiber optical system and other elements extend. As shown in FIGS. 5A and 5B, small holes 10, are provided at positions in diametrically extending pivot ridges N–N of each of segments 8, 8'. Wire 11 extends through each of said holes 10, one end of said wire 11 being fixed to forward end segment 8*a* one face of which is tapered to form a diametrically extending pivot ridge similar to that of segment 8, said segment 8*a* being connected to camera portion I, while the other end of said wire 11 is fixed to rear end segment 8'*c* which is similar to segment 8*a* and connected to the forward end of flexible connecting portion IV, so that segments 8, 8' are urged toward each other and aligned with each other by wires 11 with said ridge of one segment bearing against the opposite ridge of the next segment thereby permitting each of segments 8, 8' to be relatively pivoted to the next segment about diametrically extending pivot ridge N–N. Small holes 12, 12' are provided in each of segments 8 adjacent to the center line normal to ridge N–N as shown in FIG. 5A, and small holes 12, 12', 14, 14' are provided in each of segments 8' adjacent to the center line normal to ridge N–N as shown in FIG. 5B, the positions of holes 12, 12' in each of segments 8' corresponding to those of holes 12, 12' in each of segments 8, respectively. Wires 13, 13' extend through holes 12 and 12' in each of segments 8, 8', respectively, one end of each of wires 13, 13' being fixed to segment 8*a*, while the other end of each of wires 13, 13' extends through flexible connecting portion IV and is connected to the periphery of control drum 16 provided in control portion V, which is operated by a control lever described hereinafter. Wires 15 and 15' extend through holes 14, 14' in each of segments 8, respectively, one end of each of wires 15, 15' being fixed to forward end segment 8'*b* similar in construction to segment 8' and located at the forward end of second flexible portion III and connected to the rear end of first flexible portion II, while the other end of each of wires 15, 15' extends through flexible connecting portion IV and connected to the periphery of another control drum 17 which is provided in control portion V coaxially with previously described control drum 16 and operated by another control lever as described hereinafter.

As shown in FIG. 4, drum 17 is fixedly secured to shaft 19 journaled in bearings 18 provided in the housing of control portion V, disc 20 and second control lever 21 being fixedly secured to said shaft 19. Drum 16 is rotatably supported by shaft 19 and gear 22 is integrally fixed to drum 16. Said gear 22 meshes with intermediate gear 24 rotatably fitted on shaft 23 which is fixed to disc 20. Said intermediate gear 24 also meshes with gear 25 fixedly secured to shaft 26 which is rotatably journaled in a bearing secured to disc 20. First control lever 27 is fixedly secured to the outer end of shaft 26. A stationary lever 28 is secured to cover 29 of control portion V as shown in FIG. 4, said stationary lever 28 serving to indicate the relative positions of said control levers 21, 27 with respect to control portion V.

The positions of levers 21 and 27 are so determined that they are aligned with stationary lever 28 when camera portion I, first flexible portion II and second flexible portion III are aligned as shown in FIG. 6.

The operation of the endoscope as described above is as follows. Starting from the condition of the endoscope shown in FIG. 6, when both levers 21, 27 are simultaneously rotated in the anticlockwise direction as shown in FIG. 10, drum 17 is rotated by the actuation of second lever 21 so as to pull wire 15' and loosen wire 15 thereby causing second flexible portion III to be bent as shown in FIG. 3. In this case, drum 16 also rotates together with drum 17 by virtue of the engagement of gear 22 with gear 25 through intermediate gear 24, gear 25 being kept stationary relative to lever 21, so that wire 13' is pulled to the same extent as wire 15' while wire 13 is loosened, however, the positions of wires 13, 13' relative to segment 8'*b* do not change, because the bending of second flexible portion III absorbs the movement of wires 13, 13' within the range of second flexible portion III. Therefore, first flexible portion II is not bent. As shown in FIG. 10, the relative positions of control levers 21, 27 with respect to stationary lever 28 exactly corresponds to the bent state of first and second flexible portions II, III. When first control lever 27 is further rotated anticlockwise from the condition shown in FIG. 10 to the condition shown in FIG. 12, only drum 16 is further rotated by the engagement of gear 22 with gear 25 through gear 24, so that wire 13' is further pulled and wire 13 is loosened thereby causing first flexible portion II to be bent toward the right in FIG. 3 to assume the condition shown in FIG. 12. In this case, relative positions of levers 21, 27 with respect to stationary lever 28 also correspond to the bent state of first and second flexible portions II, III.

