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Barr

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[54] **ELECTRICAL FEED-THROUGH ASSEMBLY SUITABLE FOR ELECTRONIC DEVICES IMPLANTABLE IN A HUMAN BODY**

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[52] **U.S. Cl.**..... **174/152 GM;** 52/759; 128/419 P

[51] **Int. Cl.²**..... **H01B 17/26**

[58] **Field of Search**..... 174/50.56, 50.61, 50.63, 174/151, 152 GM; 29/473.1; 128/405, 419 R, 419 P; 52/759; 403/179

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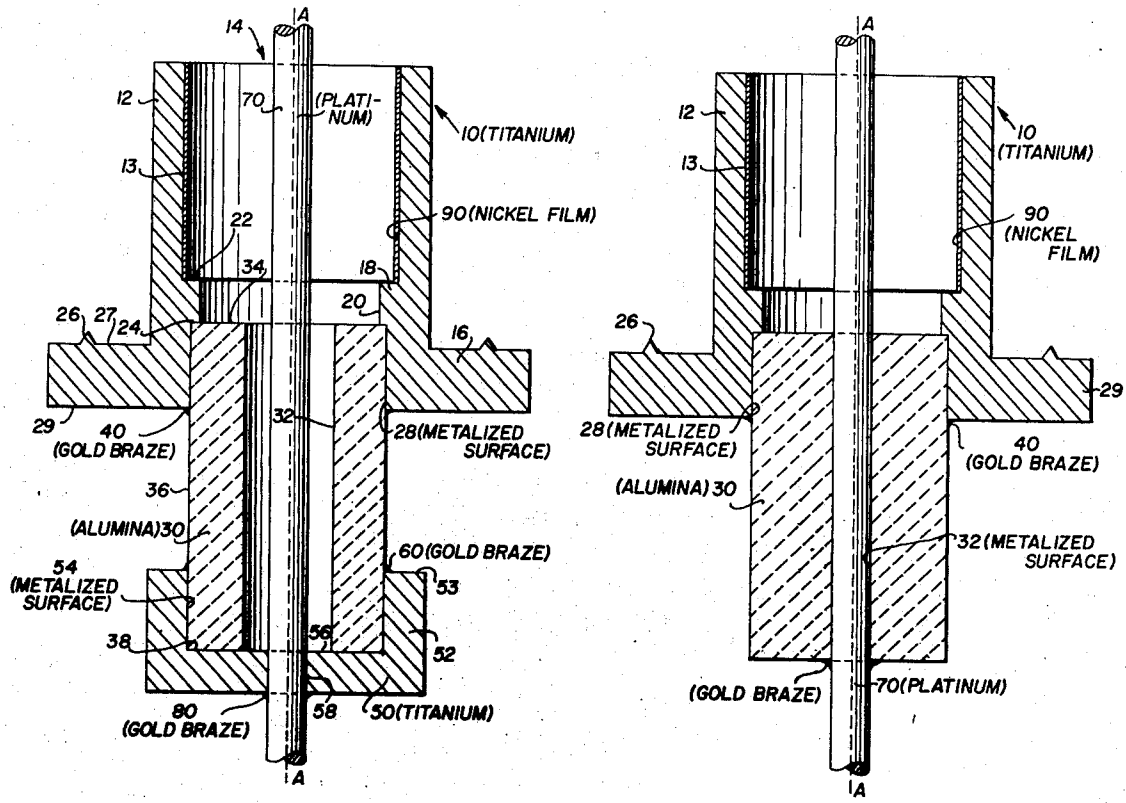
[57] **ABSTRACT**

An electrical feed-through assembly suitable for electronic devices to be implanted in a human body consisting of a titanium coupler provided with a flange into which is fitted an the alumina sleeve. A titanium coupler is fitted over the other end of alumina sleeve and compression joints are formed between the alumina sleeve and the two titanium parts. A platinum wire is sealed in the titanium coupler and extends through the sleeve and titanium coupler. A nickel coating is sputtered onto the inner surface of the titanium coupler to provide a solderable surface. The flange is used to weld the feed-through assembly onto a housing containing such an electronic device.

