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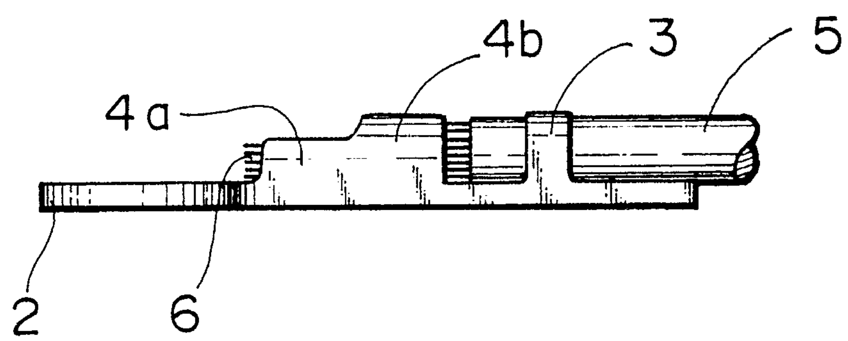
## (54) A crimp terminal and its wire crimping structure.

(57) One end of a crimp terminal is formed with a wire insulation grip portion and a bare conductor grip portion. The bare conductor grip portion is divided in two. When the terminal is crimped on the wire, the divided bare conductor grip portions are crimped in such a way that the cross section of the conductor portion held by one of the divided bare conductor grip portions will be deformed more than 40% and the cross section of the adjacent conductor portion held by the other grip portion will be deformed 10 to 30%. The first crimped portion, which is deformed more than 40%, provides a reduced electrical contact resistance and the second crimped portion, which is deformed 10 to 30%, provides a good mechanical strength or connecting force between the terminal and the wire. Thus, the crimped terminal as a whole exhibits a good electrical characteristic while at the same time providing a good mechanical strength.

FIG.1A

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# A CRIMP TERMINAL AND ITS WIRE CRIMPING STRUCTURE

## BACKGROUND OF THE INVENTION

The present invention relates to a crimp terminal which provides secure connection, both mechanical and electrical, between it and a conductor.

### Prior Art

Figure 6A and 6B show a conventional crimp or solderless terminal. Reference numeral *1* designates a crimp terminal; *2* indicates a tongue, a connecting portion of the terminal that is connected to a mating terminal; *3* a grip portion that holds the wire insulation; and *4* another grip portion that firmly holds the bare portion of a copper conductor. Denoted *5* is an insulated wire and *6* is a copper conductor. The end portion of the wire *5* is stripped of insulation to expose the bare copper conductor *6*, and then the wire end is inserted into the grip portions *3*, *4* of the terminal that are crimped against the bare conductor and insulation.

To improve the electrical characteristic of the connecting portion (in other words, to reduce contact resistance), it is preferred to increase the crimping force and thereby produce plastic deformation in the grip portion *4* and the copper conductor *6* to securely hold them together. But, too large a crimping force will result in an excessive deformation in the copper conductor *6*, which can easily break. In other words its mechanical strength is reduced. That is, as the electrical characteristic is improved, the mechanical strength reduces. Conversely, as the mechanical strength is increased, the electrical characteristic deteriorates. Hence it has been impossible to meet the both requirements at the same time.

This invention has been accomplished to overcome the above drawback, and its objective is to provide a crimp terminal whose electrical and mechanical characteristics are improved and also provide a crimping structure for securely connecting the crimp terminal and the copper conductor.

## SUMMARY OF THE INVENTION

To achieve the above objective, the crimp terminal and its wire crimping structure according to this invention comprises: a crimp terminal having at one end thereof a first grip portion for holding a wire insulation and a second grip portion for holding a bare copper conductor, said second grip portion being divided in two sections and crimped against the bare conductor in such a manner that the copper conductor deformation ratio at one of said two sections is different from the other, said copper conductor deformation ratio being obtained by first calculating a difference between copper conductor cross sections before and after crimping and then dividing said difference by said copper conductor cross section before the crimping, said two sections being crimped against the bare conductor in such a manner that at one of said two sections the copper conductor deformation ratio is more than 40% and that at the other section said copper deformation ratio is 10 to 30%.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a crimp terminal of this invention and a wire crimped together, Figure 1A being a front view and Figure 1B a top view;

Figures 2 to 4 are graphs showing the relationship between the copper conductor deformation factor, electrical characteristic, and bonding force of the crimp terminal;

Figure 5 shows the relationship between the cross-sectional area of wires (wire size) and the average bonding force required for the wires; and

Figure 6 shows a conventional crimp terminal and a wire crimped together, Figure 1A being a front view and Figure 1B a top view.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the accompanying drawings one embodiment of this invention will be described. Figure 1A and 1B show the crimp terminal according to this invention that is connected with a wire.

