Aug. 26, 1969 E. B. McDERMOTT 3,463,156

HEMOSTATIC CLIP AND APPLICATOR

Filed May 27, 1965 2 Sheets-Sheet 1

FIG.1

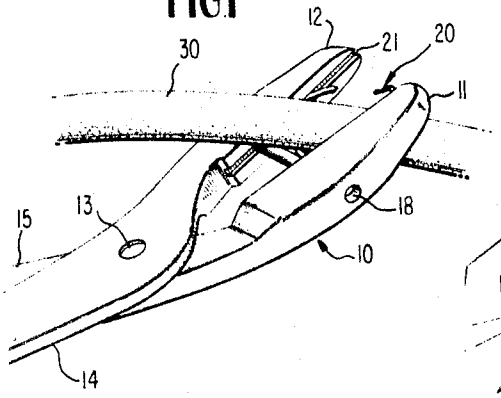


FIG.2

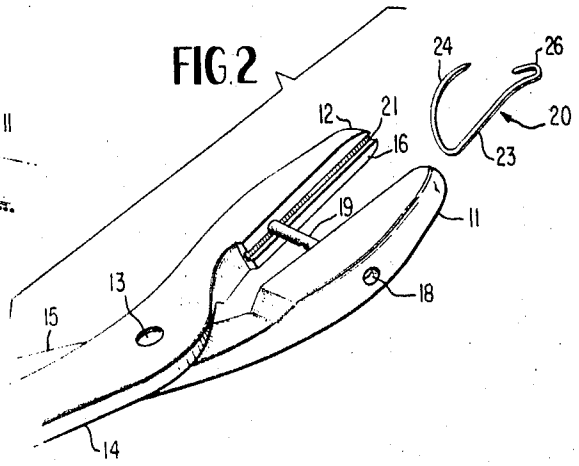


FIG.3

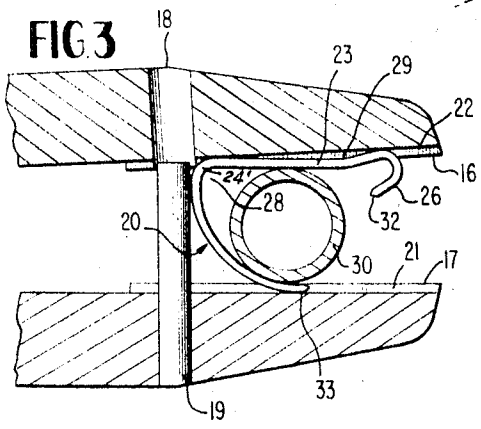
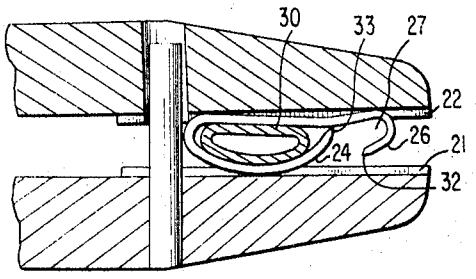


FIG.4



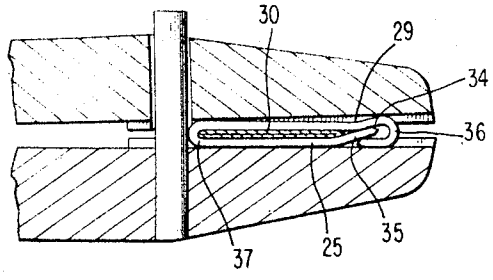


FIG.5

FIG.7

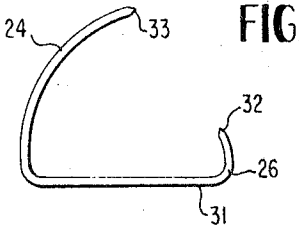


FIG.6

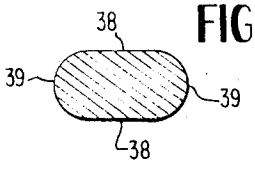
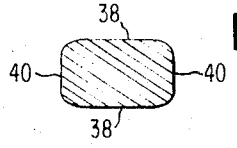


