United States Patent [19]

Berg

[11] **3,707,933**

[45] **Jan. 2, 1973**

[54] **APPARATUS FOR TERMINAL MANUFACTURE**

[76] Inventor: **Quentin Berg**, c/o Berg Electronics, Inc., Exit 16, York Expressway, New Cumberland, Pa. 17070

[22] Filed: **Dec. 21, 1970**

[21] Appl. No.: **100,252**

[52] **U.S. Cl.**.....**113/1 R, 113/119, 72/341**

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

[58] **Field of Search**.....113/119, 1 R; 90/18, 19, 21, 90/DIG. 7; 29/630 A, 630 R; 339/258 R; 72/341

[56] **References Cited**

UNITED STATES PATENTS

3,559,604	2/1971	Ruehleman	113/119
2,600,190	6/1952	Batcheller	113/119 UX
3,494,253	2/1970	Hood et al.	90/21
3,566,660	3/1971	DeDek	113/119 X
3,555,497	1/1971	Watanabe	339/258 R

FOREIGN PATENTS OR APPLICATIONS

522,831	6/1940	Great Britain	90/19
690,629	4/1953	Great Britain	90/19

Primary Examiner—Richard J. Herbst
Attorney—Thomas Hooker

[57] **ABSTRACT**

An end mill is used to form a reduced thickness step in an indefinite length of strip material. If, due to tolerances and other factors the reduced thickness material is slightly too thick, it is swaged to a reduced thickness following which terminals are formed of both the thinned and original thickness material.

