United States Patent

Weston

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[54] COMPOUND LEVER MECHANISM

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[30] **Foreign Application Priority Data**

Nov. 29, 1968 Great Britain 56,781/68

[52] **U.S. Cl.** **128/321**, 24/137, 81/416, 74/521

[51] **Int. Cl.** **A61b 17/28**

[58] **Field of Search** 128/321, 322, 323, 324, 325, 128/354, 340; 81/415–417, 427, 428; 30/254, 261; 294/18, 16, 28, 118; 33/25; 24/44, 81, 137, 252, 254, 255, 257; 74/521; 132/46, 48

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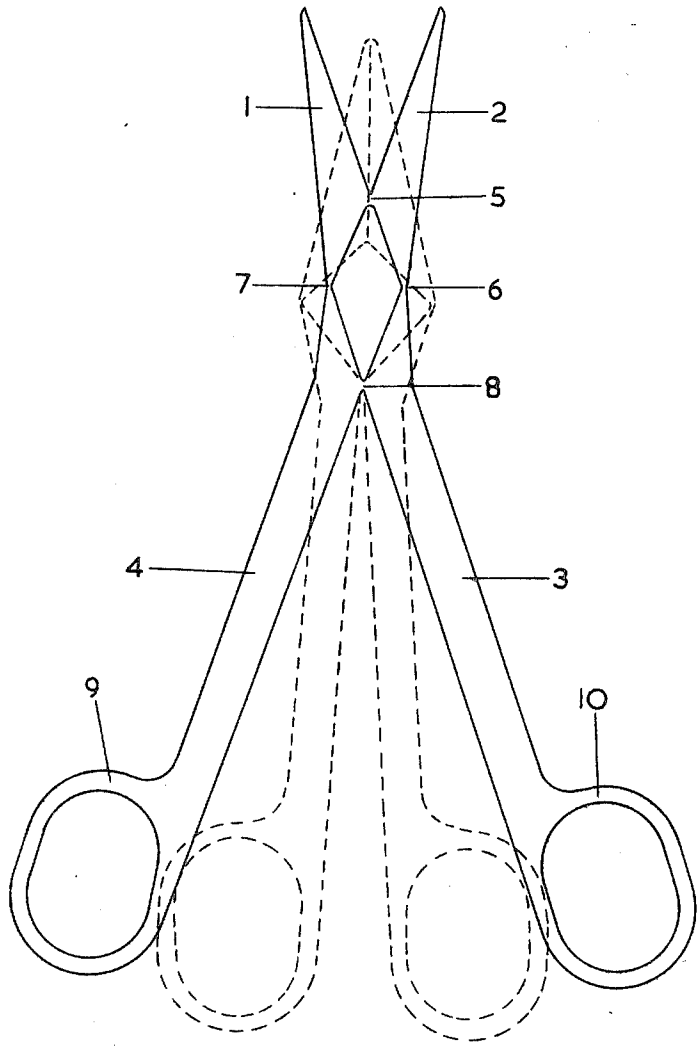
[57] **ABSTRACT**

A compound lever mechanism of integral construction comprising a pair of opposed compound levers having common fulcra each compound lever comprising two or more simple first order levers articulated in series, the common fulcra and joints between the simple levers being provided by localized zones of the construction adapted to flex preferentially when sufficient force is applied to the levers. The mechanism is suited for incorporation in a compound lever forceps or like device, thus enabling devices having a scissors action to be formed in one piece, for example as one-shot polypropylene injection moldings.

