

[54] **SURGICAL CLAMP WITH CAM-ACTION LEVER**

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[58] Field of Search..... **128/346, 325, 337; 251/4, 9, 10; 24/251, 255, 263, 160, 246, 248**

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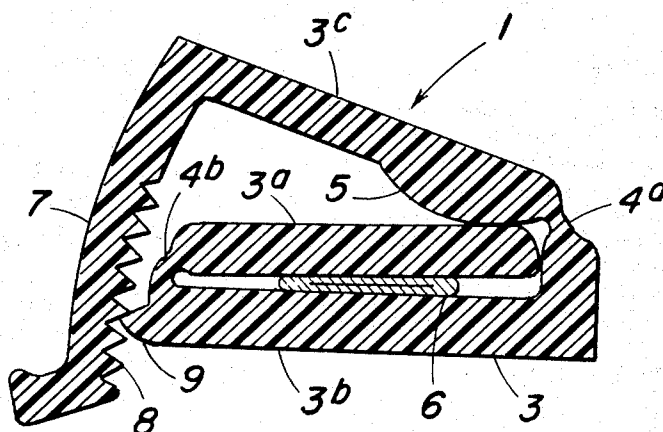
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ABSTRACT

A disposable plastic clamp particularly suited for medical uses is provided. The clamp is preferably made all in one piece and has three portions which are pivotally movable relative to each other. Two of these portions are jaws between which the object to be clamped is placed and the third portion is a cam-action lever arm which provides a high mechanical force for tightly closing the jaws of the clamp. A catch is also provided for holding the jaws closed in a fixed position.

11 Claims, 3 Drawing Figures



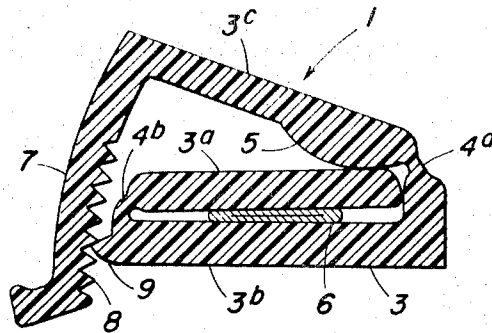


Fig. 1.

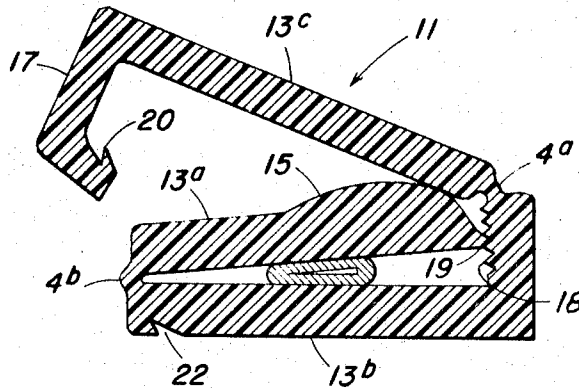


Fig. 2.

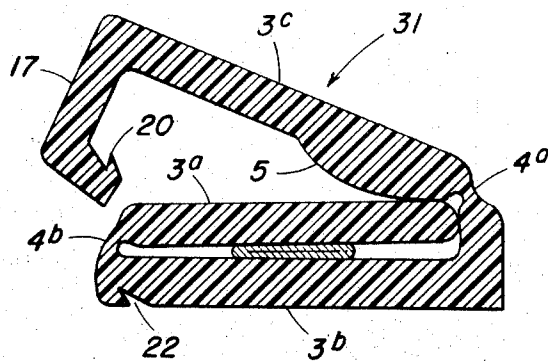


Fig. 3.

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SURGICAL CLAMP WITH CAM-ACTION LEVER

This is a continuation of United States Patent Application Ser. No. 833,051 filed on June 13, 1969, and now abandoned.

In the medical field there are many instances in which it is necessary to clamp a tubular organ, such as the bowel, the intestines, an umbilical cord, or a large blood vessel tightly closed to prevent contamination of, or leakage from, the organ. In such instances, it is essential that the tubular organ being compressed is clamped firmly in position so that no slippage of the clamp can occur. In addition, it is often necessary to provide a firm crushing force to the organ to ensure that any blood vessels in the organ are clamped tightly closed so that bleeding cannot occur. This is particularly true in the case of an umbilical cord. One technique used in the past has been to circumferentially tie the umbilical cord tightly closed with a piece of tape. Using this technique, however, is difficult to completely close off the blood vessels. Moreover, rebleeding often results due to the fact that the tissue directly beneath the tape is forced or extruded out from under the tape thereby releasing the compression of the blood vessels; see Neligan & Smith, "Prevention of Hemorrhage from the Umbilical Cord," *Arch. Dis. Child.* 38:471, 1963.

