Aug. 27, 1963 J. A. GLASSMAN 3,101,715

NON-CRUSHING CLAMP

Filed July 12, 1961

Fig. 1.

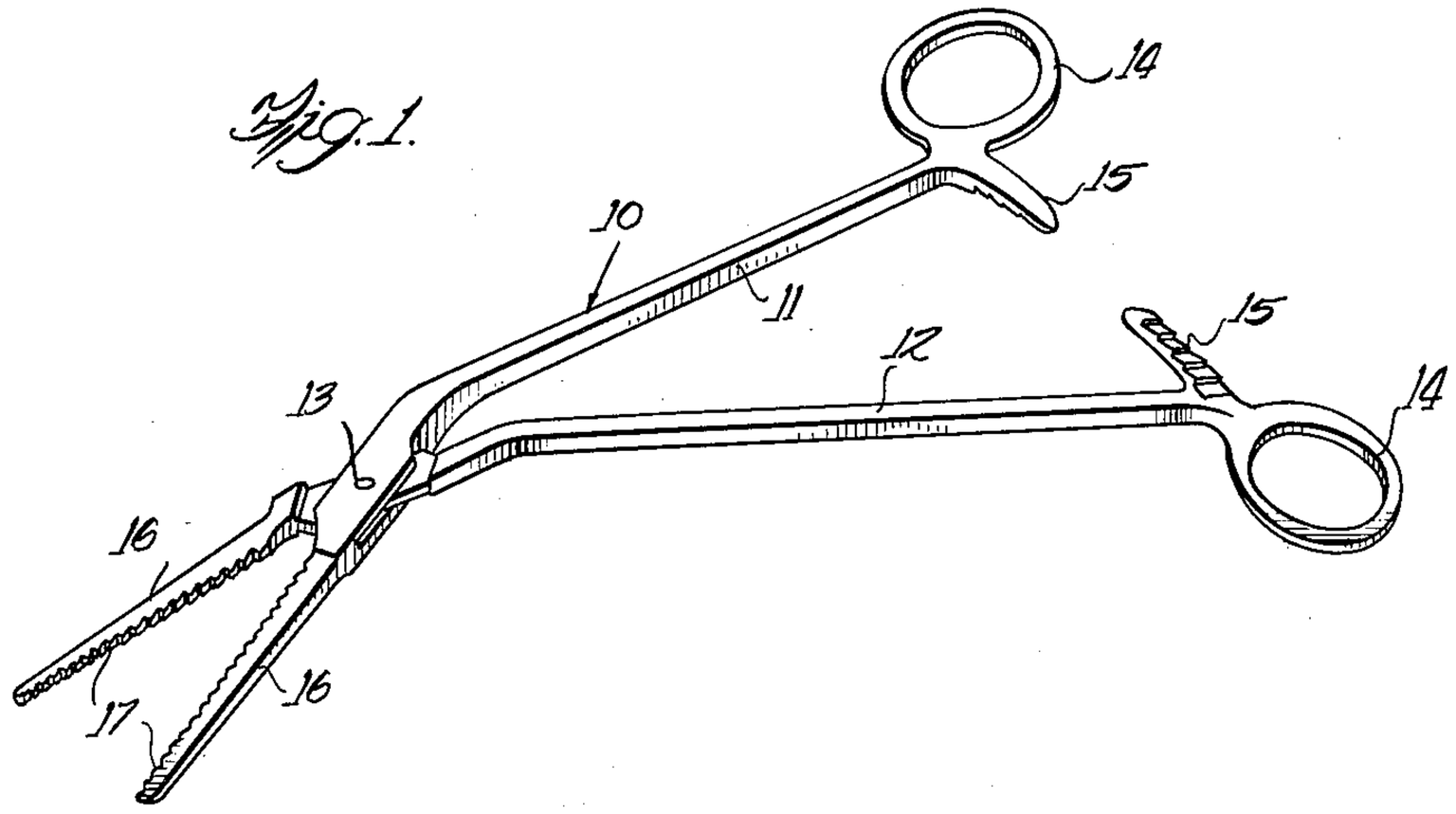


Fig. 2.

