United States Patent [19]

Murray

[11] 3,707,932

[45] Jan. 2, 1973

[54] **ELECTRICAL CONNECTOR, METHOD AND APPARATUS**

[75] Inventor: **Robert Maclay Murray,** Elizabethtown, Pa.

[73] Assignee: **AMP Incorporated,** Harrisburg, Pa.

[22] Filed: **Aug. 28, 1970**

[21] Appl. No.: **68,033**

Related U.S. Application Data

[62] Division of Ser. No. 864,787, Oct. 8, 1969, Pat. No. 3,587,502.

[52] **U.S. Cl.** **113/119**

[51] **Int. Cl.** **B21d 53/36**

[58] **Field of Search** .113/119; 339/258 R, 242, 47 R, 339/95 R, 95 A, 95 T, 95 B, 95 D, 47 C; 72/39, 40, 340; 90/24 A; 29/630

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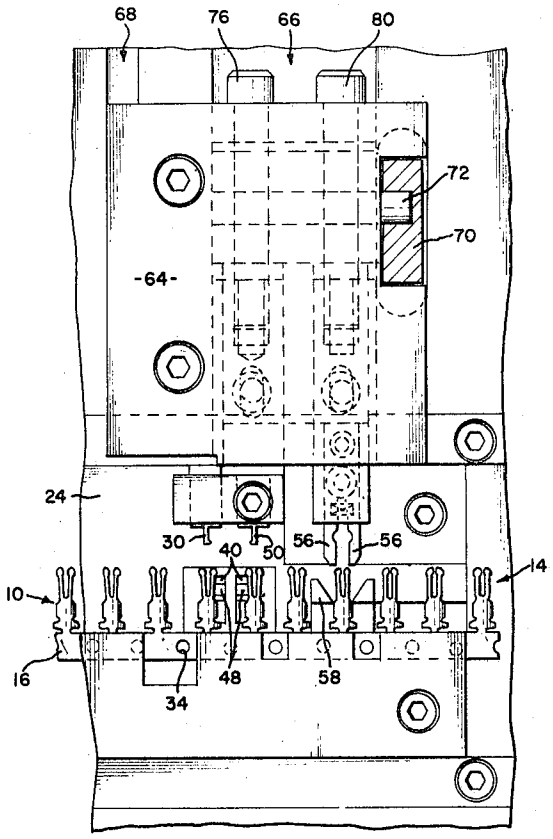
Primary Examiner—Richard J. Herbst

Attorney—William J. Keating et al.

[57] **ABSTRACT**

An electrical connector formed by a die blanking operation having an improved smooth edge contact surface formed by a fine scraping of said edge to remove the rough fractured surface remaining after the blanking operation; also, the method and apparatus for forming said improved smooth contact surface.

6 Claims, 15 Drawing Figures



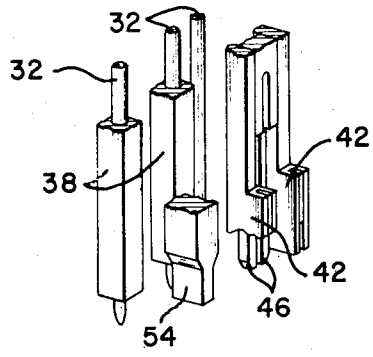
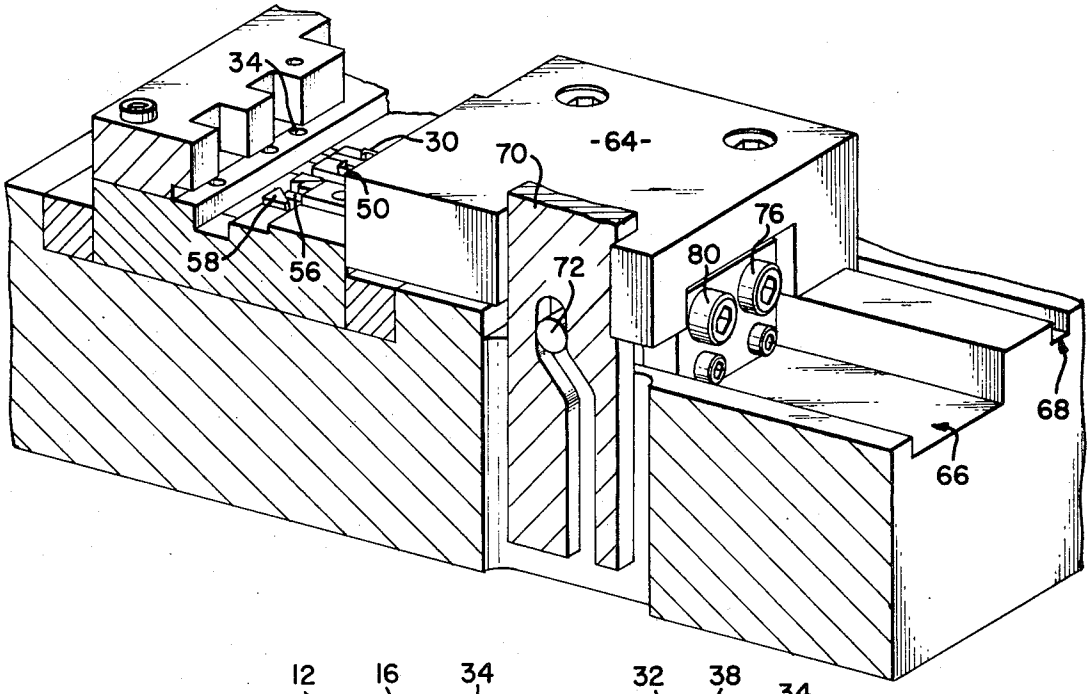