5 Claims, 2 Drawing Figures



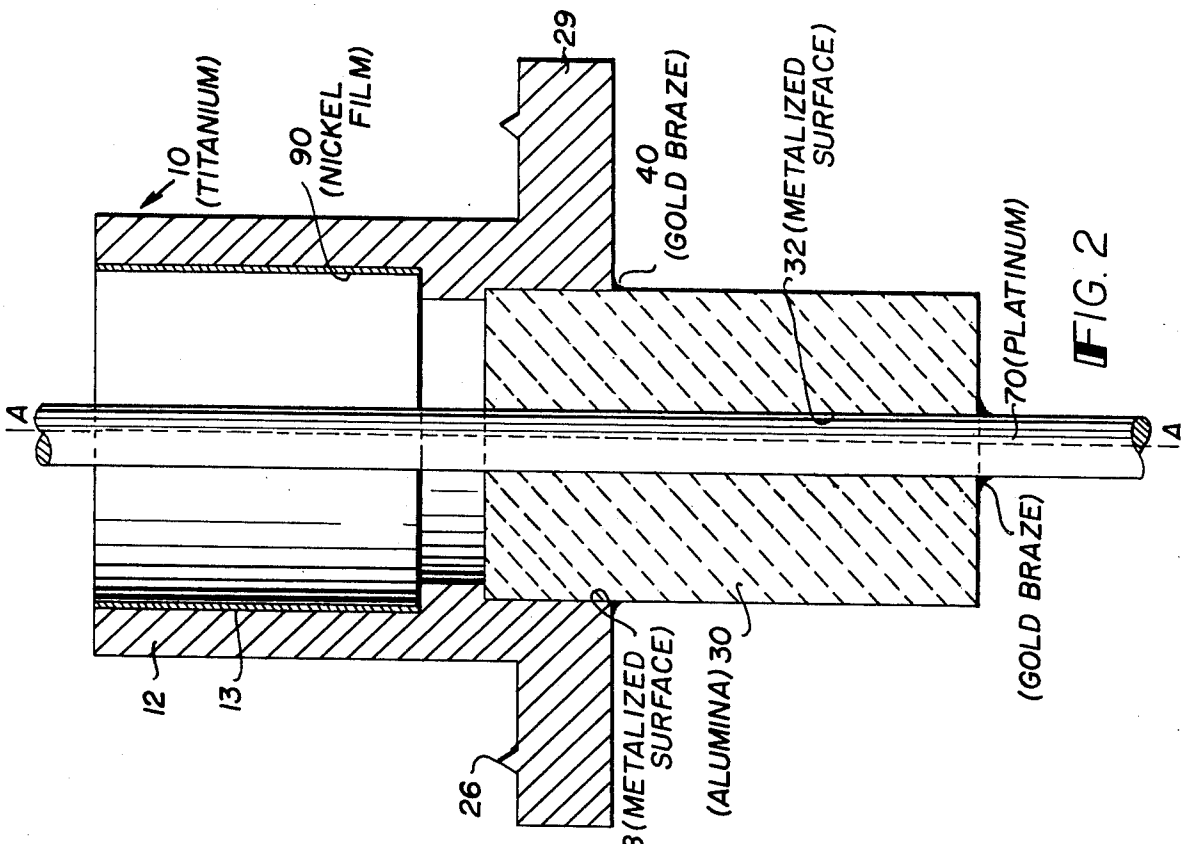

10 (TITANIUM)
90 (NICKEL FILM)
29
40 (GOLD BRAZE)
32 (METALIZED SURFACE)
70 (PLATINUM)
A
A
12
13
26
28 (METALIZED SURFACE)
(ALUMINA) 30
(GOLD BRAZE)

