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⑤④ **ELECTRICAL CONTACTS COMPRISING PALLADIUM ALLOY AND CONNECTORS MADE THEREFROM.**

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## Description

### Technical field

This invention relates to electrical contacts useful in connectors as well as other applications, such as in voltage regulators, relays and switches.

### Background of the invention

Generally, for a composition to be suitable for use as an electrical contact, the composition should be non-fusing with the mating contact material and have a low, ohmic, contact resistance with a relatively small contact pressure. In addition, the material must be capable of maintaining the low resistance after a large number of operations over an extended life period.

Among the contact materials employed in the past are the precious metals such as gold, palladium and platinum and alloys of such metals with each other as well as with metals such as silver and nickel. It is often found that the contact or connector is multi-layer or inlaid type structure. For example, a gold-palladium-silver based alloy has been developed for use as an inlay in contact connector applications. The inlay comprises a relatively inexpensive base metal strip having a channel cut out of the strip into which channel has been inlaid the desired contact metal alloy. Typical base metals are copper, brass, Cu-Be and Cu-Ni-Sn alloys, as well as stainless steel and other spring metal alloys.

Two problems which exist with respect to the prior art contact alloys are their wear performance characteristics and their cost. Another available alloy in current use as a contact material is a 40% silver-60% palladium alloy (hereinafter designated as R156). This alloy may be used either with or without a diffused gold layer on its surface. This and other prior art alloys exhibit limited wear behavior and are generally relatively high in cost.

### Summary of the invention

This invention is an electrical contact suitable for use in connectors and other devices such as relays, switches, voltage regulators and the like comprises a base metal having a palladium alloy thereon represented by the composition:

30—60 Pd, (70-b) to (40-b) X and 0.05 to 5Y wherein the numerals are given in weight percent of each of the components and wherein b is the weight percent of component Y, X being at least one of Co and Cu, and Y being at least one of Ru, W, B, Ir and Nb, such that when X is solely Cu, Y is selected from B and Ir, B being present up to 0.25% by weight.

The alloy may be in the form of a multi-layer metal tape comprising said alloy which tape can be clad to or inlaid in a base metal to form a contact.

The contact alloys embodying the present invention generally exhibit improved wear characteristics due to an increase in hardness, but yet still exhibit sufficient ductility for use in metal

cladding, inlaying or welding to a base metal for electrical contact applications. Further these alloys generally have superior wear characteristics, they can be used in thinner layers than prior art noble metal alloys, thereby reducing the cost of the contact and connector or other device employing these alloys. In addition, since a large part of the alloy is comprised of a non-noble metal, the cost of the alloy even at the same thickness as prior art alloys is reduced.

### Brief description of the drawings

Fig. 1 is a graphical representation showing the Vickers hardness versus ductility, as measured by percent reduction of thickness of rolling without cracking, or alloys in the novel alloy system as compared to a prior art R156 alloy;

Fig. 2 is a graphical representation of a recrystallization study of a novel alloy in accordance with this invention as compared with the prior art R156 alloy and represented as a graph of anneal temperature versus Vickers hardness;

Fig. 3 is a plot showing properties of a Ps-Co-Ru ternary alloy system;

Fig. 4 is a partial isometric elevational view of a tape employing the alloys of this invention. The tape is suitable for cladding and forming inlays for metal contacts for connectors;

Fig. 5 is a drawing representing what the inventor believes to be the effect of annealing on the hardness and chemical composition of a typical metal tape as shown in Fig. 4;

Fig. 6 is a partially cut-away isometric view of a connector having a contact employing the novel alloy of the invention; and

Fig. 7 is a side elevational blow-up of the contact portion of the connector of Fig. 6.

### Detailed description

The electrical contacts embodying this invention, which may be employed in connectors and other electrical devices requiring electrical contacts, are comprised of a hardened palladium alloy. The alloy composition is generally present as an inlay, cladding or other type coating over at least a portion of a base metal forming the electrical contact. Further, the alloys may be one layer of a multilayer tape. Such a tape can then be used for cladding, bonding, welding or inlaying to a base metal. Such base metals are typically metals such as copper, brass, copper-beryllium and copper-nickel-tin-alloys as well as stainless steel or other spring metal alloys.

The alloys of the invention may be represented by the following composition wherein the numerals represent weight percent of the components:

30—60 Pd, (70-b) to (40-b) X and 0.05 to 5 Y wherein X is at least one of Co and Cu, "b" is the weight percent of the component Y and Y is at least one of Ru, W, B, Ir and Nb, and when X is solely Cu, Y is selected from B and Ir, with B being present in an amount of up to 0.25% by weight.

The alloys are suitable for use either with or without gold or gold alloy top layers. Based upon

the improved hardness and ductility of the novel alloys as compared with the currently employed commercial R156 alloy, it is expected that contacts made from these novel alloys will also have superior wear properties. It is contemplated that the new alloys are particularly suitable as an inlay material and therefore their ability to be rolled without cracking, i.e., their ductility, is important to the formation of such metal inlays or of cladded contacts. Also, the recrystallization behavior and ductility of the new alloys which are important to metal inlaying or cladding art at least equal to that of the prior art alloy.

For example, referring to Fig. 1, the ductility as measured by percentage deformation by rolling without cracking versus the Vickers hardness of Pd-Co-Y alloys wherein Y is Ru, W or B, one of the alloy systems in accordance with the present invention, is shown in comparison to the prior art R156 alloy. It can be seen that for any given ductility i.e., percentage reduction in thickness by rolling, the new alloys generally have a higher Vickers hardness than R156. Correspondingly, for any given Vickers hardness the new alloys are more ductile than the prior art alloy.

Further as can be seen in the recrystallization study represented by the graph of Fig. 2 showing annealing temperature versus Vickers hardness of a novel alloy as compared with R156, the Vickers hardness of the novel alloy is greater than that of the referenced prior art alloy at any given anneal temperature. The particular novel alloy shown, in fact, has a lower hardness than novel alloys with more Ru as well as many other alloys included in the claimed alloy systems.