4 Claims, 13 Drawing Figures

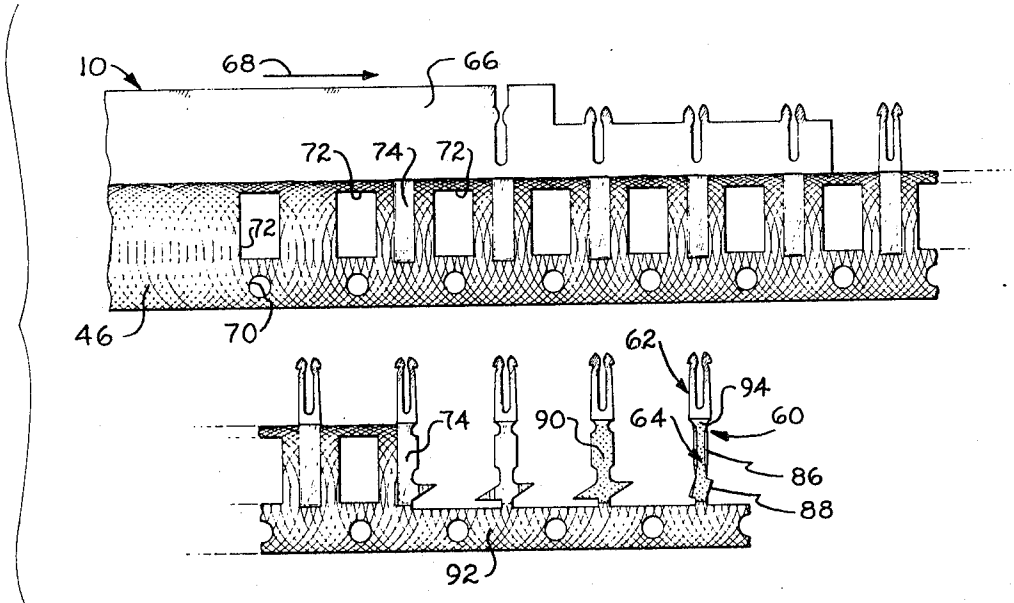


Fig. 1

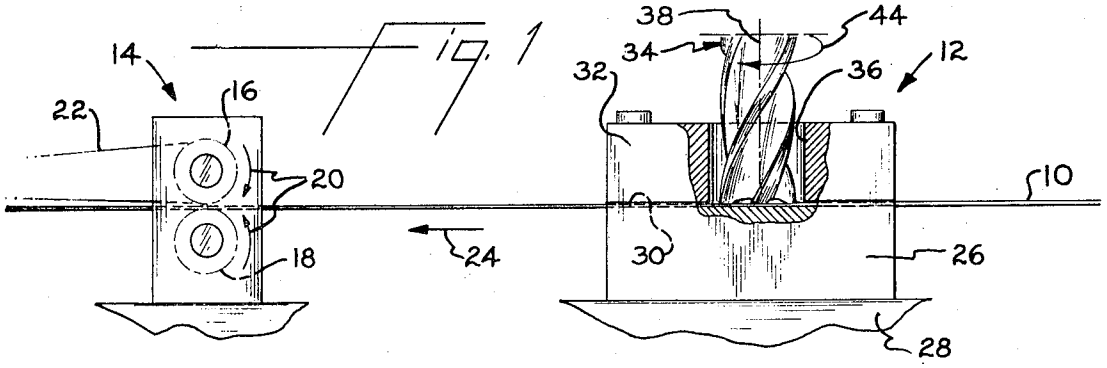


Fig. 2

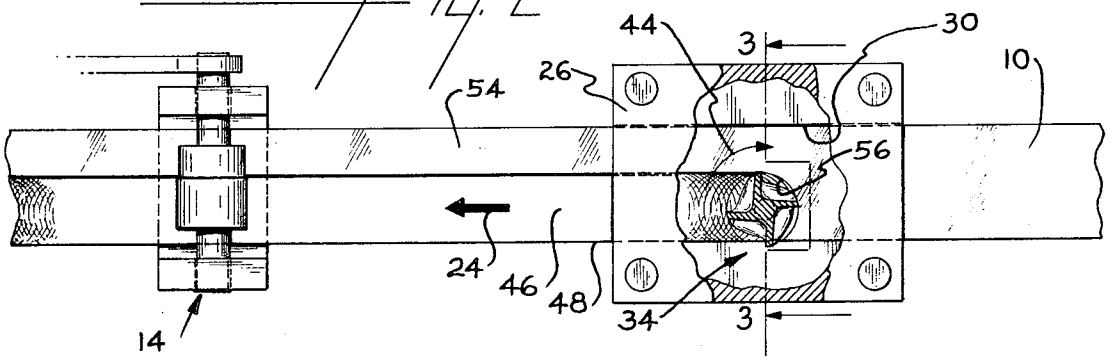


Fig. 3

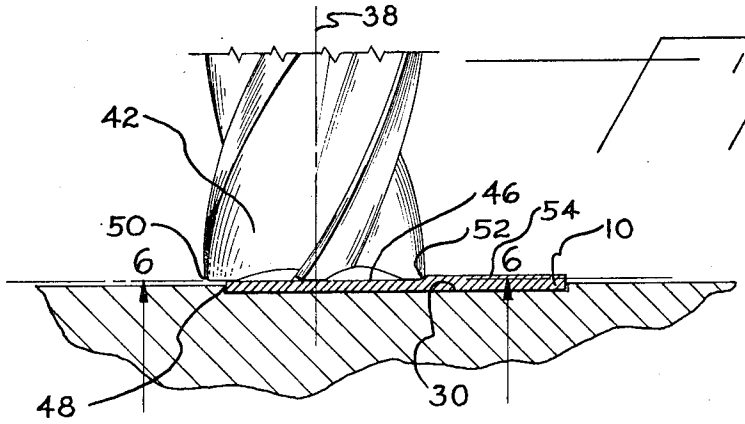
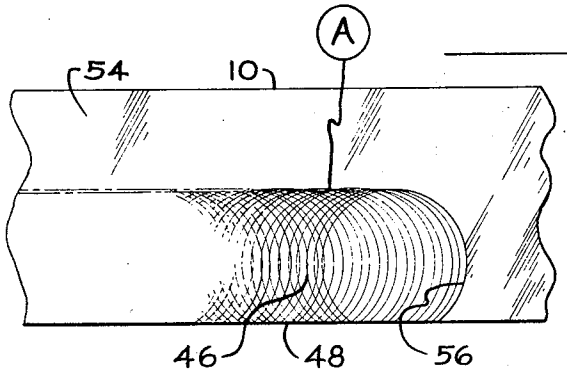