FIG. 2

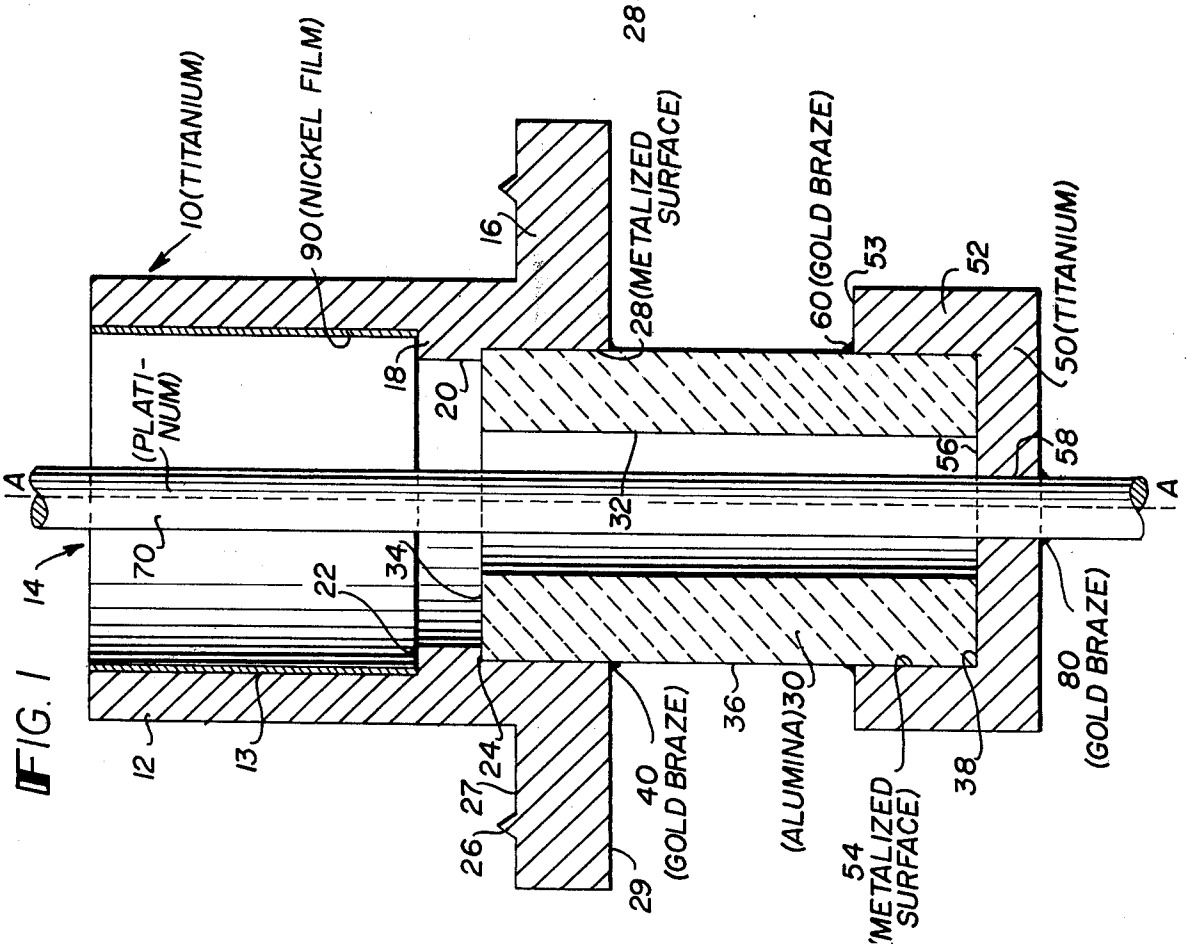

10 (TITANIUM)
90 (NICKEL FILM)
16
28 (METALIZED SURFACE)
60 (GOLD BRAZE)
53
52
50 (TITANIUM)
(PLATI-NUM)
18
20
56
58
A
A
32
14
70
22
34
12
13
24
26
27
29
40 (GOLD BRAZE)
36
(ALUMINA) 30
54 METALIZED SURFACE
38
80 (GOLD BRAZE)

FIG. 1

ELECTRICAL FEED-THROUGH ASSEMBLY SUITABLE FOR ELECTRONIC DEVICES IMPLANTABLE IN A HUMAN BODY

The present invention relates to a novel feed-through assembly particularly suited to seal and to serve as a feed-through for a housing containing an electronic device which is destined for implant into the human body, the seal being liquid and gas tight and the feed-through assembly being body compatible.

Many feed-throughs are known in the art, all ostensibly serving the purpose of sealing an electronic device within an enclosure in a liquid and gas-tight fashion while providing electrical feed-through. Despite the pro-liferation of prior art structures in this field, critical problems remain for the particular application concerning the implantation of an electronic device within the human body. Such devices must meet stringent characteristics vis-a-vis being gas-tight and light-tight and also must exhibit total compatability with the human body. Thus far, in the development of the prior art no feed-through assembly completely satisfies all stringent requirements imposed upon a feed-through for this special case.

Accordingly, the principal purposes and object of the present invention are to provide a novel feed-through assembly that satisfies all requirements for a feed-through assembly suitable for implantation within a human body.

