

[54] **MATRIX-TYPE ELECTRODES HAVING  
BRAZE-PENETRATION BARRIER**

[75] Inventor: **Paul O. Wayland**, Montour Falls,  
N.Y.

[73] Assignee: **Westinghouse Electric Corporation**,  
Pittsburgh, Pa.

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[58] **Field of Search**..... **200/166 C, 166 CM, 166 F;**  
**29/630 C, 630 R, 420, 420.5**

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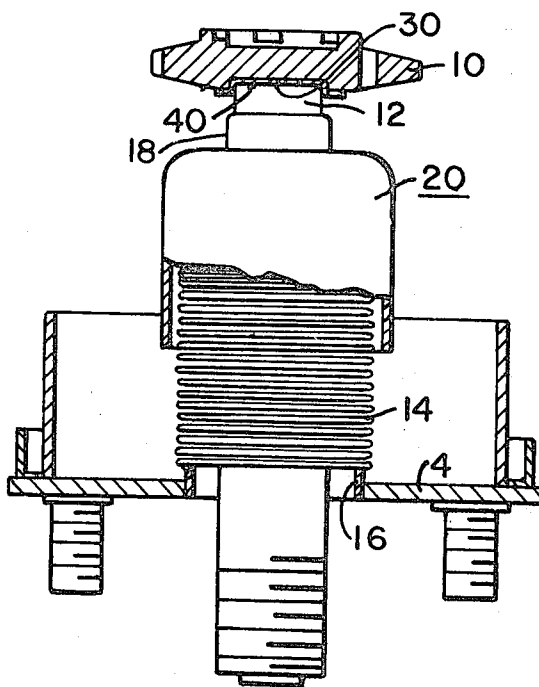
*Primary Examiner*—Charles W. Lanham  
*Assistant Examiner*—James R. Duzan  
*Attorney, Agent, or Firm*—W. R. Crout

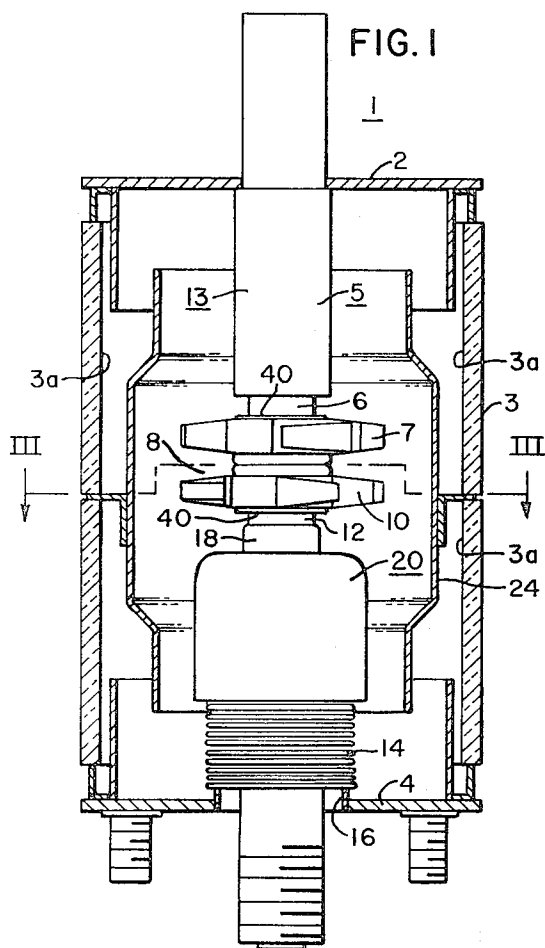
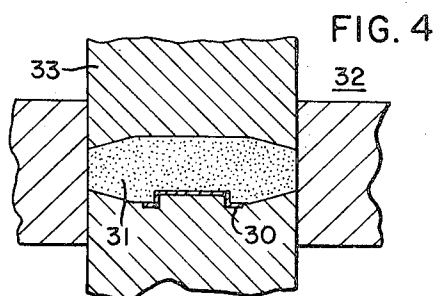
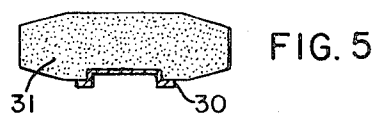
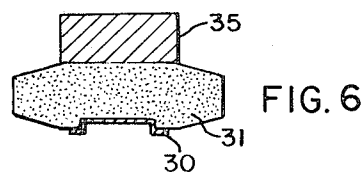
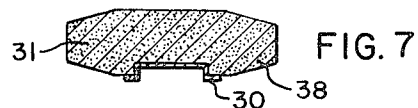
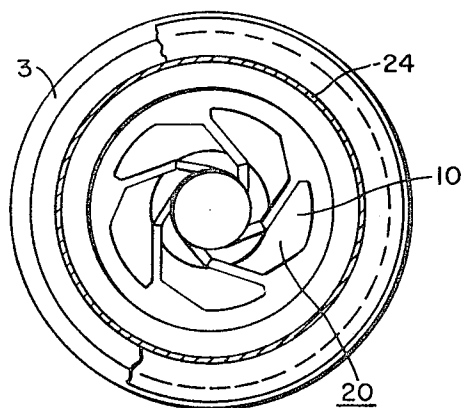
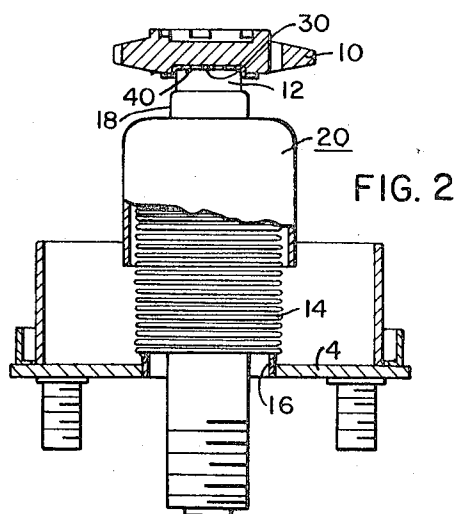
[57] **ABSTRACT**

