PATENT SPECIFICATION (11) 1 570 143

1 570 143

(21) Application No. 34983/77 (22) Filed 19 Aug. 1977
(31) Convention Application No. 10567/76
(32) Filed 19 Aug. 1976
(31) Convention Application No. 2 642 338
(32) Filed 21 Sept. 1976 in
(33) Switzerland (CH) and Fed. Rep. of Germany (DE)
(44) Complete Specification published 25 June 1980
(51) INT CL³ B23K 20/10
(52) Index at acceptance
B3R 14 17B
H1N 652 805

(54) ELECTRICAL CONTACT ELEMENT AND METHOD OF PRODUCING SAME

(71) We, G. RAU, a German company, of Kaiser-Friedrich-Strasse, 7, 7530 Pforzheim, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

The invention relates to an electrical contact element of the type in which at least one contact piece is joined to a carrier by welding. A method for producing such contact elements is also described.

In order to avoid welding during electrical switching operations of the contact elements, it is desirable that the contact pieces are produced from contact materials which do not weld easily. If such contact elements are used, difficulty can be experienced when joining the contact to the carrier by brazing or welding. This is particularly true of composite materials comprising silver containing non-metallic inclusions, for example, AgCdO, $AgSnO_2$, AgMgO and AgC, that are often used as contact materials. These contact materials contain, embedded in the silver matrix material, non-metallic particles of cadmium oxide, tin oxide or megnesium oxide, for example, and these inclusions may take the form of fibre-like strands lying at right-angles to the eventual contact surface of the contact piece. Although the non-metallic inclusions have the desired effect of offering considerable resistance to welding during the switching operation, their use leads to considerable difficulties in the joining of the contact materials when the existing welding or brazing methods are employed.

It is known, for the purpose of securing contact piece of fusion-resisting material to a carrier, to provide the contact piece with a readily weldable or brazable layer on its rear face i.e. that face which faces the carrier. Intermediate layers of this kind can be produced by various known methods. In the case of internally oxidized material, it is possible to form the weldable or brazable layer by, for example, oxidation on the rear face of the silver layer or by prior cladding of the rear face. Another known possible method involves the production by powder metallurgy of a brazable or weldable intermediate layer by multi-layer pressing or by converting multi-layer ingots to the required size and shape. The production of such contact pieces having a weldable or brazable rear face is very complicated and costly.

It is also known to connect contact materials, having poor welding properties, directly to a carrier by ultrasonic welding. The ultrasonic welding process offers advantages as regards the low thermal loading of the contact material, but in many cases does not result in satisfactory shear strength when the contact pieces and the carrier material are directly joined to each other. Certain favourable combinations of material, i.e. AgCdO and brass, cannot be joined together sufficiently firmly by means of the existing ultrasonic welding techniques.

One ultrasonic welding method includes a procedure for joining up aluminium electric conductors wherein the contact zones are first covered with a contact foil by ultrasonic spot-welding or ultrasonic roller-welding. A soldered, screw-type or clamp-type connector is then provided at the connection zones thus prepared. Composite foils of copper and aluminium, or gold or silver foils are used as the contact foils. The connection of contact pieces to the carrier, previously clad by means of ultrasonic welding, is difficult and is costly to carry out on a mass-production basis.

The present invention seeks to provide an electrical contact element in which at least one contact piece is joined to a carrier by welding, a high-strength connection being present between the contact piece and the carrier.

In accordance with a first aspect of the invention, there is provided an electrical element comprising at least one contact piece joined to a carrier by sonic welding, and an intermediate layer of a cold-weldable metallic

material which is inserted between the or each contact piece and the carrier prior to sonic welding.

In such sonic welding, using frequencies in the sonic range of between approximately 20 kHz and 50 Hz, and particularly when readily cold-weldable intermediate layers are used, a surprisingly solid joint between the contact piece and the carrier is achieved. Compared with an ultrasonic welding procedure, sonic welding, particularly at low frequencies, offers the possibility of using higher energy in the welding operation. The intermediate layer may consist either of a pure metal, preferably aluminium but optionally silver, copper or titanium, or of a metal alloy having similar properties, for example, an aluminium-copper alloy. It has been found that for the usual dimensions of contact elements, the thickness of the intermediate layer should advantageously be less than 1 mm, and preferably less than 0.2 mm.

