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Morton et al.

[11] **3,751,960**

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[54] **WIRE PIERCING METHOD AND APPARATUS**

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[21] Appl. No.: **187,293**

[52] **U.S. Cl.** **72/326**, 72/324, 72/332, 72/374

[51] **Int. Cl.** **B21d 31/02**

[58] **Field of Search** 72/324, 326, 332, 72/374, 376; 81/9.51; 140/123, 123.5, 123.6

[56] **References Cited**

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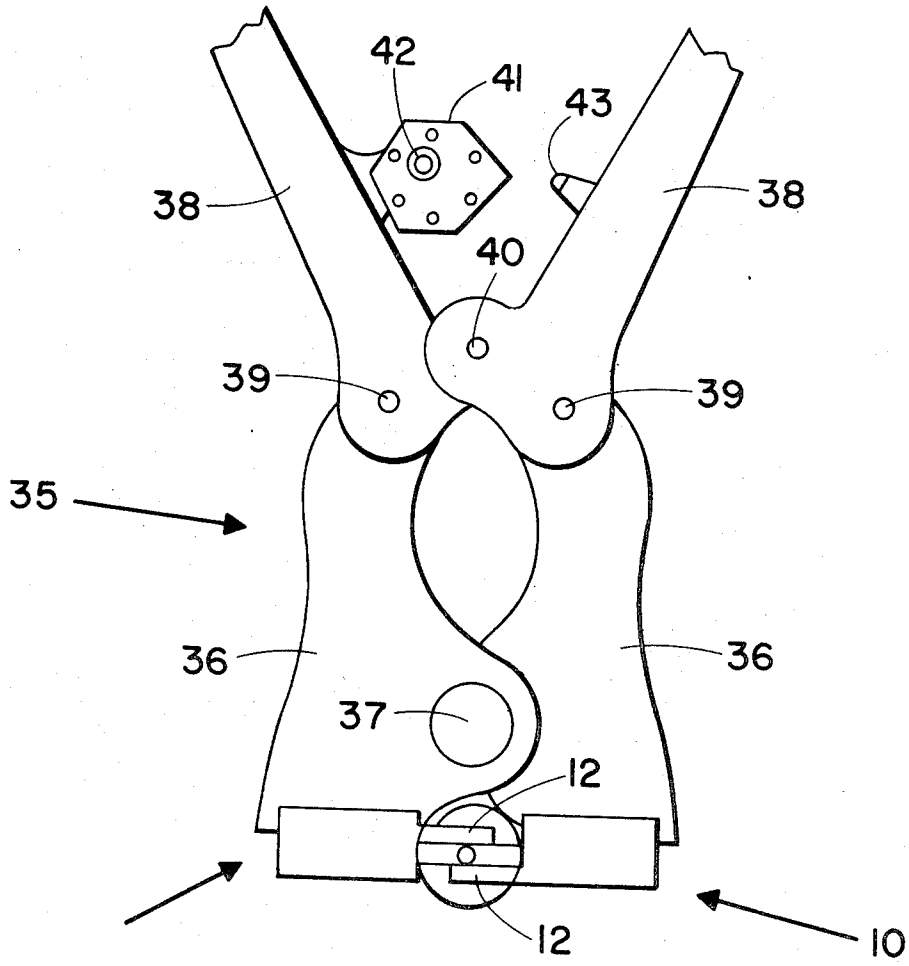
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Primary Examiner—Charles W. Lanham
Assistant Examiner—James R. Duzan
Attorney—Sidney T. Jelly

[57] **ABSTRACT**

Holes are formed in wires by shearing a wire along its diameter and deforming the two halves in opposite directions. A tool for forming such holes has two opposed cutting edges and an abutment surface associated with each cutting edge. Relative movement of the cutting edges, in a shearing action, slits the wire and the abutment surfaces push the wire halves in opposite directions to form a hole -which can be larger in diameter than the diameter of the wire.

