United States Patent

[11] 3,593,903

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[54] **SURGICAL INSTRUMENT FOR SUTURING HOLLOW ORGANS IN INFANTS**
8 Claims, 6 Drawing Figs.

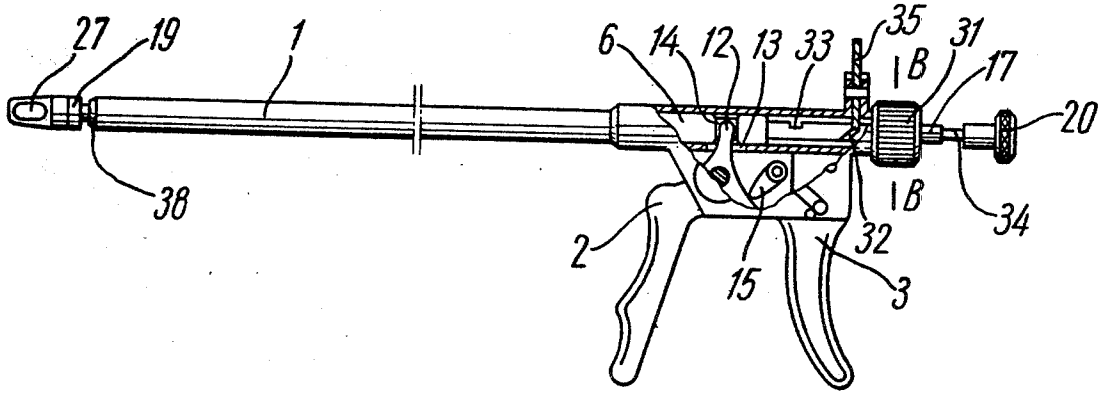
[52] U.S. Cl. 227/76, 227/19
[51] Int. Cl. B25c 5/02
[50] Field of Search 227/19, 76

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Primary Examiner—Granville Y. Custer, Jr.
Attorney—Waters, Roditi, Schwartz & Nissen

ABSTRACT: A surgical instrument is provided for suturing hollow organs in infants and comprises an oblong tubular body with an open tapered front end with staple slots spaced around the periphery thereof and an oblong hollow rod passes inside the body and is capable of axial movement therealong. A cylindrical staple ejector is loosely mounted on the rod and is provided with toothlike pins spaced around its periphery to fit into the slots in the body. An elastic member is mounted between the rod and the ejector so that a constant travel rate is obtained for the staple ejector. A stem is mounted inside the hollow rod so as to be free to move axially and to rotate around its own axis when extended all the way out of said body, the front end of the stem being pointed and supporting a detachable tapered head having a surface facing the body with staple bending depressions spaced around the periphery of the head.