In some circumstances, a further considerable advantage can be achieved if the intermediate layer is a powder layer. The thickness of the layer is preferably below 100 μm. The layer may consist of one or more components having good cold-welding properties.

In a preferred embodiment, the contact element comprises a contact piece made of silver-cadmium oxide joined to a brass carrier by way of an aluminium intermediate layer consisting of a foil or powder.

In accordance with a second aspect of the invention there is provided a method of producing a contact element according to the first aspect of the invention, said method comprising inserting the metal foil between the contact piece and the carrier for the purpose of forming the intermediate layer, and applying pressure while carrying out sonic welding.

Preferably the metal foil is inserted loosely between the contact piece and the carrier. The contact piece is advantageously placed on a cut piece of foil which is larger than the peripheral contour of the contact piece. Then, during sonic welding, a piece having the same size as the contact piece can be separated off from the foil and the unrequired foil can be removed.

The thickness of the foil is in the order of magnitude of the thickness of the intermediate layer, i.e. advantageously below 1 mm and preferably below 0.2 mm. During the welding operation and because of the high pressure and the frictional movement under the effect of the sonic vibration, a precisely matching piece, corresponding to the size of the area over which the contact piece is connected, is rubbed out of the foil, and the excess foil material can be removed in a particularly simple manner. If so required, the foil may consist of cut pieces corresponding to the size of the area over which the connection is to be made.

It is possible to adapt the method of this invention to continuous production by continuously feeding the carrier and the foil together continuously in the form of strip, sonic welding being carried out on each of the contact pieces in turn after they have been placed in position, and the excess foil material being then removed from the carrier which is in the form of strip. Additional continuous advance of the contact material in the form of wire or strip appears to be advantageous in some circumstances. The use of the above-described method has provided, among other things, a novel contact element wherein a joint having high shear strength was obtained between a contact piece made of AgCdO and an intermediate layer made of aluminium foil and laid on a brass carrier.

In accordance with a third aspect of the invention there is provided a method of producing a contact element according to the first aspect of the invention, said method comprising inserting metal powder between the contact piece and the carrier for the purpose of forming the intermediate layer, and applying pressure while carrying out sonic welding.

The powdered constituents of the intermediate layer may be placed loose on the carrier, or may be dusted onto the contact piece and/or the carrier or may be mixed with a binding agent and painted onto the contact piece and/or carrier. The use of, for example, the well-known material, aluminium-bronze, which contains a partially volatile binding agent, has been found to be advantageous. When the powder for forming the intermediate layer is loosely heaped, the excess is usually pressed out sideways during the sonic welding operation, so that small differences in measuring out the quantity of powder do not interfere with the formation of the required intermediate layer responsible for adherence. The thickness of the powder layer prior to welding is preferably less than 100 μm. In some cases, complete cohesion within a uniform layer is not necessary and it suffices to provide islands of powder with irregular spaces between them.

The contact pieces produced in accordance with the invention exhibit advantageous properties in many of their applications. They can be manufactured economically as mass-produced articles and permit the use of contact materials having a considerable capacity for resisting fusion. Since the parts to be connected are not heated to any considerable extent during sonic weldings, the original mechanical properties of the carrier and the contact piece are for the most part retained.

Example I.

A small contact piece in the form of a plate made of AgCdO, in which were in-

corporated non-metallic cadmium oxide components in a silver matrix material, had a diameter of 4.5 mm and a thickness of 1.4 mm. After a pure aluminium foil having a thickness of 0.1 mm had been interposed, this contact piece was joined by sonic welding to a carrier consisting of a brass strip, 8 mm in width and 0.7 mm in thickness. The output of the sonic oscillator was 1200 W and the frequency 18 kHz. A compressive force of approximately 736 N was applied during the welding operation. The welding time was 1.5 sec. During welding the residual portion of the aluminium foil became detached at the edge of the surface over which the joint was made, and was removed. The shear strength of the welded joint was approximately 80 N/mm^2.