In order to overcome this problem, plastic disposable umbilical cord clamps have been provided. These clamps provide a means for holding the umbilical cord and vessels therein clamped tightly closed for over 24 hours or more after which it is possible to remove the clamp without bleeding occurring. One such clamp is described in U.S. Pat. No. 3,040,749 to Payton. Another similar clamp is described in U.S. Pat. No. 3,204,636 to Kariher et al. Such clamps have the drawback that all of the force required to close the clamp must be applied manually and directly by the fingers of the user, and it can be somewhat difficult to apply sufficient force to completely close the clamp.

Furthermore, for this same reason these clamps are not suitable for use in other operations such as for use in bowel operations since it is difficult, if not impossible, to manually apply sufficient direct force to tightly clamp the bowel in position so that no slippage is possible. Thus, it has been necessary to provide special clamps which are used for such surgery. One such clamp is called the deMartel clamp which is a high compression steel clamp used in bowel surgery. This clamp requires a special tool to force the clamp into its closed position. These clamps close with such compressive force that slippage of the clamp cannot occur. Hence the clamp can be handled without the danger of its slipping off the bowel even when traction is applied. However, this clamp is relatively expensive because it requires a special closing tool. Moreover, this clamp is bulky and cannot be fitted into small places.

A plastic bowel clamp is described by Fleischer and Mersheimer, in "A New Disposable Colostomy and Ileostomy Clamp," *American Journal of Surgery*, 115:874, 1968. The clamp described therein is used only to gently compress the ends of the bowel to prevent leakage, and it is necessary to have a considerable portion of the bowel protrude beyond the clamp so that the bowel cannot slip from the clamp. This clamp as well as other digitally closed clamps which have in the past been used for bowel surgery, do not however, solve the

problems since with the construction employed, it is still quite difficult to apply adequate force by the fingers of the user to ensure sufficiently tight clamping of the bowel so that there is no possibility of slippage of the bowel from the clamp. As a result, using such clamps it has not been feasible to transect the bowel close to the clamp, since if any slippage were to occur, the clamp could slip off the bowel and soilage of the peritoneal cavity could result.

In order to avoid this as noted above, the practice has been to allow a large cuff or marginal section of bowel tissue to extend beyond the clamp. However, this is not desirable since it is difficult if not impossible to be use that this cuff of tissue is adequately sterilized, and the cuff or margin of tissue has been found to be a source of contamination of the wound and breeding place for infection. Further, secondary mechanical closing devices were used in addition to the clamps referred to above to ensure complete compression of the tissue and minimize the possibility of infection, since the clamps heretofore used did not provide sufficient closing force to completely cut off and occlude all the vessels in the bowel.

This invention provides a simple plastic clamp made all in one piece which is able to provide an extremely high compressive force for clamping a tubular vessel or organ, whether large or small, tightly closed so as to compress the tissue and occlude the vessels therein to prevent bleeding and minimize the possibility of contamination or infection of the wound. Furthermore, in the clamp of the invention, a high mechanical advantage is obtained in the clamp closing mechanism so that it is possible to close the clamp tightly without having to directly manually apply the total force required to close the clamp.

As a further feature of the invention, one embodiment of the clamp is suited for clamping tubing, such as infusion tubing, in a manner such that flow through the tubing is restricted to a desired extent but not cut off completely. The clamp can be fixed in any one of a series of sequential clamped positions and thus can be used to conveniently vary the amount of flow through a tubing by compressing the tubing to any desired extent.

The clamp of this invention comprises, a unitary clamp body formed of plastic material having at least three clamp portions pivotally linked together by bendable portions of the clamp body; two of said clamp portions defining clamping jaws between which the object to be clamped is placed, and the third clamp portion comprising a lever arm, preferably a cam-action lever arm, which is positioned so as to bear against one of the jaws in a manner to exert a force thereagainst to urge the jaws together and compress the object to be clamped; and means on the body and operatively associated with at least two of said clamp portions for holding the clamp jaws in a fixed position.