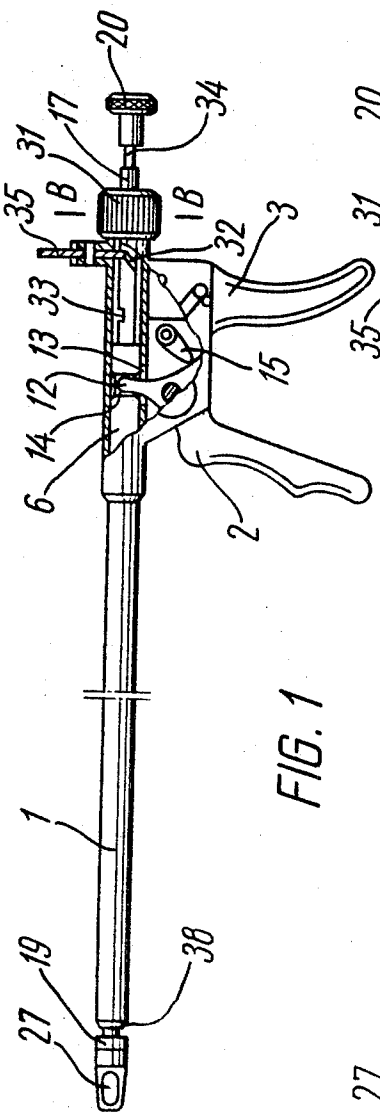


FIG. 1

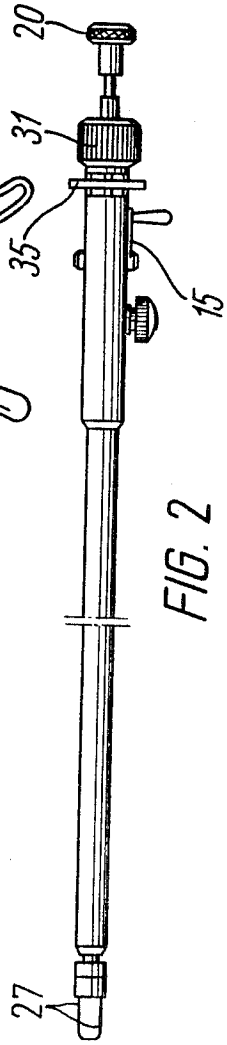


FIG. 2

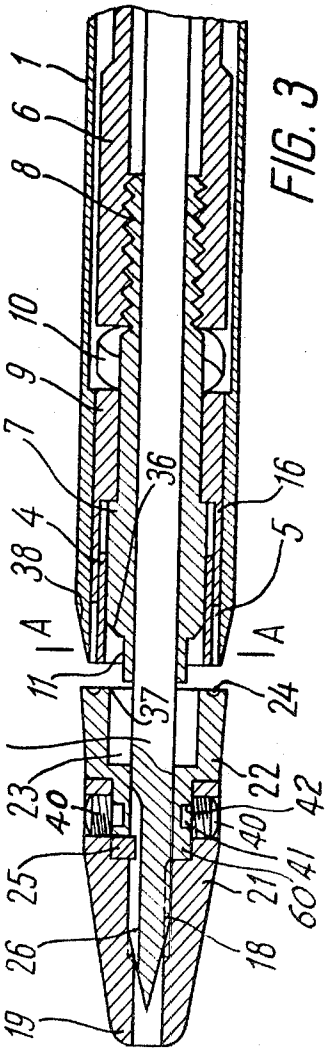


FIG. 3

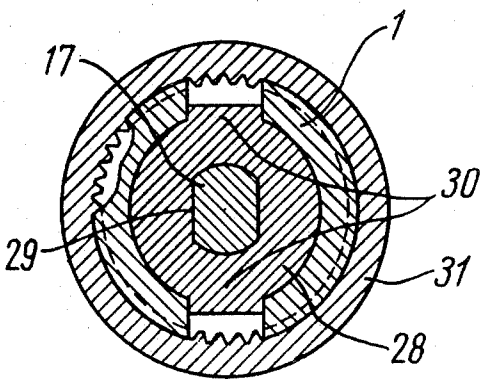


FIG. 5

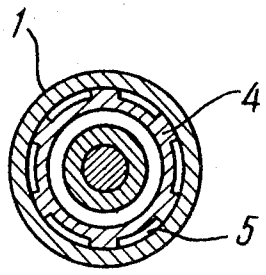


FIG. 4

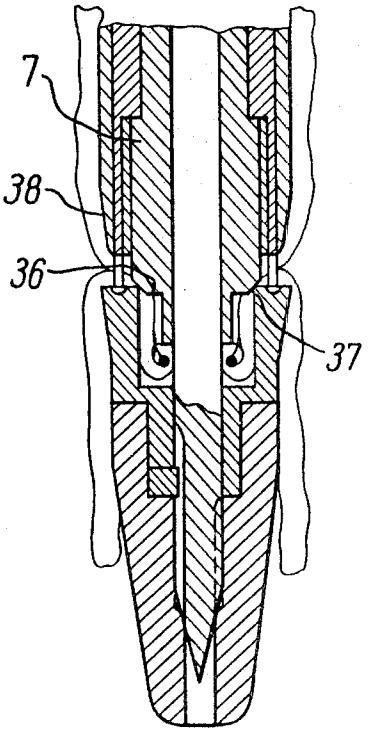


FIG. 6

SURGICAL INSTRUMENT FOR SUTURING HOLLOW ORGANS IN INFANTS

This invention relates to surgical instruments for applying circular staple sutures when placing anastomoses on hollow organs and, more specifically, to instruments for placing esophageal anastomoses in newborn infants in cases of atresia.