A braze-penetration barrier is provided for a sintered and infiltrated matrix-type of electrode or contact, so that, in effect, two joints are provided, one joint being provided between the metallic braze-penetration barrier and the sintered and infiltrated body portion of the matrix-type contact or electrode, and the other or second joint being provided between the metallic braze-penetration barrier member and the supporting rod-like metallic stem-portion of the interrupting contact or electrode.

The braze-penetration barrier member may be provided, for example, by pressing a preformed braze-penetration barrier member with the particles of the matrix system in the press, which is subsequently sintered and infiltrated with a lower-melting-temperature infiltrant material, such as copper or silver, for example, which penetrates into the pores of the higher-melting-temperature matrix material, such as tungsten or chromium, for example.

**5 Claims, 8 Drawing Figures**





## MATRIX-TYPE ELECTRODES HAVING BRAZE-PENETRATION BARRIER

### REFERENCES TO RELATED APPLICATIONS

Applicant is not aware of any related patent application pertinent to the instant invention.

### BACKGROUND OF THE INVENTION

Typical construction practice for attaching the contacts of a vacuum interrupter to the terminal electrodes is by brazing with high-temperature materials (i.e., those which melt above 800°C). A particular problem, which is encountered when this joint is made against sintered and infiltrated matrix-type contacts or electrodes, such as, for example, chromium infiltrated with copper, is the following. Since the matrix is never much more than 98 percent theoretical density, it, therefore, has interspersed micropores. These micropores are available to highly-wettable braze fillers, such as copper-nickel-manganese alloys, and are dragged away from the joint region in an unpredictable manner, thus creating unsound joints. Alternative braze fillers, such as copper-gold alloys, do not exhibit this tendency, but are expensive relative to copper-nickel-manganese alloys.

Accordingly, the present invention is concerned with joining circuit-interrupting contacts or electrodes to supporting rod-like stem portions in a manner which is conductive to a sound joint therebetween, and which is capable of resisting shock forces during the opening and closing operations of the circuit interrupter without breaking the contact head body portion away from its rod-like supporting stem portion.