In the drawings, wherein like reference numerals are used throughout:

FIG. 1 is a view in cross section to an embodiment of the clamp of the invention,

FIG. 2 is a view similar to FIG. 1 of another embodiment of the clamp of the invention.

FIG. 3 is a view similar to FIG. 1 of another embodiment of the clamp of the invention combining features illustrated in FIGS. 1 and 2.

The clamp 1 shown in FIG. 1 comprises a unitary plastic body 3 having three clamp portions 3a, 3b and 3c. The clamp portions are pivotally connected together by hinge-action portions or links 4a and 4b which comprise thin bands or strips of the plastic material of the clamp body. One clamp end portion 3a, and the middle clamp portion 3b define the clamping jaws. The jaws are rectangular in cross section so as to provide flat clamping surfaces, but they could have any cross sectional configuration which provides mating surfaces for the jaws. For example, the jaws could have meshing teeth.

The jaws are pivotally linked to each other by the thin hinge-action band or strip 4b formed in the clamp body and overlies each other when the clamp is in use. The jaw 3a is straight but the jaw 3b is L-shaped, as can be seen by reference to FIG. 1. The middle clamping portion or jaw 3b could also be straight rather than L-shaped. The L-shaped configuration is preferred since the shorter leg of the L provides a convenient means for spacing the clamp portion 3c from the jaws.

The clamp portion 3c comprises a lever arm preferably a camaction lever arm which is linked to the jaw 3b by the thin band 4a in the plastic material and provides a mechanical advantage for forcing closed the jaws on the object to be clamped. The width of the hinge-action linking portions 4a and 4b of the clamp is determined with reference to the thickness of the jaws and desired spacing of the jaws and the cam-action lever arm 3.

The lever arm 3c shown in FIG. 1 has a cam surface 5. The cam surface 5 is positioned adjacent the link portion 4a in a manner to engage the top surface of the jaw 3a adjacent to the end which is next to the link portion 4a. When the clamp as shown in FIG. 1 is to be used, the portion 3a is pivoted so that it overlies the jaw 3b to define between the jaws the space in which the object 6 to be clamped is placed. Thus, when the portions 3a and 3b are in this position, the end of the jaw 3a is directly beneath the cam surface 5 on the lever arm 3c and is also adjacent the fulcrum of the lever arm 3c. In this manner, the cam surface 5 when forced against the jaw 3a, exerts a high force against the jaw 3a to urge it with a high clamping force against the object 6 due to the combined effect of the lever and the cam-actions. This crushes or severely compresses the object 6 between the jaws. It is to be noted that the cam surface 5, although shown on the lever arm 3c, could instead be on the side of the jaw 3a which faces the lever arm 3c. It is also possible for both the lever arm 3c and the jaw 3a to have cooperating cam surfaces. The cam surface or surfaces can be sharply or gently curved depending upon the rate at which, and the amount of, force that must be applied in order to achieve the desired degree of compression and the amount of force available.

Means are provided for holding the clamp closed in a clamped position. This means can comprise a catch such as that shown in U.S. Pat. No. 3,204,636 to Kariher et al., or the type shown in U.S. Pat. No. 3,040,749 to Payton, or any similar catch mechanism known to those skilled in the art. The catch, however, preferably is a ratchet catch which is suitable for holding the clamp in any one of the series of fixed clamped positions. Thus, with this type catch the clamp can be used for clamping infusion tubing or the like, to vary the amount of compression of the tubing and thus control the flow therethrough. It also is possible to provide

a combination of both a ratchet catch, and an additional catch for holding the clamp in a completely closed position. However, if the clamp is to be used only for example, on an umbilical cord, a bowel, or other organ, a single position clamp such as that described hereinbelow is suitable and a ratchet type catch need not be used.

The catch mechanism can hold any two of the three clamp portions in a fixed position in relation to each other. It is preferred however, that the cam-action lever arm be one of the portions held. In this manner, the lever force is constantly applied to the jaws and accidental slippage of the catch mechanism is unlikely since it would be necessary for the lever force to be overcome in order for slippage of the catch to occur.

The catch mechanism can be formed for example on an arcuate extension on the lever arm which engages a cooperating member on the end of one of the jaws as is more particularly described below. It is also possible however for the catch mechanism to be formed on both of the jaws so that the jaws lock each other together in a clamped position. This can be done by forming a catch mechanism on the end of one jaw, and a cooperating catch mechanism on a facing portion of the other jaw, for example on the shorter leg of the L-shaped jaw so that when the two jaws are brought together the mechanisms engage each other.