As shown in these drawings, the crimp terminal *1* is formed by punching and bending a metal sheet. Denoted *2* is a tongue formed at one end of the terminal that is to be connected with a mating terminal. The other end of the terminal is formed with a grip portion *3* that grips the wire insulation and with two other grip portions *4a*, *4b* that grip a bare copper conductor *6*. These gripping portions are formed by first punching from a metal sheet strips that extend from both sides of the terminal *1* and bending these strips in circle from both sides toward the center. Designated *5* and *6* are an insulation-covered wire and a copper conductor, respectively.

Our experiments have found that there is a relationship, as shown in Figures 2 to 4, between the deformation factor of the crimped copper conductor in the crimp terminal and the electrical and mechanical characteristics of the terminal. In the graph, for a certain size of crimp terminal, the abscissa represents a copper conductor deformation factor (%), the ordinate on the left-hand side indicates a residual resistance ratio as an electrical characteristic (no dimension), and the ordinate on the right-hand side designates a bonding force (kgf) between the wire and the terminal as a mechanical characteristic.

The copper conductor deformation factor is defined as follows.

Copper conductor deformation factor
$= [(A - A')/A] \times 100\%$
where $A = S \times N$
S : cross sectional area of a single core wire of the conductor before being crimped
N : number of core wires in the conductor
A : cross sectional area of the conductor before being crimped
$A'$ : true cross sectional area of the conductor after being crimped (measured by using a microscope)
The larger the value of the copper conductor deformation factor, the smaller the height of the crimped terminal will be.

The residual resistance ratio (R.R.R) is defined as $R_{293K}/R_{4.2K}$, where $R_{293K}$ is the electrical resistance of the crimped portion at 20° C and $R_{4.2K}$ is the resistance of the crimped portion when placed in liquid helium. The greater the residual resistance ratio, the better the condition of the boundary surface of the crimped portion and its electrical characteristic. This invention has been achieved by utilizing the fact that there is a definite relationship between the copper conductor deformation ratio and the residual resistance ratio.

The greater the bonding force (kgf) represented by the vertical axis on the right, the larger the tensile strength of the crimped portion and the better its mechanical characteristic.

Figures 2 to 4 show the characteristics of the crimped portion of the terminal connected with copper conductors, which are 3, 0.5 and 1.25 $mm^2$ in cross section and are made up of 41, 7 and 16 core wires, respectively, each wire being 0.32 mm in diameter. In these figures, curves (1) indicate the residual resistance ratio and curves (2) the bonding force.

The residual resistance ratio increases as the copper conductor deformation ratio increases, as indicated by the curves (1), and the electrical characteristic is improved. The residual resistance ratio becomes sufficiently high for the copper conductor deformation ratio of 40% and its rate of increase reduces from that point forward. From this it is seen that when the copper conductor deformation ratio is set higher than 40%, the crimped portion will have a good and stable electrical characteristic.

As for the bonding force, it remains high for the copper conductor deformation ratio range between 10% and 30%, as indicated by the curves (2). Figure 5 is a graph showing the relationship between the wire size and the average bonding force required for the wire. The bonding forces in the above range in Figures 2 to 4 satisfy the required value. Making use of this fact, this invention divides the bare conductor grip portion into two parts *4a*, *4b*, so that when they are crimped their heights or the copper conductor deformation ratios differ from each other. This is illustrated in Figure 1.