It has been found that when the palladium is alloyed with cobalt (no copper), the preferred additive is ruthenium in a quantity of from 0.5 to 5 weight percent.

When the palladium is alloyed with copper (no cobalt), the preferred additive is boron in a weight range of from 0.05 to 0.10 weight percent. The ruthenium, tungsten and niobium, which are suitable additives to a palladium-cobalt alloy to achieve the desired properties of hardness and ductility, are not as suitable for a palladium-copper alloy due to their relative insolubility in such an alloy and the brittleness of the resulting ternary alloy. Further, in order to achieve the desired combination of hardness and ductility so as to allow the alloyed material to be rolled without cracking, one should stay within the weight percent ranges as previously set forth.

The preferred amount of tungsten added to the palladium-cobalt system is 0.5 to 2 weight percent, while the preferred amount of boron in that system is 0.1 to 0.25 weight percent. Similarly, the preferred amount of iridium added to a palladium-copper alloy is from 0.25 to 1 weight percent. The particular amounts of materials for achieving optimum performance will depend upon the ratio of palladium to cobalt and palladium to copper, respectively.

Fig. 3 is an example showing the relative brittleness of one of the preferred ternary alloy

systems, namely, the palladium-cobalt-ruthenium system. As can be seen from the figure, as one goes above 5 wt. % Ru (outside the ranges set forth herein), the brittleness of the alloy increase above that which is desirable.

The novel alloys can be prepared by simply melting the constituent components together to form a homogeneous molten solution, casting the solution onto an appropriate mold and then allowing the solution to cool so as to solidify the melt.

Referring now to Fig. 4, there is shown a laminar structure metal tape 1 comprising the novel alloy as one of the layers. This tape is particularly suitable for cladding to or inlaying in a base metal such as a spring metal alloy base metal. As can be seen from the figure, the tape 1 comprises three layers. The top layer 2 is made of either a gold or gold-silver or gold-silver alloy doped further with carbon, carbides, nitrides, boron or borides. Examples of suitable nitrides, carbides and borides are boron nitride, titanium carbide and tantalum nitride. When the top layer 2 is to act as an inert surface layer to inhibit corrosion, that layer should generally be between  $1.27 \times 10^{-5}$  cm to  $7.62 \times 10^{-5}$  cm (5 microinches to 30 microinches thick. Such a layer is generally termed a gold cap layer. Alternatively, one can also make the top layer 2 a flash gold coating which acts predominantly as a lubricant while only giving minimal corrosion resistance. Such layers are generally from  $1.27 \times 10^{-6}$  to  $6.35 \times 10^{-6}$  cm (0.5 to 2.5 microinches in thickness. The second layer 4 of the tape 1 is a layer of the novel alloy as set forth herein. The preferred alloy for such a tape is 65 wt. % Co, 33 wt. % Pd and 2 wt. % Ru. Typically, this second layer 4 is from  $3.81 \times 10^{-5}$  cm to  $5.08 \times 10^{-4}$  cm (15 to 200 microinches) in thickness. Underlying and in contact with the second layer 4 is a bottom layer 6 made of nickel. Preferably, the nickel should be a high purity nickel (99.9+%) so as not to add contaminants to the second layer 4 upon annealing. The thickness of the nickel layer 6 may be any desired thickness, but is typically from  $3.81 \times 10^{-4}$  cm to  $11.43 \times 10^{-4}$  cm (150 to 450 microinches). The nickel layer 6 serves several purposes. First, the nickel layer 6 acts as a base material for the thin gold cap and palladium alloy layers. Secondly, the nickel layer 6 enhances the bondability of the tape 1 to the underlying base metal material. Thirdly, it prevents base metal atoms and impurities from diffusing up into the palladium alloy layer 2 after the tape 1 is clad to the base metal. If desired, one can optionally add a fourth layer (not shown) between the palladium alloy layer 4 and the bottom nickel layer 6 to further insure that the ruthenium and cobalt or the like in the palladium alloy layer 4 does not diffuse into the nickel layer and underlying base metal. This optional layer is preferably a thin silver layer of a thin layer of silver alloy. Also, it should be obvious to one skilled in the art that one may make a tape with a bottom layer other than nickel and that one can omit the top layer of

gold. Further, one can bond the novel alloy directly to a base metal, the tri-layer structure merely being the more generally preferred structure for a tape to be clad or inlayed to a base metal.

After the tape is formed with the various distinct layers, the tape is annealed typically at temperatures of from 600°C to 850°C for times of from 0.5 to 60 minutes. During such annealing, there is a diffusion of constituents between layers and the relative hardness as well as the composition of the layers is effected.

If one refers to Fig. 5, there is depicted the relative hardness and chemistry of each of the three layers 2, 4 and 6 before annealing and then again after annealing of a Pd-Cu-Ru alloy, showing the change in hardness and chemistry of the layers due to annealing. As can be seen from this figure, it is proposed that the chemistry of the layers changes upon annealing due to the diffusion of some of the gold into the underlying palladium alloy layer 4 and some of the palladium diffusing into the gold layer 2. Diffusion into the underlying nickel layer 6 which acts as a diffusion barrier for components in the base metal strip, is not considered. Further, there is only minimal diffusion of ruthenium and cobalt into the gold layer 2 from the Pd alloy layer 4. Also, the Co is believed not to effectively diffuse into the gold layer beyond the equilibrium Co in gold concentration which may be controlled by the annealing temperature. With respect to the hardness, a change in the hardness profile can be seen partially due to the diffusion and partially due simply to the effects of the annealing temperature.