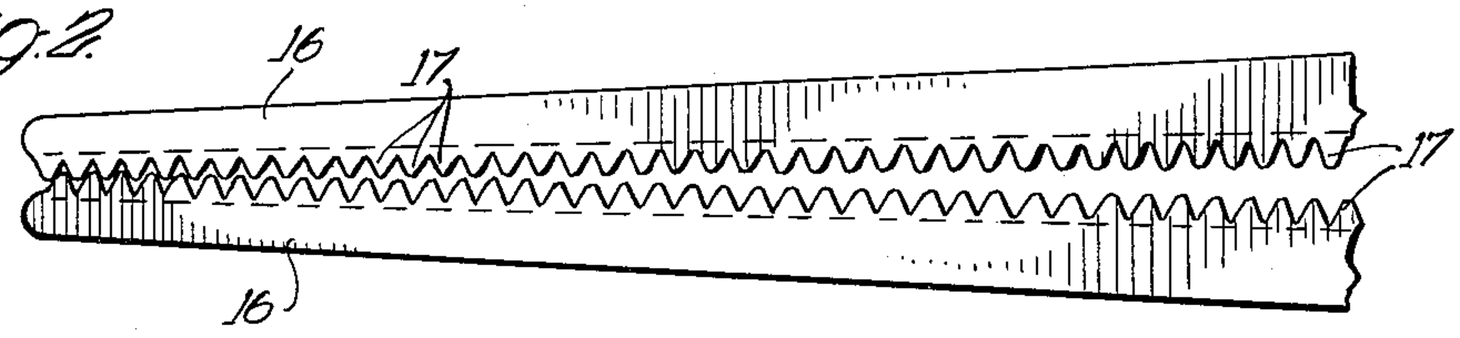


Fig. 3

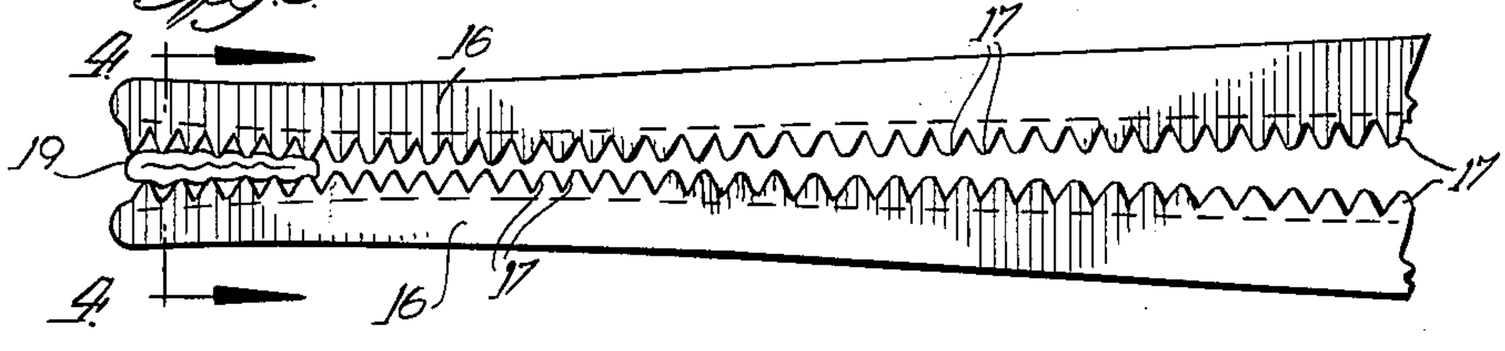
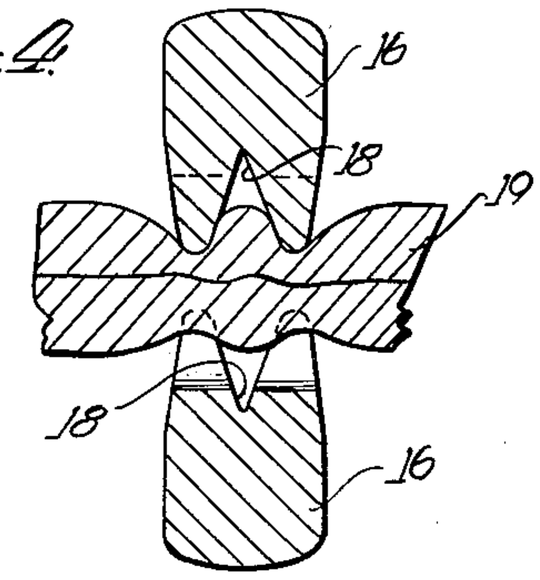


Fig. 4.