### SUMMARY OF THE INVENTION

The present invention solves the foregoing problem by associating a thin metallic braze-penetration barrier with the fabrication of the sintered and infiltrated matrix-type head portion of the contact. In one process, for example, the braze-penetration thin metallic barrier member constitutes an insert, which is utilized in the pressing operation to press the powdered high-temperature materials prior to the subsequent sintering operation. Following the subsequent infusion of the infiltrant material, such as copper, or silver, for example, into the micropores of the sintered matrix-type contact, the thin metallic braze-penetration barrier member is firmly joined to the head portion of the matrix-type contact. As a second operation, the metallic supporting stem portion is joined, such as by a separate brazing process, to the aforesaid relatively thin metallic insert member constituting a braze-penetration barrier member. The braze-penetration barrier member may be, for example, a preformed thin metallic member formed, for example, of mild steel, with a cup-like depression, and associated with the pressing and sintering operations. As mentioned, there then results the second sound joint between the outer exposed surface of the thin metallic braze-penetration barrier member and the associated supporting rod-like stem portion of the final contact assembly.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view taken through a vacuum-type circuit interrupter illustrating the principles of the present invention, the contact structure being illustrated in the closed-circuit position;

FIG. 2 is a fragmentary enlarged detailed view of the lower movable contact of the interrupting device of FIG. 1 illustrating the improved metallic braze-penetration barrier member of the present invention joined by brazing to the supporting-stem portion;

FIG. 3 is a plan view taken of the movable contact, the view being taken substantially along the line III—III of FIG. 1;

FIG. 4 diagrammatically illustrates the pressing operation in a conventional-type press, wherein the thin metallic braze-penetration barrier member is pressed, as an insert, along with the powdered granular material of the refractory matrix body;

FIG. 5 illustrates the green compressed compact which is removed from the press and later subjected to a sintering operation;

FIG. 6 illustrates the infiltration process, wherein a relatively low-temperature infiltrant material, such as copper, or silver, is placed upon the sintered matrix body for subsequent infiltration;

FIG. 7 illustrates the finished infiltrated blank piece after vacuum-melting and prior to the machining operations; and

FIG. 8 is a vertical sectional view taken through the machined finished contact head illustrating more clearly the thin metallic cup-shaped braze-penetration member.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 generally illustrates a vacuum-type circuit interrupter, generally designated by the reference numeral 1, and illustrated in the closed-circuit position. As shown, the vacuum "bottle" or interrupter 1 comprises an upper end plate 2, an insulating wall envelope 3, formed of a suitable ceramic material, for example, and a lower end plate 4. A stationary contact structure, generally designated by the reference numeral 5, projects interiorly within the upper end plate 2, and includes a supporting electrode rod-like stem-portion 6, which is joined by a brazing operation, as more fully described hereinafter, to a stationary contact 7, the latter being machined to a configuration more clearly shown in FIGS. 2, 3 and 8 of the drawings.

Cooperable with the stationary contact 7 is a lower movable contact 10, joined by a similar brazing operation to an upwardly-extending rod-like supporting stem-portion 12, the latter extending through a metallic bellows seal 14, as well known by those skilled in the art. In more detail, the lower end of the metallic bellows seal 14 is brazed within an aperture 16, provided in the lower end plate 4, whereas the upper end of the bellows 14 is suitably secured to the stem-portion 18 of the movable contact assembly, generally designated by the reference numeral 20.

During the opening operation, the movable contact 10 is moved downwardly by a suitable operating means, not shown, and disengages from the stationary contact 7 to establish an arc therebetween (not shown). This arc is rotated around the separated contacts by the magnetic forces generated, and due to the evacuated

condition within the envelope 3, this arc is quickly extinguished. To prevent the deposition of metallic vapor along the inner walls 3a of the ceramic casing 3, there is interposed between the arcing region 8 and the ceramic envelope 3 a metallic condensing shield, designated by the reference numeral 24. Generally, the manner of arcing is set forth in U.S. Pat. No. 2,949,520 — Schneider, and the method of preventing the deposition of the metallic vapor on the inner walls 3a of the envelope 3 is set forth in U.S. Pat. No. 2,892,911 — Crouch.

The present invention is not concerned with the details of interruption, but is directed specifically to the fabrication of either the stationary contact assembly 13, or the movable contact assembly 20 by the joining, or brazing operations of the electrode stem-portions 6 or 12 to the associated stationary and movable contacts 7 or 10 by the manipulating means described more fully hereinafter.