Referring now to Fig. 6, there is shown a connector 10 incorporating a contact 14 which employs the novel alloy and metal tape 1 made from such alloy. Fig. 7 is a blow-up of the contact 14 portion of the connector 10. The connector 10, as shown, comprises a plastic body 12 encasing a plurality of spaced external elongated contacts 14 for interconnecting the connector 10 to various other devices or circuits. The contacts 14 are embedded within cavities provided therefor within the plastic terminal block or insulating body 12. The contacts 14 have a solder coated tail 16 which extends out of the body 12 and a head portion 18 having a multilayer metal alloy tape 1 inlayed therein. The contacts 14 extend transversely within the connector 10 and are registered with a port or hole 22 on the side of the connector 10 or opposite the contact tail 16 for accepting a connector pin 24, e.g., from another circuit source. The contact 14 is better shown with the reference to Fig. 7 which shows a side view of a connector contact 14. The base 20 of the contact 14 is made primarily of a resilient or spring alloy composition, e.g., a Cu/Ni/Sn alloy. Extending transversely along the tip of the head 18 of the contact 14 is the metal inlay tape 1. The inlay tape 1 is a tri-layer tape as previously described with reference to Fig. 4. This tape 1 was rolled bonded into a channel scribed in the base metal. The base

metal was then punched and formed as is well known in the art to result in the connector contact shown.

#### 5 Example 1

10 The manufacture of the triclaid tape starts with metal strips of each material to be bonded together, i.e., gold, novel alloy and nickel whose thickness represent the general thickness ratio of the final composite tape. The surfaces of the metal strips to be bonded are degreased, cleaned and scratch brushed to roughen the surfaces in order to improve the bonding capabilities. The scratch brushed surfaces are then recleaned to remove debris from the scratch brushing operation.

15 The triclaid tape can be manufactured in one step by alignment of the three strips stacked in the appropriate sequence and roll bonded together. Each strip should have a tack tension applied to it as it is being rolled to insure consistent rolling behavior and uniform product thickness. As is known in the art, the exact layer thickness depends upon the levels of back and front tensions, strip initial thickness, strip material, percentage of deformation, use of lubrication, rolling pressure and amount of slippage between strips.

20 Alternatively, the triclaid tape can be manufactured in two steps by first bonding one pair of metal strips, i.e., the gold and hardened palladium alloy, and then bonding the bi-metal strip to the nickel. In general, a minimum reduction in thickness is required to achieve any bonding between two metal strips and the required minimum amount is a function of the metal (alloys) and rolling temperatures. To bond a gold strip to the novel alloy, a reduction of 45—65% is required. To bond the nickel to the novel alloys, a deformation of about 75% reduction or more is required. After the strips have been roll bonded together, they are annealed at about 700—850°C to further increase the bond between metal layers and to soften the metal for further processing. The triclaid tape can then be slit into the desired width and cut to length for metal inlaying or cladding to the base metal strip. More than one strip can be inlayed or cladded to a wide base metal strip at one time to allow for production of multiple strips which may have multiple inlays on its surfaces.

25 Alternatively, the novel palladium alloy can be bonded to the nickel strip and the gold surface layer can be applied either before or after inlaying/cladding into the base metal strip by plating, sputtering or some other process.

30 Annealing the bonded strip is dependent upon the composition of the metal layers. Nickel can be fully annealed at 600°C for 5—15 minutes; the novel palladium alloys can be annealed in the temperature ranges of from 600—850°C. The most critical anneal for interdiffusion of elements between metal layers occurs when the layers are in the final base metal strip configuration just prior to the final rolling to achieve the desired

temperature in the base metal strip. It is at this point in the processing when interdiffusion between layers is critical due to the very thin layer thicknesses.

Cladding is typically defined as the operation where metal strips are joined by rolling together while the inlaying process involves cutting or skiving a channel in the base metal in order to incorporate a second metal strip, or in this case, a triclad metal strip containing the novel alloy. The metal inlaying process is generally preferred if the location of the second metal strip is critical or if the thickness of the inlay would be a significant proportion of the total thickness of the finished strip (i.e., greater than 15%).

The cleaning procedures for metal cladding the triclاد strip and base metal are identical to those described earlier, whereas for metal inlaying it is not necessary for extensive base metal cleaning or scratch brushing since a new surface will be skived into the strip just prior to bonding. The typical reduction to bond the nickel surface to a base metal alloy, i.e., CDA725 (a Cu-Ni-Sn alloy) is between 55—75% reduction with higher bond strength associated with the higher reduction. Annealing of the inlayed composite strip is in the range of 600—850°C for the typical novel alloy inlay for 0.5 to 60 minutes to control the interdiffusion of elements. The final rolling of the inlayed strip is typically 40—55% reduction to achieve the desired temperature in the (CDA725) base metal.

The completed base metal strip containing the metal inlay can now be slit to the appropriate width which also accurately locates the position of the inlay in reference to the strip width for ease in stamping. The finished strip may be inspected and processed through a stretcher-leveler to reduce strip camber and coil set if it is necessary. Other optional processes might include application of a solder top and/or bottom layer for easier assembly of parts.

The finished strip can then be fed into a high speed punch where the contact is stamped and formed. This is typically a reel-to-reel operation after which the formed contacts are inserted into the plastic housing of the connector and cut from the reel. Finished connectors are then inspected and tested.

It should be understood that the above is but one example of the use of the novel alloy as an electrical contact material. Numerous other configurations are possible including structures not employing inlays.

### Claims

1. An electrical contact comprising a base metal having a palladium alloy thereon, characterized in that said alloy is comprised of from 30—60 weight percent Pd (70-b) to (40-b) weight percent X and 0.05—5 weight percent Y wherein b is the weight percent of component Y, X is at least one of Co and Cu and Y is at least one of Ru, W, B, Ir and Nb, and when X is solely Cu, Y is

at least one of B and Ir with B being present in an amount of up to 0.25 weight percent.

2. The contact according to Claim 1, characterized in that X is Cu and Y is selected from 0.05—0.1 weight percent B, from 0.25—1 weight percent Ir, and their mixtures.

3. The contact according to Claim 1, characterized in that X is Co and Y is selected from 0.5—5 weight percent Ru, 0.5—2 weight percent W, and their mixtures.

4. The contact according to Claim 1 or 3, characterized in that said alloy has 33 weight percent Pd 65 weight percent Co and 2 weight percent Ru.