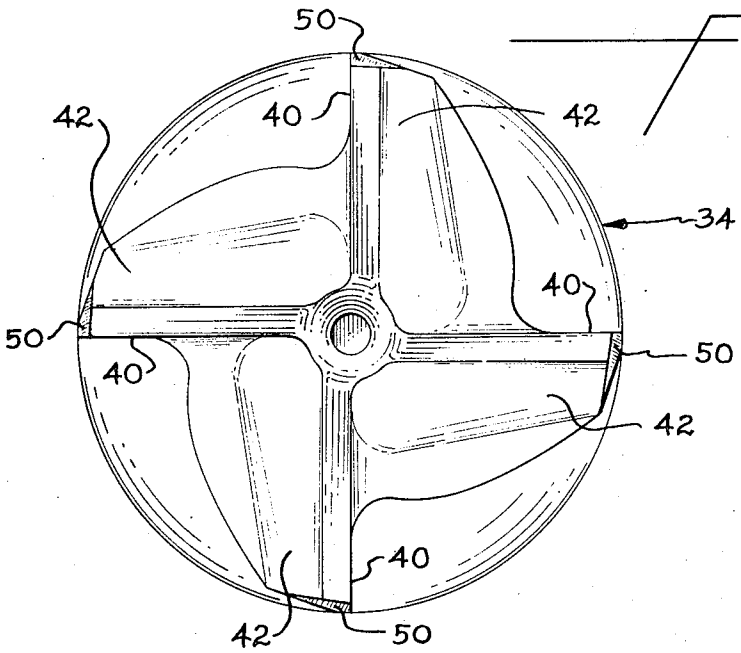
Fig. 4



INVENTOR.
Quentin Berg

BY Thomas Hooker,
His Attorney

Fig. 6



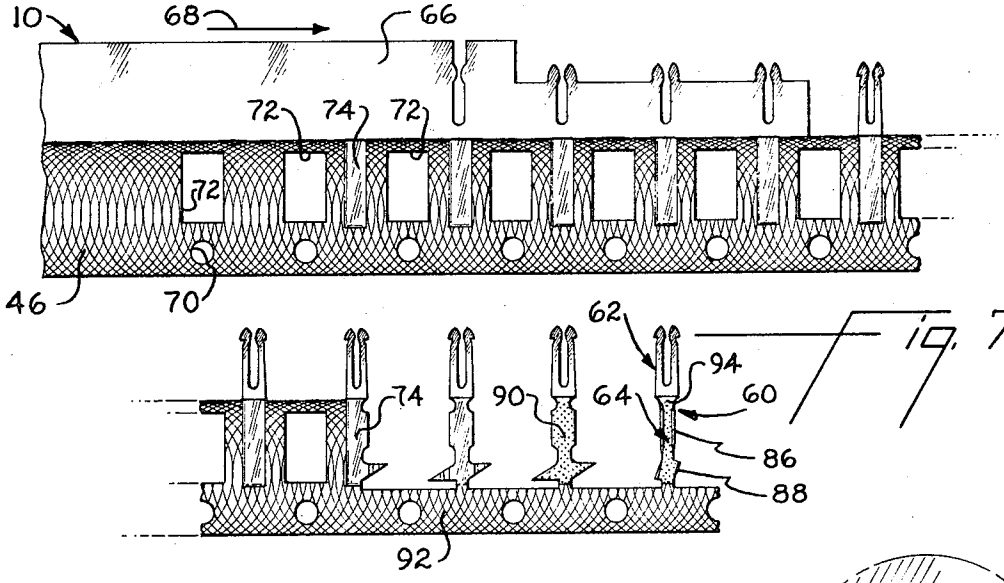


Fig. 7

Fig. 8

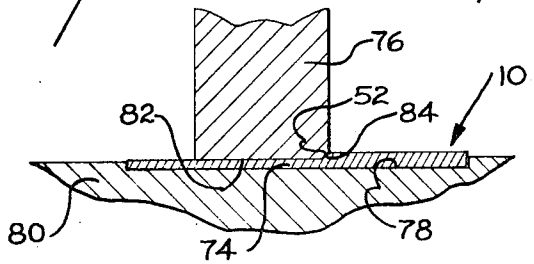
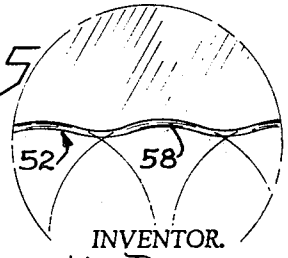