Fig. 1



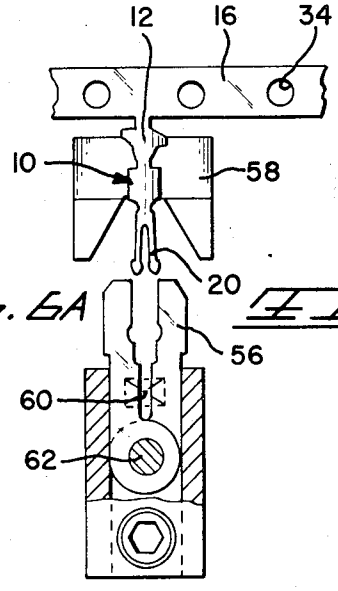


Fig. 6A

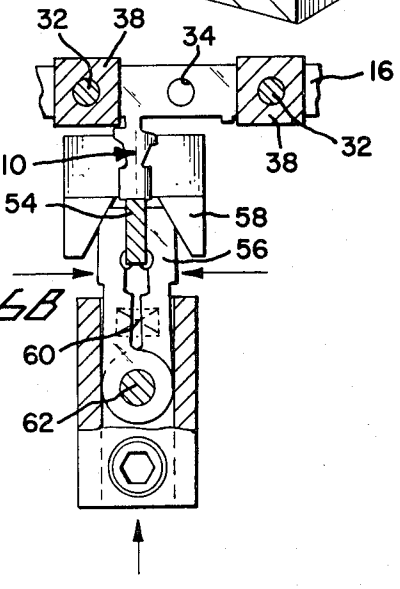


Fig. 6B

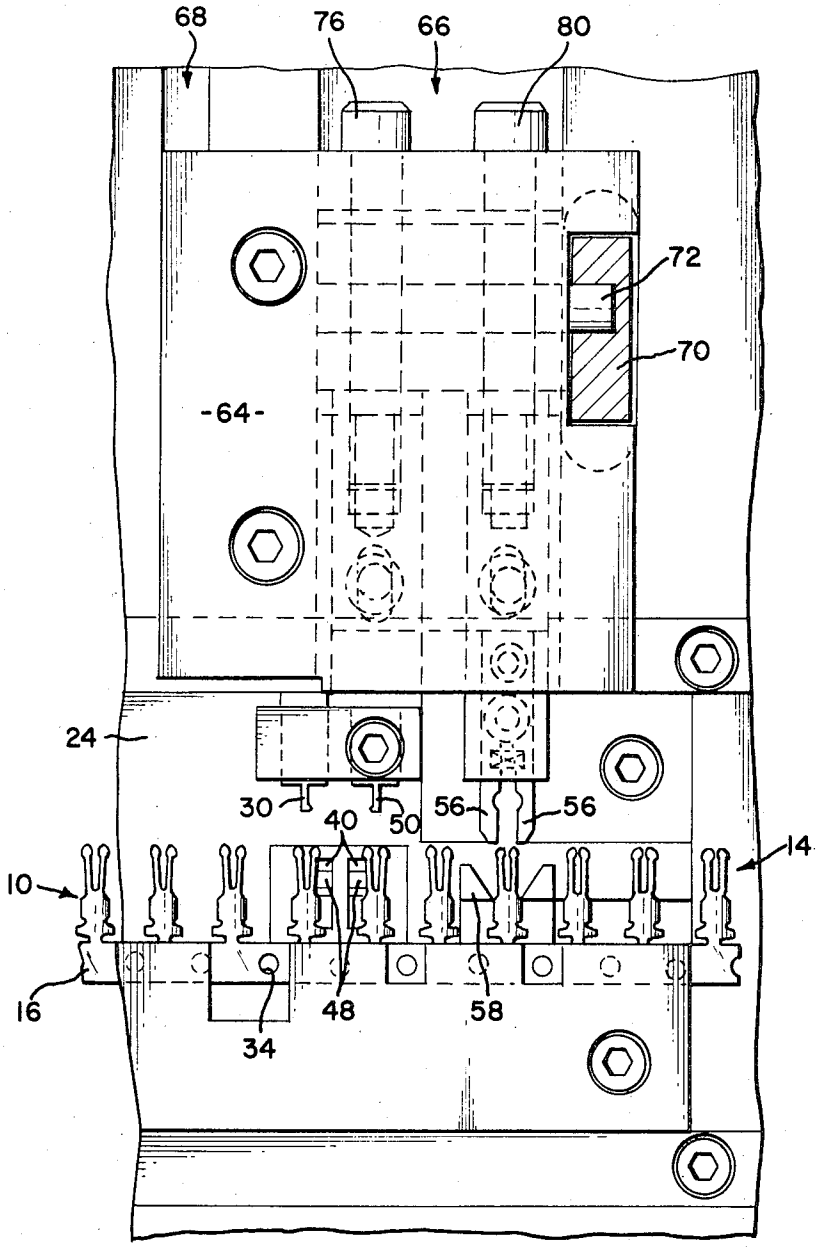


Fig. 2

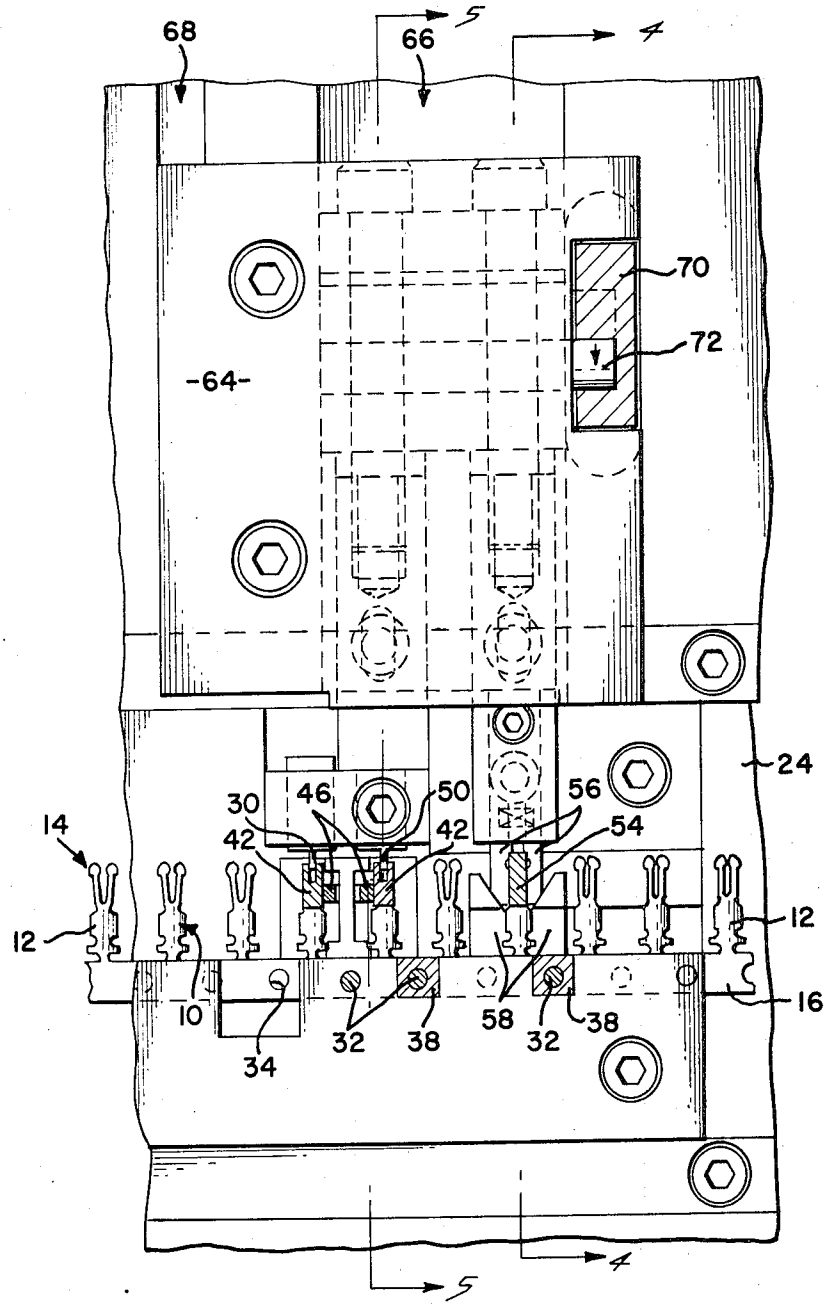

68
66
5
4
70
72
-64-
24
14
30
46
50
56
42
42
54
12
12
16
10
34
32
38
58
32
38
5
4