Known in the present day surgical practice are surgical instruments for placing circular anastomoses between hollow organs (cf. USSR Author's Certificates Nos. 195,041 and 141,589; patents: Great Britain No. 942,122, U.S. No. 3,193,165, Canada No. 736,256, Switzerland No. 407,407, France No. 1,349,201 and No. 1,461,464, Italy No. 674,174 and 724,978, Japan No. 456,544, Belgium No. 668,917). Said instruments feature a tubular body carrying a staple portion , said tubular body housing a central stem and a movable hollow rod with a cylindrical knife and a staple ejector, a detachable supporting head with depressions for bending the staple ends and a circular recess at whose bottom a replaceable plastic washer is located.

Located inside said supporting head, in the course of the instrument operation, are: a stem connecting the supporting head to the staple portion, the cylindrical knife and the tissues being sutured which are fixed between the end faces of the staple and supporting portions of the instrument.

The aforementioned known instruments are impracticable for suturing the esophagus in newborn infants in the case of atresia thereof, this being due to anatomical peculiarities inherent in newborn infants, mostly on account of the small size of their organs, as well as due to the fineness and delicacy of the tissues thereof.

An instrument designed for suturing the esophagus in newborn infants should have the diameter of its working portions (i.e., the tubular staple portion and the supporting head) not exceeding 6 or 7 mm., since for placing anastomotic sutures, said portions are to be introduced into the inner cavity of those sectors of the esophagus which are to be sutured.

It is evident that the inner space of the supporting head of such a diameter is not sufficient to accommodate all the necessary components for obtaining a high-quality suture and for making an incision to obtain an anastomotic aperture through which the sutured portions are free to intercommunicate.

Appertaining to the aforementioned components are: the depressions for bending the staples, said depressions being provided on the end face surface of the abovesaid supporting head; the cylindrical knife capable of cutting an aperture for a free communicating between the sutured portions of the esophagus; the stem connecting the supporting head of the instrument to the staple portion thereof; the circular recess at the bottom of which the replaceable plastic washer is provided, said recess serving to accommodate the esophageal ends being sutured and to excise the surplus tissue to restore a free permeability of the organ involved.

Moreover, to provide a reliable excision of the anastomotic aperture and a minimum traumatic lesion inflicted upon the living tissues, a slitlike gap or clearance should be provided between the inner surface of said circular recess and the outer surface of the cylindrical knife, said gap or clearance being in excess of twice the maximum thickness of the esophageal walls being sutured.

A free spaces should be left between the inner surface of the knife and the stem for the lower end of the esophagus constricted with a purse string or circumflexional suture to freely sink thereinto.

Apparently, it is by reason of the difficulties mentioned above that despite the great progress in mechanization of the process of placing sutures during surgical operations and the wide variety of special suturing instruments available, there has not been previously suggested any instrument which is capable of placing anastomoses between the esophagus sections in the case of its atresia occurring in newborn infants.

It is therefore a primary object of the present invention to develop a small-size surgical instrument for suturing the esophagus in newborn infants in the case of its atresia.

It is a specific object of the present invention to provide such a surgical instrument that is capable of quickly and reliably placing a circumferential anastomotic suture, as well as to provide a guaranteed excision of the surplus tissue to restore the lumen of the sutured esophagus with a minimum traumatic lesion inflicted upon the tissues thereof during the process of placing an anastomosis.

To accomplish the objects mentioned above, provision is made in the body of the instrument of the invention for an elastic or springy member capable of insuring a constant rate of travel of the staple ejector at various rates of travel of the rod carrying a puncher, whereas the central stem is free to move reciprocally along the body and to rotate around its own axis when extended all the way out of the body.