5. The contact according to Claim 1, characterized in that said alloy is directly bonded to said base metal.

6. The contact according to Claim 1, characterized in that said alloy is bonded to the base metal via an intermediate metallic bond-promoting layer.

7. The contact according to Claim 6, characterized in that said intermediate layer comprises nickel.

8. The contact according to Claim 7, characterized in that said intermediate metallic layer consists of nickel having a purity of at least 99.9%.

9. The contact according to any one of preceding Claims 1—4, characterized in that said alloy is present in a multilayer tape comprising a top layer selected from gold and a gold alloy, a middle layer of said palladium alloy and a bottom metallic bond-promoting layer.

10. The contact according to Claim 9, characterized in that said multilayer tape has been annealed to allow diffusion between certain of the layers.

11. The contact according to Claim 9, characterized in that said annealing took place at temperatures of from 600—850°C.

12. The contact according to Claim 9 or 10, characterized in that selectively said tap is clad to the base metal surface or is inlayed in a channel formed in said base metal.

13. The contact according to Claim 9, characterized in that said bond-promoting layer comprises nickel.

14. The contact according to Claim 9, characterized in that said bottom layer consists essentially of nickel having a purity of at least 99.9%.

15. The contact according to Claim 9, characterized by an additional layer between said middle layer and said bottom layer, said additional layer comprising Ag or an Ag alloy.

16. The contact according to Claim 9, characterized in that said top layer is a gold alloy comprising gold, silver and at least one of carbon, carbides, nitrides, boron and borides.

17. The contact according to Claim 16, characterized in that said top layer contains at least one of titanium carbide, tantalum nitride and boron nitride.

18. The contact according to Claim 9, characterized in that the thickness of the top layer is

from  $1.27 \times 10^{-6}$  cm to  $7.62 \times 10^{-5}$  cm (0.5—30 microinches), the thickness of the middle layer is from  $3.81 \times 10^{-5}$  cm to  $5.08 \times 10^{-4}$  cm (15—200 microinches) and the thickness of the bottom layer is at least  $3.81 \times 10^{-4}$  cm (150 microinches).

19. The contact according to Claim 18, characterized in that the thickness of the top layer is from  $1.27 \times 10^{-5}$  cm to  $7.62 \times 10^{-5}$  cm (5—30 microinches) preferably from  $1.27 \times 10^{-6}$  to  $6.35 \times 10^{-6}$  cm (0.5—2.5 microinches).

20. The contact according to Claim 1, characterized in that it forms a part of an electrical connector comprising an insulating housing having a plurality of spaced metal electrical contacts therein and means for allowing contact to be made with said electrical contacts with external contacts or connectors wherein said electrical contacts comprise a base metal having said conductive alloy thereon.

### Patentansprüche

1. Elektrischer Kontakt, der ein Grundmetall mit einer hierauf befindlichen Palladiumlegierung umfaßt, dadurch gekennzeichnet, daß sich die Legierung zusammensetzt aus

- 30 bis 60 Gew.-% Pd,
- (70-b) bis (40-b) Gew.-% X und
- 0,05 bis 5 Gew.-% Y,

worin bedeuten

b den Anteil in Gew.-% der Komponente Y,  
X wenigstens eines der Elemente Co und Cu und

Y wenigstens eines der Elemente Ru, W, B, Ir und Nb,

mit der Maßgabe, daß wenn X ausschließlich Cu ist, Y wenigstens eines der Elemente B und Ir ist, wobei B in einem Anteil von bis zu 0,25 Gew.-% vorhanden ist.

2. Kontakt nach Anspruch 1, dadurch gekennzeichnet, daß

X gleich Cu ist und

Y gewählt ist von 0,05 bis 0,1 Gew.-% B, von 0,25 bis 1 Gew.-% Ir und von Mischungen hiervon.

3. Kontakt nach Anspruch 1, dadurch gekennzeichnet, daß

X gleich Co ist und

Y gewählt ist von 0,5 bis 5 Gew.-% Ru, von 0,5 bis 2 Gew.-% W und von Mischungen hiervon.

4. Kontakt nach Anspruch 1 oder 3, dadurch gekennzeichnet, daß

die Legierung 33 Gew.-% Pd, 65 Gew.-% Co und 2 Gew.-% Ru hat.

5. Kontakt nach Anspruch 1, dadurch gekennzeichnet, daß

die Legierung direkt an das Grundmetall gebondet ist.

6. Kontakt nach Anspruch 1, dadurch gekennzeichnet, daß

die Legierung an das Grundmetall über eine metallische bond-fördernde Zwischenschicht gebondet ist.

7. Kontakt nach Anspruch 6, dadurch gekennzeichnet, daß

die Zwischenschicht Nickel umfaßt.

8. Kontakt nach Anspruch 7, dadurch gekennzeichnet, daß

die metallische Zwischenschicht aus Nickel einer Reinheit von wenigstens 99,9% besteht.

9. Kontakt nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß

die Legierung in einem vielschichtigen Band vorhanden ist, das eine aus Gold und einer Goldlegierung gewählte obere Schicht, eine mittlere Schicht aus der Palladiumlegierung und eine untere metallische bond-fördernde Schicht umfaßt.

10. Kontakt nach Anspruch 9, dadurch gekennzeichnet, daß

das mehrschichtige Band warmbehandelt worden ist, um eine Diffusion zwischen gewissen der Schichten zu ermöglichen.

11. Kontakt nach Anspruch 9, dadurch gekennzeichnet, daß

die Warmbehandlung bei Temperaturen von 600 bis 850°C stattfand.

12. Kontakt nach Anspruch 9 oder 10, dadurch gekennzeichnet, daß

wahlweise das Band auf die Grundmetallfläche aufgebracht oder in einem in dem Grundmetall gebildeten Kanal eingelegt ist.

13. Kontakt nach Anspruch 9, dadurch gekennzeichnet, daß

die bond-fördernde Schicht Nickel umfaßt.

14. Kontakt nach Anspruch 9, dadurch gekennzeichnet, daß

die untere Schicht im wesentlichen aus Nickel einer Reinheit von wenigstens 99,9% besteht.