In the similar way, first and second flexible portions II, III can be selectively bent as desired as shown in FIG. 7 to 9, 11, 13 and 14 by appropriately operating either or both levers 21, 27, the relative positions of levers 21, 27, 28 indicating the bent state of the flexible portions, respectively.

In order to prevent the control of flexible portions II, III from being disturbed by the external force applied inadvertently by the path leading to the hollow space in the living body through which the endoscope is inserted, it is preferable to provide friction means or click stop means between disc 20 and lever 27, alternatively, worm gear means may be employed between levers 21, 27 and drums 17, 16, respectively.

It is also evident that the present invention described above can be incorporated in the flexible portion using articulated portions as shown in FIG. 1 which can bend the flexible portions at a plurality of points.

It is also evident that drums 16, 17 can be replaced by pinion-rack means which can pull or loosen wires in the similar way as described hereinbelow.

FIG. 15 shows a modification of the control mechanism shown in FIGS. 3 and 4. The mechanism shown in FIG. 15 is provided with brake means in order to positively maintain the controllable flexible portions in their controlled states. The mechanism shown in FIG. 15 is similar to that shown in FIG. 4 except that brakedrum 30 having annular V-shaped groove 30' in its periphery and secured to bearing plate 18 is adapted to rotatably support shaft 19 and that brake drum 31 having annular V-shaped groove 31' in its periphery is integrally secured to gear 25, said brakedrums 30 and 31 being adapted to be releasably clamped between a pair of brakeshoes 32, 32' each having mating surfaces 32*a*, 32'*a* engageable with V-shaped grooves 30' 31' of said brakedrums 30 and 31. Said pair of brake drums 30, 31 are relatively movably assembled by a pair of bolts and nuts 33, 33' as shown in FIG. 16. Springs 34 are provided on bolts 33 between nuts 33' and brake shoe 32' so as to normally urge the pair of brake shoes 32, 32' toward each other so that brakedrums 30, 31 are tightly clamped therebetween when braking action is desired to be applied to the shoes. Shaft 36 extends rotatably through control lever 21 and disc 20, the outer end of said shaft 36 being provided with knob 37 while brake releasing piece 35 is secured to the inner end of shaft 36. Piece 35 has an elongated configuration in cross section in the plane normal to the axis of shaft 36 so that when shaft 36 is rotated by knob 37, brakeshoes 32, 32' are moved between a position in which

shoes 32, 32' are urged toward each other by the action of spring 34 so that the braking action is applied to brakedrums 30, 31 and a position in which brakedrums 30, 31 are released from brakeshoes 32, 32'.

In operation, when first control lever 27 is rotated, gear 22 and hence drum 16 are rotated through gear 25 fixed to lever 27 and intermediate gear 24 so that first flexible portion II is bent. Drum 16 is positively held in its controlled position by virtue of the braking action applied to brakedrum 31 fixed to gear 25, thereby permitting first flexible portion II to be maintained in its controlled state. When second control lever 21 is rotated, gear 25 rotates about the axis of shaft 19 together with the pair of brakeshoes 32, 32' while gear 25 is prevented from rotating about its axis relative to disc 20 by virtue of braking action of shoes 32, 32'. Lever 21 is held in its controlled position by virtue of the braking action acting between brakedrum 30 fixed to bearing plate 18 and brakeshoes 32, 32' rotatable about the axis of shaft 19 together with second control lever 21. Therefore, the mechanism shown in FIG. 15 permits the controllable flexible portions of the endoscope to be positively held in their controlled state. When it is desired to release the brake means, it is only necessary that to rotate knob 37 so as to move brakeshoes 32, 32' away from brakedrums 30, 31.