With a view to attaining a simple and reliable operation of the instrument, said elastic member is made as a split washer loosely set over the rear portion of the puncher and located inside the instrument body between the end of the rod and the end face of the staple ejector which is likewise set freely on the rear portion of said puncher.

For the purpose of saving space, the cutting device has a puncher associated with the rod and is adapted to interact, during the operation, with the edge of acylindrical depression or recess provided at the face end of the supporting head which receives the puncher.

According to the invention said puncher is provided with a cylindrical projection for the tissues being sutured which is inserted into said cylindrical depression or recess in the supporting head.

In accordance with the present invention, for the purpose of convenience, the central stem has a cylindrical tailpiece with a knurled or milled surface, whereas the supporting head has flat regions for a reliable holding of said head by a clamping tool.

An embodiment of the present invention is described hereinbelow by way of example with reference to the appended drawings, wherein:

FIGS. **1** and **2** are, respectively, a side elevation and a plan view of the surgical instrument for suturing hollow organs in infants;

FIG. **3** is a longitudinal section of an operative end portion of the instrument shown in FIGS. **1** and **2**;

FIG. **4** is a section taken on line A–A of FIG. **3**;

FIG. **5** is a section taken on line B–B of FIG. **1**; and

FIG. **6** is a sectional view showing the operation of the instrument according to the invention.

Referring to FIGS. **1** and **2**, the instrument of the invention comprises an oblong tubular body **1**, a movable handle **2** articulated with the body at the rear portion thereof and a stationary handle **3** rigidly coupled to the body **1**.

Located inside the front portion of the body **1** is a splined bushing **4** fixed in position so as to form staple slots **5** (FIGS. **3**,**4**) in combination with the inner surface of the body **1**.

A tubular rod **6** passes inside tubular body **1**, said rod carrying at its front end a puncher **7** threaded thereto. The puncher **7** has a rear portion or tailpiece **8** on which is loosely supported a cylindrical-shaped staple ejector **9** and a split spring washer **10**. The washer **10** affords the possibility for the puncher **7** to move with respect to the staple ejector **9** over a length corresponding to the range of the suturing gap spacing or, in other words, the provision of the spring washer makes it possible, with the travel of the staple ejector **9** being invariable, for the travel of the rod **6** along with the puncher **7** to vary within a required range.

The front end of the puncher **7** is fashioned as a cylindrical portion **11** which extends beyond the body **1** (FIGS. **1**,**3**).

The rod **6** is movable lengthwise of the instrument body **1** by means of a linkage coupled to the movable handle **2** and including an actuating arm **12** of fork-shape passing through an opening **13** in body **1** so as to straddle the rod **6** on lateral surfaces **14** thereof (FIG. **1**).

In order to secure the movable handle against movement, a swivel safety lock **15** (FIGS. 1,2) is provided.

Spaced around the periphery of the cylindrical staple ejector **9** are toothlike pins **16** adapted to fit onto the staple slots **5** to drive staples therefrom under the action of the rod **6** (FIG. 3).

Extending inside the tubular rod **6** and the puncher **7** is a stem **17** whose front pointed end **18** is screwed into a supporting head **19**. A knob **20** on the rear of stem **17** is cylindrical and its outer surface is knurled to facilitate manipulation thereof (FIGS. 1 and 2).

The supporting head **19** is made up of two portions, namely, tapered portion **21** and portion **22**, so interconnected that the tapered portion can rotate independently around its axis, while the portion **22** remains stationary (FIG. 3). This is achieved by the construction shown in FIG. 3 wherein the tapered portion **21** is loosely mounted on a cylindrical projection **60** of portion **22**, said portion **60** having a circular groove **42** disposed therein and loosely accommodating end portions **41** of two screws **40** screwed into the tapered portion **21**.

At the rear of the supporting head **19** is a cylindrical recess **23** for receiving the lower end of the esophagus to be sutured by forcible insertion by the cylindrical projection **11** on the puncher **7** (FIGS. 3 and 6).