This object is accomplished, according to the present invention, by using specific materials, using specific geometric configurations for components, and the combining of these specific materials and components into a unique feed-through assembly which, although bearing a superficial resemblance to many prior art suggestions in this field, nevertheless, is characterized by specific and unique differences which serve to make the feed-through assembly of the present invention distinctive and completely suitable for implantation into a human body whereas similarly appearing prior art suggestions are unsuitable for implantation into the human body for one or more reasons. Thus, to appreciate the impact of the present invention and to gain an insight into the extent of its advance, one must pay close attention to detail. The foregoing and other objects and advantages of the present invention will become more evident from the following description of the preferred embodiment of the invention when taken in conjunction with the drawing in which FIG. **1** shows in section the inventive feed-through assembly and FIG. **2** shows a further embodiment of the inventive feed-through assembly. Referring to the drawing, the feed-through assembly is cylindrical in form with respect to axis A—A. The assembly consists of a titanium coupler (CP grade) generally designated by the reference numeral **10** which has a cylindrical annular portion or skirt **12** open at one end **14**, the right side as shown in the drawing. The other end of coupler **10** is fashioned with an integral flange **16.** An inwardly extending annular ring **18** having a central axial opening **20** of a diameter less than the opening of the end **14** is located between flange **16** and annular portion or skirt **12.** The ring **18** provides an annular shoulder or surface **22** on the side nearest the end **14** and an annular shoulder or surface **24** on the side nearest the flange portion **16** with the outer diameter of the shoulder **24** being less than the outer diameter of the shoulder **22.** The inner diameter of both shoulders **22** and **24** corresponds to

the diameter of the opening **20.** The flange portion **16** is also annular (cylindrical) and contains on its face nearest end **14** an annular V-burr **26,** the purpose for which will become evident from the following. The flange portion **16** has an inner diameter equal to the outer diameter of the shoulder **24.**

Received within the annular opening of the flange portion **16** is an annular alumina sleeve **30** the bore of which is identified by reference numeral **32.** The outer diameter of the alumina sleeve **30** equals the outer diameter of shoulder **24** and the alumina sleeve **30** is received within the annular opening of the flange **16** with one end **34** resting against shoulder **24** and its outer surface **36** engaged with the inner surface **28** of the annular flange portion **16.** The portion of the outer surface **36** of the annular sleeve **30** in contact and engaging inner surface **28** is suitably metalized with titanium by a conventional hydride treatment and a brazed compression joint is formed between surfaces **28** and **36** using as the braze material pure gold; the braze bead is indicated by the reference numeral **40** in the drawing. As the brazing techniques are well known in the art no elaboration is deemed necessary. In the brazing of surfaces **28** and **36,** the braze material, exemplified by the bead **40,** is placed at the junction of the surfaces and upon subjecting this portion of the assembly to sufficient heat, the braze material by appropriate action enters into the joint between the surfaces. In the preferred embodiment, selection of the brazing material must specifically meet two principal criteria. First, the braze must be made to provide an excellent seal and second, the braze material must not contain any components objectionable to the human body, and must be completely body compatible. The preferred braze material is pure gold as stated above. Other materials, the use of which is not precluded in this invention would include gold-nickle, and gold-palladium alloys with or without minor amounts of chromium.

The other end of the alumina sleeve **30** has received thereon a titanium cap **50** (CP grade) having an annular skirt portion **52** whose inner surface **54** contacts and engages the surface **36** of the alumina sleeve. Inner surface **56** of the cap **50** bears against and contacts the end face **38** of the alumina sleeve **30.** The cap **50** is annular in configuration in the sense that a central hole **58** is defined having a diameter approximately half the inner diameter of the alumina sleeve **30** bounded by surface **32.** The inner surface **54** engages and contacts the outer surface **36** of alumina sleeve **30** and a second compression joint is formed therebetween like the first. The brazed bead is identified by the reference number **60.** The preparation of surface **36** and the technique fof making the compression joint is the same as that described for the compression joint between surfaces **28** and **36.** The braze material, like before, is pure gold.

Received within the alumina sleeve **30** is a platinum wire **70** having a diameter equal to the diameter of the hole **58.** Wire **70** constitutes the electrical feed-through and is brazed into the opening **58** by conventional brazing techniques utilizing a pure gold braze as described previously. The braze bead is identified by reference number **80.** Platinum wire **70** is **99.5%** pure and projects out of cap **50** to the left as shown in the drawing which represents the exterior or outside. Wire **70** extends through the alumina sleeve **30** spaced from the surface **32,** through the coupler **10** spaced from the surface **20,** through the lower cylindrical annular portion

12 spaced from inner surface 13, and the interior of a housing containing an electrical or electronic devices sought to be implanted within a human body. The housing, not shown, would contain an open mouth, with or without a flange, that would abut against surface 27 of the flange 16 in contact with the V-burr 26 which serves the purpose of facilitating an electrical welding operation to seal in a perfectly gas-tight, liquid-tight fashion the flange 16 to the open mouth of the housing or any other opening in the housing.