Next, we will explain how the invention works. As shown in Figure 1, the end of the wire *5* is stripped of insulation to expose its bare conductor *6* and the wire end is inserted into the crimp terminal *1*. Then the grip portions *3*, *4a*, *4b* are crimped against the wire to connect them together. At this time, the grip portion *4a* is crimped with a force strong enough so that the copper conductor deformation ratio for this portion will be 40% or more. This will increase the residual resistance ratio, as seen from Figures 2 to 4, and thereby improve the electrical characteristic.

Then, the grip portion *4b* is crimped with a less force than that applied to the grip portion *4a* so that the copper conductor deformation ratio for the portion *4b* will be 10 to 30%. The bonding force of the grip portion *4b* is maintained at high level, i.e., the mechanical strength of the crimped portion is high. With the above structure, the grip portion *4a* provides an improved electrical characteristic and the grip portion *4b* provides a strong mechanical strength.

As explained above, the crimp terminal of this invention has its conductor gripping portion divided in two. One of the divided grip portions provides a strong mechanical connection and the other portion ensures a good electrical contact.

## Claims

A crimp terminal and its wire crimping structure, comprising: a crimp terminal having at one end thereof a first grip portion for holding a wire insulation and a second grip portion for holding a bare copper conductor, said second grip portion being divided in two sections and crimped against the bare conductor in such a manner that the copper conductor deformation ratio at one of said two sections is different from the other, said copper conductor deformation ratio being obtained by first calculating a difference between copper conductor cross sections before and after crimping and then dividing said difference by said copper conductor cross section before the crimping, said two sections being crimped against the bare conductor in such a manner that at one of said two sections the copper conductor deformation ratio is more than 40% and that at the other section said copper deformation ratio is 10 to 30%.