Fig. 5



INVENTOR.
Quentin Berg

BY
Thomas Hooker,
His Attorney

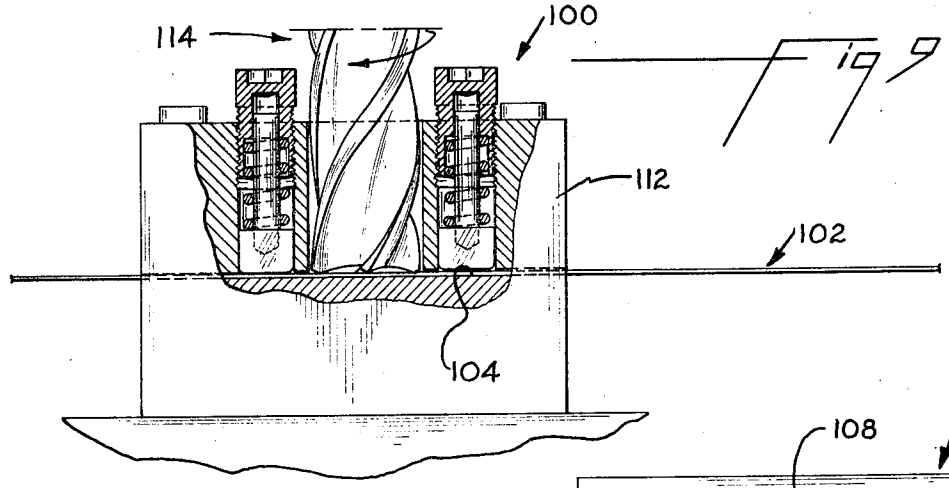


Fig. 9

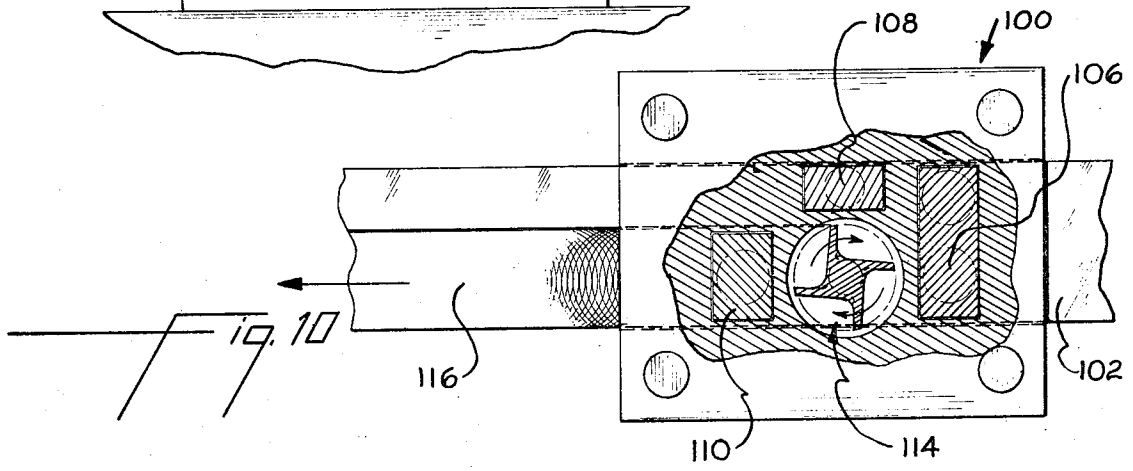


Fig. 10

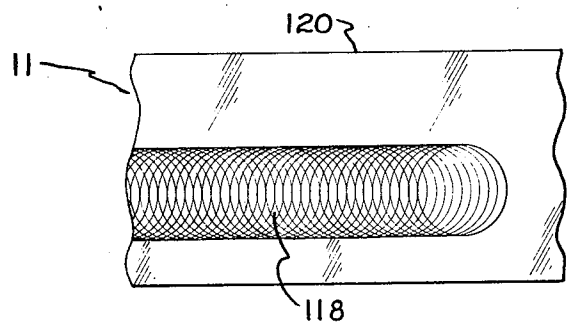


Fig. 11

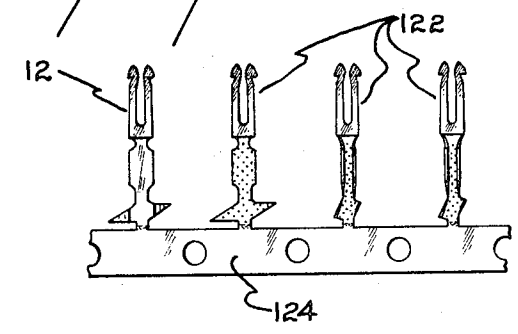


Fig. 12

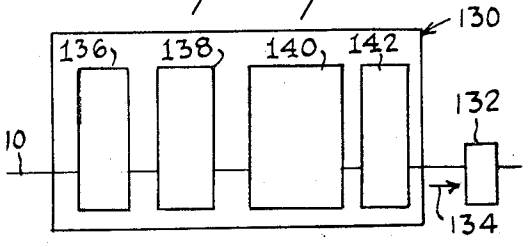


Fig. 13

INVENTOR.
Quentin Berg

BY
Thomas Hooker,
His Attorney

APPARATUS FOR TERMINAL MANUFACTURE

The invention relates particularly to the formation of crimp type electric terminals from an indefinite length of strip stock where it is required that different parts of the terminals be formed of metal of different thicknesses, with the thickness of the metal in at least one part of the terminal strip maintained to a precise tolerance.