Inventor
Jacob A. Glassman

Dawson, Dillon, Fallon & Longmuir
Attorneys

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NON-CRUSHING CLAMP

Jacob A. Glassman, Miami Beach, Fla., assignor to V. Mueller & Company, Chicago, Ill., a corporation of Illinois

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The invention relates to a non-crushing clamp particularly useful for gripping body tissues during surgery.

In surgery, particularly intestinal surgery, it is important to use surgical clamps which are capable of firmly holding the tissue or bowel without perforating or otherwise damaging it. A conventional crushing clamp, when applied to a segment or bowel for five or ten minutes will tend to produce a vertical crush in the bowel wall that will then be followed by a secondary horizontal hemorrhagic necrosis extending in opposite directions beyond the primary site of the crush. In order to avoid such undesirable effects of crushing clamps, surgeons have sometimes turned to the use of arterial clamps for intestinal surgery, the assumption being that if arterial clamps do not damage delicate arteries then they are also safe for intestinal work. In practice, it has been found that such an assumption is erroneous and that the sharp elongated teeth of an arterial clamp not only tend to produce a severe vertical crush with concomitant lateral hemorrhagic necrosis but in addition may induce gross leakage through perforations created in the bowel wall. Although a small perforation made in an arterial wall may not be considered serious because the blood is sterile and the leak self-sealing, a perforation in a bowel wall may be highly dangerous because the perforation is not self-sealing and the bowel contents are non-sterile. Consequently, there is a definite need for a non-crushing and non-perforating clamp particularly adapted for use in intestinal surgery.

A main object of the present invention is to provide a surgical clamp that can either gently or firmly grasp the bowel or a delicate body tissue without initiating lateral hemorrhagic or inflammatory necrosis and without perforating or otherwise injuring the clamped tissue. Another object is to provide a non-crushing and non-perforating surgical clamp which is capable of being adjusted to vary the clamping force but which will not damage the clamped tissue even when maximum force is applied.

Other objects will appear from the specification and drawings in which:

FIGURE 1 is a perspective view of a surgical clamp embodying the present invention;

FIGURE 2 is a broken enlarged side elevational view of the jaws of the clamp in closed condition;

FIGURE 3 is a broken enlarged side elevational view of the jaws as they appear when a body vessel is clamped therebetween;

FIGURE 4 is a still further enlarged vertical cross sectional view taken along line 4—4 of FIGURE 3.

In the embodiment of the invention illustrated in the drawings the numeral **10** generally designates a non-crushing surgical clamp having a pair of side members **11** and **12** intermediately and pivotally connected in cross-over relation by pivot pin or screw **13**. Each side member is provided at one end thereof with a handle ring **14** and locking means comprising a pair of inwardly extending ratchet elements **15** are disposed adjacent the handle rings. At their opposite ends, side members **11** and **12** are provided with elongated tapered jaws **16** equipped with clamping teeth **17**.

As illustrated most clearly in FIGURES 1 and 4, the teeth **17** of each jaw are arranged in a pair of longitudinally extending rows separated by a longitudinal groove **18**. The rows extend substantially the entire length of the elongated jaws and the rows of the opposing jaws are disposed in opposing relation.

Each tooth **17** is nearly microscopic in size, having a length under .05 inch and preferably under .03 inch. In addition, each tooth has the shape of a pyramid with a rounded apex. While the degree of taper of the teeth may vary somewhat, it has been found that satisfactory results are obtained where the included angle of each groove **18** ranges between 20 to 30 degrees and where the included angles between successive teeth of a longitudinal series fall within approximately the same degree range.