FIG.8



INVENTOR
EDWARD B. McDERMOTT

BY Browne, Schuyler & Beveridge
ATTORNEYS

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FIG. 9

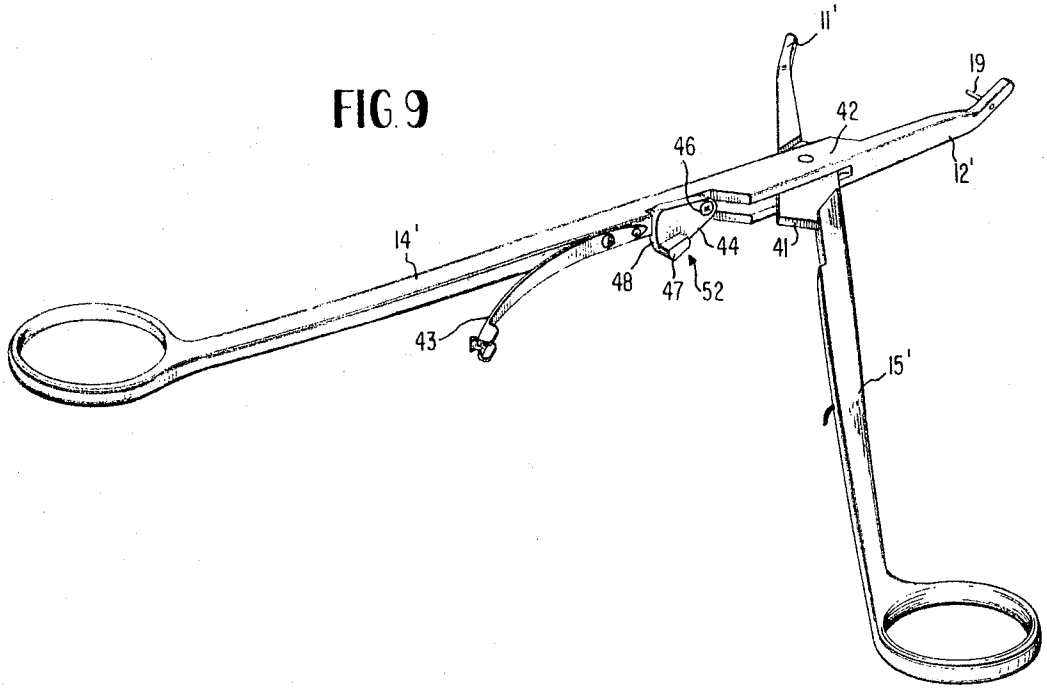
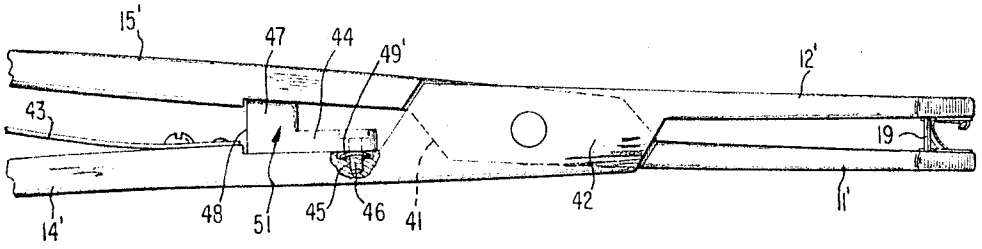


FIG. 10



INVENTOR

EDWARD B. McDERMOTT

BY Browne, Schuyler & Beveridge

ATTORNEYS

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HEMOSTATIC CLIP AND APPLICATOR

Edward B. McDermott, 23 Flower Lane, Manhasset, N.Y. 11030; Bernard Rackear, executor of said Edward B. McDermott, deceased

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U.S. Cl. 128—325 13 Claims

This invention relates generally to hemostatic devices and more particularly to a metallic clip and applicator therefor.

Surgical operations normally require the tying off of considerable numbers of blood vessels during the making of an incision. Because no suitable clip of acceptable characteristics has been available, hand tying with standard suture materials has been a necessity. In deep surgery, hand tying is difficult for the surgeon to perform, especially where space is anatomically limited. The positiveness of such ligations is also a source of serious concern to the surgeon. At lesser depth, the hundreds of bleeders which the surgeon must tie off take up as much as three-quarters of the total operating time.

It is accordingly an object of this invention to provide a positive, quick-closing hemostatic clip.