Fig. 3

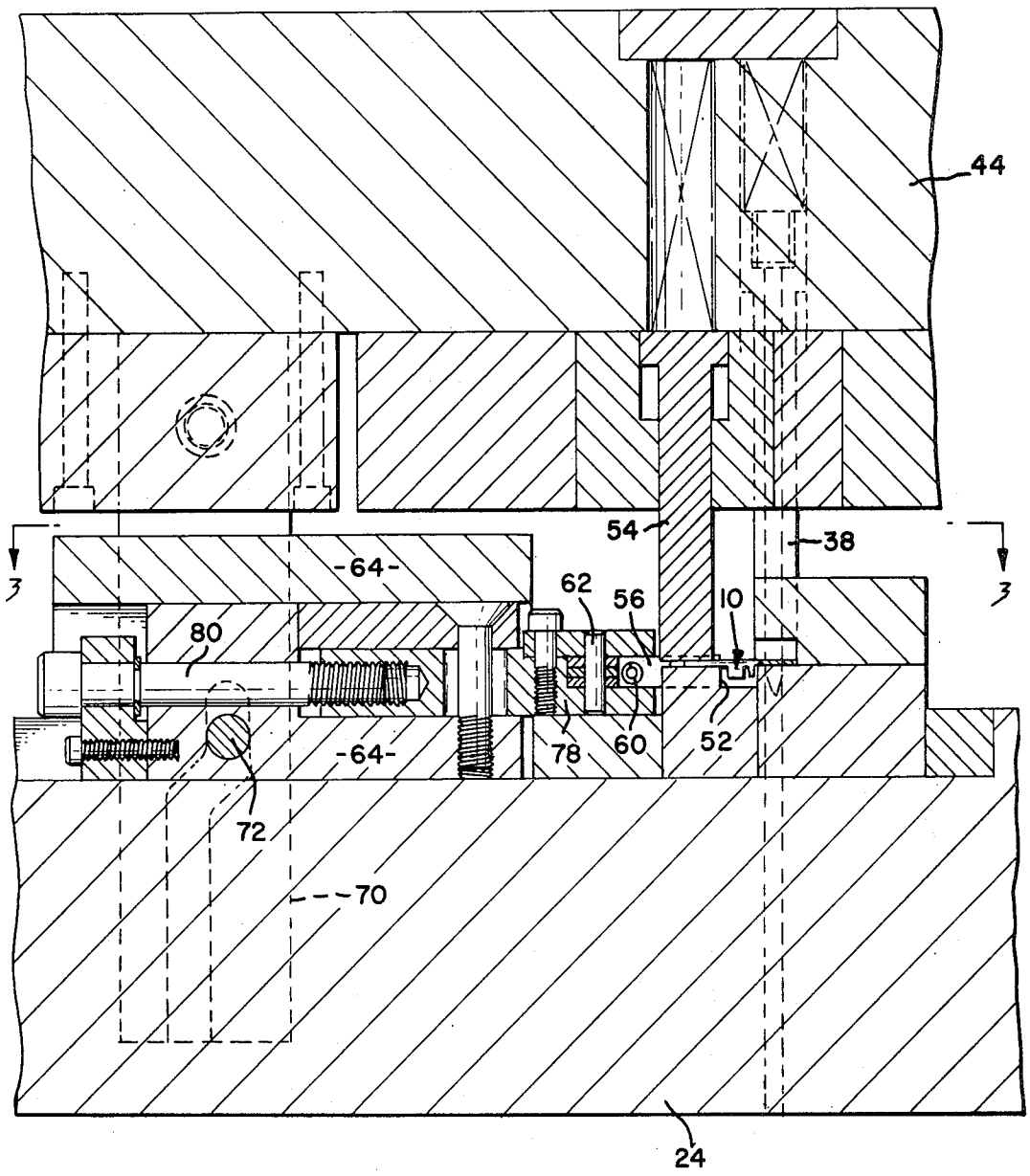


Fig. 4

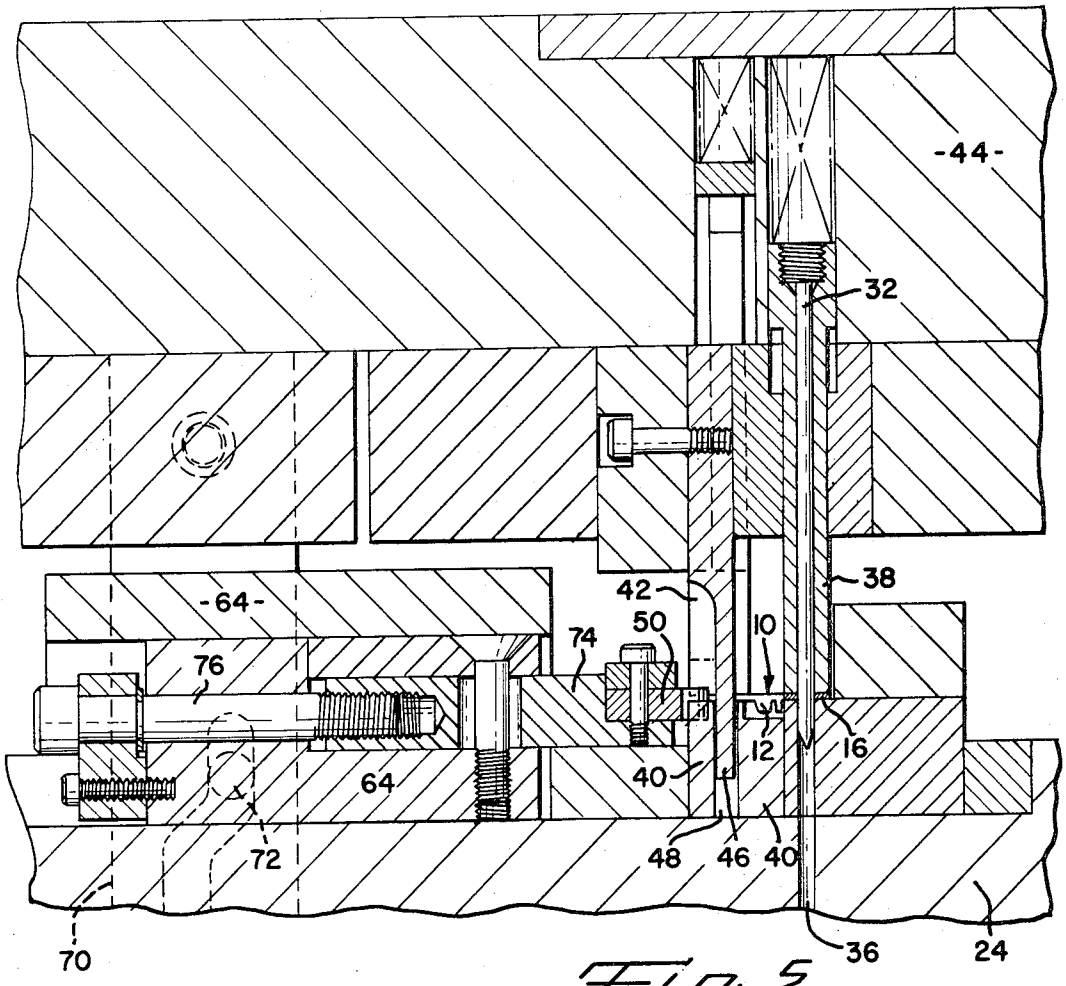

-44-
32
38
42
50
10
74
-64-
76
64
12
16
40
72
48
46
40
70
36
24

Fig. 5

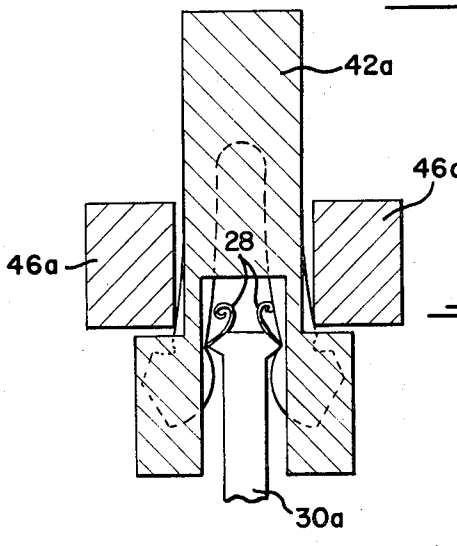

42a
46a
46a
28
30a

Fig. 10

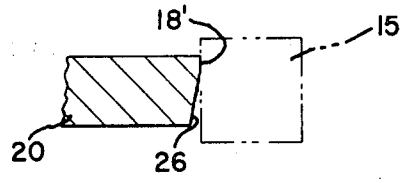


Fig. 7A

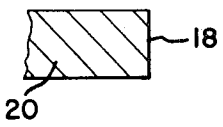


Fig. 7B

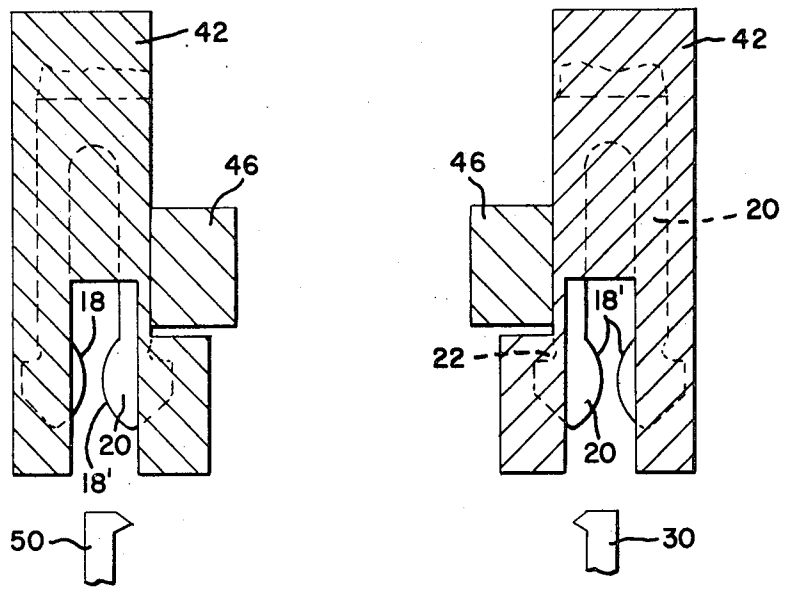


Fig. 8

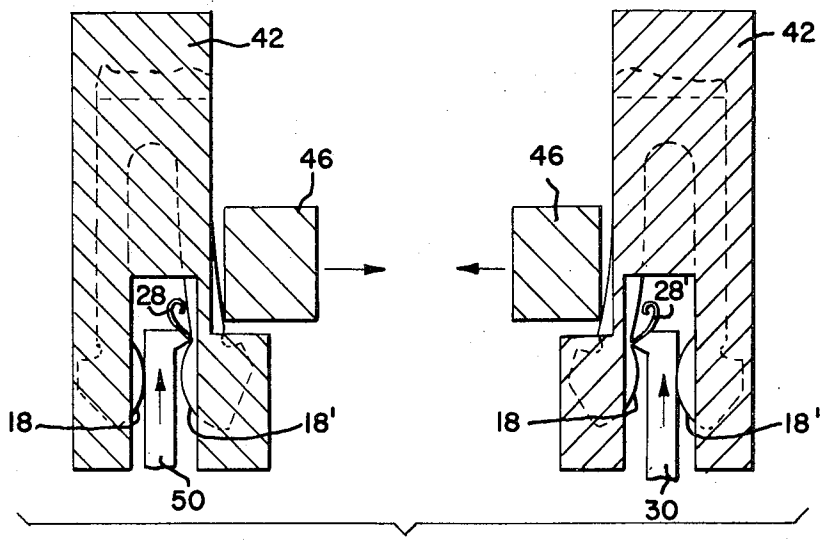


Fig. 9

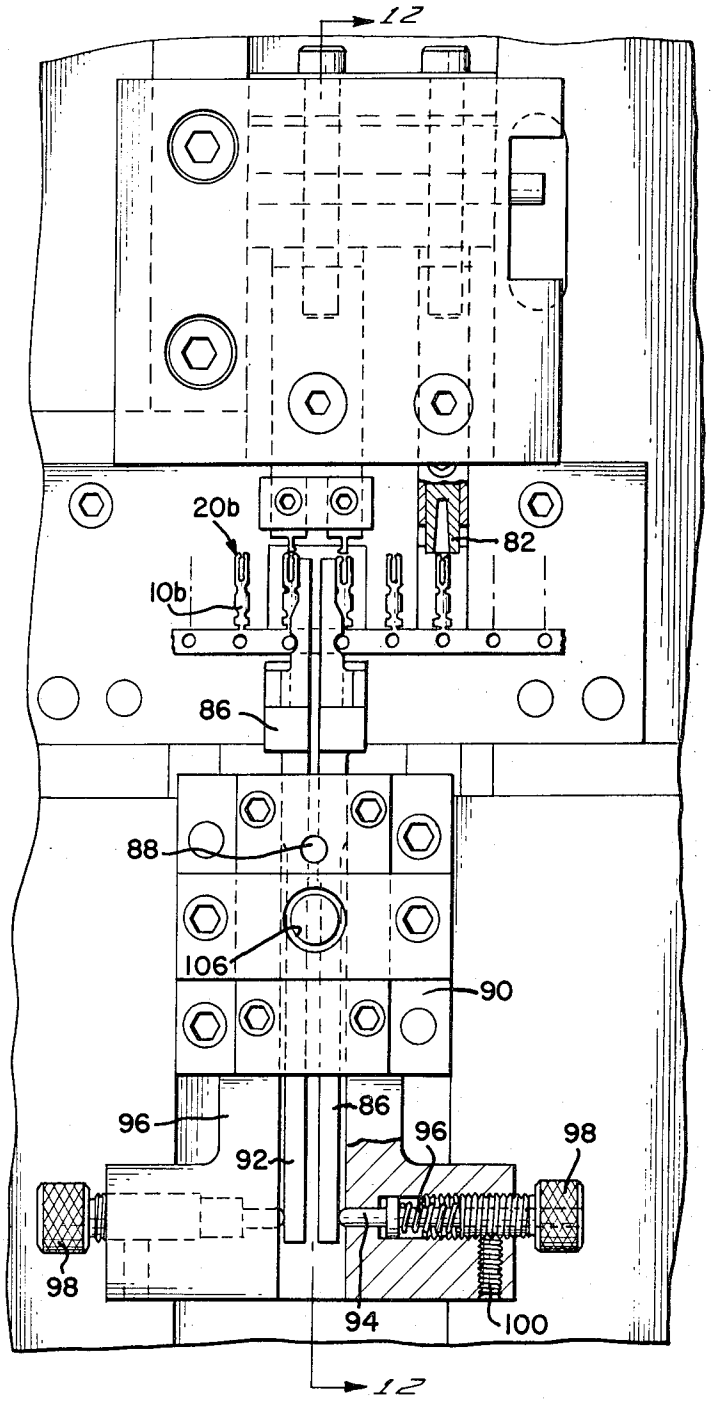


Fig. 11

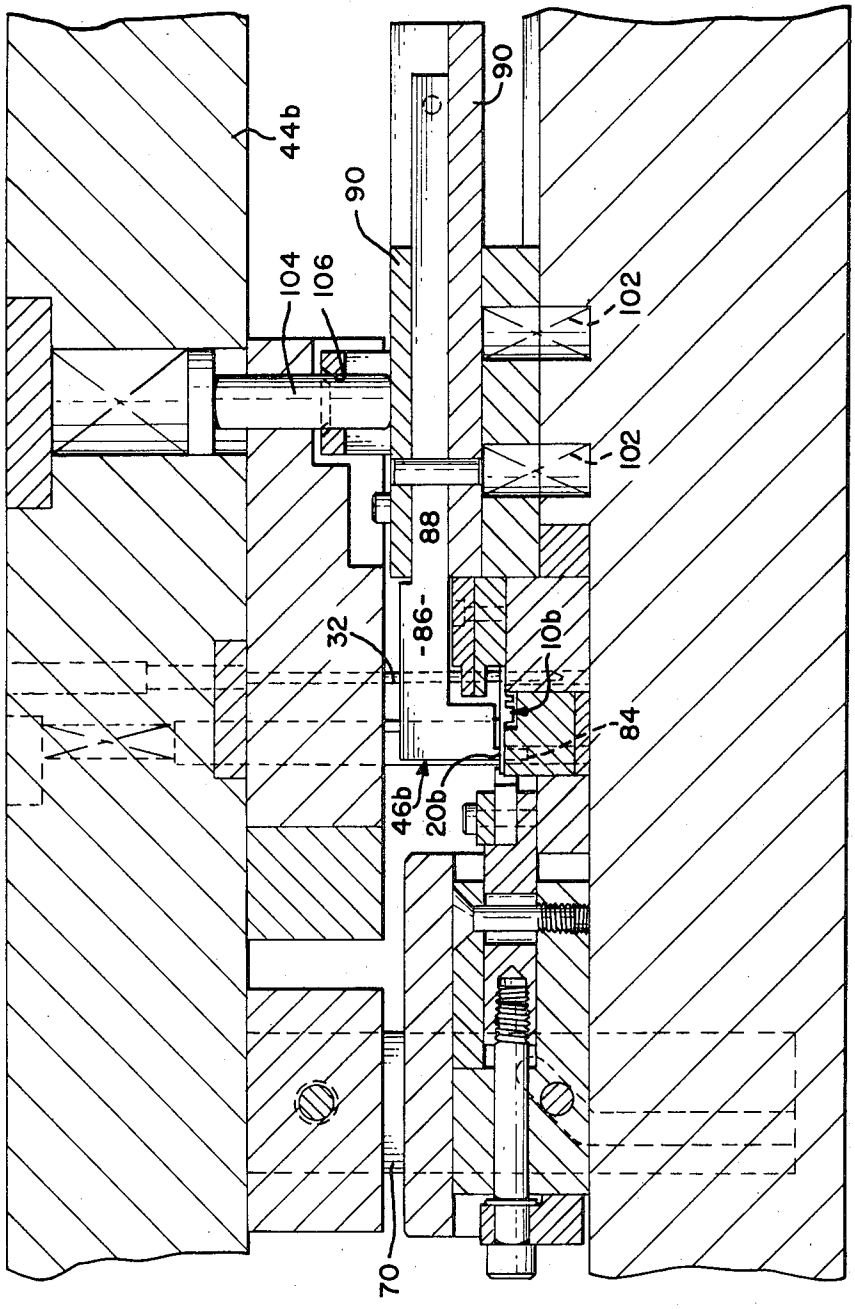


FIG. 12

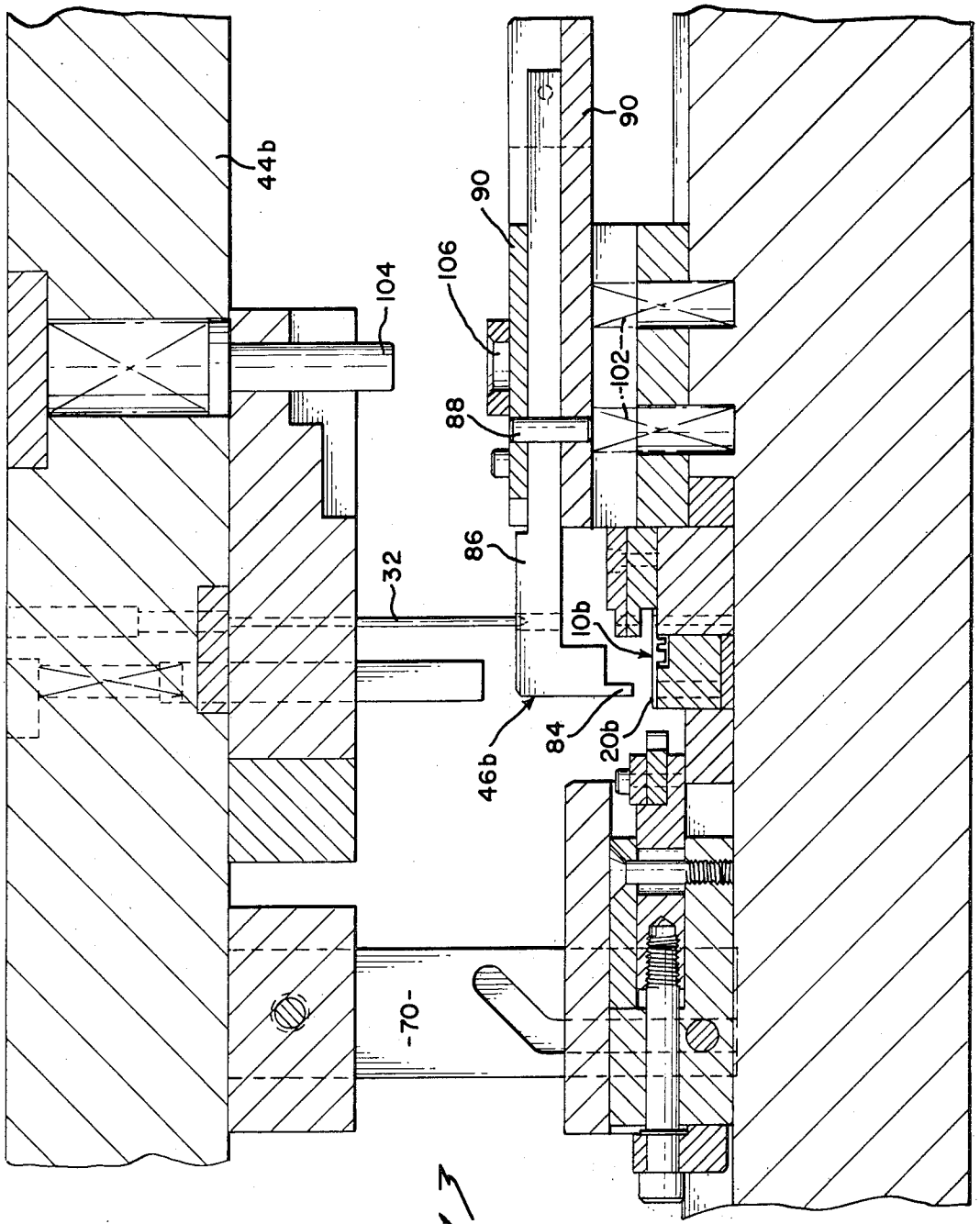


FIG. 17

ELECTRICAL CONNECTOR, METHOD AND APPARATUS

This is a divisional application of application Ser. No. 864,787, filed Oct. 8, 1969, now U.S. Pat. No. 3,587,502.

The present invention relates to electrical connectors having edge contact surfaces and method and apparatus for making the same.

In the manufacture of electrical connectors, particularly of the crimp-type, most are blanked or stamped out on a progressive die from a thin strip of flat metal stock. In some of these connectors the contact surface (i.e., that surface of the connector which makes actual electrical contact) is formed from the cross section of the flat metal stock. A problem has long existed in such edge contact surfaces where only a small portion of the cut edge forming the contact surface has a smooth shear. The remainder of this surface is formed by a break or fracture of the metal portion of the cut face. This is apparently due to the methods required for accomplishing these stamping operations. In a punch die it is typical that a spacing between the punch and its corresponding die should be approximately 6 percent of the width of the material being stamped out. Therefore, the piece stamped out on one side will take the shape of the punch and then will fracture outwardly (and downwardly) an amount approximately equal to the spacing between the punch and its die and then will shear the last 20 to 30 percent of the cross section in a shape identical to the die. Typically, a piece thus blanked out will have an edge surface which is a smooth shear cut of about twenty percent and then is a rough fractured undercut angled therebelow. It