In the fabrication of powder metal components which are made by pressing the higher-temperature component of the system into a porous matrix, and then sintering and subsequently infusing a lower-melting-temperature material into the pores, it is usually the case that a theoretical density of perhaps 97 to 99 percent results. This means that some of the pores in the matrix (1 to 3 percent) are unfilled. Many applications for infiltrated matrix parts, such as electrical contacts, require brazing to some other material, such as a copper conductor supporting stem, with highly wettable braze materials, such as copper-nickel-manganese alloys, or high-temperature gold alloys.

In practice, I have discovered that some fraction of these brazing solders will penetrate the 1 to 3 percent voids in the powder metal part, thereby making it impossible to accurately predict the proper amount of braze material to be placed into the joint. Since the amount of braze material, normally required for such a joint, is very small in comparison to the masses of the parts to be joined, and it was not uncommon to have excess braze material, which would run out of the joint (as with a 1 percent voided contact), or a deficiency of braze material leaving a weak joint, in the case where we were brazing to a contact with 3 percent voids, i.e., the variation ranging from 1 to 3 percent voids may represent a volume for possible takeup of the brazing material, which is nearly equivalent to the volume of braze material required to make an adequate joint.

My present invention is particularly related to a method and contact article, and, in part, concerns the making of a powdered metal part from a porous metal matrix infiltrated with a lower-temperature infiltrant material, such as copper or silver, for example, in which is incorporated a dense metallic layer to act as a braze barrier against braze material being taken into the 1 to 3 percent voids, which are usually present in the infiltrated matrix body. In my invention, in one example, I press a refractory powder together with a mild steel insert, for example, to a controlled porosity level, and then sinter and subsequently infiltrate with the lower-temperature infiltrant, such as copper or silver, for example. After infiltration, the insert is intimately attached, or joined to the matrix body via the infiltrant material. The mild steel insert, for example, acts as a braze barrier against braze material penetrating the residual voids, or micropores of the infiltrated matrix body, thus permitting placement of just exactly the

proper amount of braze material to form a sound mechanical and electrical joint. The joint is then a composite joint between the infiltrated matrix body joined to the steel insert via the infiltrant material, and then from the steel insert to the rod-like supporting material, or conductor stem via a highly predictable volume of high-temperature braze material.

In general, the constraints, or limits, on the materials usable in such a system are as follows: The matrix can be any powdered metal, metal oxide, or semiconducting material. The infiltrant must be of a lower melting point than the matrix, and the insert, or braze barrier piece, or member must be of a higher-melting point than the infiltrant, and must be non-reactive with the matrix and infiltrant to an extent, which excludes it from being destroyed during the sintering and infiltration processes.

Typical materials for the system are the refractories chromium, molybdenum and tungsten for the matrix material, for example, copper or silver, for example, for the infiltrant, and mild or stainless steel, nickel or refractories, for example, for the braze-penetration barrier member.

The composition of a particularly desirable matrix-like contact, suitable for the contact body portion 10, is set forth in British Patent No. 1,194,674 by Alfred Alexander Robinson, published June 10, 1970, and assigned to the English Electric Company of England. Also, Canadian Patent No. 836,115 relates to the same composition, and the details of fabrication of the matrix-like contact body are set forth in detail in these two patents.

For reference, the melting points and boiling points of metals, herein referred to, are given by certain authorities as follows in degrees centigrade:

|                 | Melting Point | Boiling Point |
|-----------------|---------------|---------------|
| silver (Ag)     | 960.8         | 2200          |
| copper (Cu)     | 1083          | 2570          |
| cobalt (Co)     | 1492          | 3000          |
| chromium (Cr)   | 1800          | 2665          |
| molybdenum (Mo) | 2625          | 4800          |
| tungsten (W)    | 3380          | 6000          |

FIGS. 4-8, generally, illustrate one process for firmly attaching the braze penetration insert member 30 to the refractory matrix material 31 in a hydraulic press 32. The plunger 33 moves downwardly within the hydraulic press, compacting the matrix material, and following ejection from the press 32, as pictured in FIG. 5, the piece is then sintered and subsequently infiltrated with a suitable infiltrant material, such as copper, or silver 35, for example, as illustrated in FIG. 6.