FIGS. 17A to 20 show the second embodiment of the endoscope constructed in accordance with the present invention. The endoscope shown in FIG. 17A is similar to that shown in FIG. 3 except that pinion 55 and a pair of racks 57, 57' meshing with pinion 55 for actuating wires 48, 48' and pinion 54 and a pair of racks 56, 56' meshing with pinion 54 for actuating wires 46, 46' are provided in place of drums 16, 17 of FIG. 3, and that closely wound helical springs 60, 60' extend from abutment portion 53 of control portion V to rear end segment 8*d* of first flexible portion II through which wires 48 and 48' extend as shown in FIGS. 17A, 18 and 19, respectively, and closely wound helical springs 59, 59' extend between said abutment portion 53 and rear end segment 8'*c* of second flexible portion III through which wires 46, 46' extend as shown in FIGS. 17A and 19, respectively.

Springs 60, 60' extend through flexible connecting portion IV with sufficient surplus length so as to permit bending of portion IV without requiring any relative movement between springs 60, 60' and wires 48, 48' passing therethrough. Also, springs 59, 59' extend through flexible connecting portion IV and second controllable flexible portion III with sufficient surplus length so as to permit bending of portions III, IV without requiring any relative movement between springs 59, 59 and wires 46, 46' passing therethrough. It is evident that springs 60, 60'; 59, 59' must be of noncompressive nature so as to transmit the relative movement of the wires to the springs given at the ends adjacent to abutment portion 53 to the opposite ends thereof. In the region of connecting portion IV, it is preferred to employ metallic pipes in place of closely wound helical springs. The forward end of each of wires 48, 48', 46, 46' is fixed to respective segments 8'*b*, 8*a* in the same way as shown in FIG. 3.

It must be noted that, in the construction shown in FIG. 3, when second flexible portion III is to be bent, wires 13, 15 (or 13', 15') must be simultaneously pulled while only wire 13 (or 13') must be pulled in order to bend first flexible portion II, whereas, in the construction shown in FIG. 17A, since closely wound helical springs are provided, it is only necessary to pull only wire 48 (or 48') in order to bend second flexible portion III while first flexible portion II can be bent by pulling only wire 46 (or 46').

In operation, pinion 55 or 54 is selectively rotated so as to bend either of first or second flexible portion II or III, while both pinions 55 and 54 are rotated in desired directions so as to bend both first and second flexible portions II, III as shown in FIGS. 23 and 24.

FIG. 17B shows a modification of the control mechanism shown in FIG. 17A. The control mechanism shown in FIG. 17B comprises drum 55' and 54' for actuating wires 48, 48', 46, 46', respectively, in place of pinion-rack means 55, 57, 57', 54, 56, 56' shown in FIG. 17A. The operation of the control mechanism of FIG. 17B is similar to that shown in FIG. 17A.

FIG. 20 shows the detail of the control mechanism to be used in the endoscope shown in FIG. 17A. The control mechanism shown in FIG. 20 is similar to that shown in FIG. 4 except that drums 16, 17 for pulling wires shown in FIG. 4 are replaced with pinions 55, 54 and pairs of racks 57, 57', 56, 56' meshing with pinions 55, 54, respectively, as shown in FIG. 20, pinion 54 being fixedly mounted on separate shaft 58 rotatably mounted in bearing plate 18 to which shaft 58 gear 61 is secured. Gear 61 meshes with intermediate gear 64 rotatably fitted on shaft 69 to which second lever 21, disc 20 and pinion 55 are secured. Intermediate gear 64 meshes with gear 62 fixed to shaft 26 to which first lever 27 is fixed. When first lever 27 is rotated, gear 62, intermediate gear 64 and gear 61 are rotated so that pinion 54 actuates racks 56, 56' thereby pulling wire 46 or 46' so as to bend first flexible portion II in desired direction. When second lever 21 is rotated, pinion 55 actuates racks 57, 57' thereby pulling wire 48 or 48' so as to bend second flexible portion III in desired direction. In this case the rotation of lever 21 causes gear 62 to be rotated about the axis of intermediate gear 64 thereby rotating intermediate gear 64 together with shaft 69. However, since the ratio of gear 61 to intermediate gear 64 is made sufficiently small in the present invention, the bending of first flexible portion II resulting from the rotation of gear 62 about intermediate gear 64 when only second flexible portion III is to be bent can be neglected.

FIGS. 21 and 22 show a modification of the control mechanism shown in FIG. 20.