The terminals are formed by feeding uniform thickness strip stock past a fixed end mill which is rotated to cut a reduced thickness step in the strip. Following this stress relief windows are formed at intervals along the step. If the material between the windows is too thick it is then swaged or stamped to the exact desired thickness. The material displaced during the swaging step bulges into the adjacent windows formed in the step and does not alter the thickness of the adjacent unmilled portion of the strip. By the use of this method the thickness of the material located between the swaging tooling is controlled to within ± 0.0003 inches of the desired thickness. A crimp type terminal is then formed, preferably by a stamping operation, from both the thinned material and a portion of the original thickness strip material with the crimp barrel of the terminal formed from the thinned material. The terminal may be secured to a carrier strip cut out of the step.

Large numbers of crimp type terminals are used in modern electronic apparatus such as computers where it is essential that the electrical properties of each terminal be retained within a very close tolerance throughout the useful life of the apparatus. An electronic computer may utilize as many as 100,000 terminals each of which must function properly in order for the computer to function properly. If a single terminal fails, the entire computer fails. It is essential that the crimp type connections between the terminals and conductors in the computer have uniform low contact resistance throughout the life of the computer. Computers use solid state components, integrated circuits, memory frames and other circuit elements which are driven by low voltage and amperage currents and accordingly are easily affected by slight changes in the contact resistance of a single crimp connection.

In order to achieve the uniformity of the crimp connection in each of the large number of terminals, the crimp barrel of each terminal must be formed from metal stock having an exact thickness so that when crimped to the conductor a long lived low contact resistance crimp connection is formed. If the crimp barrel is formed of material too thin, then the crimping tooling will not form a tight low resistance connection between the terminal and the conductor. If the thickness of the crimp material is too great, there is a tendency for the crimp barrel to rebound open following crimping. In either case the desired crimp connection is not formed and it is likely that the contact resistance of the connection will increase during the life of the computer.

In certain types of computers and the like, it is desirable to use crimp type terminals where the disconnect portion of the terminal is formed from strip material having a greater thickness then the thickness of the material used to form the crimp barrels. The disconnect portions of the terminals may be formed from commercially available strip stock of uniform

thickness. The difficulty arises in thinning the strip stock to provide the required thinner material for the crimp barrels. The problem of providing the thin crimp barrel material is compounded by the fact that the terminals must be rapidly and inexpensively mass produced in large numbers yet must conform to the very stringent thickness tolerance in order to achieve the desired reliability of the crimp connections.

Hood et al. U.S. Pat. No. 3,494,253 discloses apparatus for forming a step in an indefinite length of strip material. It has been proposed that the Hood apparatus be used for forming the reduced thickness crimp barrel material in the manufacture of computer crimp terminals performed by sub-assembly **140**. The Hood patent utilizes a circumferential cutter for forming in a step in the strip which is moved continuously past the cutter. The result is a reduced thickness step having a scalloped surface due to the fact that each individual cutting tooth on the cutter cuts one portion of the strip as it is swept in a circular path, and the next cutter tooth cuts a different portion of the strip located slightly upstream of the first portion, thus resulting in undesired variations in thickness of the step.

Additionally the use of a circumferential cutter as taught by Hood et al imparts differential stresses in the milled step which tend to cause terminal carrier strips formed therefrom to twist or snake during reeling and to jam when fed along the feed path of a terminal applicator. The teeth of a circumferential cutter dull sooner than the cutting teeth of an end mill so that the use of an end mill in forming the reduced thickness step reduces down time necessitated when the cutting mills are changed and also reduces the frequency of adjustment of the cutting tool relative to the strip.

Accordingly, an object of the invention is to provide a method and apparatus for forming crimp type electric terminals from strip stock material in which the disconnect portion of the terminal is formed from the strip stock and the crimp barrel is formed from a reduced thickness portion of the strip stock. The thickness of the crimp barrel material is held to a very close tolerance in order to assure minimum contact resistance at the crimp connection.

Another object is to provide a method and apparatus for reducing the thickness of a strip of metal of indefinite length.

A further object of the invention is to provide electric terminals formed from differential thickness strip material. The terminals may be secured together on a carrier strip of indefinite length. The strip is not stressed so that reeling and feeding of the strip in an applicator is facilitated and snaking and binding are reduced.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings of which there are three sheets.

IN THE DRAWINGS:

FIG. 1 is a partially broken away side view of apparatus used to mill a step in strip stock:

FIG. 2 is a top view of the apparatus shown in FIG. 1;

FIG. 3 is an enlarged sectional view taken generally along line 3—3 of FIG. 2;

FIG. 4 is an enlarged view of the top of the strip in FIG. 2;

FIG. 5 is an enlarged view of portion A of FIG. 4;

FIG. 6 is an enlarged view of the cutting end of the end mill illustrated in FIG. 1;

FIG. 7 is a view illustrating the manufacturing steps performed on the milled strip during the formation of terminals therefrom;

FIG. 8 is a sectional view of the tooling used to perform one of the steps of forming the strip;

FIG. 9 is a partially broken away view of a modified milling apparatus;

FIG. 10 is a partially broken away view of the miller of FIG. 9;

FIG. 11 is a view of a strip with a different step milled therein; and

FIG. 12 is a view similar to part of FIG. 7 illustrating the manufacture of terminals from the strip of FIG. 11.