An attempt to join the AgCdO contact plate directly to the brass carrier by sonic welding met with no success and resulted in no adherence at all.

Example II.

A small contact piece in the form of a plate of AgCdO in which were incorporated non-metallic cadmium oxide components contained in a silver matrix material, had a diameter of 8 mm and a thickness of 1.5 mm. After a layer of pure aluminium powder, having a particle-size of less than 10 μm, had been heaped on the plate, the contact piece was joined by sonic welding to a carrier consisting of a brass strip having a width of 10 mm and a thickness of 2 mm.

The output of the sonic oscillator was 4000 W and the frequency 10 kHz. During the welding operation a compressive force of approximately 1000 N was applied. The welding time was 0.1 sec.

The shear strength of the welded joint was approximately 100 N/mm^2.

The accompanying drawing is a diagrammatical side elevation of an ultrasonic welding machine suitable for manufacturing the electrical contact elements of the present invention. The machine comprises a sonic oscillator 1, whose main direction of oscillation is indicated by the double-headed arrow. Small contact pieces in the form of plates 2 are joined in turn to a brass carrier strip 4, an aluminium foil 3 or an aluminium powder applied by dusting being interposed between the plates and the strip to form the intermediate layer. The required welding pressure indicated by arrow F, is applied by way of an anvil 5. The individual contact plates 2 were fed from a supply container by way of a suitable feed chute, (not shown) onto the surface of the aluminium foil 3. The direction of advance of the aluminium foil 3 and of the carrier 4 is parallel to the double-headed arrow.

WHAT WE CLAIM IS:—

1. An electrical contact element comprising at least one contact piece joined to a carrier by sonic welding, and an intermediate layer of a cold-weldable metallic material which is inserted between the or each contact piece and the carrier prior to sonic welding.

2. A contact element according to claim 1 wherein the frequency used in the sonic welding lies in the range between 20 kHz and 50 Hz.

3. A contact element according to claim 1 or 2 wherein the thickness of the intermediate layer is less than 1 mm.

4. A contact element according to claim 3 wherein the thickness of the intermediate layer is less than 0.2 mm.

5. A contact element according to any one of claims 1 to 4 wherein the intermediate layer is a foil.

6. A contact element according to any one of claims 1 to 4 wherein the intermediate layer is in the form of a powder.

7. A contact element according to any one of the preceding claims wherein the intermediate layer consists, at least in its major part, of aluminium.

8. A contact element according to any one of the preceding claims wherein the contact piece is made of silver-cadmium oxide, and the carrier of brass.

9. A method of producing a contact element as claimed in any one of the preceding claims, said method comprising inserting the metal foil between the contact piece and the carrier for the purpose of forming the intermediate layer, and applying pressure while carrying out sonic welding.

10. A method of producing a contact element as claimed in claim 9, wherein the contact piece is laid on a cut piece of foil which is larger than the peripheral contour of the contact piece, and wherein the required foil is separated from the foil material during sonic welding and the unrequired foil is removed.

11. A method of producing a contact element according to claim 10, wherein the carrier and the foil are fed continuously in the form of strip and, after the contact pieces have been placed on the carrier, sonic welding is carried out on each of them in turn, the excess foil material being then removed from the carrier which is in the form of a strip.

12. A method of producing a contact element as claimed in claim 6, said method comprising inserting metal powder between the contact piece and the carrier for the purpose of forming the intermediate layer, and applying pressure while carrying out sonic welding.

13. A method of producing a contact ele-

ment according to claim 12 wherein the layer of powder is applied together with a binding agent.

14. A method of producing a contact element according to claim 12 wherein the thickness of the layer of powder is less than 100 μm before sonic welding is carried out.

15. An electrical contact element according to claim 1 substantially as hereinbefore described.

16. A method of producing a contact element according to claim 9 substantially as hereinbefore described.

17. A method of producing a contact element according to claim 12 substantially as hereinbefore described.

STEVENS, HEWLETT & PERKINS,
Chartered Patent Agents,
5, Quality Court,
Chancery Lane,
London, W.C.2.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1980.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1570143 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*