FIG.1B

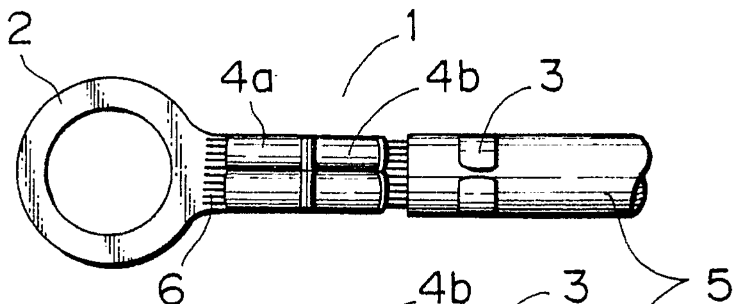



FIG.1A

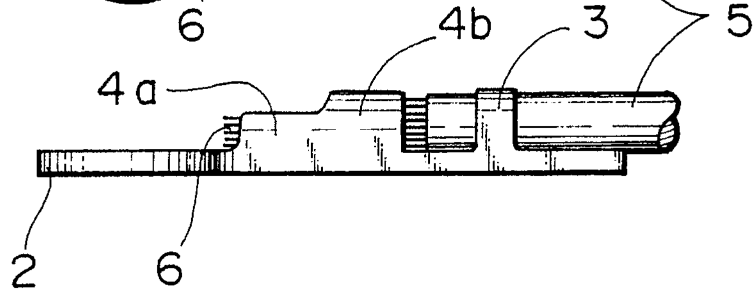



FIG.2

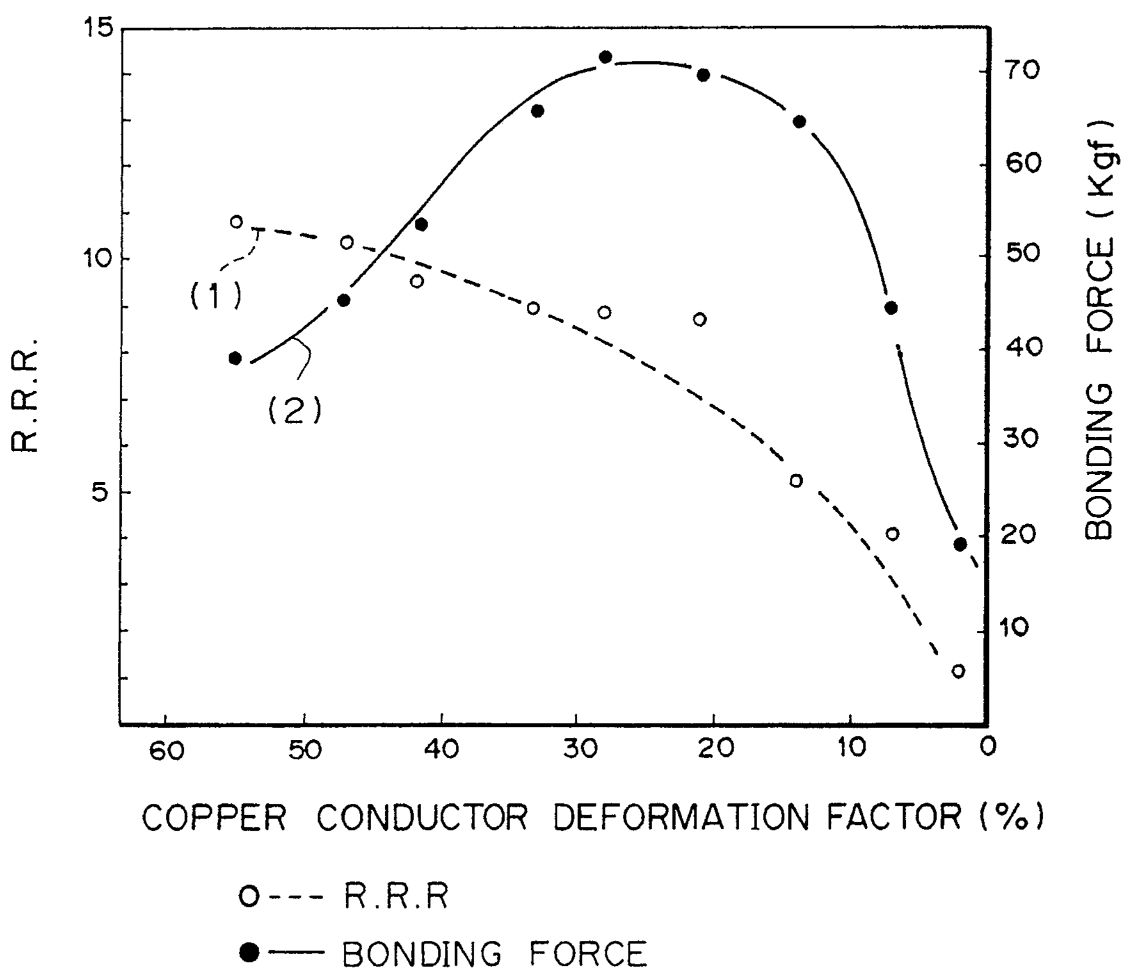


FIG. 3