FIG. 13 is a schematic view of the machine used to perform the manufacturing operations on strip 10 as illustrated in FIG. 7.

As illustrated in FIG. 1, a flat metal strip 10 of indefinite length is fed through a milling apparatus 12 by strip feed 14. The feed 14 comprises a pair of feed rollers 16 and 18 which are rotated in the direction of arrows 20 by suitable drive means 22. One of the rollers may be resilient so that the strip 10 is frictionally engaged between the rollers and rotation of the rollers moves the strip in the direction of arrow 24 past the miller.

The miller 12 includes a base block 26 mounted on support 28 and having a flat strip feed groove 30 formed therein. A cover plate 32 rests on the top of the block 26 and is secured thereto so as to confine the strip 10 in the groove 30. The groove has sufficient width and depth to permit the strip to be pulled freely through the miller. End mill 34 is mounted in suitable drive means (not shown) with the cutting end of the mill projecting down through an opening 36 in cover plate 32. The rotational axis of the end mill is perpendicular to the longitudinal axis of the groove 30 and of strip 10 as the strip is moved past the mill. Cutting edges 40 of the mill teeth 42 (see FIG. 6) are spaced above the bottom of strip feed groove 30 a distance less than the thickness of the strip 10. As indicated in FIGS. 1 and 2, mill 34 is rotated in the direction of arrows 44. Rotation of the end mill cuts away a portion of the strip 10 to form a reduced thickness step 46 on one side of the strip. The diameter of the end mill is somewhat greater than the width of the step 46 so that each cutting edge 40 of the mill sweeps over strip edge 48 to assure that a smooth corner is obtained.

Bevels 50 are provided at the outer edges of the end mill cutting teeth 42 so that, as illustrated in FIG. 3, the mill cuts out a slanted surface 52 between the step 46 and the top of the strip 54.

The milling apparatus 12 illustrated in the drawings may be provided with means for cooling the end mill and for removing chips from the work area. These means are conventional and form no part of the invention.

During the milling operation, feed 14 moves strip 10 through the milling apparatus 12 at a uniform rate of speed and the end mill is rotated at a relatively high rotational speed in order to mill the step 46. Most of the material removed from the step is cut away during the period of time when each cutter 42 sweeps past the upstream arcuate edge 56 of the step 46. Each sweep of a tooth 42 past edge 56 removes a chip of strip material. During the completion of each revolution of end mill 34, the tooth 42 sweeps over the step 46. Because of the practical difficulties in maintaining the end mill axis 38 exactly perpendicular to the longitudinal axis of the strip 10, and in maintaining the feed groove 30 so that the bottom surface thereof is perfectly flat, the teeth 42 engage the strip 10 during the entirety of each revolution of the tool 34 with the exception of the time when they are to one side of strip edge 48. The pattern formed in the step 46 by this type of milling is illustrated in FIG. 4. In contrast to the use of a circumferential cutting tool for forming strips as disclosed in Hood et al. U.S. Pat. No. 3,494,253, the use of an end mill to form a step in strip 10 as disclosed does not impart twisting stress to the thinned portion of the strip. This is because the stresses from the milling operation are distributed relatively uniformly throughout the step.

Milling of the step is performed by cutting away material both against the direction in which the strip is moved past the mill, and also in the direction the strip is moved past the mill. Thus, the milling operation tends not to affect the strip feed and the strip is moved uniformly past the mill.

Each of the cutting teeth 42 sweeps over the entire surface of the step 46 so that the thickness of the step is uniform despite the fact that one or more of the teeth 42 may project toward the strip a distance slightly greater than the remaining teeth. Each of the teeth 42 performs essentially the same amount of work and cuts virtually idential chips from the upstream step edge 56 during each sweep past the edge. This feature extends the useful life of the end mill. As indicated in FIG. 5, the uniform movement of the strip 10 past the end mill 34 forms crests and valleys in the slanted step edge 52.

The portion of the strip downstream from strip feed 14 may be wound on a reel for storage. Subsequently the strip is unwound from the reel and fed to a punch press used to form the individual crimp terminals.

