

[54] STAPLING DEVICE

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[73] Assignee: Alchemia Ltd. Partnership, Palo Alto, Calif.

[21] Appl. No.: 541,546

[22] Filed: Oct. 13, 1983

[51] Int. Cl.⁴ A61B 17/04

[52] U.S. Cl. 227/19; 128/334 R; 227/DIG. 1; 227/120; 227/129; 227/156

[58] Field of Search 128/334 R, 334 C; 227/DIG. 1, 19, 156, 120, 129

[56] References Cited

U.S. PATENT DOCUMENTS

| | | | |
|-----------|---------|-------------------|------------|
| 3,940,935 | 3/1976 | Richardson | 60/528 |
| 3,953,253 | 4/1976 | Clark | 148/131 |
| 4,006,747 | 2/1977 | Kronenthal et al. | 227/DIG. 1 |
| 4,016,721 | 4/1977 | Richardson et al. | 60/528 |
| 4,109,844 | 3/1978 | Becht | 227/19 X |
| 4,144,057 | 3/1979 | Melton | 75/134 C |
| 4,179,057 | 12/1979 | Becht et al. | 227/19 |
| 4,281,785 | 8/1981 | Brooks | 227/156 X |
| 4,304,613 | 12/1981 | Wang et al. | 148/11.5 N |
| 4,351,466 | 9/1982 | Noiles | 227/19 X |

FOREIGN PATENT DOCUMENTS

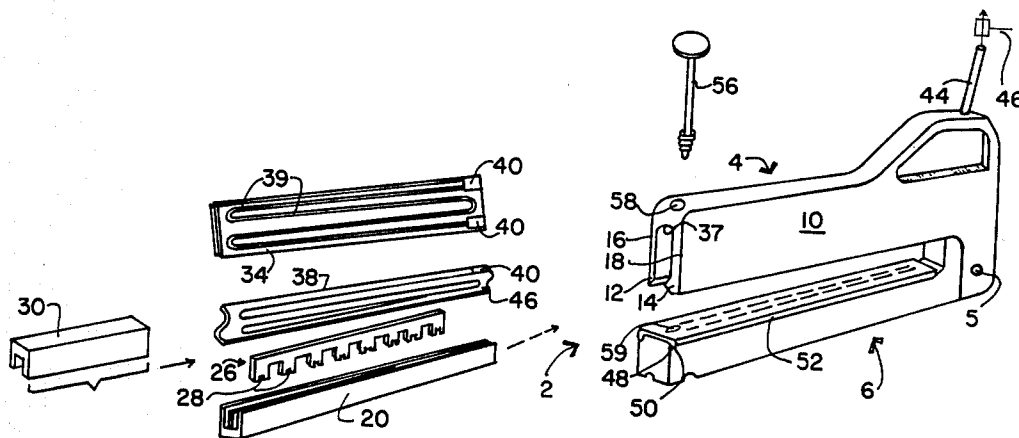
2703529 3/1978 Fed. Rep. of Germany .

Primary Examiner—Paul A. Bell
Attorney, Agent, or Firm—Howard L. Rose

[57] ABSTRACT

A stapling device utilizes heat recoverable material (the driver) having shape memory to drive staples through materials to be joined and in one embodiment, against an anvil for crimping the ends of the staples. The heat recoverable material, preferably a metal such as Nitinol, may have heat applied by a heater mounted on at least one surface thereof or by induction or other method of heating. If a heater is mounted on a surface of the driver, upon insertion of the driver into the staple device, the heater makes electrical connection with terminals for connection to a supply circuit. In a specific embodiment staples may be provided, fabricated from heat recoverable metal so that each staple may carry its own heat recoverable, staple driving element. The staple tines may have a heat recoverable shape with the ends of the tines directed toward one another so that staple closure occurs as heat migrates from the staple driving region to the tines thereof. Alternatively, the heat recoverable staple may complete a circuit through the staple upon contact with the anvil, thus heating the staple. Alternatively, the staples may have a heat recovered state with the ends parallel to one another so that the application of heat will open the staples and permit ready removal.