Another object of the invention is to provide a metallic clip which closes and locks merely by the application of pressure at the jaws of an applicator device.

Another object of the invention is to provide a hemostatic clip which is compatible with growth processes such that the clip is accepted by the body over a considerable period of time.

A further object of the invention is to provide an improved surgical applicator for a hemostatic clip of improved speed and certainty of result in tying off blood vessels.

A still further object of the invention is to provide an improved method of hemostasis.

These and other objects of the invention will be evident as the description proceeds in connection with the drawings in which:

FIG. 1 is a perspective view of the jaws of an applicator clamp, a blood vessel, and a clip being closed thereon, according to this invention;

FIG. 2 illustrates the jaws of the clamping device of FIG. 1 and a hemostatic clip to be applied thereby, not yet inserted;

FIG. 3 is a sectional view of the clamping jaws, blood vessel, and clip of FIG. 1 inserted therein;

FIG. 4 is a sectional view of the apparatus as in FIG. 3 with the jaws partially closed;

FIG. 5 is a sectional view of the apparatus of FIG. 3 in the closed position;

FIG. 6 is a cross-sectional view of a preferred form of stock for manufacture of a hemostatic clip;

FIG. 7 shows an alternative form of the hemostatic clip;

FIG. 8 shows an alternative form of hemostatic clip stock;

FIG. 9 shows an alternative form of the applicator including an open-jaw position lock; and

FIG. 10 shows details of the positioning lock.

The objects of the invention are achieved by the use of an applicator and a formed clip of somewhat flattened wire-like material arranged to be folded together to pinch off blood flow through veins or arteries. A self-locking feature is provided in the construction of the clip so that it is held closed in the manner of a safety pin, but of simpler structure, and of material suitable for temporary or permanent use within living tissue. A special applicator provides ease and speed of performing the clamping operation at the time time locking the clasp in the closed position. A clip of round-edged flat material is preferred to avoid damage to surrounding tissue and is preformed with an open side arranged to be closed firmly and locked at one end while leaving throughout the body of the clip an open space sufficient for the wall of the blood vessel being closing off. Application is by a simple squeezing operation at the handles of the applicator; while premature closing of the clip is prevented by a jaw-positioning lock.

Proceeding to a more detailed description of the applicator, attention is directed first to FIG. 1 wherein there is shown at **10** an applicator of suitable type, here illustrated as a set of forceps somewhat like a conventional temporary blood vessel hemostasis clamp, suited for manual operation to close a blood vessel. Such a clamp, when modified to serve as an applicator tool, is provided with contoured jaws **11** and **12** attached together through a suitable pivot point **13**, or otherwise through multiple pivot points to provide a parallel-jaw operation. In either case, it is convenient to employ narrow jaws of stainless steel, or the like, extended from handles as at **14** and **15** by which the jaws are operated. Conventionally, in such clamps, jaws **11** and **12** are disposed at an offset angle to handles **14** and **15** in order to facilitate operation of the jaws adjacent to the side of an incision. Jaws **11** and **12** are shown illustratively of a shortened form of applicator.

Applicator **10** may be a hemostasis clamp of conventional type somewhat modified to exhibit channeled jaw surfaces **16** and **17**, and may be slender and elongated to reach deep within an incision without occupying excessive space therein. As will be seen in FIG. 2, surface **16** has a straight, flat-bottomed channel **21**, nearly rectangular in section, running longitudinally from the tip of the jaw. Surface **17** on the opposing face is of the same construction. The opposing channels **21** and **22** are laterally parallel and have nearly coincident center lines when closed. The depth of each channel is the same as the thickness of the stock of hemostatic clip **20**. Each channel is sufficiently wider than the hemostatic clip to permit longitudinal motion therein.

In FIG. 3 may be seen pin **19** rising perpendicularly from the bottom of groove **21** towards clearance hole **18** in opposing jaw **11**. Hole **18** and pin **19** are preferably located on the lateral midlines of grooves **22**, **21**. Pin **19** acts as a locator stop for hemostatic clip **20** when it is inserted into the applicator jaws. It is positioned according to the dimensions of the hemostatic clip to be applied thereby so that the hooked end of portion **23** is safely back from the tip of jaw **11**. The pin also acts as a firm stop behind hemostatic clip **20** when a vessel is brought into the hemostatic clip and pressed against the inner wall near clip bend **28**, as seen in FIG. 5.

