A method of manufacture of clip applying jaws in which the jaws are formed by progressive die stamping, and wherein clip entry grooves and clip holding grooves in the jaw faces are formed by broaching tools forming part of the progressive stamping die.
METHOD OF MANUFACTURE OF CLIP APPLYING JAWS

Field of Invention

The present invention relates generally to instruments used in surgery, namely, surgical clip applicators having jaws for crimping a clip to tissue in a surgical procedure, and specifically to a method of manufacture of such jaws.

Background of the Invention

Surgical clips may be fabricated of one of several materials including titanium, stainless steel, and tantalum. Clips are generally U-shape with arched cross piece and parallel legs extending from each end of the cross piece. The clip inner surface is patterned, as by knurling for example, to aid adhesion to tissue. The cross section of the clip may be rectangular, semi-circular, triangular, or inside crescent in shape. When semi-circular or inside crescent the clip outer surface is curvilinear. When triangular, the inner surface is base and outer surface converges to apex of triangle. In normal practice, the clip is built first, and then jaws. The contour of clip outer surface determines contour of clip entry and clip holding grooves formed in clip applicator jaws.

Clip applicator jaws comprise elongate parallel jaw arms joined to each other at one end to form common base, with the arms spaced apart and at their opposite ends having integral confronting jaws capable of receiving and holding a surgical clip for application in surgery. The jaws are preferably fabricated of stainless steel such that the jaw arms have a natural resilience or spring force wherein the arms return to parallel after being squeezed together for applying a clip in surgery. As a result, a gap normally exists between opposing jaws faces and clips fed into the jaws in
operation of the instrument are held between these faces. The jaw heads are normally canted with respect to the jaw arms to provide visibility to physician who can see clip held by jaws at a surgical site. For this purpose, the optimum cant is an angle of about 30°. A smaller cant angle of jaw head to arms is required in endoscopic instruments used with trocars.

Confronting jaw faces themselves each have a clip entry groove and a clip holding groove that conform to the outer surface of a surgical clip. In a preferred embodiment described below, jaw faces have triangular grooves.

Jaws are normally formed by a metalworking method known as progressive stamping in which a strip of metal unrolled from a coil is fed through all the stations of a progressive stamping die. By this method base, arms, and canted jaws are formed, and at the final station of a progressive die, the finished jaws are separated from the carrying web of coil material.

In conventional manufacturing practice, finished jaws are collected in batches and are then taken to a milling machine, usually a computer numerical control milling machine, where each set of jaws is manually loaded for milling an entry groove and holding groove into each jaw face.

This practice is labor intensive and requires an added precision milling machine both of which result in significant increased cost of each jaw so made. Moreover, manual transfer of jaws in batches from progressive stamping machine to computer numerical control milling machine creates significant concern for unwanted and undesirable variances in manufacturing tolerances and undue increase in manufacturing complexity. Clip applying instruments comprise a complex set of clip handling components the assembly and functioning of which must meet a
performance standard approved by the FDA. Manufacturing complexities bear a regulatory cost in addition to that arising from manufacturing considerations.

The present invention provides a method of manufacture of clip applying jaws in which jaws are made in a progressive stamping die eliminating a separate milling process for forming entry grooves and holding grooves in jaw faces and the manifold attendant disadvantages.

Summary of the Invention

In accordance with the present invention, clip applying jaws are manufactured utilizing a progressive stamping die for forming jaw set base, arms, jaw heads, canting jaw heads with respect to jaw arms, and forming jaw face entry groove and holding groove for loading and holding a surgical clip.

In accordance with the invention, a progressive stamping die for fabricating jaws is fitted with broaching tools for forming both the entry groove and holding groove to finished product specification.

In accordance with the invention, a significant manufacturing cost saving is realized by eliminating a separate milling operation for jaw grooves. Integrity of jaw manufacturing dimensions and tolerances, as well as product uniformity is ensured by completing jaw fabrication in one pass through a progressive stamping die.

Objects of the Invention

An object of the invention is to provide significant reduction in cost of manufacture of clip applying jaws.

Another object of the invention is to eliminate the need for transferring of partly formed jaws to another machine for completing part manufacture.
Another object of the invention is to simplify jaw manufacture by forming completed parts in one machine thereby avoiding part tolerance complexities inherent in transferring a part from one machine to another to complete its formation.

Another object is to provide a method of manufacture for clip applier jaws in which the jaws are formed in full in a progressive stamping die.

Another object is to provide a method of manufacture for clip applier jaws in which the jaws are formed in full by a progressive stamping die including jaw face entry groove and holding groove.

Other and further objects of the invention will become apparent with an understanding of the following detailed description of the invention or upon employment of the invention in practice.