is possible to increase the percentage of smooth shear surface somewhat by a reduction in the clearance below the 6 percent figure but only at severe penalties with relatively little gain. Thus, by reducing this clearance and with liberal use of specialized lubricants one might be able to achieve 40 percent and occasionally approach a fifty percent smooth shear surface but with greatly increased power requirements, tool wear, and tool breakage and many other detrimental trade offs well known to those skilled in the art. Since in the manufacture of more modern miniaturized connectors this fractured portion of these edge contact surfaces can amount to more than eighty percent, the resulting design limitations and contact inefficiencies can be sufficient to render such connectors fatally faulty. In such connector design requirements the edge surface must have a minimum smooth shear surface of 50 percent consistently to be effectively reliable. This problem becomes particularly acute where either the edge contact surface or the mating surface with which it is designed to make electrical contact has a cylindrical shape (circular or otherwise), because the contact area of such a connector becomes more dependent on the height of the contact surface and independent of its length. The more brittle the material, the larger the break caused by this fracturing.

Attempts to solve this foregoing problem by decreasing the punch clearance or by very fine "shaving" steps (i.e., subsequent fine stamping or blanking steps) did not meet with material success, since the degree of break was not materially reduced.

A second problem is encountered with the use of edge contact surfaces formed by stamping operations in a sliding contact which is to be made substantially perpendicular to the direction in which the surface was formed by stamping. This problem concerns the very small tool marks which the stamping die leaves in the "-smooth" sheared contact surface but which are sufficiently large to act as a rasp-like surface which can soon wear away the ultra-thin gold surface commonly used on mating contact surfaces.

It is an object of the present invention to provide methods and apparatus for overcoming the problems discussed herein.