15. Kontakt nach Anspruch 9, gekennzeichnet durch

eine zusätzliche Schicht zwischen der mittleren Schicht und der unteren Schicht, wobei die zusätzliche Schicht Ag oder eine Ag-Legierung umfaßt.

16. Kontakt nach Anspruch 9, dadurch gekennzeichnet, daß

die obere Schicht eine Goldlegierung ist, die Gold, Silber und wenigstens einen der Bestandteile Kohlenstoff, Carbide, Nitride, Bor und Boride umfaßt.

17. Kontakt nach Anspruch 16, dadurch gekennzeichnet, daß

die obere Schicht wenigstens einen der Bestandteile Titancarbid, Tantalnitrid und Bornitrid enthält.

18. Kontakt nach Anspruch 9, dadurch gekennzeichnet, daß

die Dicke der oberen Schicht  $1,27 \times 10^{-6}$  cm bis  $7,62 \times 10^{-5}$  cm (0,5 bis 30 Mikrozoll) (beträgt, der Dicke der mittleren Schicht  $3,81 \times 10^{-5}$  cm bis  $5,08 \times 10^{-4}$  cm (15 bis 200 Mikrozoll) beträgt und

die Dicke der unteren Schicht wenigstens  $3,81 \times 10^{-4}$  cm (150 Mikrozoll) beträgt.

19. Kontakt nach Anspruch 18, dadurch gekennzeichnet, daß

die Dicke der oberen Schicht  $1,27 \times 10^{-5}$  cm bis  $7,62 \times 10^{-5}$  cm (5 bis 30 Mikrozoll), vorzugsweise  $1,27 \times 10^{-6}$  bis  $6,35 \times 10^{-6}$  cm (0,5 bis 2,5 Mikrozoll) beträgt.

20. Kontakt nach Anspruch 1, dadurch gekennzeichnet, daß er Bestandteil eines elektrischen Verbinders ist, der umfaßt

ein Isoliergehäuse mit einer Vielzahl beabstandeter elektrischer Metallkontakte darin und

Mittel zum Ermöglichen eines herzustellen Kontaktes mit den elektrischen Kontakten mit äußeren Kontakten oder verbindern, wobei die elektrischen Kontakte ein Grundmetall mit besagter leitender Legierung hierauf umfassen.

### Revendications

1. Un contact électrique comprenant un métal de base sur lequel se trouve un alliage de palladium, caractérisé en ce que cet alliage comprend de 30 à 60% en poids de Pd, (70-b) à (40-b)% en poids de X et 0,05 à 5% en poids de Y, avec les notations suivantes: b est le pourcentage en poids du composant Y, X est l'un au moins des éléments Co et Cu et Y est l'un au moins des éléments Ru, W, B, Ir et Nb, et lorsque X consiste exclusivement en Cu, Y est l'un au moins des éléments B et Ir, avec B présent en une proportion s'élevant jusqu'à 0,5% en poids.

2. Le contact selon la revendication 1, caractérisé en ce que X consiste en Cu et Y est sélectionné parmi 0,05—0,1% en poids de B, 0,25—1% en poids de Ir, et leurs mélanges.

3. Le contact selon la revendication 1, caractérisé en ce que X consiste en Co et Y est sélectionné parmi 0,5—5% en poids de Ru, 0,5—2% en poids de W, et leurs mélanges.

4. Le contact selon la revendication 1 ou 3, caractérisé en ce que l'alliage contient 33% en poids de Pd, 65% en poids de Co et 2% en poids de Cu.

5. Le contact selon la revendication 1, caractérisé en ce que l'alliage est directement fixé sur le métal de base.

6. Le contact selon la revendication 1, caractérisé en ce que l'alliage est fixé sur le métal de base avec interposition d'une couche métallique intermédiaire favorisant l'adhérence.

7. Le contact selon la revendication 6, caractérisé en ce que la couche intermédiaire consiste en nickel.

8. Le contact selon la revendication 7, caractérisé en ce que la couche métallique intermédiaire consiste en nickel ayant une pureté d'au moins 99,9%.

9. Le contact selon l'une quelconque des revendications 1—4 précédentes, caractérisé en ce que l'alliage est présent dans une bande multicouche qui comprend une couche supérieure sélectionnée parmi d'or et un alliage d'or, une couche médiane constituée par l'alliage de palladium et

une couche métallique inférieure favorisant l'adhérence.

10. Le contact selon la revendication 9, caractérisé en ce que la bande multicouche a été recuite pour permettre une diffusion entre certaines des couches.

11. Le contact selon la revendication 9, caractérisé en ce que l'opération de recuit a été effectuée à des températures de 600 à 850°C.

12. Le contact selon la revendication 9 ou 10, caractérisé en ce que la bande est sélectivement plaquée sur la surface de métal de base ou incrustée dans une rainure qui est formée dans le métal de base.

13. Le contact selon la revendication 9, caractérisé en ce que la couche favorisant l'adhérence consiste en nickel.

14. Le contact selon la revendication 9, caractérisé en ce que la couche inférieure consiste essentiellement en nickel ayant une pureté d'au moins 99,9%.

15. Le contact selon la revendication 9, caractérisée par une couche supplémentaire entre la couche médiane et la couche inférieure, et cette couche supplémentaire consiste en Ag ou en un alliage d'Ag.

16. Le contact selon la revendication 9, caractérisé en ce que la couche supérieure est un alliage d'or comprenant de l'or, de l'argent et l'un au moins des composants suivants: du carbone, des carbures, des nitrures, du bore et des borures.