BRIEF DESCRIPTION OF THE DRAWING

A preferred embodiment of the invention has been chosen for detailed description to enable those having ordinary skill in the art to which the invention appertains to readily understand how to construct and use the invention and is shown in the accompanying drawing in which:

Figure 1 is a plan view of clip applier jaws fabricated by the method of the present invention.

Figure 2 is a section view taken along line 2-2 of Figure 1.

Figure 3 is a section view taken along line 3-3 of Figure 2.

Figure 4 is a section view taken along line 4-4 of Figure 2.

Figures 5a and 5b are side elevation and bottom view, respectively, of a surgical clip.

Figure 6 is an enlarged plan view of a jaw head of the jaws of Figure 1.
Figure 7 is an enlarged perspective view of a jaw head of Figure 1 showing clip holding groove and entry groove configurations.

Figure 8 is a schematic view of jaws being formed in a progressive stamping die from a coil of metal, typically stainless steel.

Figure 9 is a schematic view showing tool for formation of jaw face groove in progressive stamping die.

**Detailed Description of the Invention**

Referring now to Figures 1-5, clip applicer jaws 10 fabricated according to the invention typically comprise elongate parallel jaw arms 12 joined at a common base 14 having an opening 16 for anchoring the jaws within a clip applying instrument. The arms have integral jaw heads 18 for receiving, holding, and applying a clip 20 in a surgical procedure. The arms have a cam surface 12a cooperating with a cam puller 22 for closing the jaws and crimping a clip. The jaws are preferably fabricated of stainless steel such that the jaw arms have a natural resilience or spring force wherein the arms return to parallel after being squeezed together for applying a clip in surgery.

Each jaw arm terminates in a jaw head canted at an optimal angle of about 30° as an aid to visibility of jaws and clip at a surgical site. Jaw heads have confronting faces 18a (Fig 4) with a gap between opposing jaw faces. Clips fed into the jaws in operation of the instrument are held between these faces. Each jaw face has an entry groove 18b and a clip holding groove 18c that conform to the outer surface of a clip.

Surgical clips 20 shown in Figs 5a-b are generally U-shape with arched cross piece 20a and parallel legs 20b-c extending from each end of the cross piece. Inner
leg surface 20d may be patterned to aid adhesion to tissue. In a preferred clip embodiment chosen for illustrating the principles of the invention, the cross section of the clip is triangular with inner surface 20e as base and outer surfaces converging to apex 20f of triangle. Jaw face entry groove 18b and clip holding groove 18c have triangular contour conforming to clip cross section.

Figures 3, 4, 6, and 7 illustrate jaws heads with confronting faces each having a clip receiving groove 18c extending substantially the full length of the face. Each groove is defined by concave wall forming the base of the groove, and upper and lower marginal edges along the jaw face. At the bend or apex A of canted jaw head to jaw arm, an entry groove 18b is formed for guiding clips into jaw grooves during operation of the instrument. The entry groove 18b is defined by extension of jaw face lower marginal edge 18d through apex A, extending across inner surface 12b of jaw arm, terminating at a first point 12c along the upper edge 12e of jaw arm, and by forming a recess 12d in the upper edge 12e of jaw arm between the first point 12c and a second point 12f at the upper marginal edge 18e of grooved jaw face 18a. Entry grooves guide clips into the jaw face clip holding grooves.

Jaw formation by progressive stamping die is shown schematically in Figure 8 where a coil of metal such as stainless steel is fed step-by-step in a web W through a plurality of forming stations A-K to progressively cut away metal from the web so as to deliver a set of jaws from the die. Formation proceeds in the direction of arrow L through stations at which web material is removed leaving jaw preforms with jaw heads bent 30° or less (depending on type of jaw) from a plane defining the jaw arms.

In accordance with the invention, a broaching tool 30 shown in Figure 9 forming part of the progressive die forms each jaw face clip entry groove and clip
holding groove. The progressive die comprises pressure plate 32, die block 34 and forming base 36. The broaching tool is mounted in vertically sliding die block 34 and comprises a drive cam 30a, cam follower tool head 30b, and broach 30c all fitted to die block 34. The tool head is spring biased and drive cam 30a acts against that bias in driving the broach in forming grooves in a jaw head.

There are several configurations of operation of the broaching tool according to the invention.

At station B, the jaw heads are held steady by die blocks b' as clip entry grooves 18b are formed by broaching tools acting together in the direction of arrows M. The work piece advances to station G where a double edge broach tool acting in the direction of the arrow N forms clip holding grooves 18c in jaw head held by die blocks g'.

In another configuration there is a two part first step for forming clip entry grooves and a second step for clip holding grooves. In part one of the first step, a work piece arrives at a broaching station and first broaching tool forms clip entry groove in one jaw face. In part two, the work piece is then indexed to next station where second broaching tool forms entry groove in other jaw face.