Spaced around the periphery of the rear portion of the supporting head **19** are staple bending depressions **24**. In order to insure that the supporting head is set in definite position with respect to the stem **17**, provision is engaged in a longitudinal groove **26** (FIG. 3) made on projection **60** of portion **22** for a fixed guide key which engages in a longitudinal groove **26** (FIG. 3) at the end **18** of the stem **17**. When the pointed end **18** of the stem **17** is introduced into the supporting head **19**, the guide key **25** enters the groove **26** provided on the stem **17**, thus preventing the cylindrical portion **22** from rotating about the stem **17** and ensuring a strictly definite position of the portion **22** relative to the stem in the circular direction. The stem **17** is then further advanced into the head **19** by rotating stem **17** while holding portion **19** against rotation as will be explained more fully later.

The tapered portion **21** of the head is provided with two flat regions **27** for the engagement of the supporting head **19** by a clamping tool (FIGS. 1,2).

In order to insure that the staple slots **5** in the body **1** are in strict alignment with the staple bending depressions **24** in the rear end of the supporting head **19**, the stem **17** occupies an angular fixed position with respect to the instrument body **1**. This is attained by the provision of a washer **28** having a profiled opening whose shape corresponds to that of the cross-sectional area of the stem **17**, and by the presence of projections **30** adapted to fit into corresponding slots in the body **1** (FIG. 5).

The washer **28** is fixed to the body **1** by means of a nut **31** (FIGS. 1,2,5).

The stem **17** is provided with two transverse slots **32**, **33** and an annular recess **34** (FIG. 1).

When the slot **32** receives a swivel retainer **35** a required suturing gap is obtained between the rear end of of head **19** and the front end of body **1** (FIG. 1).

The slot **32** is inclined relative to the axis of the stem **17** so that the lower portion of the retainer **35**, while sliding over the walls of the slot **32**, causes the supporting head **19** either to approach the front end of the body **1** or to move away from it within the spacing range of the suturing gap.

The slot **33** serves for locking the stem **17** by the retainer **35** in such a position that pointed end **18** is completely retracted inside the body **1**.

The recess **34** makes it possible for the stem **17** to rotate about its own axis when the recess **34** is aligned with the profiled opening **29** in the washer **28**, viz. With the pointed end **18** of the stem **17** extended all the way out of the body **1**.

INSTRUMENT APPLICATION TECHNIQUE

Prior to making use of the instrument it should be loaded with staples and sterilized.

This done, the instrument is prepared for operation, for which purpose the movable handle **2** is locked by the safety lock **15**, the supporting head **19** is unscrewed from the instrument and the pointed end **18** of the stem **17** is retracted into the body **1**, whereupon the stem is fixed in that position by the engagement of the retainer **35** in slot **33**.

Then, the body **1** of the instrument is introduced perorally into the upper blind section of the patient's esophagus.

When cylindrical projection **11** extending from the body **1** reaches the bottom of the upper blind section of the esophagus, the stem **17** is released by withdrawing the retainer **35** from slot **33** and the stem is moved all the way forward by manual manipulation of knob **20**. As a consequence, the pointed end **18** of the stem **17** pierces the bottom of the esophagus penetrates into the operational wound, the cylindrical projection **11** penetrating the into the wound through the resulting hole together with the stem **17**.

By the use of any suitable clamping tool, the tapered portion **21** of the supporting head **19** is held by its flat regions **27** provided for the purpose, and the head **19** is introduced into the operational wound to fit over the pointed end **18** of the stem **17** so that the guide key **25** of the portion **22** of said head engages in the groove **26** in the stem **17**. Thereupon the stem is rotated by turning knob **20** until it is screwed home into the tapered portion **21** of the supporting head **19**. When assuming that position, the stem **17** is free to rotate, since the recess **34** provided therein is located in the profiled opening **29** in the washer **28**.

Having been made fast on the stem **17**, the head **19** is introduced into the lumen of the lower section of the esophagus. This done, a purse string or circumflexional suture is drawn tightly around the stem **17** and tied thereon, said suture being preliminarily placed on the edge of the lower section of the esophagus.