It is a further object of the present invention to improve the effectiveness of edge contact surfaces of standard electrical connectors.

It is yet another object of the present invention to provide electrical connectors having edge contact surfaces which are substantially miniaturized and yet maintain superior contact qualities over similar prior connectors.

It is yet another object of the present invention to provide electrical connectors having edge contact surfaces which give demonstratively increased trouble-free service.

It is yet another object of the present invention to provide method and apparatus for producing such improved edge contact surfaces with only minor modifications or additions to current manufacturing methods and apparatus.

Broadly the methods and apparatus of the present invention achieve these objects by a "scraping" of the edge contact surface which results in cutting away or planing the surface substantially along, rather than across, the surface. This scraping is done to a depth sufficient to remove substantially all evidence of the fracture and leave behind the exactly desired contour, typically flat, for said surface. This scraping operation is effective to remove the fractured surface without subsequent fracture, because it is done in a direction such that the metal is at all times substantially supported and does not cross an unsupported edge.

In this specification and the accompanying drawings I have shown and described a preferred embodiment of my invention and have suggested various alternatives and modifications thereof; but it is to be understood that these are not intended to be exhaustive and that many other changes and modifications can be made within the scope of the invention. These suggestions herein are selected and included for purposes of illustration in order that others skilled in the art will more fully understand the invention and the principles thereof and will thus be enabled to modify it and embody it in a variety of forms, each as may be best suited to the conditions of a particular use.

In the drawings:

FIG. 1 is an isometric view of the stationary dies together with hold-down and locating tools of the moving die, illustrating a portion of a preferred embodiment of apparatus according to the present invention for forming improved edge contact surfaces (also showing the scraping and sizing device in the advanced position on the stationary die);

FIG. 2 is a plan view of the stationary die in FIG. 1 (with the scraping and sizing device shown in the

retracted position, and additionally showing a strip of connectors in process);

FIG. 3 is similar to FIG. 2 but with the scraping and sizing device in the advanced position and the hold-down and locating tools also shown in position as taken along lines 3—3 in FIG. 4;

FIG. 4 is a vertical cross-section through the moving and stationary dies when in engagement, taken along lines 4—4 in FIG. 3;

FIG. 5 is a vertical cross-section through the moving and stationary dies when in engagement, taken along lines 5—5 in FIG. 3;

FIG. 6A is an enlarged plan view partially in section of the sizing device;

FIG. 6B is a view similar to FIG. 6A showing the sizing device in the advanced position and the hold-down and locating tools in plan section;

FIG. 7A is a greatly enlarged cross-section of a connector showing the edge contact surface after stamping;

FIG. 7B is similar to 7A but showing the edge contact surface after scraping;

FIG. 8 is an enlarged detail in plan section of stamped connectors in successive stations after engagement of the two dies but prior to advance of the scraping tool;

FIG. 9 is a view similar to FIG. 8 but showing the scraping tool in the advanced position;

FIG. 10 is a view similar to FIG. 9 showing an alternative embodiment with a double-edged scraping tool;

FIG. 11 shows a preferred embodiment similar to that illustrated in FIGS. 1–9 for producing a connector somewhat modified in shape from that shown in the preceding figures being a plan view of the stationary die with the scraping and sizing device in the retracted position and with the sizing device and the adjustment for the backstop in partial section;

FIG. 12 is a vertical cross-section taken along lines 12—12 in FIG. 11 showing the two dies in engagement and particularly showing the adjustable backstop; and

FIG. 13 is similar to FIG. 12 but showing the two dies in spaced relation.