In the second step, the work piece is again indexed to another broaching station where a single broach tool having dual broaching edges forms clip holding grooves in both jaw faces in a single pass.

In still another configuration, a work piece arrives at broaching station and has jaw arms spread apart. A single broach tool having dual broaching edges forms clip entry grooves in both jaw faces in a single pass. The work piece is then indexed to next station where a single broach tool having dual broaching edges forms clip holding grooves in both jaw faces in a single pass.
The method of manufacture of clip applying jaws performed by the present invention includes the following steps:

passing a metal web step-by-step through a series of stations in progressive stamping die,

removing metal from the web passing through the stations to form a set of preform jaws having a base with means such as an opening for anchoring the jaws to a clip applier instrument, parallel jaw arms integral at one end with the base, extending in parallel from the base, and each arm having a jaw formed at its other end, the jaws of said arms being in confronting relation with confronting jaw faces,

canting the jaw heads of the set of preform jaws at an angle with respect to jaw arms,

advancing the canted preform jaws to a first subsequent die station in the progressive stamping die,

forming a clip entry groove in each jaw face of each preform jaw set at said first subsequent station by means of a broach,

advancing the preform jaws to a second subsequent die station in the progressive stamping die, and

forming a clip holding groove entry in each jaw face of each preform jaw set at said second subsequent station by means of a broach.

The method may include the step of spreading the jaw arms to form an acute angle with each other prior to the step of forming a clip entry groove in each jaw face of each preform jaw set by means of a broach.

The method applies also formation of a jaw arm in one piece with a pair of jaws arms later assembled in a clip applying instrument. With a single jaw arm, an entry groove may be formed with a broach as at station B of Figure 8, and clip
holding groove as at station G. Alternatively, a single jaw arm may be spread for formation of entry groove with a straight ahead broach, and returned to normal straight ahead alignment for formation of clip holding groove as at station G, Figure 8.

Various changes may be made to the structure embodying the principles of the invention. The foregoing embodiments are set forth in an illustrative and not in a limiting sense. The scope of the invention is defined by the claims appended hereto.
What is claimed is:

1. A method of manufacture of clip applying jaws including the following steps:

   passing a metal web step-by-step through stations of progressive stamping die,

   removing metal from the web passing through the stations to form a set of preform jaws having a base with anchor means, parallel jaw arms integral at one end with the base, extending in parallel from the base, and each arm having a jaw formed at its other end, the jaws of said arms being in confronting relation with confronting jaw faces,

   canting the jaw heads of the set of preform jaws at an angle with respect to jaw arms,

   advancing the canted preform jaws to a first subsequent die station in the progressive stamping die,

   forming an entry groove in each jaw face of each preform jaw set at said first subsequent station by means of a broach,

   advancing the preform jaws to a second subsequent die station in the progressive stamping die, and

   forming a clip holding groove in each jaw face of each preform jaw set at said second subsequent station by means of a broach.

2. A method of manufacture of clip applying jaws including the following steps:

   passing a metal web step-by-step through stations progressive stamping die,

   removing metal from the web passing through the stations to form a set of preform jaws having a base with anchor means, parallel jaw arms integral at one end with the base, extending in parallel from the base, and each arm having a jaw
formed at its other end, the jaws of said arms being in confronting relation with confronting jaw faces,
canting the jaw heads of the set of preform jaws at an angle with respect to jaw arms,
advancing the canted preform jaws to a first subsequent die station in the progressive stamping die,
spreading the jaw arms to form an acute angle with each other,
forming an entry groove in each jaw face of each preform jaw set at said first subsequent station by means of a broach,
advancing the preform jaws to a second subsequent die station in the progressive stamping die, and
forming a clip holding groove in each jaw face of each preform jaw set at said second subsequent station by means of a broach.

3. A method of manufacture of clip applying jaws including the following steps:
   passing a metal web step-by-step through stations of progressive stamping die to form at least one jaw arm with jaw head and jaw face,
canting the jaw head at an angle with respect to jaw arm,
advancing the canted jaw head to a first subsequent die station in the progressive stamping die,
forming an entry groove in the jaw face at said first subsequent station by means of a broach,
advancing the jaw arm to a second subsequent die station in the progressive stamping die, and
forming a clip holding groove in the jaw face of the jaw arm at said second subsequent station by means of a broach.

4. A method of manufacture of clip applying jaws including the following steps:
   passing a metal web step-by-step through stations of progressive stamping die to form at least one jaw arm with jaw head and jaw face,
   canting the jaw head at an angle with respect to jaw arm;
   advancing the canted jaw head to a first subsequent die station in the progressive stamping die,
   broaching an entry groove in the jaw face at said first subsequent station by means,
   advancing the jaw arm to a second subsequent die station in the progressive stamping die, and
   broaching a clip holding groove in the jaw face of the jaw arm at said second subsequent station.