21 Claims, 19 Drawing Figures



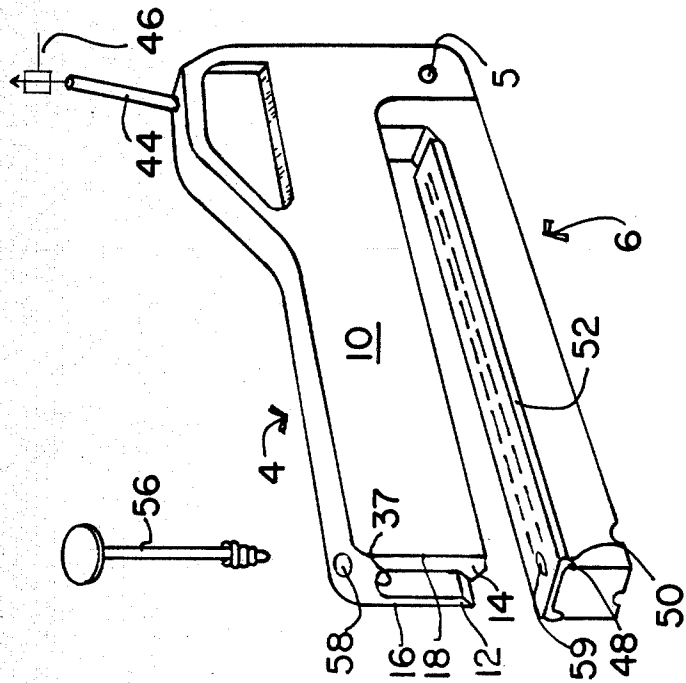


FIG. 1

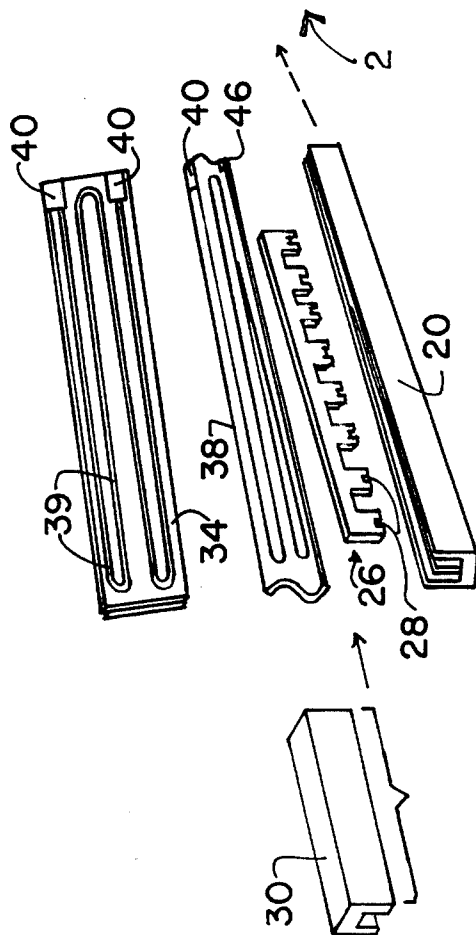


FIG. 7

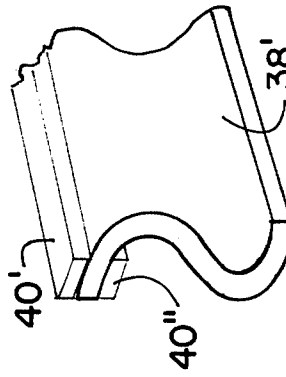


FIG. 6

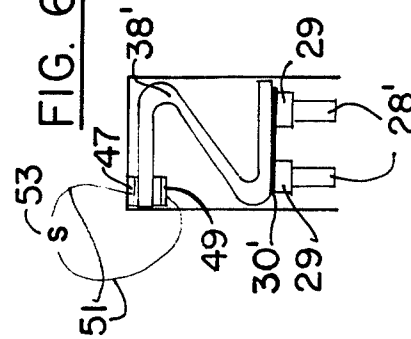


FIG. 4

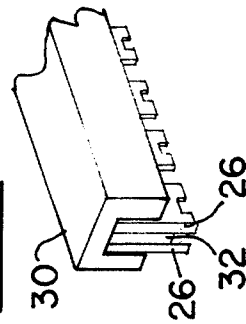
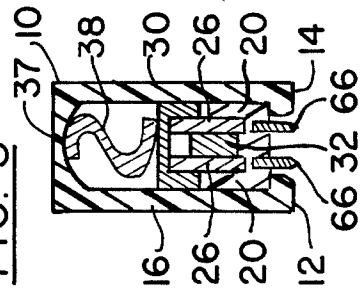