In FIGURE 2 it will be seen that the teeth of the opposing jaws are staggered so that when the jaws are closed the teeth of one jaw will be disposed in alignment with the spaces between the teeth of the other jaw. It will also be noted that when the jaws are fully closed (FIGURE 2) the dulled teeth interdigitate only at the distal ends of the jaws and that the teeth of the opposing jaws are spaced apart at the jaws' proximal ends.

An important aspect of the invention lies in the fact that the elongated tapered jaws **16** are longitudinally flexible and that, when the jaws are closed as in FIGURE 2, the force necessary to bend the distal ends of the jaws apart until the teeth are spaced the same distance as the teeth at the jaws' proximal ends is less than the penetration force required for perforation of an intestinal wall. Thus, when the clamp is applied to a bowel wall or some other delicate tissue as shown in FIGURE 3, the jaws will tend to flex apart to prevent crushing or perforation of the tissue by the teeth at the jaws' distal ends even when maximum clamping force, as determined by the relative positions of ratchet elements **15**, is applied.

The flexibility of the jaws decreases towards their proximal ends because of their increasing thickness and the proximity of the interconnecting pivot pin **13**. Despite the relative stiffness of the proximal end portions of the jaws there is no danger that the teeth at the proximal ends will crush or perforate a tissue or vessel because such teeth are incapable of intermeshing or interdigitating, as already described. In other words, even if bowel tissue or other tissue should be clamped between the proximal ends of the jaws the normal spacing between the teeth at those ends, even when the jaws are fully closed, will prevent damage to the tissue.

The holding power of the jaws arises to a considerable extent from the staggered relationship of the teeth which tends to cause waves or undulations in a tissue **19** clamped therebetween. FIGURES 3 and 4 illustrate in somewhat diagrammatic fashion the appearance of such a tissue when held between the spring jaws of the clamp. The undulations of the tissue when viewed in section prevent relative movement of that tissue and the jaws in directions extending longitudinally of those jaws. Furthermore, the tissue cannot slide or slip transversely between the jaws because a portion of the tissue tends to bulge within the space defined by the opposing grooves **18** and bears against the tapered inner surfaces of the teeth. Thus, the tissue is firmly locked against longitudinal or lateral movement while, at the same time, it remains undamaged by the small teeth.

While in the foregoing I have disclosed an embodiment of the invention in considerable detail for purposes of illustration, it will be understood by those skilled in the art that many of these details may be varied widely without departing from the spirit and scope of the invention.

I claim:

1. A surgical clamp comprising a pair of elongated jaws hingedly connected for pivotal movement towards and away from each other, each of said jaws being longitudinally flexible and providing two parallel rows of teeth defining a single longitudinal groove therebetween, said

rows of teeth of the opposing jaws being disposed in opposing relation and the teeth of opposing rows being disposed in staggered relation, said jaws being of increasing thickness and stiffness towards the hinge connection therefor and being relatively inflexible adjacent said connection, said teeth of said opposing jaws adjacent the hinge connection therefor being spaced apart when said jaws are fully closed, said teeth of said opposing jaws at the opposite ends thereof being interdigitated when said jaws are closed.

2. An intestinal clamp having a pair of elongated and longitudinally flexible jaws hingedly connected adjacent their proximal ends for pivotal movement between open and closed positions, said jaws each having longitudinally extending rows of fine teeth, the rows of opposing jaws being disposed in opposing relation with the teeth of the opposing rows being staggered, said jaws being of increasing thickness and stiffness towards the proximal ends thereof and being relatively inflexible adjacent said proximal ends, said teeth of said opposing jaws being spaced apart adjacent proximal ends of the jaws when the same

are closed, said teeth at the distal ends of said jaws intermeshing when said jaws are closed, said flexible jaws being bendable to prevent intermeshing of the teeth at said distal ends when a tissue is disposed therebetween.

3. The structure of claim 2 in which the teeth of said jaws are rounded.

4. The structure of claim 2 in which said teeth are of a length less than approximately .05 inch.

5. The structure of claim 2 in which each of said jaws has two longitudinally extending rows of teeth with a single longitudinal groove extending therebetween.

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