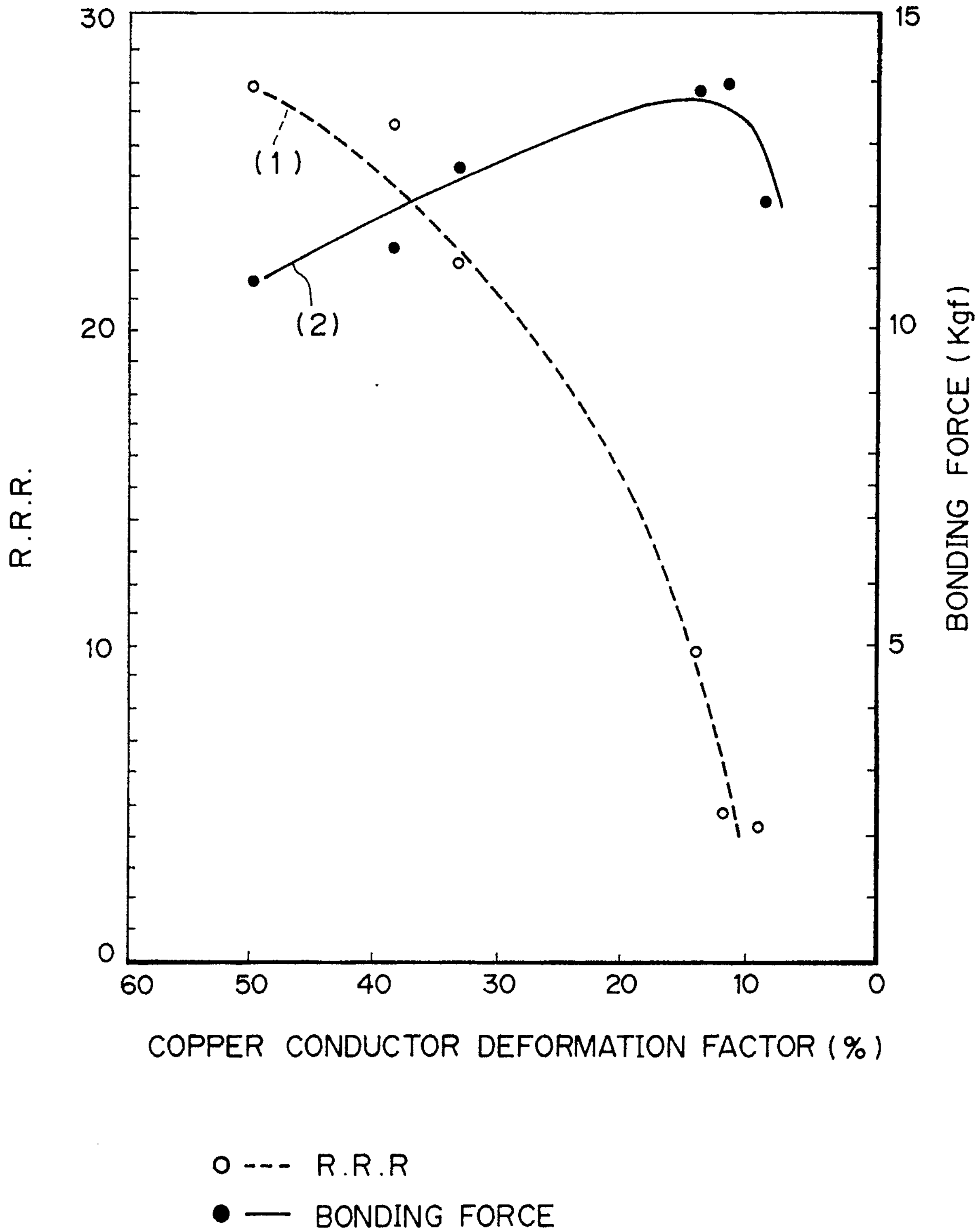

30
20
10
0
15
10
5
R.R.R.
BONDING FORCE ( Kgf )
(1)
(2)
60
50
40
30
20
10
0
COPPER CONDUCTOR DEFORMATION FACTOR ( % )
R.R.R
BONDING FORCE