FIG. 3



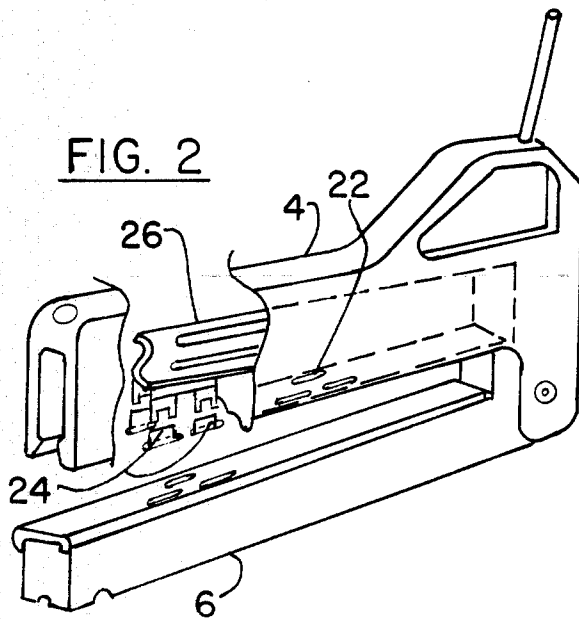


FIG. 8

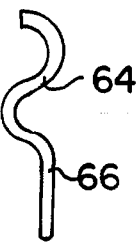


FIG. 9

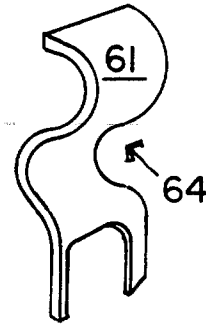


FIG. 5

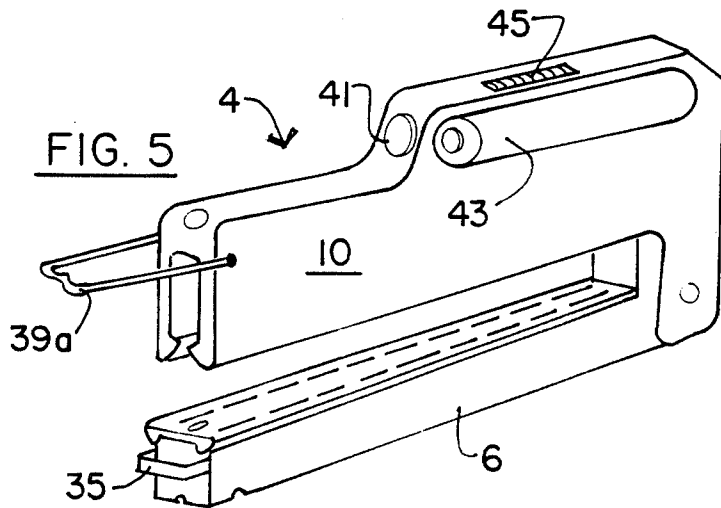


FIG. 10

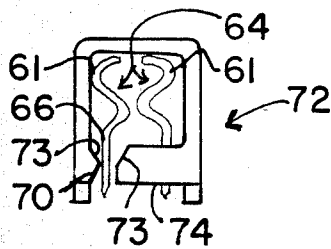


FIG. 11

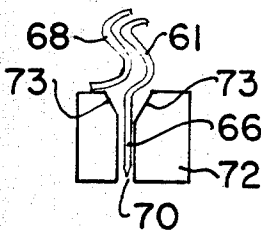


FIG. 12

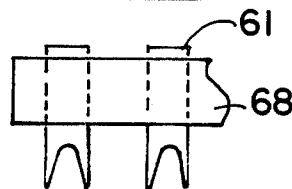


FIG. 13

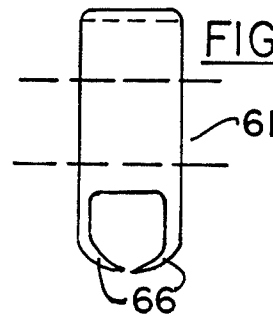


FIG. 15

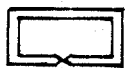


FIG. 16

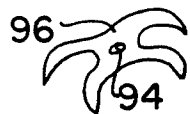
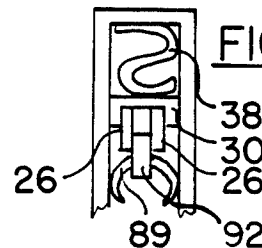
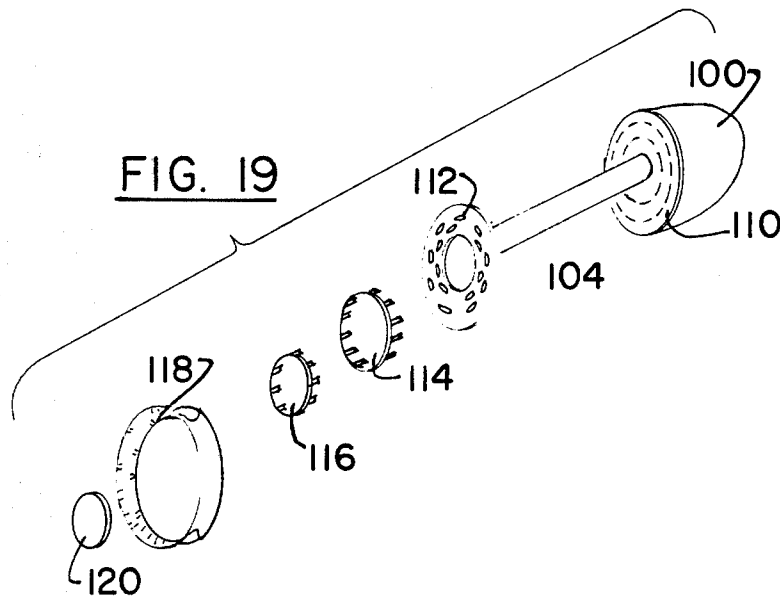
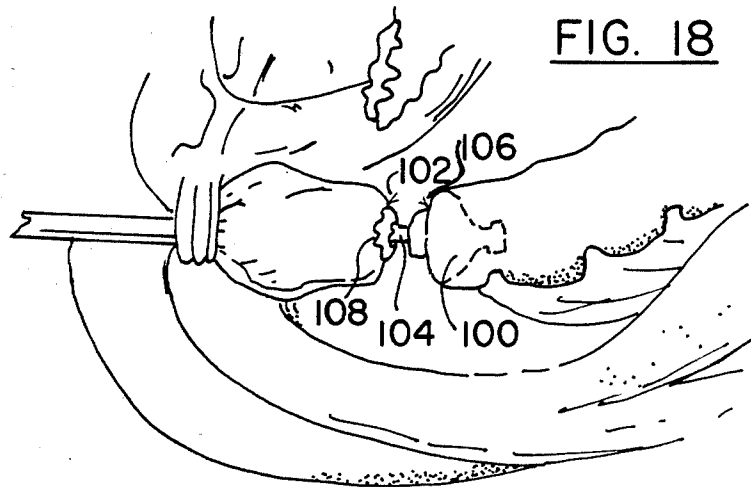
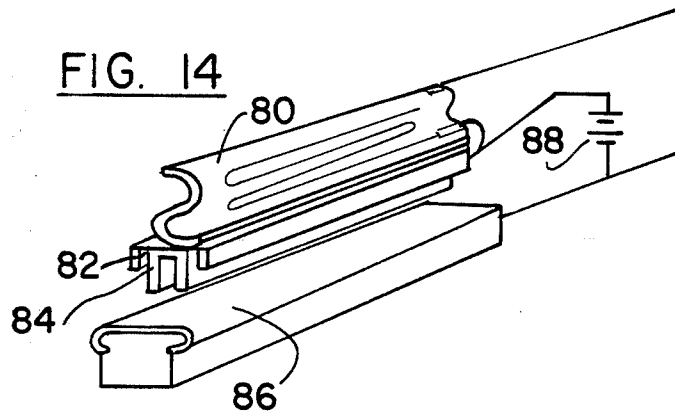


FIG. 17





STAPLING DEVICE

RELATED APPLICATION

This application is related to copending application Ser. No. 277,112, filed on June 25, 1981 by John F. Krumme and entitled Shape Memory Surgical Staple Apparatus and Method for Use In Surgical Suturing.

BACKGROUND OF THE INVENTION

The present invention relates to stapling devices and more particularly to surgical stapling devices utilizing a heat recoverable element to drive the staples.

Surgical stapling devices are employed in many surgical procedures in place of conventional suturing procedures; stapling produces less trauma to tissue than suturing. Surgical stapling devices, such as disclosed in U.S. Pat. Nos. 3,252,643; 3,692,224; 4,216,891; etc., conventionally employ a pair of parallel elongated jaws pivoted so that they may be placed on opposite sides of the ends of regions of tissue to be joined. One of the jaws carries the staples and the other jaw carries the anvil against which the staples are pressed and formed after penetrating the tissues to be joined.