9 Claims, 5 Drawing Figures



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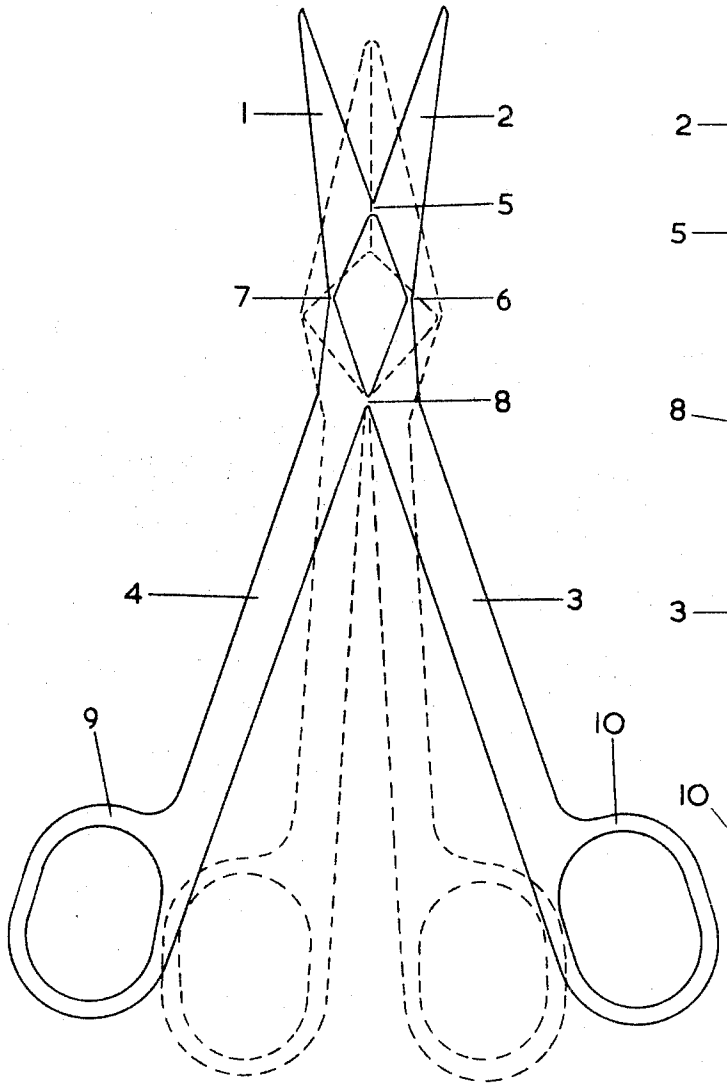

Fig. 1

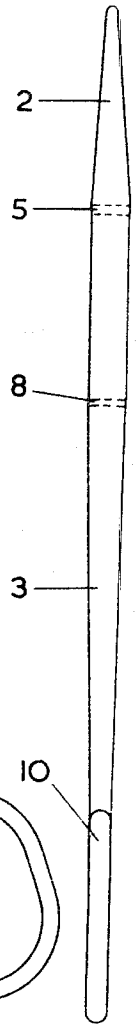

Fig. 2

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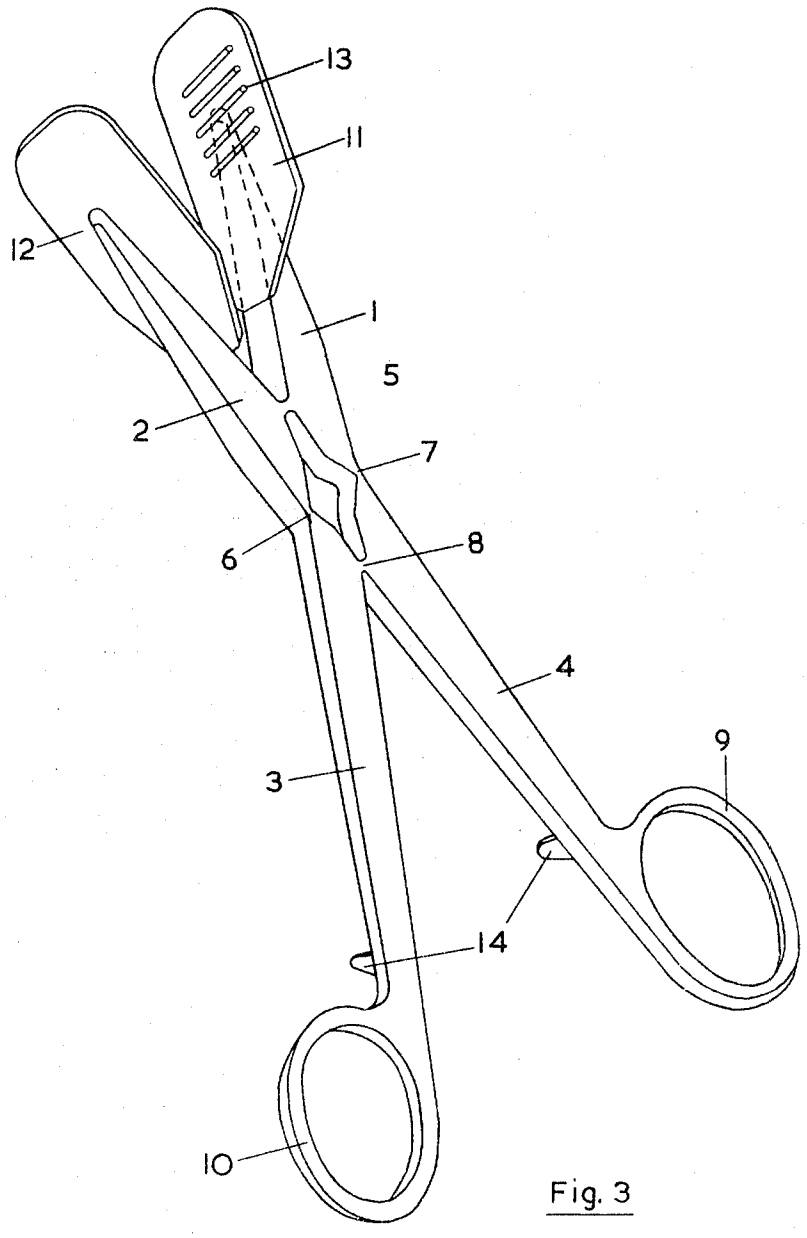