5 Claims, 9 Drawing Figures



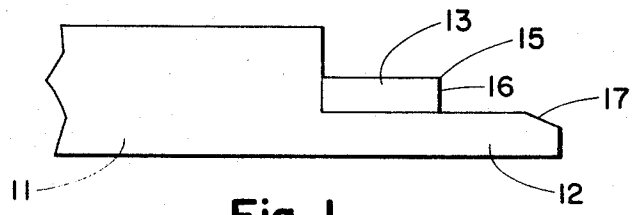


Fig. 1

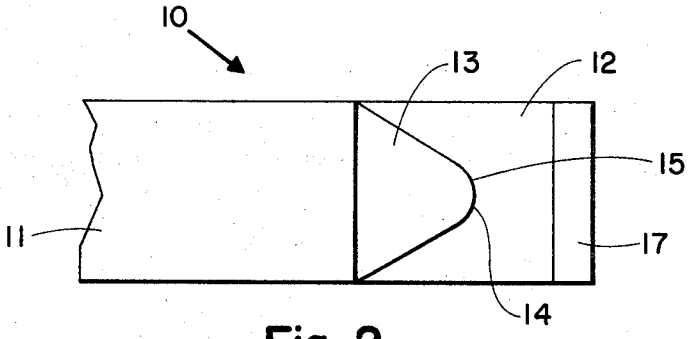


Fig. 2

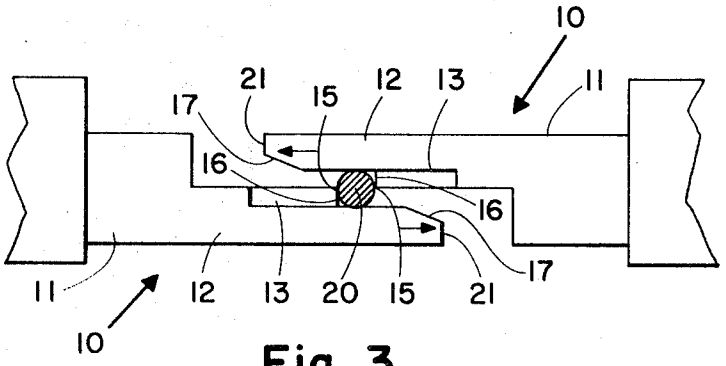


Fig. 3

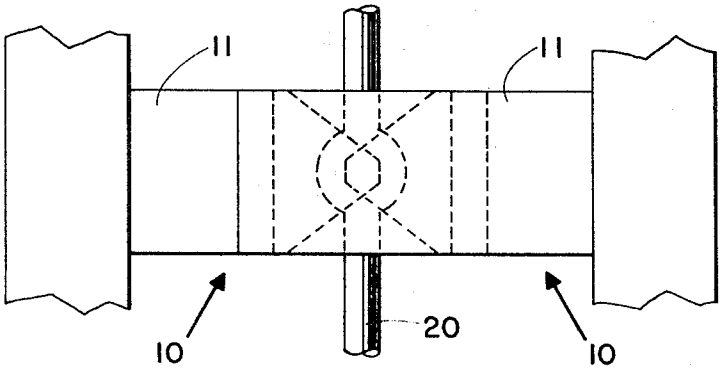


Fig. 4

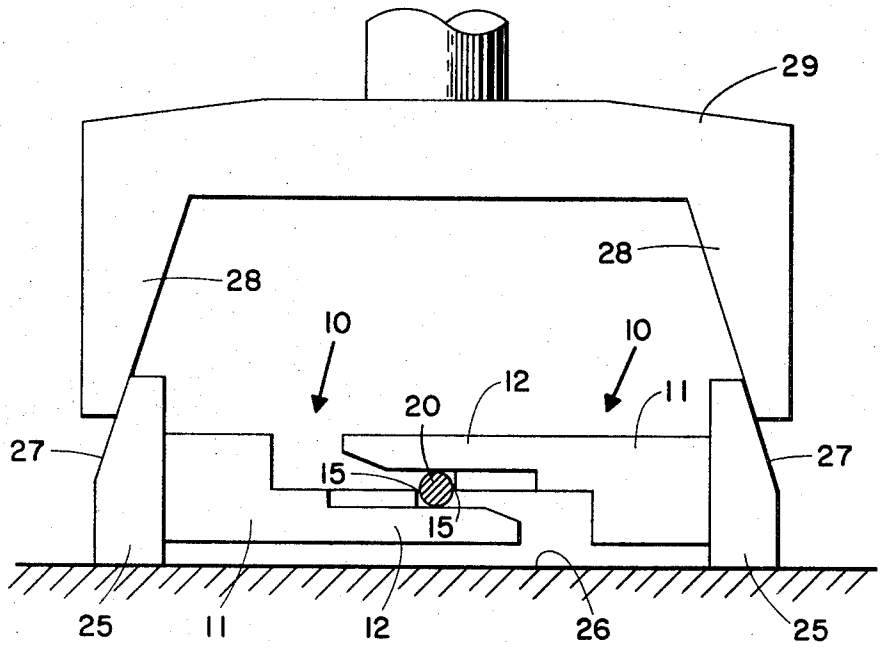


Fig. 5

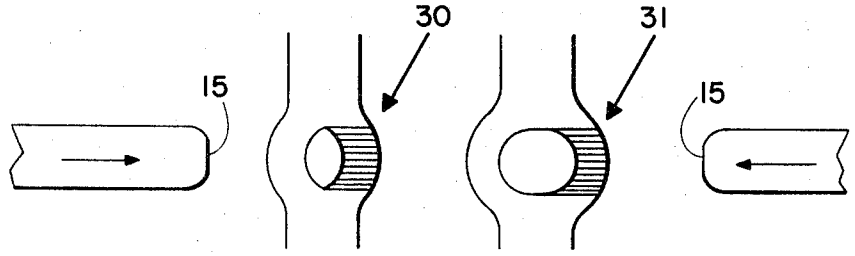


Fig. 6