In addition to the flat-bottomed grooves and the stop pin described above, the applicator, as adapted from a standard hemostasis clamp, differs in another important feature, more particularly shown in FIGS. 9 and 10. The jaws **11'** and **12'** correspond to jaws **11** and **12** of FIGS. 1 and 2, while handles **14'** and **15'** correspond to handles **14** and **15**. While the form of the clamp differs considerably from that of FIG. 1, it illustrates an alternative type of clamp adaptable as a clip applicator in generally the same manner, but includes an additional feature serving to expedite the completion of blood vessel tie-off, and avoiding certain difficulties which would otherwise arise.

One of the problems with U-shaped or V-shaped clips presently in use is that they frequently fall from the applying forceps before they can be applied to a vessel. The hemostatic clip described hereafter fits so tightly into opposing channels **21** and **22** that it cannot be dislodged

during ordinary surgical procedure. However, if a nurse during loading, or a surgeon before clip application, should accidentally close the forceps' jaws partially, the clip would then be partially closed and upon release of the accidental pressure, the clip would fall from the jaws. To prevent this, a position lock is added to a standard clamp. In this form of clamp a strong and rigid conventional arrangement includes a tongue portion **41** which is a broadened and somewhat thinned section of the handle **15'** which is positioned within a slotted portion **42** of the handle **14'**. One of the handles may be provided with a return spring **43** tensioned to cause reopening of the jaws when they have been closed during use.

The open-jaw stop or position lock may be fitted to one of the handles, and consists of positioning member **44** mounted on the inside of the handle being fitted with hole **45** to receive screw **46** passing through member **44** to retain the same in rotatable position about the axis of the screw **46** mounted perpendicular to the handle. Handles **14'** and **15'** are appropriately cut away to receive the body of the positioning member between the handles when closed. However, a spacing land **47** is provided at one side of the member **44** having a sufficient height so that the handles can be closed only sufficiently to grasp the open clip between jaws **11'** and **12'**. Adjacent spacing land **47** there is a flush portion **48** which, when placed between the handles, permits their complete closing to clench the clip in the jaws **11'** and **12'**. Preferably, screw **46** is provided with a spring washer **49'** shaped to provide tension on the member **44** thereby to retain it either in the open or the closed position and thereby to make the spacing land **47** effective to prevent the premature closing of the jaws beyond a predetermined open-jaw spacing, or to permit the full closing of the jaws when the flush land **48** lies between the handles. Member **44**, when in the closed position as at **51**, provides a position lock against which considerable pressure can be applied as the surgeon grasps the clamp and prepares to apply the clip to a vessel, while the released position as shown at **52** is the position of member **44** when the hemostatic clip is to be closed on a vessel.

Clip **20** is preferably formed of a stainless steel such as the alloy known in the trade as 316 L, which is particularly suitable for the purpose since it is compatible with body processes. When made of such a material and suitably shaped without sharp or cutting edges, a foreign body of this type and configuration may be permanently retained within the flesh, or may be removed at the close of an operation. Such a clip constitutes a highly efficient hemostasis device when used in conjunction with the above described applicators and is found to be effective in saving time and sometimes the life of a patient. Other materials may be substituted for alloy 316 L but these materials should be selected for compatibility with the body and must possess suitable characteristics of rigidity and bendability.

Preferably, the clip stock is of flattened metallic wire such as would be produced by taking a standard round wire of the selected alloy and passing it through pinch rollers to produce flattened surfaces on opposite sides, leaving rounded edges as at **38** and **39** of FIG. 6. Wire of flattened form is utilized to prevent any cutting through of the blood vessel when the jaws are firmly clamped together, and has desirably rounded edges as at **39**, serving both to prevent any tendency to cut the vessel **30** or the surrounding tissue if left in place bearing against the flesh. The material from which the clip is made is preferably annealed so that the clip may be bent for closing and locking without appreciable elastic return. It may be formed of alloy wire drawn to a shape, as illustrated in FIG. 6 or FIG. 8, or may be round wire rolled flat in one dimension as in FIG. 6, or in perpendicular dimensions as in FIG. 8. In either case, it has a broad inner face and rounded edges.