As a further possibility the cam surface can be formed with teeth which engage tooth-like retainers on the facing surface of the upper jaw. The teeth are formed so as to permit the lever arm cam surface to bear against and move along the jaw forcing the jaws together but do not permit movement in the reverse direction. This can be done by forming the teeth at an angle such that the retainers engage the teeth and thereby prevent the jaws from separating.

If the clamp is to be used only once and disposed of, the catch mechanism employed can be such that once it is closed, it cannot be reopened. Thus, after a single use the clamp must be disposed of. If, however, the clamp is to be reused, the catch mechanism must be releasable. One way of providing an easily releasable catch is to make the bendable link portions of the clamp sufficiently flexible so that, if for example, a ratchet catch is used, one portion of the ratchet mechanism can be moved laterally until it is clear of the other portion of the catch. Other easily releasable catches and catch mechanisms known to those skilled in the art can also be used.

It is preferred that the lever action not be used to compress any part of the clamp body itself to permit the catch to be closed. If this is done, it is not possible to keep the clamp as tightly closed as would otherwise be possible due to spring-back in the compressed portion of the body.

The lever arm 3c in the embodiment shown in FIG. 1 is provided with an extending arcuate tail portion 7 which is formed with a toothed ratchet surface 8. The ratchet surface 8 engages a matching pawl-type catch 9 at the end of the central jaw 3b. Together the ratchet surface 8 and the pawl 9 define an adjustable catch mechanism by which the clamp can be held closed in any one of a series of fixed clamped positions ranging from completely shut, to any of a series of desired spacings between the jaws 3a and 3b. The clamp catch mechanism can be released by merely moving the end

of arm 3c laterally until the surface 8 is clear of the pawl.

The clamp 11 shown in FIG. 2 is similar to that shown in FIG. 1 in that it is formed all in one piece and has three clamp portions, 13a, 13b and 13c pivotally connected by links 4a and 4b which are thinned portions of the plastic material of the body. In contrast to the previous embodiment, the cam surface 15 is on the jaw 13a rather than on the lever arm 13c. However, the cam surface acts in the same way to assist in closing the clamp. In addition, the embodiment of the clamp shown in FIG. 2 has a tail portion 17 on which a closure catch is formed. The closure catch 20 is of the type similar to that shown in U.S. Pat. No. 3,040,749 and comprises a hook 20 which mates with a recess 22 formed in the bottom surface of the jaw 13b. This hook and recess are designed to hold the clamp completely and tightly closed for operations on a bowel, or umbilical cord such as described above. However, the clamp is also provided with a ratchet catch comprising a toothed ratchet surface 18 on the shorter arm of the L-shaped jaw 13b and a pawl-type catch 19 formed on the end of the jaw 13a. The ratchet catch combination 18 and 19 makes it possible to clamp the arm 13a and 13b in any one of a series of fixed positions.

The clamp 31 shown in FIG. 3 combines desirable features illustrated in FIGS. 1 and 2 and is comprised of the cam-action lever arm 3c linked to the jaw 3b by the thin band 4a. Jaw 3b is, in turn, linked to the jaw 3a by the hinge-action linking portion 4b. As is now understood, the cam surface 5 on lever arm 3c, when forced against the jaw 3a, exerts a high clamping force on jaw 3a to effect closing of jaws 3a and 3b. In addition, a tail portion 17 of lever arm 3c is provided with hook 20 adapted to mate with recess 22 formed in the bottom surface of jaw 3b for the purpose described hereinabove with respect to FIG. 2. It is noted that the embodiment illustrated in FIG. 3 does not include the aforescribed ratchet catch and, therefore, the illustrated clamp 31 functions as a single position clamp. It is of course understood that, if desired, suitable ratchet means may be provided to afford clamping in any one of a series of fixed positions as previously explained. When jaws 3a and 3b obtain their closed position wherein hook 20 is mated with recess 22, it is observed that the three clamp portions 3a, 3b and 3c are disposed in parallel relationship.