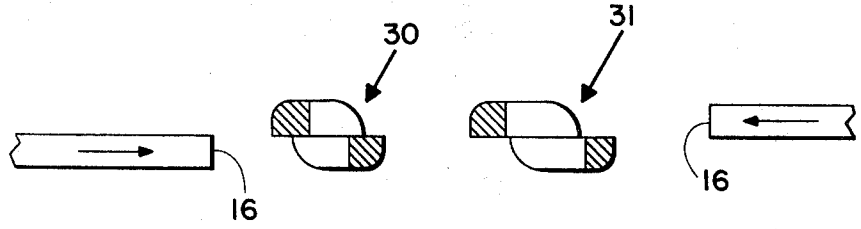


Fig. 7

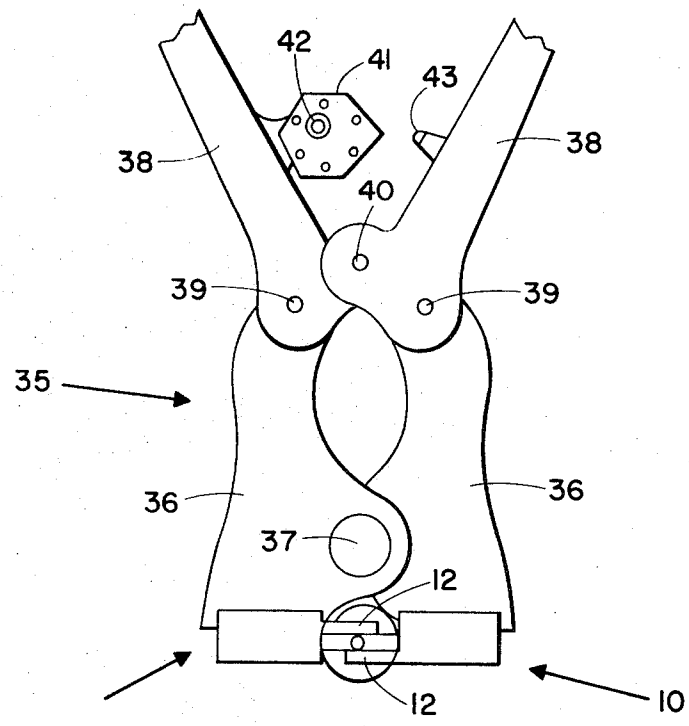


Fig. 8

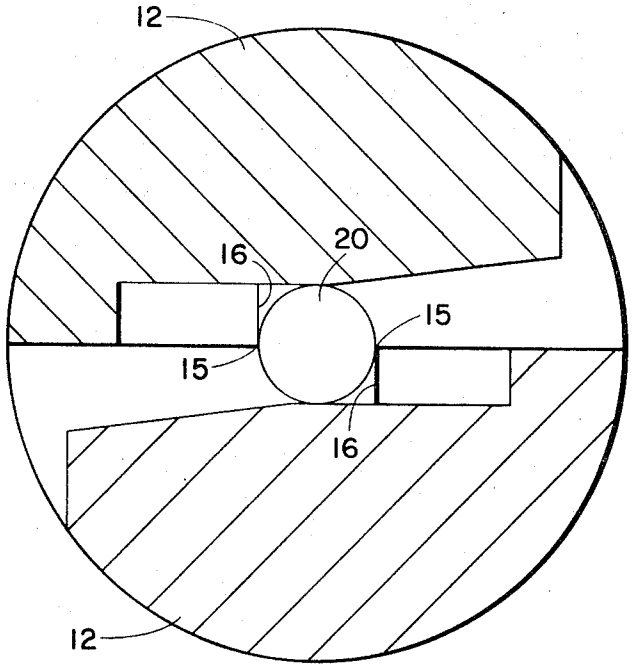


Fig. 9

WIRE PIERCING METHOD AND APPARATUS

This invention relates to piercing holes in wires, and particularly to the piercing of holes in fine wires for attachment of the wires to terminals in electrical and electronic apparatus.