For convenience in discussing and illustrating preferred embodiments of the present invention, the figures have been related to a crimp-type electrical connector **10** having a conventional F-crimp terminating portion **12** with a dual tine contact engaging portion **14** extending therefrom. These tines **20** are designed to cooperate to electrically engage and mechanically grip a contact post **15** inserted in the slot formed between the opposing contact surfaces **18**. This connector **10** as illustrated in FIGS. **2** to **10** is shown in strip form (i.e., still attached to the locating strip **16**). This is the form in which such connectors are typically supplied to the customer for later application by automatic applicating machines. As can be most clearly seen from FIGS. **8** to **10**, this particular connector **10** has an arcuate edge contact surface **18** on the inside of each tine **20** and has a retaining notch **22** for holding the connector **10** in a molded connector block (not shown) when in service. In contrast, the connector **10***b* shown in FIGS. **11** to **13** is somewhat simplified having no retaining notch **22**.

FIG. **2** shows a portion of the stationary bottom die **24** of the progressive die with the locating strip **16** carrying newly formed connectors **10** attached thereto at spaced intervals. These connectors **10** move in a step-by-step progression from one station to the next in an intermittent advance from left to right as viewed in FIG. **2**.

FIG. 7A shows the rough-cut contact edge surface **18** of the connector tine **20** as it appears after having been blanked out in the previous forming operations. As can be seen from FIG. 7A in materials typically used for this type of connector, having a medium hardness and of relatively small cross-section, the break or fracture surface **26** is very rough and non-linear over as much as 80 percent of the edge surface of the tine **20**. Such a fracture surface is typically undercut so that the entire extent of this surface **26** is lost to making electrical contact with the contact post **15** (shown in dash-dot outline). Even if the fracture surface **26** were in line with the contact edge surface **18**, its roughness would provide only very poor contact because only the highest points of the roughness would be in engagement with the post **15**. Furthermore, this roughness would also score the post **15** as it slides across it, destroying any plating (which typically is gold). The destruction of the plated surface can be very serious in affecting the quality and longevity of the contact assembly, particularly in installations where repeated disconnections are made (as in changing from one pre-programmed plug-in control to another).

FIGS. **8** and **9** show in detail the scraping method of the present invention being performed by apparatus according to the present invention (which latter is more generally shown in FIGS. **2** and **3**). FIG. 7B shows the contact edge surface **18** after the scraping process according to the present invention has been performed. It can be seen that this process has scraped off a layer of material **28** (see FIG. **9**) leaving a straight, effectively smooth, superior contact surface throughout the entire extent of the edge **18**. Any minor tool marks left by such scraping are parallel to the direction of sliding contact and, therefore, relatively inconsequential.

As viewed in FIGS. **2** and **3**, the connectors **10** shown at the far left are newly formed and have yet to be processed according to the present invention, while those at the far right have been both scraped and sized.

After a connector **10** has been advanced to a position just opposite the first scraping tool **30** it is precisely positioned by strip pilots **32** passing through strip pilot holes **34** in the strip **16** and on into pilot holes **36** in the stationary die **24**. Spring loaded strip holders **38** clamp the strip **16** in position. At the first scraping station, the right-hand tine **20** of the connector **10** therein is supported from beneath by support **40**. Hold-down tool **42**, carried on the upper moving die **44**, firmly positions the tine **20** on the support **40** preventing any twisting of the tine **20** but permitting a limited horizontal motion therebetween. Positioned between the two hold-down tools **42** are two flexible stops **46**. These stops **46** move down with the upper die **44** and pass into slots **48** made in the tine supports **40**. These stops **46** engage the outer portions of the tines **20** when the latter are held in position between the hold-down tools **42** and their respective supports **40** during the scraping operation. These stops **46** serve both to prevent the tine **20** from being overstressed and also to maintain a proper pressure of the tine **20** against the scraping tools **30** or **50**, see FIGS. **3**, **5** and **8**, and especially FIG. **9** (which latter shows the flexibility of the stops **46**).

It will be noted that the first six connectors **10** from the left in FIGS. **2** and **3** have their tines oriented in a slightly open V-orientation rather than substantially parallel as illustrated at the right in these same figures. This was done in order to leave sufficient room between the tines **20** on a given connector **10**, to permit passage of the scraping tools **30** or **50** therebetween to gain access to the blanked out contact edge surface **18'**.

In order to shape the connector to its final design configuration, they must pass through a sizing operation. In the connectors illustrated in FIGS. **1** to **10** this sizing operation is complicated by the shape of the tines **20** having a retaining notch **22**. As during the scraping operation, the tines **20** of the connector **10** are firmly held to prevent twisting but to permit horizontal displacement during the sizing operation. The tines are supported from below by support **52** (see FIG. **4**) and are held there against by a hold-down tool **54**. As can be seen from FIGS. **2** and **3**, and FIGS. **6A** and **6B**, as the movable sizing unit advances horizontally perpendicular to the strip **16** to engage the tines **20** in the sizing station, the sizing fingers **56** pass on either side of the tines **20** (while the latter are gripped between the hold-down **54** and its corresponding support **52**). As the fingers **56** advance, their outer edges (beveled at 45°) engage the sizing cams **58** (similarly angled). Further advancement of the fingers **56** causes them to be squeezed together against the pressure of the spring **60** and about pivot **62** thereby engaging the spread tines **20** and forcing them inwardly into a parallel orientation.

As illustrated in this preferred embodiment, the transverse carriage **64** used for advancing both the scraping tools **30** and **50** and the sizing fingers **56** are shaped to track in a horizontal transverse direction relative to the progression of the strip **16** through the progressive die. This carriage **64** tracks in guide slots **66** and **68**. It is actuated by a slide cam **70** which depends from the upper movable die **24**. As the cam **70** moves downwardly, it bears upon the cam follower pin **72** (which latter is fixed in the carriage **64**) forcing the carriage **64** forward towards the locating strip **16** and the connectors **10** carried thereon. The scraping tools **30** and **50** are carried in front of the leading end of the carriage **64** by a slide block **74** having a locating screw adjustment **76**. The sizing fingers have a similar slide block **78** and screw adjustment **80**.