FIG. 4

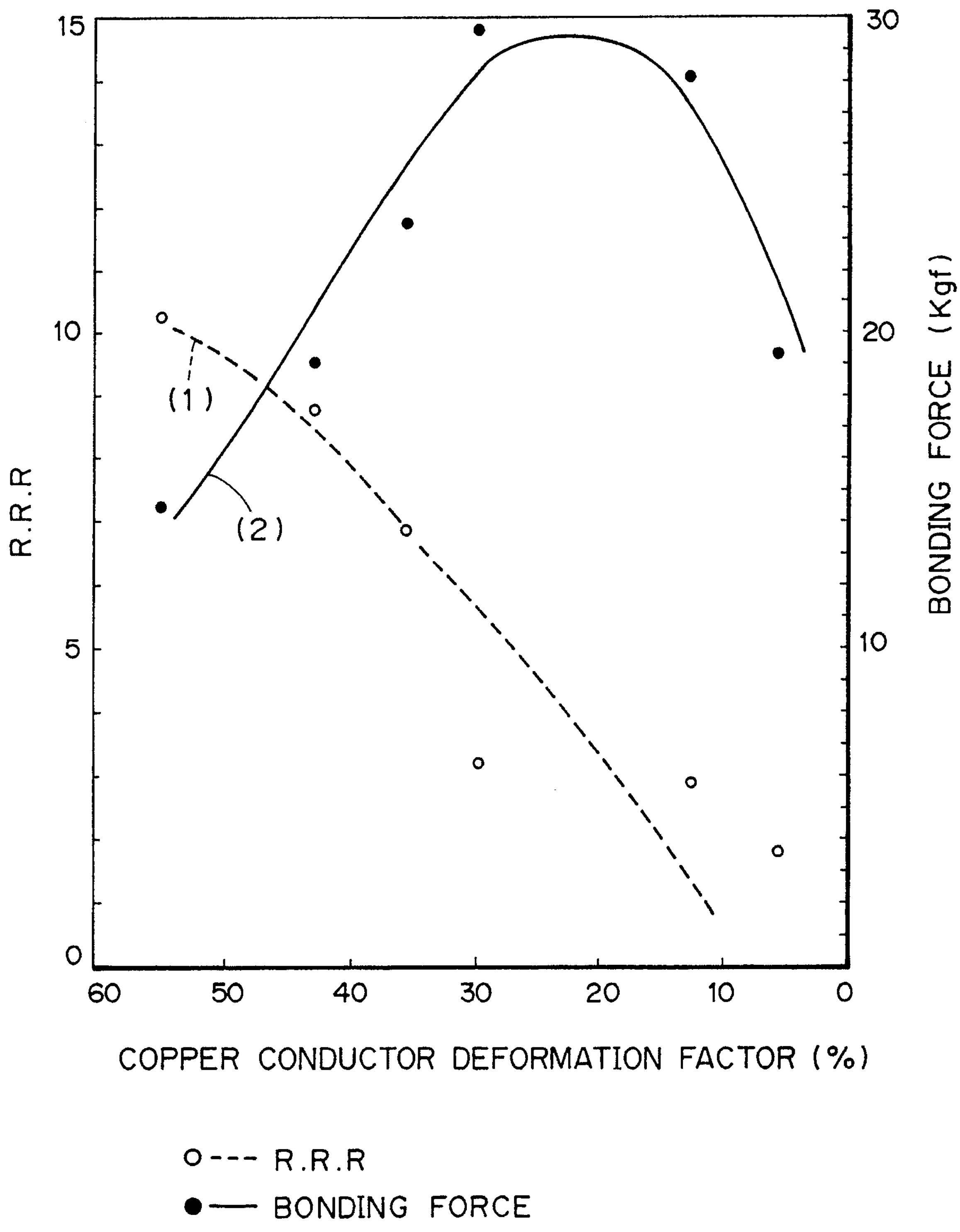

15
10
5
0
30
20
10
R.R.R
BONDING FORCE (Kgf)
(1)
(2)
60
50
40
30
20
10
0
COPPER CONDUCTOR DEFORMATION FACTOR (%)
R.R.R
BONDING FORCE