The control mechanism shown in FIG. 21 is similar to that shown in FIG. 20 except that brake means similar to those shown in FIG. 15 are added. In the brake means shown in FIGS. 21 and 22, axially shiftable shaft 36' having knob 37' at its outer end and tapered end portion 35' at its inner end is provided in place of rotatable shaft 36 of FIG. 15 in order to move shoes 32, 32' part from each other by inserting tapered end portion 35' between shoes 32, 32' by pushing shaft 36' downwardly when it is desired to release the brake means. The operation of the control mechanism shown in FIGS. 21 and 22 is similar to that shown in FIGS. 15 and 20.

FIGS. 23 and 24 show some of the manners how the first and second flexible portions are bent. It is evident from FIGS. 23 and 24 that the relative positions of levers 21, 27 indicate the bent state of the first and second flexible portions determined by the operation of the levers.

FIG. 25 shows another embodiment of the present invention. In FIG. 25, casing 101 of head I housing therein the inspecting or photographing mechanism and other means is connected to the forward end of controllable flexible portion II', the other end of which is connected to the forward end of elongated flexible connecting portion III' by means of connecting ring 105, the other end of said connecting portion III' being in turn connected to control housing of the endoscope not shown. Sheath 102 covers watertightly portions II' and III'. Controllable flexible portion II' comprises two groups II'*a*, II'*b* as shown in FIG. 26. Each of groups II'*a*, II'*b* is constituted by a plurality of relatively short tubular segments 103 similar in construction and arrangement to those as shown in FIG. 3. A hollow space 106 is provided in each of segments 103 through which a fiber optical system or photographic film and other elements employed in the endoscope is adapted to pass. Both faces of each of segments 103 are tapered to form diametrically extending pivot ridges 103*a*, respectively, in the same manner as shown in FIG. 3. Diametrically opposed two small holes 107 are provided at positions where ridges 103*a* are formed, through each of which wire 112 extends, one end of which is secured to ring 105 while the other end is secured to casing 101, thereby flexibly urging segments 103 toward each other and aligning segments 103 with each other. Further, each of segments 103 is provided with small holes or

cut out portions 108*a* and 108*b* in the center line normal to said ridges 103*a*. Intermediate ring 104 is interposed between groups II'*a* and II'*b* as shown in FIG. 26. One face of ring 104 is tapered to form a diametrically extending pivot ridge 104*a*, and the other face may be flat or tapered to form a diametrically extending ridge. Ring 104 is provided with holes 109, 109 similar to holes 107 in segment 103 and holes or cutout portions 110*a*, 110*b* similar to holes or cutout portions 108*a* of segment 103. Further holes 111*a*, 111*b* are provided in ring 104 at the positions outside of said holes or cutout portions 110*a*, 110*b*, respectively, as shown. Small holes 110'*a* and 110'*b* are provided in the forward and end face of ring 104, the positions of said holes 110'*a*, 110'*b* corresponding to said holes or cutout portions 110*a*, 110*b*, respectively. The forward end face of connecting ring 105 has the same configuration as the forward end face of intermediate ring 104. Tension wires 113*a* and 113*b* extend through holes 108*a*, 108*b* of each of segments 103, holes 110*a*, 110*b* of connecting ring 104, respectively. One end of each of wires 113*a*, 113*b* is secured to casing 101, while the other end of each of wires 113*a*, 113*b* extends through connecting portions III' and is connected to a winding mechanism provided in the control housing not shown. Closely wound helical spring 114 is provided around each of wires 113*a*, 113*b*, one end of each of springs 114 abutting against ring 104 as shown in FIG. 26 while the other end of each of springs 114 abuts against the abutment surface provided in the control housing. One ends of tension wires 115*a*, 115*b* are secured to holes 111*a*, 111*b*, respectively, of intermediate ring 104 as shown in FIG. 26. Wires 115*a*, 115*b* extend through group II'*b* of controllable flexible portion II' and flexible connecting portion III' and the other ends of wires 115*a*, 115*b* are connected to another winding mechanism in the control housing. Closely wound helical springs 116 are provided around wires 115*a*, 115*b*, respectively. One end of each of springs 116 abuts against connecting ring 105 as shown in FIG. 26, while the other end of each of springs 116 abuts against the abutment surface provided in the control housing. Closely wound helical springs 114 and wires 113*a*, 113*b* passing therethrough extend through group II'*b* of flexible portion II' and flexible connecting portion III' with sufficient surplus length so as to permit group II'*b* and connecting portion III' to be bent without requiring any relative movement between springs 114 and wires 113*a*, 113*b* passing therethrough so that the relative movement of wires 113*a*, 113*b* with respect to springs 114 given at the side of control housing by the operation of the winding mechanism can be exactly transmitted to the other sides of wires remote from the control housing. Similarly, springs 116 and wires 115*a*, 115*b* extend through connecting portion III' with sufficient surplus length so that connecting portion III' can be bent without requiring any relative movement of wires 115*a*, 115*b* with respect to springs 116.