Holes can be formed in wire, the holes being smaller than, equal to, or larger than the diameter of the wire. This enables the wire to be positioned over terminal posts or terminal lugs or tags, for soldering or other means of attachment.

A hole is formed by shearing a wire along its diameter and deforming the two halves of the sheared portion of wire in opposite directions. This forms a hole the size of which will depend upon the length sheared and the amount of deformation. The shear cut is made entirely within the wire, that is the ends of the cut do not break through the wire. Thus a slit closed at both ends is made.

In accordance with one feature of the invention apparatus for forming a hole in a wire comprises: two opposed cutting edges engaging on a common plane, the cutting edges of convex form viewed normal to the plane; an abutment surface extending substantially normal to each cutting edge in a direction away from the common plane; and means for supporting a wire with its longitudinal axis substantially in alignment with said plane. Movement of the cutting edges toward and over each other shears the wire along its axis, the abutment surfaces pushing the halves of the wire in opposite directions to form the hole.

In accordance with another feature of the invention a method of forming holes in wire comprises shearing a slit in the wire along the longitudinal axis of the wire and pushing the opposed halves of the wire in opposite direction to form a hole.

The invention will be understood by the following description of certain embodiments, by way of example, in conjunction with the accompanying drawings, in which:

FIG. 1 is a side view of one form of shearing member;

FIG. 2 is a plan view of the member illustrated in FIG. 1;

FIG. 3 is a side view of one form of tool, comprising two shearing members as illustrated in FIGS. 1 and 2, in the open position;

FIG. 4 is a plan view of the tool illustrated in FIG. 3, but in a closed position after piercing a wire;

FIG. 5 illustrates an arrangement of the tool of FIGS. 3 and 4 arranged for power operation;

FIGS. 6 and 7 illustrate diagrammatically the formation of a hole;

FIG. 8 illustrates an arrangement for a hand tool; and

FIG. 9 is an enlarged view of that part of FIG. 8 in the circle X.

An apparatus, in accordance with the present invention, includes two shearing members, for example of the form illustrated in FIGS. 1 and 2. The shearing member 10 comprises a body portion 11, having at one end an extending tongue or web 12. Formed on the web 12 and extending from the junction between the web 12 and body portion 11 is a portion 13 of generally triangular plan form having its apex 14 convex. The edge 15, remote from the web 12, forms a cutting edge. Surface 16, extending from the cutting edge 15 to the web 12 forms an abutment surface. The end of the web 12 is chamfered, or inclined at 17, to assist in correct positioning of the wire, as will be explained later.

As seen in FIGS. 3 and 4 a tool comprises two shearing members 10 mounted in opposed relationship, the cutting edges 15 in opposition and moving in a common plane. Thus, as the shearing members are moved towards each other the cutting edges 15 move first towards each other and then over each other, in a shearing action. In use the shearing members 10 are moved apart and a wire 20 positioned between the members. The wire is supported in the correct position relative to the cutting edges 15 by the webs 12. Movement of the shearing tools together causes the cutting edges 15 to shear the wire 20 and the two halves of the wire are then pushed apart by the abutment surfaces 16.

The amount of movement of the shearing members 10 can be limited by arranging for the end surfaces 21 of webs 12 to abut against the main body portions 11. It will be seen that when the shearing members are fully open, for insertion of the wire 20, the inclined portions 17 will tend to correctly position the wire on initial movement of the shearing members toward each other, acting as ramps.

The tool illustrated in FIGS. 3 and 4 can be actuated by a form of press —either manually or power operated. FIG. 5 illustrates one such tool. The shearing members 10 are attached to blocks 25 arranged to slide on a surface 26. The blocks 25 have inclined surfaces 27 which engage with complimentary inclined surfaces 28 on a press member 29. Downward movement of the press member 29 pushes the blocks 25, and the attached shearing members 10 towards each other to shear the wire 20. The blocks 25 can be formed in one piece with the shearing members.

FIGS. 6 and 7 illustrate somewhat diagrammatically the shearing and the movement of the wire halves. FIG. 6 is a plan view and two stages in the formation of a hole are shown, the hole half formed at 30 and completely formed at 31. The cutting edges 15 are represented at each side. FIG. 7 is a cross-section through the sheared portion of the wire 20 and shows how the wire halves are pushed apart by the abutment surfaces 16. The abutment surfaces are represented on each side and again two stages are shown, half formed, 30, and fully formed, 31.