In use, the tissues to be joined are placed side by side between the jaws and a knob is turned or other type of mechanical actuating mechanism operated to cause a lead screw or other type of drive to drive one jaw toward the other and clamp the tissues. When the surgeon determines that sufficient clamping force has been developed on the tissues, the knob is caused to engage a bar that in turn engages a staple driving mechanism. The mechanism causes the staples to pierce the tissues and be pressed against the anvil whereby the ends are turned over to retain the staples in the tissue.

The problems with this mechanism relate to the fact that the operation is relatively slow, the force applied to hold the tissues is basically controlled wholly by the surgeon, and thus may result in damage to the tissue. Further, the device is large, cumbersome, and awkward to use particularly in tight locations internally of the body.

Although the invention is described as a surgical stapling device, it is readily apparent that such a device may readily be employed for many different applications, particularly where it is desirable to clamp and then insert numerous staples for purposes of holding, i.e., stapling in one operation the line of material that is clamped between the jaws. Examples of those uses are in construction work applications. The invention is described with respect to surgical uses but as indicated, is applicable to a wide range of applications.

SUMMARY OF THE INVENTION

In accordance with the present invention, a material having a mechanical, i.e., shape, memory is employed to drive the staples thus eliminating the need for the unwieldy and large knob and associated mechanisms and their attendant problems found in present day surgical stapling devices of the dual-jaw type.

The material having a shape memory may be a nickel titanium alloy of the type disclosed in U.S. Pat. No. 3,174,851 known by the name "Nitinol." Further details of these materials may be found in NASA Publication SP 5110 entitled "55-NITINOL - The Alloy with a Memory, Its Physical Metallurgy, Properties, and Applications, C. M. Jackson et al, 1972. Many other materials having similar characteristics are also known. The

characteristic of these materials utilized in the present invention is the ability of a heat recoverable metallic material, after stressing to a non-stable configuration, while below a specific transition temperature, to return to its pre-stressed configuration when heated above such temperature.

In the present invention, a pair of parallel jaws of the same general configuration as in the prior art may be clamped together by a coarse, threaded screw, a spring clamp or other suitable quick acting clamp. Thereafter, an electric heater is energized by a battery, or other type of electrical source, to heat the heat recoverable metal which may preferably have an "S" or a "C" cross sectional shape prior to heating. Upon heating, the material, which is located above the base of the generally U-shaped staples, straightens out and drives the staples through the flesh clamped between the jaws and into contact with the anvil. The ends of the staples are turned and stapling is completed.

In one specific embodiment of the invention, a narrow, elongated, preferably plastic member has two rows of parallel staggered slots. A pair of staple driving members, each having a plurality of generally rectangular fingers extending from a long cross member, each has a separate finger located in each of the slots of a different one of the rows. A staple may be located as desired in the end of any slot below a finger thus establishing two rows of staples in staggered relationship.

The plastic member is held in a hollow, generally U-shaped jaw having the heat recoverable "S" or "C" shaped member disposed between the base of the U-shaped member and the top of the fingered members or in the latter instant, a bar extending over the top of the fingered members.

A metallic thin film or serpentine wire heater is formed or disposed on one or both sides of the heat recoverable member and provides sufficient heat to the heat recoverable member to quickly raise its temperature above its transition temperature when the heater is connected across an appropriate power supply. The subsequent recovery of the metal to its straight form upon heating, drives the staples through the tissue and against the anvil, whereby to form the staple ends to hold in the tissue.

In operation, the surgeon places the tissue to be stapled together, between the jaws of the device, clamps the jaws together and throws the switch to the heater. Since clamping may be effected by a quick acting mechanism of a rigid construction, clamping forces are controlled. Further, the quick acting heater produces rapid stapling. The device, due to the elimination of the large knob and related operating mechanisms, is conveniently smaller than the prior art devices. Thus, the devices of the present invention are smaller, less expensive, and faster acting than the prior art devices and require far less attention from the surgeon, resulting in consistently better performance. Significantly, as in the prior art devices, the surgeon can proportionally control staple movement with the present invention as well as the existing units; in the present case by controlling the time of the heating interval. Further, the number of staples to be inserted may be controlled by movement of the driving member longitudinally of the body of the device, each staple having a separate staple drive for activation by the movable elongated driver carrying the heater.

In one alternative form of the device, each staple is made of shape memory metal and has a small S-shaped

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