FIG. 7 illustrates the finished blank piece 38 following the vacuum-melt, and subsequently machining operations are provided to result in the machined finished contact 10, as illustrated more clearly in FIGS. 3 and 8 of the drawings.

It will be noted that the braze-penetration insert member 30 is firmly attached to the contact-head portion 31. As a second operational step, the electrode stem member 6 or 12 is brazed, as at 40, to the somewhat cup-shaped barrier insert member 30 to thereby form the movable contact assembly 20.

Many braze materials are available in the improved process of my invention. For example, I have obtained good results with No. 1600-N brazing alloy, sold by Coast Metals, Inc. of Little Ferry, New Jersey, having a nominal composition of copper — 52.5 percent, manganese — 38.5 percent, and nickel — 9 percent by weight. Another alternate brazing material may be Handy and Harman of New York City, with their "Handy High Temp 095" brazing material having a nominal composition of copper — 52.5 percent, nickel — 9.5 percent, with the balance manganese, with boron maximum 0.10 percent, iron maximum content of 0.10 percent, and total other impurities maximum content 0.50 percent. The Handy High Temp 095 is a relatively ductile copper-manganese-nickel brazing alloy for joining iron base and nickel base heat-resistant alloys.

From the foregoing, it will be noted that there is provided the braze-penetration barrier, which prevents the penetration of the brazing materials into the micropores of the contact head body. As a result, a predetermined amount of brazing material may be used, and joints may be predictably sound in nature.

Although I have illustrated the utilization of a brazing insert 30 in the hydraulic pressing operations, as set forth in FIGS. 5-7 of the drawings, it will be obvious to those skilled in the art that other ways of attaching the braze penetration member 30 to the matrix contact or electrode body 31 will be evident.

As will be recognized by those skilled in the art, the invention is applicable also to fixed electrodes in triggered gap-type devices having two spaced fixed electrodes therein.

Although I have illustrated and described a particular article and process, and means for making a contact assembly, it is to be clearly understood that the same were merely for the purpose of illustration, and that changes and modifications may readily be made therein by those skilled in the art, without departing from the spirit and scope of the invention.

What is claimed is:

1. The method of fabricating an impregnated refractory contact structure for a circuit-breaker, comprising the sequential steps of:

- a. placing a metallic plate-like barrier insert (30) within a mold;
- b. placing a predetermined quantity of metallic powdered matrix refractory pulverulent material only within the mold against said plate-like barrier insert;

c. cold-pressing the refractory pulverulent material with the insert to result in a "green" contact member;

d. removing the "green" contact member from the mold and sintering the same to remove gas therefrom;

e. infusing the sintered powdered body with a metallic infiltrant selected from the group consisting of copper, silver and their alloys; whereby the insert is firmly bonded to the matrix body of the contact; and,

f. metal-joining a metallic supporting stem portion to said contact.

2. The method of claim 1, wherein the refractory pulverulent material is selected from the group consisting of tungsten, chromium, molybdenum and their alloys.

3. The method of fabricating an impregnated refractory contact structure for a circuit-breaker, comprising the sequential steps of:

a. preforming a metallic plate-like barrier member into a cup-shaped insert;

b. placing said cup-shaped insert within a mold;

c. placing a predetermined quantity of metallic powdered matrix refractory pulverulent material only within the mold against said cup-shaped barrier insert;

d. cold-pressing the refractory pulverulent material with the cup-shaped insert to result in a "green" contact member;

e. removing the "green" contact member from the mold and subsequently sintering the same to remove gas therefrom;

f. infusing the sintered powdered body with a metallic infiltrant selected from the group consisting of copper, silver and their alloys; whereby the cup-shaped insert is firmly bonded to the matrix body of the contact; and,

g. metal-joining a metallic supporting stem portion to said cup-shaped insert and thus to the contact body.

4. The combination according to claim 3, wherein the refractory material is selected from the group consisting of tungsten, molybdenum and chromium and their alloys.

5. The method of claim 4, wherein the cup-shaped insert is selected from the group consisting of mild steel and stainless steel.

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