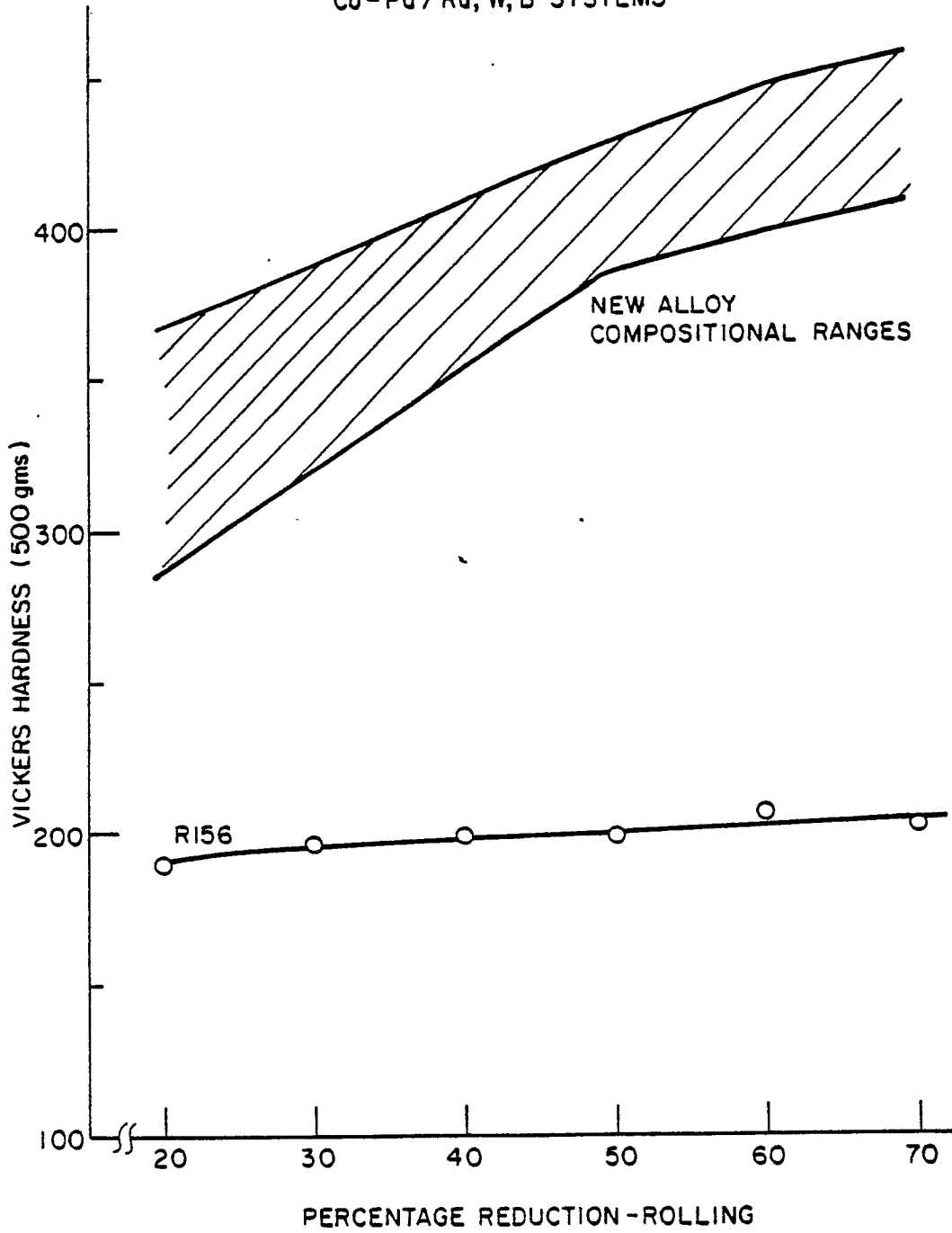
17. Le contact selon la revendication 16, caractérisé en ce que la couche supérieure contient l'un au moins des composants suivantes: du carbure de titane, du nitrure de tantale et du nitrure de bore.

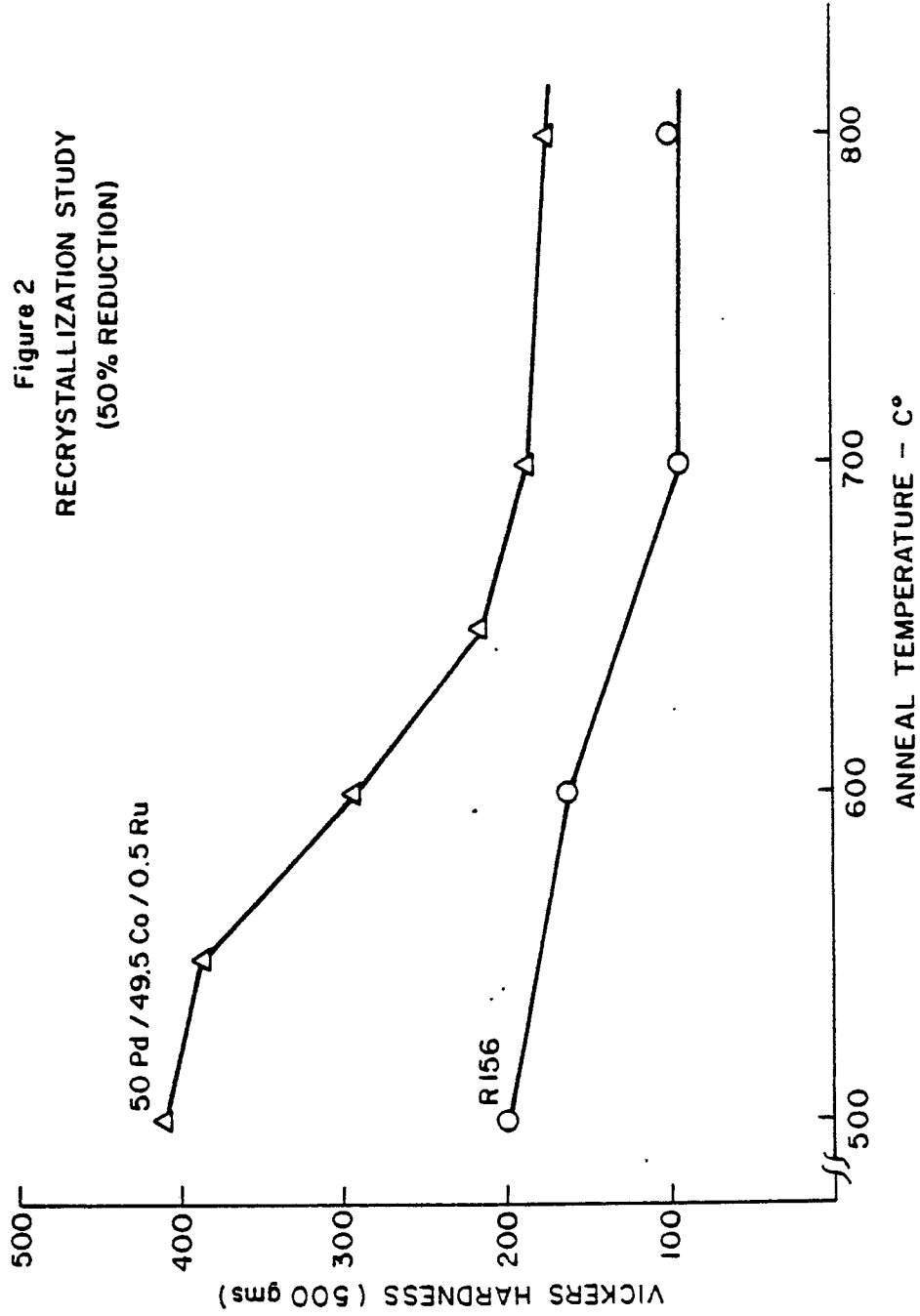
18. Le contact selon la revendication 9, caractérisé en ce que l'épaisseur de la couche supérieure est de  $1,27 \times 10^{-6}$  cm à  $7,62 \times 10^{-5}$  cm, l'épaisseur de la couche médiane est de  $3,81 \times 10^{-5}$  cm à  $5,08 \times 10^{-4}$  cm et l'épaisseur de la couche inférieure est au moins de  $3,81 \times 10^{-4}$  cm.