The clamps as described above are preferably made in one piece and of any suitable plastic material of which the thicker portions such as 3a, 3b and 3c are sufficiently rigid to perform their clamping function and of which thinner portions such as 4a and 4b have adequate tensile strength to hold the clamping portions together, but are flexible enough to act as hinges without breaking. The plastic material should also be safe for contact with human tissue without causing irritation. Such materials are well known in the art and include polypropylene, polyethylene, polyvinyl chloride, nylon, polytetrafluoroethylene, ethyl cellulose, cellulose acetate, polystyrene, polyoxymethylene, epoxide resins, ureaformaldehyde, melamine formaldehyde, phenol formaldehyde, and polyester resins. Of these, polypropylene is preferred. The clamps can have metal reinforcing members embedded in, or on, the plastic clamp if desired. However, if a suitably ridged plastic is used for the jaws and cam-action lever arm, such metal reinforcing members are not necessary.

The clamp can be made in one piece by extrusion or injection molding, or by casting or other plastic molding processes. The clamp can also be made by machining or stamping the clamp from a solid piece of plastic material. The clamp body can be unitary but not all formed in one piece as described above. However, this is less preferred. The clamp body could for example be formed in three separate portions which are then bonded together such as by heat or solvent bonding at the bendable link portions. The resulting structure is unitary although not formed all in one piece.

In order to use the clamp, the jaws of the clamp are juxtaposed in a spaced apart relationship to permit the object to be clamped to be inserted between them. The lever arm is then brought into a position such that the cam surface abuts the upper surface of the end jaw, or the lower surface of the lever arm, according to the construction employed. When a force is applied to the end of the arm, a high compressive force is applied against the object clamped between the jaws. In any of the embodiments shown in FIG. 1, FIG. 2, or FIG. 3, the object being clamped can be compressed to any desired extent and the clamp will be held fixed in a clamped position by the catch mechanism.

I claim:

1. A clamp comprised of a unitary clamp body formed of one piece of plastic material and having at least three clamp portions pivotally linked together by bendable portions of the plastic clamp body, two of said clamp portions defining clamping jaws between which the object to be clamped is placed, and the third clamp portion comprising a lever arm which is positioned so as to bear against one of the clamp jaws in a manner to exert a force thereagainst to urge the clamp jaws together and compress the object to be clamped; a cam surface included on one of said lever arm and said one clamp jaw and adapted to be contacted by one of said one clamp jaw and said lever arm, respectively, when said lever arm first bears against said one clamp jaw to assist the urging of said jaws together; and means formed by the body and operatively associated with at least two of said clamp portions for holding the clamp jaws in a fixed position.

2. A clamp in accordance with claim 1, in which said cam surface is disposed on said lever arm and positioned so as to bear against one of said clamp jaws such that said lever arm is a cam-action lever arm.

3. A clamp in accordance with claim 1, in which said cam surface is disposed on one of said clamp jaws and positioned so as to bear against said lever arm.

4. A clamp in accordance with claim 1, in which said means for holding the clamp jaws in a fixed position comprises a hook disposed on said lever arm and a recess catch situated in one of said clamp portions defining a clamp jaw, said hook and recess catch cooperating to maintain said clamp jaws in a closed position.

5. A clamp in accordance with claim 4, in which said lever arm has an extending tail portion, and in which said hook is formed on the tail portion of said lever arm.

6. A clamp in accordance with claim 1, in which said means for holding the clamp jaws in a fixed position is adapted to hold the jaws in any of a series of closed positions.

7. A clamp in accordance with claim 6, in which the means for holding the clamp jaws in any of a series of closed positions comprises a ratchet mechanism.

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8. A clamp in accordance with claim 7, in which said ratchet catch mechanism is comprised of cooperating portions formed on facing portions of the jaws.

9. A clamp in accordance with claim 1, in which the clamp is made of polypropylene.

10. A clamp in accordance with claim 1, in which one of the clamp jaws is generally L-shaped.

11. A clamp comprised of a unitary clamp body formed of one piece of plastic material and having at least three clamp portions pivotally linked together by bendable portions of the plastic clamp body, two of said clamp portions defining clamping jaws between

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which the object to be clamped is placed, and the third clamp portion comprising a lever arm which is positioned so as to bear against one of the clamp jaws in a manner to exert a force thereagainst to urge the clamp jaws together and compress the object to be clamped; and a cam surface included on one of said lever arm and said one clamp jaw and adapted to be contacted by one of said one clamp jaw and said lever arm, respectively, when said lever arm first bears against said one clamp jaw to assist the urging of said jaws together.

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