FIG. **10** shows an alternative embodiment of the present invention wherein a single scraping tool **30a** has two scraping edges. For convenience of reference, features similar to those illustrated in the preceding figures have been given identical reference numerals followed by the suffix "*a*."

As indicated above, FIGS. **11** to **13** indicate still another preferred embodiment of the present invention. Where the parts are equivalent to those illustrated in FIGS. **1** to **9**, identical reference numerals have been employed, and where they are substantially equivalent but of different structure, the same reference numerals have been employed but followed by the suffix "*b*." The connectors **10***b* have tines **20***b* which do not have retaining notches **22**. Because of this, the sizing mechanism is greatly simplified, being only a sizing cam **82** having a gradually tapered cam slot (as illustrated in FIG. **11**) which has a height only slightly greater than the thickness of the tines **20***b* and has a taper shaped to force the ends of the tines **20***b* together into the designed configuration.

Also illustrated in FIGS. **11** to **13** is an improved version of the tine stops **46***b* (best shown in FIG. **13**). The main advantage of the stop illustrated in FIGS. **11** to **13** over that illustrated in FIGS. **1** to **9** is its adjustability. This adjustability not only enables quick and convenient compensation for tool wear and for differing pressure requirements responsive to design variations, but also initially in achieving the proper design pressure. If the pressure which the tine stop **46***b* exerts against the tine **20***b* is too great, then the scraping tool **50** will tend to gouge and chatter thus destroying rather than improving the contact surface.

The actual backstop portion of the adjustable tine stop **46***b* is a finger **84** positioned to operate in the slots **48** made in the tine supports **40**. This finger **84** is carried by a rigid arm **86** which is pivoted on pin **88** carried in housing **90**. In the illustrated embodiment the pin **88** serves as a pivot pin for both arms **86**. The adjacent faces of the arms **86** at the point of engagement of the pin **88** are cylindrically recessed to receive the pin **88** therein and capture it therebetween with the respective adjacent faces spaced one from the other. The outer face of the free end **92** of the arm **86** is engaged by a spring loaded probe **94** which is forced into engagement therewith by spring **96**. The pressure of the spring **96** is adjustably varied by thumb screw **98**. Once the desired spring loading has been achieved; this adjustment can be maintained by the set screw **100**. As can best be seen in FIG. **13**, the housing **90** is carried vertically by springs **102** which serve to raise the finger **84** out of engagement with the tines **20**b thereby permitting advancement of the connectors **10***b* on the locating strip **16***b* to the next station. The housing **90** is pressed down into operative position against springs **102** by the spring loaded probe **104** which seats in socket **106**. Thus, after the connector **10***b* has been positioned for scraping, the upper moving die **44***b* moves downwardly carrying the probe **104** with it and forcing the housing **90** and the finger **84** of its arm **86** into operative position as illustrated in FIG. **12**.

With the tine stop **46**b positioned as illustrated in FIG. **12**, the pressure of the finger **84** against the tine **20**b can be increased by screwing the thumbscrew **98** inwardly. The adjustable spring tension serves not only to increase the pressure exerted by the finger **84**, but also gives the finger **84** the flexible pressure required where the contour of the tine edge contact surface **18***b* is curved.

Although it is mechanically possible and within the scope of the broader aspects of this invention to make these backstops **64** rigid rather than flexible and have the scraping tool move in a cammed path following the contour of the tine edge contact, nevertheless this would be considerably less desirable because of the extremely precise positioning of the tine that would be required and the very close tolerances which would have to be maintained.

It has been found that for a particular material and contour of the tine the scraping angles of the cutting tool can be surprisingly critical. For example, in the embodiment illustrated in FIGS. **1** to **9** when the leading face of the cutting edge of the scraping tools **30** was

angled at 30° to the perpendicular through the point of the tool and the trailing face was angled at 40°, the tool tended to gouge the surface and did not function properly. Similarly, a 45° angle did not function properly. However, when these angles were modified to 43° (and used on a tine made of number six hardness phos bronz with a thickness of 0.016 inches), this scraper advancing in a linear direction scraped off a curl 28 from the curved contact surface 18' which had a thickness of 0.0005 inches. This was enough to improve the smooth surface of the edge contact surface from about 20 percent to over 60 percent. Anything over 50 percent which can be achieved with any regularity is a significant improvement greatly increasing the utility of the contact. Furthermore, other trial scrapings with this same arrangement resulted in consistent improvement of the edge contact surface to a consistent removal of 90 to 100 percent. This scraping method is applicable to surfaces formed from metals having a thickness up to at least 0.030 inches.

It is an advantage of the scraping method disclosed herein that this processing can be accomplished within very minute and confined spaces and at a very high production rate (300 scrapings per minute being typical). In contrast, a rotary cutter or grinder would be comparatively bulky, slow and leave circular rather than linear tool marks. The grinding material would tend to become imbedded in the kind of metals typically encountered in electrical contacts. In a typical application of the embodiment illustrated in FIGS. 1 to 9, the shank of the scraping tool had a thickness of 0.020 inches and a height of 0.160 inches with the scraping point extending out from the shank at essentially right angles by about 0.01 inches. For improved wear characteristics, the point of the tool could be formed on a diamond insert.

I claim:

1. In a method of making an edge engaging electrical connector having an effectively flat edge contact surface wherein the connector is initially blanked out from flat metal stock with the blanking operation forming a substantially rough and nonlinear cut edge surface which constitutes an inefficient contact surface for the connector, the improvement which comprises the step of:

fine scraping the cut edge by cutting away a thin metal layer from said cut edge to remove at least a substantial portion of said rough and nonlinear cut edge surface and to produce a substantially new effectively flat edge contact surface thereby increasing the area and quality of said edge contact surface of said connector.

2. In a method of making an edge engaging electrical connector having an effectively flat edge contact surface as claimed in claim 1 wherein said scraping is directed along said cut edge.

3. In a method of making an edge engaging electrical connector having an effectively flat edge contact surface as claimed in claim 1 wherein said scraping is performed substantially along the direction of contact engagement intended for said edge contact surface.

4. In a method of making an edge engaging electrical connector having an effectively flat edge contact surface as claimed in claim 1 wherein said scraping is performed by:

maintaining an effective pressurized and yieldable engagement between a straight cutting edge of a scraping tool and said cut edge of said connector; and

simultaneously moving said scraping tool relative to said connector along the direction of contact engagement intended for said edge contact surface.

5. In a method of making an edge engaging electrical connector having an effectively flat edge contact surface as claimed in claim 4 wherein leading and trailing faces of the straight cutting edge of said scraping tool are provided and maintained at a substantial angle to the direction of contact engagement intended for said edge contact surface.

6. In a method of making an edge engaging electrical connector having an effectively flat edge contact surface as claimed in claim 4 with said edge contact surface having an ultimate clearance less than the size of said scraping tool, the improvement further comprising the steps of:

initially blanking out said connector from the flat metal stock so that said cut edge of said connector has a clearance sufficient to accommodate said tool; and

sizing said connector to position said substantially new effectively flat edge contact surface at its ultimate clearance after the performance of the fine scraping step.

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