Clip **20** is preformed to have a generally straight portion **23** extending throughout substantially half the length of a suitably precut strip. Portion **23** becomes the back of a clip resembling a safety pin of which the front closure member **24** is illustrated as bent about an arc comparable to the length of the straight portion **23**. Thus closure portion **24** has one end which may be linearly extended into hook **26** as portion **24** becomes flattened to the form shown at **25** when the jaws are closed. While portion **24** is illustrated as arcuate, it may, of course, be of other shape such that its overall length, while bowed, is insufficient to reach from its junction with portion **23** to hook portion **26** at the opposite end of portion **23**. Hook **26** is preferably formed by bending the strip about a suitable radius **27**, for example, approximating the lateral dimension of the flattened wire. Closure member **24** is bent at the opposite end of back portion **23** about a radius **28**, preferably approximating four times radius **27**.

It will be noted that the clip has a reverse bend **29** near the hook such that the bend **26** of the hook portion is offset from the linear portion by an amount approximately double the thickness of the wire. This construction facilitates entry of the vessel **30** and, by turning the opening in hook **26** from a sidewise direction to more of an upward position, permits point **33** to descend into the hook more easily. Points **32** and **33** are brought into locked engagement wherein the clip portion **35** is clenched between hook portions **34** and **32**. A clamping action resulting from closing jaws **11** and **12** causes closure of the clip and flattening of the bend in closure element **24** while leaving a portion **35** bent with respect to flat portion **25**, portion **35** then being approximately parallel to the back leg **34** of the hook. This construction assures a correct bending about points **27** and **28** and a straightening of element **24** as illustrated in FIG. 5.

In addition to faciliating closure, reverse bend **29** confers other distinct advantages. First, it increases the opening between hook end **32** and closure arm end **33** so that the surgeon may more easily introduce vessels into the inside of the hemostatic clip. Second, it is bend **29** which makes it possible for hook end **32** to close into a position in line with portion **25** (FIG. 5). This coplanar condition produces a closed hemostatic clip with no free ends to pierce surrounding tissue. Third, bend **29**, in conjunction with the three layers of wire in the clench area (portion **35**, and hook sides **34** and **32**) preserves the size of the open space occupied by vessel **30**. This assures that the opening between the parallel arms of the closed hemostatic clip (portion **23** and portion **25**) is always the same, regardless of the amount of pressure used to close jaws **11** and **12**. Because of this built-in safeguard, a surgeon cannot cut a vessel by closing the hemostatic clip too tightly, while permitting a complete clenching, and a more rapid hemostasis operation is facilitated.

Recapitulating, the clip may be described as having a straight back portion **23** which is connected at a first bend **24'** to the front closure member **24**, and which is connected at the reverse bend **29** to the hook **26**. The length of the wire forming the front closure member **24** is greater than the straight line distance from the bend **24'** to the outer end of the hook **26**; yet, the outer end of the bowed closure member **24** is farther from the bend **24'** than is the outer end of the hook **26**. The presence of the reverse bend **29** causes one leg **34** of the hook **26** to lie on an opposite side of the longitudinal axis of the back portion **23** from the front closure member. The reverse bend is closer to the hook-forming bend **27** than to the bend **24'**; and, the outer leg **32** of the hook **26** is shorter than the leg **34** which extends immediately from the reverse bend.

While a preferred form of the hemostatic clip has a shape generally as at **20**, including the reverse bend at **29**, the latter may be omitted and the back portion left straight as at **31** in FIG. 7, but lacks the advantages of bend **29** noted above, but it can be made to function if

it is properly proportioned. Closure arm **24** should be about ten percent longer than the length of back portion, exclusive of portion to be covered by the hook. The length of the hook may approximate one-quarter of the length of the upper arm. The hook and the upper arm must be bent on suitable radii so that, on closing, end **33** clears end **32**, while appropriate clenching can still be accomplished.