Fig. 3

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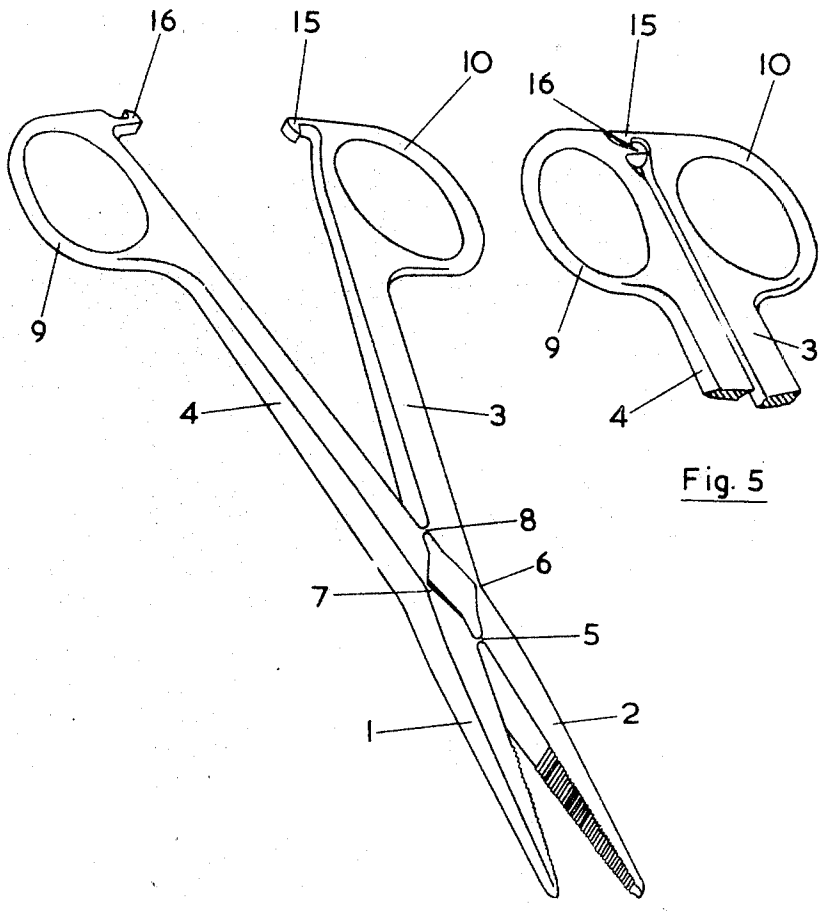

Fig. 4

Fig. 5

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COMPOUND LEVER MECHANISM

This invention relates to a compound lever mechanism and especially to such a mechanism when incorporated in compound lever forceps, pliers and like devices.

According to the present invention, a compound lever mechanism of integral construction, suitable for incorporation in compound lever forceps, pliers and like devices, comprises a pair of opposed compound levers, each compound lever comprising two or more simple first order levers flexibly jointed in series, each pair of opposed simple levers having a common fulcrum, the said fulcra and the joints between the simple lever comprising zones of preferential flexure.

By a "zone of preferential flexure" we mean a localized portion of the construction which, by virtue of its geometrical configuration and/or physical properties, is adapted to flex preferentially when sufficient force is applied to the levers and is capable of repeated flexure without fracture such as would prevent the performance of that portion as a joint or fulcrum.

Preferably the zones of preferential flexure are elongate in form and are arranged with their longest axes normal to the plane in which the levers move so as to provide lines of flexure about which the levers may rotate in a hingelike manner. This type of construction can be designed to allow a desired freedom of movement of the levers in the said plane but at the same time to provide a positive restraint on unwanted movement of the levers out of the said plane.