FIG.5

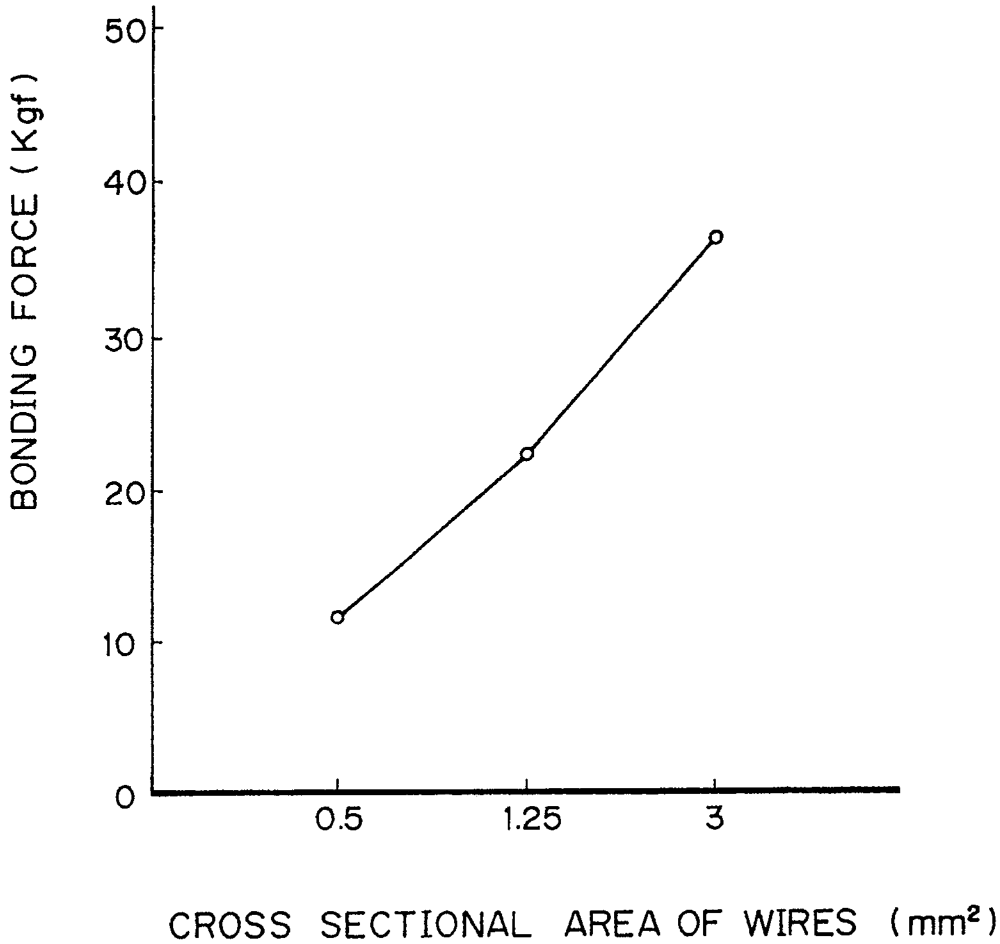
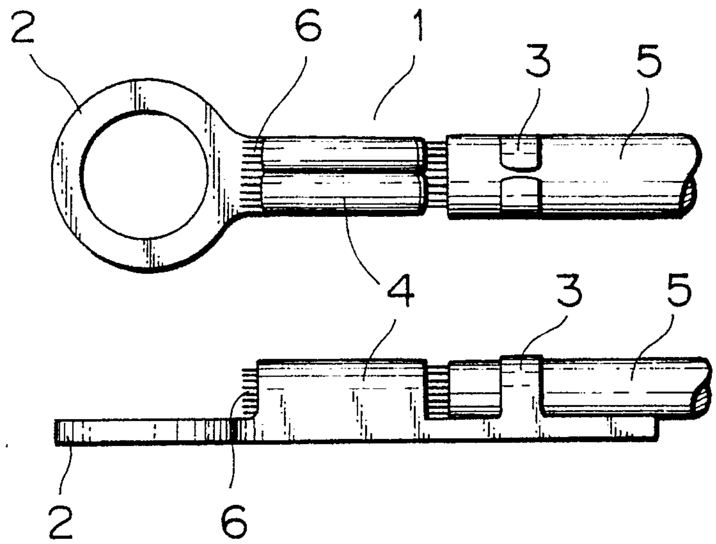



FIG.6B

FIG.6A



European Patent Office

# EUROPEAN SEARCH REPORT

Application Number

EP 90 10 9379

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.5) |
|---|---|---|---|
| A | IBM TECHNICAL DISCLOSURE BULLETIN vol. 25, no. 9, February 1983, page 4516, New York, US; G.F. GOTH et al.: "Crimped terminla with tapered or stepped shape for use with small diameter wire" * the whole document * --- | 1 | H 01 R 4/18 |
| A | DE-B-1 790 118 (AMP) * column 2, line 62 - column 3, line 13; column 4, lines 7-25,51-55; figure 3 * --- | 1 | |
| A | DE-B-2 554 310 (THOMAS & BETTS) * column 6, lines 21-36; figure 10 * --- | 1 | |
| A | UND- ODER NOR + STEUERUNGSTECHNIK vol. 15, no. 3, 1985, pages 50,63,64, Munich, DE; H.-J. DZIENGEL: "Subminiatur-Steckverbinder SBN 383 mit Schneid-Klemm- un Crimpanschlusstechnik" * page 63, right-hand column, paragraph 3 - page 64, left-hand column; figures 4,5,8 * ----- | 1 | |

| TECHNICAL FIELDS SEARCHED (Int. Cl.5) |
|---|
| H 01 R 4/00 |
| H 01 R 11/00 |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| BERLIN | 22-08-1990 | ALEXATOS G |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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