The preferred form of hemostatic clip is applied in closing a blood vessel by placing back element **23** either in channel **16** or **17** resting against pin **19** with point **33** of the front portion resting in the opposite channel, there held under slight pressure such that clip **20** will not slide from channels **16** and **17** during placement of the jaws around vessel **30**. Upon inserting vessel **30** within a clip placed on applicator jaws and adjacent to pin **19**, member **44** may be rotated to the unlocked position and the jaws may then be closed by a quick grasping action on the handles whereby the jaws are forced together to close and lock the clip. During the clamping operation, portion **24** first bends primarily around center **28** until point **33** comes into contact with the clip back **23**, or portion **34** beyond bend **29**. Further closure of the jaws causes point **33** to advance along the slope **34** until it passes a position beneath point **32** or hook **26**. Further pressure on jaws **11** and **12** causes increased bending to occur at the end **37** of the clip and a sharpending of the bend **36** around center **27** until point **32** engages portion **35** adjacent point **33** then in contact with portion **34**. The clip is thus closed and firmly clenched. FIG. 4 illustrates an intermediate closure position wherein a blood vessel **30** placed in the jaws of an applicator as in FIG. 3 is partially closed off, being shown fully closed in FIG. 5 wherein the clip is locked by closure of hook point **32** over end **35** of the closure element.

A clip formed as in FIG. 7 is closed and clenched in substantially the same way by causing bowed portion **24** to be flattened against back portion **23** with point **33** underlying point **32** of hook **26** as the clip is closed into its flattened condition to clench therein point **33**.

By means of apparatus as illustrated a positive and easy application is made of a homostatic clip of minimum size requiring only a few seconds for each application. It will be appreciated that an improved method of closing blood vessels is achieved by the use of the applicator and clip, and that this method of hemostasis permits much more rapid tying off of blood vesels, with better security from slippage or accidental opening by virtue of the clenching operation inherent in the closing of hook **26** to clench and retain therein end **35** of the front closure member when straightened as at **25**.

While the invention has been described with respect to particular embodiments, it is intended that the invention be not so limited but that it include all equivalents within the scope of the following claims.

What is claimed is:

1. A hemostatic clip formed from an elongated member, comprising

a substantially straight back portion,

a bowed front closure member extending from one end of the back portion at a first bend, said front closure member having an outer end disposed transversely from the back portion,

a hook extending from another end of the back portion and terminating in an outer end of the elongated member, said hook having two legs interconnected by a second bend and located to form an open slot facing generally toward the front closure member, and a third bend at the juncture of the hook and the end of the back portion to locate one leg of the hook on an opposite side of the longitudinal axis of the back portion from the front closure member.

2. A hemostatic clip according to claim **1** in which the leg of the hook which extends from the back portion is longer than the other leg of the hook.

3. A hemostatic clip according to claim **2** in which the first bend is closer to the third bend than to the outermost end of the bowed front closure member.

4. A hemostatic clip according to claim **3** in which the third bend is closer to the second bend than to the first bend.

5. A hemostatic clip according to claim **2** in which the single elongated member is a flat-sided wire having a uniform thickness.

6. A hemostatic clip according to claim **1** in which the first bend is closer to the third bend than to the outermost end of the bowed front closure member.

7. A hemostatic clip according to claim **6** in which the single elongated member is a flat-sided wire having a uniform thickness.

8. A hemostatic clip according to claim **6** in which the third bend is closer to the second bend than to the first bend.

9. A hemostatic clip according to claim **1** in which the single elongated member has a uniform thickness.

10. A hemostatic clip according to claim **9** in which the single elongated member is a flat sided wire.

11. A hemostatic clip according to claim **1** in which the third bend is closer to the second bend than to the first bend.

12. A hemostatic clip according to claim **1** having the following characteristics:

(a) the elongated member is a flat wire of uniform thickness;

(b) the distance from the first bend to the free end of the hook is greater than the straight line distance from the first bend to the outer end of the front closure member and less than the length of the wire in the front closure member;

(c) the second bend is closer to the free end of the hook than to the third bend; and

(d) the third bend is closer to the second bend than to the first bend.

13. The method of hemostasis including the steps of placing a blood vessel between the back portion and the front closure member of the hemostatic clip described in claim **1**, bending the clip to bring the front closure member toward the back portion until the outer end of the front closure member contacts the elongated member adjacent the third bend, bending a major portion of the bowed front closure member into parallelism with said back portion, and bringing the legs of the hook together to engage the outer end of the front closure member.

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F. BARRY SHAY, Primary Examiner

GREGORY E. McNEILL, Assistant Examiner

U.S. Cl. X.R.

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