A "common fulcrum" may take the form of a single zone of preferential flexure, in which case the adjacent faces of the opposed simple levers are provided with protrusions to enable them to function easily as first order levers; alternatively the common fulcrum may take the form of a spacer or strut, having a zone of preferential flexure at each end. It is preferred that each common fulcrum comprises a single zone of preferential flexure.

Integral constructions according to our invention may comprise either (1) a single piece of material, for example a moulding, pressing or stamping, or (2) several rigid members, or levers, flexibly jointed together by other members having the required flexural properties so as to form an integral construction. In this context the term integral is intended to exclude specifically known similar constructions in which levers are jointed by pivots which allows rotational motion between the parts without flexure.

In constructions of type (1), the whole material must be one which has intrinsically high modulus, flexibility and fatigue resistance. Preferably the material is one which also possesses a relatively high elongation to break and high elastic recovery. In such constructions, the zones of preferential flexure are introduced by careful design of the relative parts of the construction. Thus, the relative dimensions of those parts of the constructions which are to function as levers are chosen so as to impart sufficient rigidity in the direction in which levering forces are to be applied; and those parts of the construction which are to function as fulcra or joints are designed so that they have a low resistance to flexure in the desired direction. This may be conveniently achieved by reducing the thickness of material along the desired line of flexure. The degree to which this is done will depend upon the physical properties of the material of construction and on the number of repeated flexures the mechanism is likely to be required to perform in its designed lifetime.

In constructions of type (2), whereas the relative rigidity or flexibility of the component parts may be controlled merely by choice of their physical dimensions, much greater latitude is possible since material having the most appropriate properties may be chosen for the respective parts provided that they may be joined together into an integral construction. However, such constructions may require several forming and assembling operation.

In view of this, it is much preferred that a mechanism according to our invention comprises a single piece of material. A variety of mouldable or malleable materials may be used, provided that they are capable of imparting the required

rigidity, flexibility and fatigue resistance to the appropriate parts of the mechanism. The choice of material for any particular application is further governed by the intended conditions of service under which the device is to be used. For example, in a mechanism intended to be used a relatively small number of times and then discarded, fatigue resistance would be far less important than if the device were intended to function many thousands of times without fracture of its flexible parts.

In many applications, especially where ease and cheapness of construction, corrosion resistance and lightness are important, mechanisms according to our invention may be readily produced as single piece of a suitable plastics material, for example a one-shot injection moulding. Polypropylene is a particularly suitable material for this purpose, since it is readily injection moulded, inert and cheap and also possesses an unusually high fatigue resistance in thin sections, which is commonly referred to as the "hinge effect."

An especially useful form of our mechanism is one which each compound lever comprises two simple first order levers, as will be readily appreciated from the following description.

In a preferred form of our invention, the compound lever mechanism is one in which each compound lever comprises two simple first order levers and is incorporated in a compound lever forceps or like device to which it imparts a scissorslike action. Within the term "or like device" we include, for example, pliers, tongs, clamps, clips and scissors. For convenience they will hereinafter be referred to simply as forceps.

Our compound lever mechanism may be incorporated in a forceps by affixing jaws and handles to the free ends of the appropriate simple levers of the mechanism; but preferably the jaws and handles of the forceps comprise integral extensions of the said simple levers. Thus, the whole forceps may be constructed from a single piece of plastics material, for example as a stamping or pressing, or as a one-shot injection moulding.

One-piece forceps according to our invention possess several advantages over the traditional forms in which two nonidentical members are joined together by means of a pivot, apart from the obvious advantages that only one shape of article needs to be produced and that the operation of assembling two parts by means of a pivot is obviated. For example, since opposite jaws and handles are not rigidly connected there is no inherent tendency to "cross-beak." Furthermore, when constructed from resilient materials, such as moulded plastics, the natural resilience imparted to the compound lever mechanism will tend to accommodate excessive force applied to the handles, thus limiting the force transmitted to the object being gripped in the jaws. The aforementioned resilience may also be utilized to bias the forceps into an unstressed "open" position, so that they do not have to be moved manually to the open position after use.

A forceps according to our invention may also be readily provided with means for locking it temporarily in its gripping position to enable it to be used as a clamp or clip. For example, cooperating hooklike members may be provided on the inner surfaces of the handles; alternatively a plug or spacer may be inserted in the orifice defined by the levers, joints and fulcra of the compound lever mechanism. Since this orifice commonly comprises a quadrilateral or a star shape, the angles of which are radically altered when the forceps is moved from its fully open to fully closed position, the insertion of an appropriately shaped plug may be used to lock the jaws in their closed or open positions or, indeed, in any intermediate position if so desired.