When a sharp end mill is installed in the milling apparatus 12, the axial height of the end of the mill above the strip feed path 30 is adjusted to 0.0122 inches. During the milling of an entire strip 10, which may have a length of from 800 to 1,000 feet, a certain amount of wear occurs in the end mill. This wear may be as much as 0.0005 inches per strip so that the step which is milled from the upstream part of the strip will be slightly thicker than the step at the downstream end of the strip. Additionally, the step material may be thicker than contemplated due to differences in the hardness and toughness of the metal at different locations in the strip itself. The result of these variations and miller wear is that the milling operation forms a step along the entire length of the strip which is at no point thinner than 0.0122 inches but which may be 0.0130 inches thick or thicker at some places. The strip tends to be somewhat thinner at the downstream than at the upstream end.

FIG. 7 illustrates generally from left to right the steps used to form a crimp type electrical terminal 60 from the stepped strip 10. FIG. 13 illustrates the machine 130 for performing the illustrated manufacturing operations on strip 10. Machine 130 includes a conventional punch press with a number of sets of tooling ar-

ranged in sub-assemblies **136** through **142** for forming terminal **12** from stepped strip **10**. A feed **132** may be used to move the strip through the machine **130** in the direction of arrow **134**. The terminal **60** includes a disconnect portion **62** and a crimp portion **64**. The disconnect portion is formed from the original thickness of portion **66** of the strip and the crimp portion is formed from the reduced thickness step portion **46**. The strip **10** may be formed of phos-bronze in order that the terminal **60** has the desired electrical and mechanical properties.

Typically the manufacturing tolerances for the terminal **60** require that the thickness of the metal used to form the crimp portion **64** of terminal **60** is less than the thickness of the metal used to form the disconnect portion **62**. The thickness of each portion must be maintained within an exact tolerance. The thickness tolerance of the metal used to form the crimp portion **64** is assured by milling the step **46** as described and by forming the disconnect portion from the step metal in the manner to be described.

In forming terminals from the bi-level strip, the strip **10** is fed from the supply reel through a punch assembly illustrated in FIG. **13** in the direction of arrow **68** in FIG. **7**. The press assembly includes a number of press stations each of which performs an operation on a portion of the strip. These operations will be described in the sequence of operation.

The first operation performed on the strip is to punch out a pilot hole **70** and a swage relief window or opening **72** from the step. Sub-assembly **136** performs this operation. The opening **72** extends laterally across the step **46** and is located to one side of the material **74** used to form the terminal crimp portion **64**.

As previously described, the thickness of the milled step may vary from a minimum thickness of 0.0122 inches to a thickness of 0.0130 inches or more depending upon the wear on the end mill and the physical properties of the strip itself. This variation in thickness is too great to assure uniform crimp connections for the useful life of the computer or apparatus in which the terminal is used. The minimum thickness of 0.0122 inches is alright, however the step may be too thick.

In order to assure that the thickness of the step material **74** which is used to form the terminal crimp portion **64** is not greater that the maximum tolerance, the material is passed beneath a flat swaging die **76** of sub-assembly **138** after the formation of openings **72**. The strip **10** is confined in a feed path **78** formed in the support **80** beneath the die **76**. The die **76** bottoms to a clearance of 0.0128 inches above the bottom of the feed path **78** so that it will reduce the thickness of the step portion **74** to 0.0128 inches if the thickness of the material when milled was greater than 0.0128 inches. During the swaging operation, as illustrated in FIG. **8**, the material which is displaced bulges outwardly into the openings or windows **72** to either side of the step portion **74** so that the swaging step does not distort the original thickness material **66** used to form the disconnect portion **62**.

In FIG. **7**, the thickness of the step material **74** is greater than 0.0128 inches so that when the tool **76** bottoms it engages the strip to flatten portion **73** where indicated. If the thickness of the milled step **46** is less than 0.0128 inches the tool **76** when bottomed does not engage the step and the step would not carry the swaging marks. In any event, the swaging operation as described assures that the final thickness of the portion **74** of the step **46** used to form the terminal crimp portion **64** is 0.0125 ± 0.0003 inches, which is within the required thickness standards for the formation of reliable crimp connections.

During the swaging operation illustrated in FIG. **8** the bevelled corner **84** of tool **76** engages the undulating surface **52** to flatten the same. Surface **52** is flattened whether or not bottoming of the tool **76** reduces the thickness of the step portion **74**.

After the swaging operation is performed, the terminal disconnect portion **62** is cut out of the strip portion **66** in a number of steps performed by sub-assembly **140**. Following this the crimp barrel portion **64** is stamped from the swaged part **74** of the step **46** by sub-assembly **142** as illustrated. Wire crimp barrel **86** is formed entirely from the swaged portion of step **46** while the outer tips of the insulation crimp barrel **88** extend beyond the swaged portion of the step. Prior to the forming of the wire and insulation crimp barrels **86** and **88**, dimples **90** may be formed in crimp portion **64**. The dimples improve the crimp connections.