Then, the head **19** together with the lower end of the esophagus fixed thereto is brought by the knob **20** of the stem **17** closer to the instrument body **1**. When so doing, the lower end of the esophagus drawn tight with a purse string or circumflexional suture rests with its edge against the projection **11** of the puncher **7** extending out of the upper blind section of the esophagus and is thus caused to insert into the recess **23** in the supporting head **19**, whereby both the upper blind section and the lower section of the esophagus can be juxtaposed correctly and tightly. Then the stem **17** together with the supporting head **19** is fixed in that position by the engagement of the end of retainer **35** into the transverse slot **32**.

Then, the movable handle **2** is released by turning the safety lock **15** and is pressed towards handle **3**, whereby suturing is attained.

At the moment the handles **2** and **3** are brought together, a circular staple suture is driven into place by pins **116** and an excision of the tissues is performed (in a manner to be explained later) to provide for a free communication between the upper blind section and the lower sections of the esophagus that have been sutured (FIG. 6).

The formation of an anastomotic aperture in the sutured sections of the esophagus is effected by the puncher **7** which engages the sharp edge **37** of the portion **22** of the supporting head **19** by its bevelled edge **36** to punch out a round aperture.

Upon the formation of an anastomosis, the movable handle **2** is returned to its initial position and is fixed therein with the safety lock **15**.

Then, the stem **17** is released by removing the retainer **35** and is moved forward, thus causing the supporting head **19** to move away from the body. Next, the body **1** of the instrument is likewise moved slightly forward. Owing to the tapered shape of the working end **36** of the body **1** it is free to pass inside the sutured sections of the esophagus and through the anastomotic suture thus obtained.

Once the working end of the instrument body as passed beyond the anastomotic suture, the supporting head is brought closer to the body by the displacement of stem **17**, whereupon the entire instrument is extracted from the esophagus.

What we claim is:

1. An instrument for suturing hollow organs in infants, said instrument comprising an elongated tubular body with an open tapered forward end having staple slots spaced along the periphery thereof; an elongated hollow rod passing inside said body and capable of axial movement with respect thereto; a cylindrical staple ejector freely mounted on said rod and including a plurality of peripherally arranged pins engaged in said slots in the body; a spring member between said rod and ejector to provide for relative movement between the rod and the ejector; a stem disposed inside said rod for axial movement, and for rotation about its axis in a fully extended position relative to the body, said stem having a pointed forward end extending out of the open forward end of the body and a rear portion; a supporting head detachably mounted on said pointed forward end of said stem and having a broad end portion facing rearward in the direction of the body, said end portion of the head having a cylindrical recess and staple bending depressions. said depressions being provided peripherally on the end portion of said head; means on said rod and said head for cutting tissues placed in said recess; means coupling said stem with the body for holding the stem in the body and manually actuated means for axially moving said rod and ejector in said body so that staples in said slots are pushed out of said slots to puncture the tissues to be sutured and be bent in said staple bending depressions.

2. An instrument as claimed in claim 17 wherein the means for cutting tissues comprises a puncher disposed inside the body and attached to the rod at the forward end thereof and

interacting in operation with an edge of said cylindrical recess in the end portion of the supporting head.

3. An instrument as claimed in claim 2 wherein the spring member comprises a split washer freely mounted on the puncher and disposed inside said body between the forward end of said rod and the staple ejector, the latter also being freely mounted on the puncher.

4. An instrument as claimed in claim 2 wherein the puncher includes a cylindrical projection at the forward end thereof for forcing the sutured tissues into said cylindrical recess of the supporting head.

5. An instrument as claimed in claim 1 comprising a manually actuated knob on said rear portion of the stem with a roughened surface for moving the stem in said rod.

6. An instrument as claimed in claim 1 wherein said supporting head has flat regions on opposite sides thereof to allow reliable holding by a clamping means.

7. An instrument as claimed in claim 1 wherein the means coupling the stem with the body comprises a retainer secured at the rearward portion of the body.

8. An instrument as claimed in claim 1 wherein said manually actuated means for axially moving the rod with the ejector comprises movable and fixed handles, each secured to the body and mean coupling the movable handle and rod such that when the movable handle is moved relative to the fixed handle the rod is moved therewith.