Our forceps may be designed with a variety of handles and jaws to enable them to be used in a wide range of applications. Examples of possible applications include wound dressing or obstetric forceps, photographic or philatelic forceps, eyebrow tweezers, sugar tongs, salad servers, pruning aids or seedling lifters. It is also within the scope of our invention to substitute blade members for the jaws to produce scissors.

When moulded in plastics materials our forceps possess intrinsic insulating and acid-resistant properties which may be

used to advantage. For example, they may be used to hold wires during soldering or to immerse objects in acid baths. When provided with releasable means to retain the jaws in their gripping positions, they may be used as clips or clamps for a variety of purposes, for example, as hemostat clamps, paper clips or clothes pegs.

As has already been mentioned, forceps according to our invention may be advantageously formed from polypropylene because of its well-known "hinge" effect. However, other plastics materials may also be used, especially in applications which are not required to withstand the remarkable degree of repeated flexing possible with polypropylene. For example, forceps may be moulded from polystyrene, polyethylene and their copolymers; polymers and copolymers of 4-methyl pentene-1, such as those methyl pentene polymers sold under the Registered Trade Mark "TPX" By Imperial Chemical Industries Limited; polyamides, such as nylon; ABS copolymers, or polyesters, such as polyethylene terephthalate.

When certain polymers are used, for example, nylon and polyacetal, so-called "coined" hinges may be incorporated in the device, by localized compression of the polymer in those areas in which the aforementioned zones of preferential flexure are to be located.

In order that the invention may be more fully understood, several embodiments will be described, by way of example only, with reference to the accompanying drawings of which

FIG. 1 is a plan view of a general purpose forceps incorporating a compound lever mechanism according to our invention;

FIG. 2 is a side elevation of the forceps of FIG. 1;

FIG. 3 is an isometric view of photographic tongs according to our invention;

FIG. 4 is an isometric view of a dressing forceps or hemostat clamp according to our invention; and

FIG. 5 is a part view of the forceps of FIG. 4 locked in its gripping position.

Referring to FIGS. 1 and 2, the forceps illustrated comprises in essence, a single laminar piece of polypropylene of substantially uniform thickness, formed in the shape shown in FIG. 1, the extremities being tapered slightly as shown in FIG. 2. This shape was chosen so that it generated several well-defined zones or members within the overall integral construction. For convenience, the remainder of this description will be phrased as though the forceps illustrated consisted essentially of four individual leverlike members flexibly interconnected.

Four flat members, or levers, **1**, **2**, **3**, **4**, are provided with triangulated extremities, adjacent apices of which are flexibly jointed by thin elongate webs **5**, **6**, **7**, **8**, the planes of said webs being normal to the plane of the drawing.

Pairs of articulated simple levers **1** and **4**, and **2** and **3** thus form a pair of opposed compound levers, webs **6** and **7** being capable of acting as flexible joints between the component simple levers of each pair, while webs **5** and **8** are capable of acting as common fulcra between the two compound levers, about which simple levers **1**, **2**, **3** and **4** may function as first order levers. Levers **1** and **2** are designed as gripping jaws, having serrations on their inner faces, whereas levers or handles **3** and **4** are provided with rings **9** and **10** at their extremities remote from flexible webs **6**, **7** and **8**, to facilitate operation, scissors fashion.

In use, when inward pressure is applied to handles **3**, **4**, by insertion of thumb and forefinger in rings **9**, **10**, the forceps is caused to assume the shape shown in broken lines in the drawing. It will be seen that this has the effect of bringing together jaws **1** and **2** in a gripping action. Because of the natural resilience of polypropylene on release of the inward pressure on handles **9**, **10**, the forceps springs back to its original shape. Once the jaws **1**, **2** have been brought together further inward pressure results in outward movement of webs **6**, **7** thus limiting the pressure transmitted to the jaws **1**, **2**.

The thickness of webs **5**, **6**, **7**, **8** must be such that they present considerably less resistance to flexure than is possessed by levers **1**, **2**, **3**, **4**. Generally speaking the webs have a thickness of about 0.020 inch to 0.060 inch, to allow ready flexure but to impart sufficient resistance to twisting of the device about the normal plane of its laminar parts.