As illustrated, the terminals **60** formed from the strip **10** project to one side from a carrier strip **92** which is formed from the step **46**. The milling operation used to reduce the thickness of this portion of the step equalizes the cutting stresses along the strip **92** so that the strip does not tend to twist or snake during winding of the terminals and strip on a supply reel or during feeding of the strip in an applicator. The use of a circumferential mill to form steps in strip stock in accordance with the teaching of the prior art Hood et al. U.S. Pat. No. 3,494,253, produced unequal stresses in the carrier strip formed therefrom with the result that the terminal strip tends to twist, snake and tangle. Use of the disclosed milling techniques reduces these problems.

Crimp barrel **86** is spaced from disconnect portion **62** by a flat neck **94** of the sized step material **74**. The thickness of neck **94** may be checked by a suitable instrument to assure that the thickness of the crimp barrel **86** is within the tolerance required to form a reliable crimp connection.

FIGS. **9** and **10** illustrate a different embodiment of the milling apparatus **12** of FIGS. **1** and **2**. The milling apparatus **100** of FIGS. **9** and **10** is identical to miller **12** with the exception that the strip **102**, which is pulled through the miller by a feed like feed **14**, is firmly held against the bottom of feed path **104** by three spring backed clamps **106**, **108** and **110**. The clamps are mounted in the top plate **112** of the milling apparatus. Clamp **106** extends nearly across the entire width of the strip **102** immediately upstream of the end mill **114** which is used to cut step **116** in the strip. The clamp **108** is located laterally to one side of the end mill **114** and clamp **110** is located immediately downstream of the end mill and engages the reduced thickness step **116**.

The three clamps assure that the portion of the strip which is milled is held against the bottom of the feed path **104** thereby preventing any lifting or chatter of the strip which could occur as a result of the milling operation. For instance, the tendency for the individual cutter blades of the end mill to lift the strip from the

feed path during cutting is eliminated. In this way the minimum step thickness is further assured. In other respects the milling apparatus **100** is identical to apparatus **12**.

FIG. **11** illustrates a modification of the invention according to which a reduced thickness step **118** is formed within the width of strip **120**. Step **118** may be formed by the use of a milling apparatus as illustrated in either FIGS. **1** or **9** in which a small diameter end mill is used and where the end mill is located so that it does not sweep over the edge of the strip.

FIG. **12** illustrates terminals **122** which may be formed from the strip **120** in the same way as indicated in FIG. **7**. The terminals **122** are secured to a carrier strip **124** which in this case is formed from an original thickness portion of the strip **120** as opposed to the carrier strip **92** of FIG. **7** which is formed from the reduced thickness step material. The terminals **122** are identical to terminals **60**.

While the inventions disclosed herein are particularly useful in the manufacture of electric terminals, it is not intended that they be limited solely to this art since the manufacture of stepped strip material of indefinite length to precise tolerances may be useful in applications which do not relate to terminals. Likewise, it is not intended that the invention be related to the manufacture of electric terminals of the particular type disclosed. Obviously terminals may be manufactured in accordance with the invention which utilize a disconnect portion of a type different than that disclosed in terminal **60**.

While I have illustrated and described preferred embodiments of my invention, it is understood that these are capable of modification, and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

I claim:

1. Apparatus for forming crimp type terminals from an indefinite length of strip stock including end mill cutting means for reducing the thickness of a longitudinally extending portion of the strip stock to a thickness greater than a given minimum thickness, means for assuring that the thickness of the reduced thickness portion of the strip stock is not greater than a given maximum thickness tolerance and means for cutting out terminals from the strip stock with the terminals including a crimp barrel formed from the reduced thickness portion of the strip stock.

2. Apparatus for forming crimp type terminals from metal strip stock including milling means including an end mill and feed means for moving the strip stock past the end mill for reducing the thickness of a part of the strip, means for reducing the thickness of portions of said part of the strip if such thickness is greater than a given maximum thickness tolerance and means for forming crimp terminals from said strip stock with crimp barrels formed from said portions of the reduced thickness part of the strip.

3. Apparatus as in claim **2** wherein said means for reducing the thickness comprises a strip support and a swaging tool moveable toward and away from said support, the distance from said tool to said support when bottomed being equal to the maximum thickness tolerance.

4. Apparatus as in claim **3** including punch means for forming displacement relief windows in the reduced thickness part of the strip located adjacent said strip portions.

* * * * *