In operation, group II'*a* of controllable flexible portion II' can be bent in desired direction as shown in FIG. 34 or 35 by operating the winding mechanism for pulling wires 113*a* or 113*b*. When it is desired to bend only group II'*b* of flexible portion II' as shown in FIGS. 36 and 37, only the winding mechanism for pulling wire 115*a* or 115*b* is operated. If both the winding mechanisms are simultaneously operated, flexible portion II' can be bent to assume any desired configuration as shown in FIGS. 30 to 33 depending upon the selection of the wires to be pulled.

Although the flexible portion has been shown as consisting of two groups, it is evident more than two groups of the controllable flexible portion can be provided in accordance with the teaching of the present invention.

I claim:

1. Mechanism for controlling the flexure of an endoscope, comprising a controllably flexible portion, a set of tension wires being fixed with their one ends to the forward end of said controllably flexible portion at the peripheral portion thereof and extending therethrough so as to be connected with their other ends to a control means housed in a control portion connected to said controllably flexible portion, thereby permitting said controllably flexible portion to be bent in a desired direction by pulling selected ones of the wires in said set by operating said control means, wherein the improvement comprises the fact that said controllably flexible portion comprises at least two sections each adapted to be bent in a desired direction separately from each other by pulling selected ones of the wires in the set which are fixed with their one ends to the forward end of each of said sections and which extend through said controllably flexible portion so as to be connected with their other ends to said control means so that each of said sets of wires are actuated separately, and said control means comprises a stationary control lever on said control portion, and a plurality of rotatable control levers in gear relationship with control drums about which the other ends of said set of tension wires are wound, to place the control levers in a substantially parallel relationship with their respective controlled portions.

2. Mechanism according to claim 1, wherein said control means comprises drum means for operating said sets of wires, respectively.

3. Mechanism according to claim 2, wherein said control means comprises brake means adapted to releasably apply braking force to said control means thereby permitting the bent state of the controllable flexible portion given by the operation of said control means to be positively maintained.

4. Mechanism according to claim 1, wherein closely wound noncontractable flexible helical springs are provided around the respective wires of said sets of wires, each of said springs extends from the rear end of the section in the controllably flexible portion to which the wire extending through said each spring belongs to an abutment surface in said control portion thereby permitting the relative movement of each of the wires with respect to the spring therearound occurring at the abutment surface by the operation of the control means to be exactly transmitted to the forward portion of the wire at the forward end of the spring so that the controllably flexible portion is bent in accordance with the operation of the control means.

5. Mechanism for controlling the flexure of an endoscope comprising a controllably flexible portion, a pair of tensioning wires fixed with their one ends to the forward end of said controllably flexible portion at substantially diametrically opposite peripheral positions adjacent to the center line normal to the neutral plane of bending of said controllably flexible portion and extending therealong so as to be connected with their other ends to a control means housed in a control portion of the endoscope thereby permitting said controllably flexible portion to be bent in desired direction by pulling a selected one of said wires in said pair by the operation of said control means, wherein the improvement comprises closely wound noncontractable flexible helical springs provided around the respective wires of said pair, each of said springs extending from the rearward end of said controllably flexible portion to an abutment surface stationarily provided in said control portion thereby permitting the relative movement of each of the wires with respect to the spring therearound which occurs at said abutment surface, by the operation of said control means, to be exactly transmitted to the forward portion of the wire at the forward end of the spring so that said controllably flexible portion is bent exactly in correspondence to the operation of said control means.