The shearing members can also be mounted on a hand tool. FIG. 8 illustrates one such arrangement with shearing members 10 attached to a form of toggle action tool having substantially parallel action at the jaws. The main body portion of the tool is indicated at 35, comprising two halves 36 pivotally connected at 37. A handle 38 is attached to each half 36, each handle pivotally attached to its related body half 36 by a pivot 39, the handles also pivotally connected at 40.

Shearing members 10 are attached to the body halves 36 and are seen in more detail in FIG. 9. The shearing members 10 are substantially of the same form as in FIGS. 1 and 2. One modification is that the opposed surfaces of the webs 12 have a slight inclination for the major part of the length of the web to allow for the slight relative rotation of the shearing members as they move together. It will be appreciated that the arrangement of the tool of FIG. 8 does not give an absolute in line movement of the shearing members 10, there being some rotation about the pivot 37.

The movement of the shearing members 10 can be controlled to give a range of hole sizes. Attached to one

of the handles **38**, FIG. **8**, is a hexagonal member **41**. The member **41** is rotatable on pivot **42** and is mounted off-centre so that each flat is a slightly different distance from the centre of the pivot **42**. Thus the wire **30** will be sheared and distorted to six differing amounts providing six different hole sizes. As an example, with a 0.0032 inch dia. wire, and each flat on the hexagonal member **41** arranged to be 0.004 inch higher than the previous flat, a variation in hole size from 0.022 inch dia. to 0.042 inch dia. in six steps can be obtained. An abutment member **43** is fixed to the other handle.

In use, the apparatus of FIG. **8** is prepared by opening the handles **38**. A wire is then inserted between the shearing members **10** and handles closed -moved towards each other. As the handles move the shearing members towards and over each other and the cutting edges **15** engage the wire, as seen in FIG. **9**. Continued movement of the handles **38** causes shearing of the wire by the edges **15** and displacement of the halves of the wire by the abutment surfaces **16**. The length sheared and the amount of displacement will be controlled by the hexagonal member **41** and abutment **43**.

While the invention can be used for wires of any size —the size and power of the apparatus being suitably arranged to meet requirements, the invention is particularly applicable to the piercing of fine wires in the assembly of wired equipment and apparatus as in the electronics industry. The invention may be used for forming holes in the leads of components, such as resistors and capacitors for example, and for forming holes in connecting leads and wires. The invention is of considerable value for applications where fragile terminals are used; where space requirements are very tight; where the gauge of the wire is not suitable for wire wrapping; and where access is difficult. As described, the size of the hole formed can be varied and can be larger than the diameter of the wire. The wire can be placed over a terminal post, or other connecting means, and soldered or otherwise fixed in place.

What is claimed is:

1. Apparatus for piercing a wire to form a hole, said apparatus including two shearing members mounted for relative movement towards and away from each other, each shearing member comprising:

a body portion including a forward end and a rearward end,

a support member extending from said forward end of said body portion,

a support surface on said support member,

a cutting member on said support member, said cutting member including a convex apex;

an abutment surface on said cutting member extending from said support surface normal thereto,

an outer surface on said cutting member the plane of said outer surface parallel to said support surface and spaced from said support surface a distance equal to half the thickness of said wire and intercepting said abutment surface, and

a cutting edge on said cutting member at the intersection of said abutment surface and said outer surface, said cutting edge of convex form in the plane of said outer surface;

means supporting said shearing members in opposition said apeces of said cutting members in alignment, said planes of said outer surfaces substantially coincidental, said support members positioned one on each side of said coincidental planes;

and means for moving said shearing members relative to each other along an axis passing through said body portions and support members.

2. Apparatus as claimed in claim **1**, each shearing member including an inclined end surface at its end opposed to said web, said inclined end surfaces arranged whereby movement of a member in a direction normal to said common plane acts on said inclined end surfaces to urge the shearing members together.

3. Apparatus as claimed in claim **2**, the member acting on said inclined end surfaces comprising a press member, said press member having inclined surfaces for cooperation with said inclined end surfaces.

4. Apparatus as claimed in claim **1** comprising a toggle action pliers, said shearing members attached one to each jaw of said pliers, movement of the handles of the pliers moving the shearing members in a direction substantially parallel to said common plane.

5. Apparatus as claimed in claim **4** including adjustable abutment means for controlling the closing of said pliers and controlling the shearing of the wire.

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