19. Le contact selon la revendication 18, caractérisé en ce que l'épaisseur de la couche supérieure est de  $1,27 \times 10^{-5}$  cm à  $7,62 \times 10^{-5}$  cm, et de préférence de  $1,27 \times 10^{-6}$  à  $6,35 \times 10^{-6}$  cm.

20. Le contact selon la revendication 1, caractérisé en ce qu'il fait parti d'un connecteur électrique comprenant un boîtier isolant dans lequel se trouvent un ensemble de contacts électriques métalliques espacés, et des moyens pour permettre d'établir un contact entre ces contacts électriques et des contacts ou des connecteurs externes, dans lequel les contacts électriques comprennent un métal de base sur lequel se trouve l'alliage conducteur précité.

Figure 1  
SUMMARY HARDNESS -VS- DUCTILITY  
Co-Pd / Ru, W, B SYSTEMS





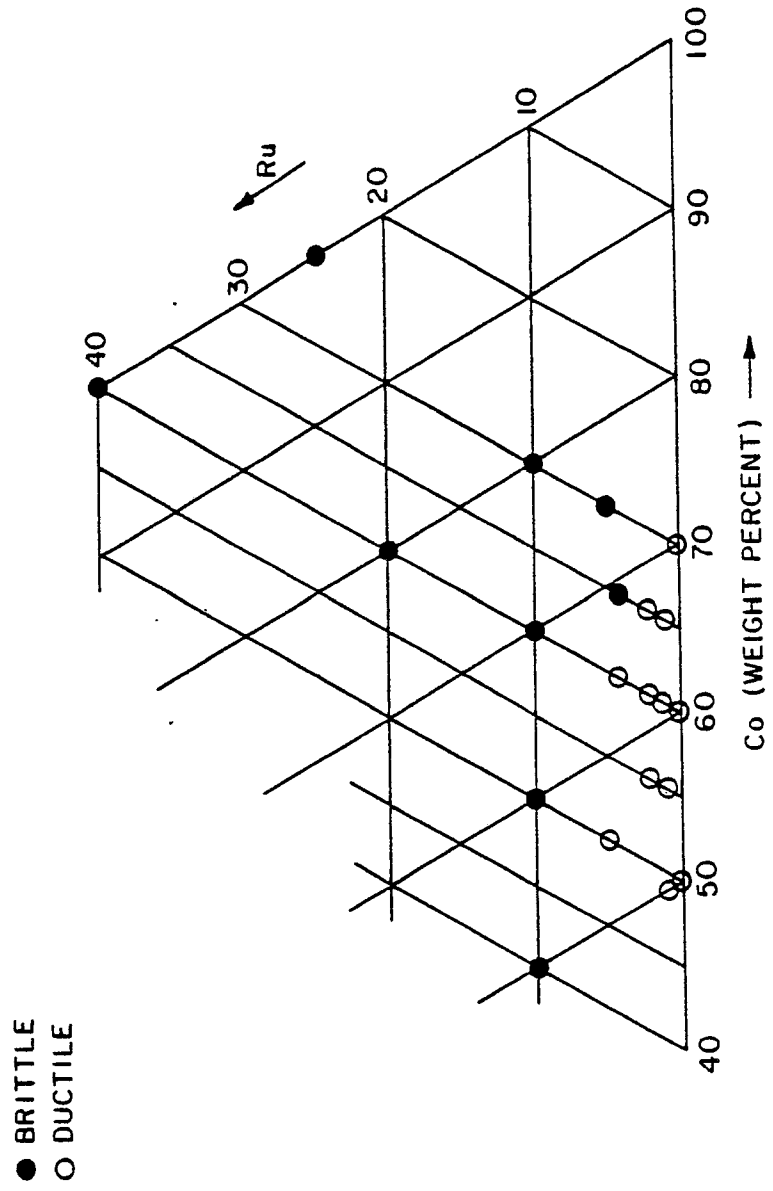


Figure 3  
Co-Pd-Ru TERNARY ALLOY SYSTEM

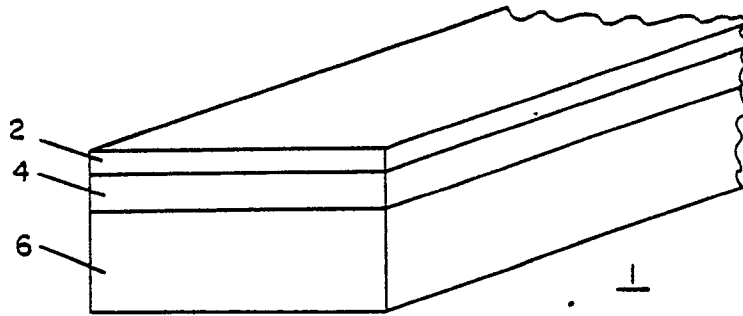


Figure 4

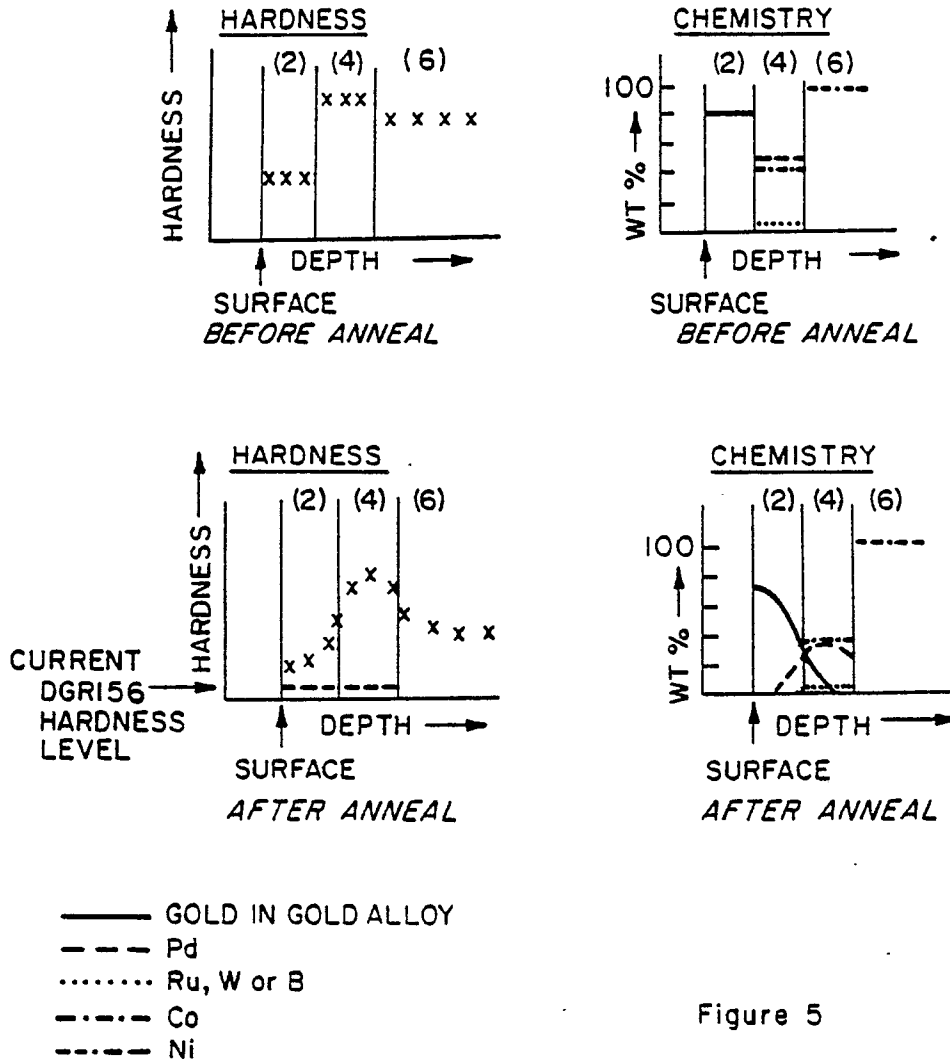


Figure 5

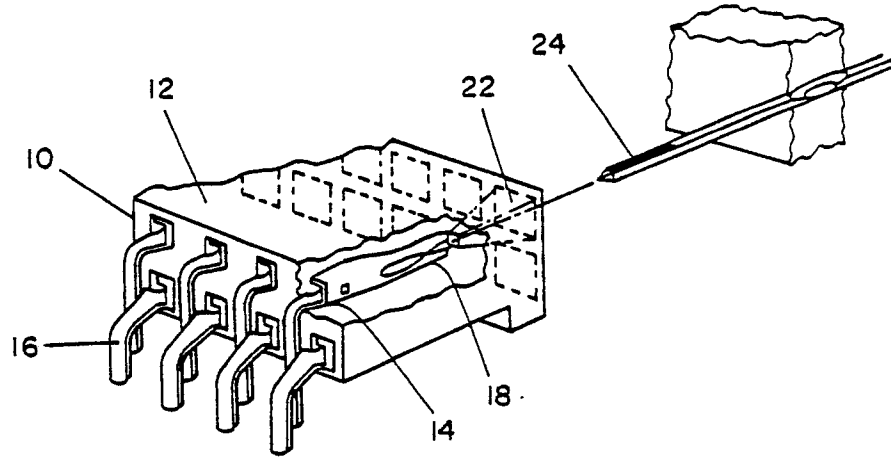


Figure 6

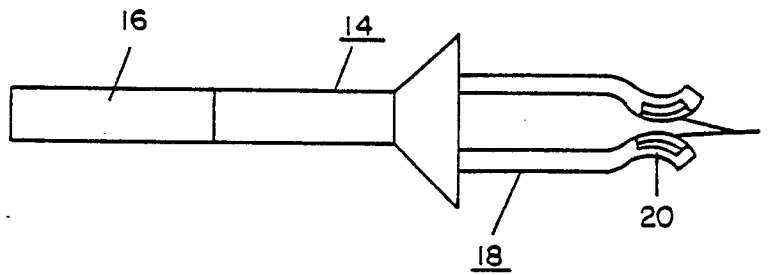


Figure 7