6. Mechanism for controlling the flexure of an endoscope including a controllably flexible portion, a pair of tensioning wires fixed with their one ends to the forward end of said controllably flexible portion at substantially diametrically opposite peripheral positions adjacent to the center line normal to the neutral plane of bending of said controllably flexible portion and extending therealong so as to be connected with their other ends to a control means housed in a control portion of the endoscope, thereby permitting said controllably flexible portion to be bent in desired direction by pulling selected one of said wires in said pair by the operation of said control means, wherein the improvement comprises the fact that said

controllably flexible portion comprises at least two sections of which a first section is located at the foremost end of said controllably flexible portion while a second section is connected to the rearward end of said first section, said first and second sections having respectively a pair of tensioning wires with their one ends securely fixed to the respective ends of said first and second sections and extending therealong so as to be connected with their other ends to a first and second control means housed in said control portion, respectively, thereby permitting each of said first and second sections to be bent in desired direction separately from each other by the operation of the control means corresponding to the section to be bent, a first lever rotatably mounted on a rotatable disc rotatably mounted in said control portion at a position radially offset from the center of rotation of said disc and operably coupled to said first control means such that said first section is bent by the operation of said first lever in the same direction, and substantially by the same angle, as those of the rotation of said first lever, and a second lever fixedly secured to said rotatable disc so as to be rotated therewith and operably connected to said second control means such that said second section is bent by the operation of said second lever in the same direction, and substantially by the same angle, as those of the rotation of said second lever, the direction of said first lever being made parallel to the longitudinal direction of said first section with said first lever being located forwardly of said second lever when both said first and second sections are held in the straight state while the direction of said second lever is made parallel to the longitudinal direction of said second section when said second section is held in the straight state, thereby permitting said first lever to be always parallel to said first section regardless of the flexure of said first and second sections by virtue of the mounting of said first lever on said rotatable disc the rotation of which also causes the actuation of said first control means together with said second control means when rotated by the operation of said second lever, while said second lever is made always parallel to said second section regardless of the flexure thereof, so that the state of flexure of said first and second sections is directly indicated by the directions of said first and second levers, respectively.

7. Mechanism according to claim 6, wherein a stationary lever is fixedly secured to said control portion, the direction of said stationary lever being made parallel to the longitudinal direction of the rearward end of said controllably flexible portion connected to said control portion, thereby permitting the state of flexure of the entire length of said controllably flexible portion to be directly indicated by the directions of said stationary lever, said first and second levers, respectively.

8. Mechanism according to claim 6, wherein each of said first and second control means comprises a drum on which the pair of tensioning wires are secured, the drum of said first control means being provided with a coaxial gear integral therewith and rotatably mounted on a shaft secured to said rotatable disc and extending along the axis of rotation thereof, said coaxial gear being coupled with a gear integrally secured to said first lever by the interposition of an idle gear rotatably mounted on said disc, the drum of said second control means being fixedly secured to said shaft secured to said disc, so that the drum of said first control means is rotated by either of the operation of said first lever and the rotation of said disc by the operation of said second lever which also causes the rotation of the drum of said second control means.

9. Mechanism according to claim 6, wherein each of said first and second control means is comprised of pinion-rack means having a pair of parallely located racks adapted to be moved oppositely to each other by a pinion interposed therebetween and engaging therewith with the pair of tensioning wires being secured to said pair of racks, respectively, so as to be actuated thereby, the pinion of said first control means being rotatably mounted on a stationary shaft provided in said control portion and having a coaxial gear integral therewith, said coaxial gear being coupled with a gear integral with said first lever through the interposition of an idle gear rotatably mounted on a center shaft fixedly secured to said rotatable disc along the axis of rotation thereof while the pinion of said second control means is fixedly secured to said center shaft so as to be rotated together with said second lever, so that the pinion of said first control means is rotated by either of the operation of said first lever and the rotation of said disc by the operation of said second lever which also causes the rotation of the pinion of said second control means.

10. Mechanism according to claim 6, wherein said first and second control means are provided with brake means adapted to releasably apply braking force thereto thereby permitting the bent state of said first and second sections to be positively maintained.