The device illustrated was made from "Propathene" (R.T.M.), I.C.I.'s brand of polypropylene. Data relating to the choice of dimensions to obtain best use of the "hinge effect" in this material may be obtained from the I.C.I. publication "-Propathene for Integral Hinges."

It will be appreciated that the proportions of levers **1**, **2**, **3**, **4** may be varied considerably within the general concept of our invention, to give added rigidity to certain parts of the device, to allow the jaws to accommodate articles of various shapes, or to vary the degree of leverage obtainable.

Photographic tongs, illustrated in FIG. **3**, are one example of such a modification. Again these are of integral polypropylene construction and have a general similarity to the forceps of FIG. **1** as indicated by the reference numerals **1** to **10** which refer to like parts. Additionally, the tongs of FIG. **3** are provided with spatulate members **11**, **12** at the extremities of jaw members **1**, **2**. Raised ridges **13** are provided on the cooperating faces of spatulate members **11**, **12** to improve their grip. Protrusions **14** are provided on the lower faces of handles **3**, **4**, close to rings **9**, **10**. Tongs as illustrated in FIG. **3** are particularly adapted for use in photographic developing or the like. In use, prints, film, etc., may be readily gripped by the spatulate ends **11**, **12** and protrusions **14** allow the tongs to be hooked on to the side of a developer dish while the jaws rest on the bottom of the dish, thus preventing the tongs from inadvertently slipping into the dish.

Wound dressing forceps illustrated in FIGS. **4** and **5** consist of a one-shot injection moulding of polypropylene. It is of similar general form to the forceps illustrated in FIG. **1**. These dressing forceps are suitable for inclusion in sterile packs enclosed in airtight plastic bags, generally referred to as "-dressing packs." Sterilization of the forceps may be performed after packing by means of ethylene oxide treatment or irradiation, in keeping with known techniques.

Forceps illustrated in FIGS. **4** and **5** are provided with interlockable hooklike members **15**, **16** on the inner faces of handles **3**, **4**. These may be used to secure the jaws in their gripping position with a "snap" action; they may be released by relative displacement of handles **3**, **4** out of the normal plane of movement.

Lockable forceps of this type may be used as temporary hemostat clamps, being supplied presterilized in airtight packs as described above. However, it may be desirable to omit hooklike members **15**, **16** if the forceps are to be used exclusively for handling dressings.

The invention has been illustrated by means of devices incorporating a pair of compound levers each comprising two simple levers; but it will be readily appreciated that the same constructional principles may be repeated in the longitudinal direction of the drawing by using compound levers comprising three or more simple levers, to produce devices akin to a "lazy tongs." Such devices have well-known applications where remote control is required.

I claim:

1. Forceps-type device of integral construction in plastics material comprising

a first compound lever comprising a first operating handle and a first jaw member each being first order levers,

a first flexible joint joining the first operating handle to the first jaw member,

a second compound lever comprising a second operating handle and a second jaw member each being first order levers,

a second flexible joint joining the second operating handle to the second jaw member,

a first common fulcrum for the first and second operating handles,

a second common fulcrum for the first and second jaw members,

said first and second flexible joints and said first and second common fulcra comprising localized portions of the integral construction which flex without substantial flexure of the attached operating handles or jaw members on application of force to said operating handles or jaw members and constitute lines of flexure about which the operating handles or jaw members rotate in hingelike manner.

2. A forceps-type device according to claim 1 which is in the form of a single piece of plastics material.

3. A forceps-type device according to claim 2 in the form of a one-shot injection moulding.

4. A forceps-type device according to claim 2 in which the plastics material is selected from ethylene polymers, propylene polymers, polyamides, polyesters and polyacetals.

5. A forceps-type device according to claim 4 in which the plastics material is polypropylene.

6. A forceps-type device according to claim 1 having means for releasably locking the jaws in their gripping position.

7. A forceps-type device according to claim 1 wherein said first and second flexible joints are opposed to each other in spaced relationship between said fulcra, the joined levers being so shaped between said fulcra that the thickness varies gradually from a minimum at said joints to a maximum at said fulcra.

8. A forceps-type device according to claim 7 wherein the levers are gradually tapered inwardly from the flexible joints to the fulcra so that each flexible joint is essentially a line across the width of the joined levers and an essentially diamond-shaped open space is left between the fulcra and joints to permit inward movement of the joints.

9. A forceps-type device according to claim 8 wherein the levers constituting said first and second operating handles are shaped so that when the jaw members are open, the distance between said handles increases gradually from the first common fulcrum to the outer ends of said handles and said outer ends may be brought into contact to close said jaw members.

* * * * *