The inner surface 13 of the lower cylindrical portion 12 contains a coating 90 of pure nickel which has been sputtered onto the surface 13. The purpose of this sputtered nickel film 90 is to provide a surface that adheres excellently to titanium and to which one can solder.

The inventive feed-through assembly, as described, enables the flange 16 to be sealed onto a housing in a gas-tight, liquid-tight manner to satisfy the stringent requirements for electronic devices implantable in a human body and leaves exposed to the human body only materials that are body compatible. An example of such an electronic device would be one to regulate or control heart function. With the flange 16 sealed to the housing, the platinum wire 70 provides the electrical feed-through whereby energy or information can pass into and out of the housing. The brazing of the wire 70 in the hole 58 by means of the particular braze material, as well as, the two compression joints formed by the titaninum cap 50 and alumina sleeve 30 on the one hand, and by the titanium flange 16 and alumina sleeve 30 on the other hand, using the particular braze material provide three additional excellent liquid-tight, gas-tight seals that satisfy the most stringent requirements for such seals and all have the further advantage of total body compatability. One will note that the free end 53 of the skirt portion 52 is spaced substantially from the outer annular surface 29 of the flange 16 so that the braze beads 60 and 40 will be kept totally isolated both physically and electrically.

To highlight the advantages of the present invention, one can construct a feed-through assembly, according to the teachings of the present invention, wherein the flange 16 has a diameter of approximately one-fourth of an inch. For this particular model of construction, the platinum wire 70 is 0.020inch in diameter seated into hole 58 of the titanium cap 50 which itself is only 0.140inch in diameter. The alumina sleeve 30 is one-tenth of an inch in diameter having an inside diameter of approximately 0.040inch or twice that of the platinum wire 70. The alumina sleeve 30 is approximately one-sixth of an inch long and the spacing between the end 53 of the titanium cap 50 and the outer surface 29 of the flange 16 is approximately 1/12 of an inch. The spacing between the platinum wire 70 and surface 13 on the inside of annular portion 12 is approximately 0.050inch. The overall length of the unique assembly is approximately one-third of an inch. One immediately recognizes that a feed-through assembly constructed according to the teaching of the present invention can be of relatively small size and yet will meet the stringent liquid-tightness and gas-tightness requirements and will satisfy all requirements for body compatability. The accomplishment of the present invention represents a significant advance in the art.

A modification of the inventive assembly is possible with some sacrifice in quality. The modification is shown in FIG. 2. One may eliminate the titanium cap 50 and use a direct joint between the platinum wire 70 and the inner surface 32 of the alumina sleeve 30. In this instance, however, the diameter of the inner surface 32 is about the same as the diameter of the platinum wire and the inner surface 32 is first metalized by conventional means. A braze ring is applied to the joint between the platinum wire 70 and the metalized portion of the surface 32 of the alumina sleeve 30 and when subjected to appropriate heat, the braze ring will liquify and flow between the outer surface of the platinum wire 70 and the surface which closely embraces the platinum wire 70 in this constructional modification. The braze material used is the same as described previously.

Although the invention has been described in terms of a preferred embodiment, nevertheless changes and modification obvious to one skilled in the art, from a knowledge of these teachings, are deemed to be within the purview of the claimed invention.

What is claimed is:

1. An electrical feed-through assembly suitable for electronic devices implantable in a human body comprising
   1. a titanium coupler including an annular skirt portion open at one end, an annulus integrally formed with the other end of said annular skirt having an inner diameter less than the inner diameter of said annular skirt, and an annular flange integrally formed with said annulus having a larger outer diameter than that of said annulus and having an inner diameter for its opening that is greater than the inner diameter of said annulus to define therebetween a shoulder,
   2. an alumina sleeve having an outer diameter equal to the inner diameter of said annular flange and having one end thereof received within the opening of said annular flange and bearing against said shoulder,
   3. liquid-tight and gas-tight compression joint means formed between said annular flange and the end of said alumina sleeve received therein and including the inner surface of said annular flange, the outer surface of said alumina sleeve received within said annular flange, and a braze material,
      a. said braze material being selected from the group consisting of gold, gold-nickel alloys and gold-palladium alloys,
   4. a platinum wire extending through said alumina sleeve and projecting out of the other end thereof and extending through said titanium coupler and projecting out of the open end of said annular skirt portion, said wire being spaced from said titanium coupler and the inner surface of said annular skirt portion.
   5. a nickel film on the inner surface of said annular skirt portion, and
   6. liquid-tight and gas-tight means sealing said platinum wire in the other end of said alumina sleeve.

2. An electrical feed-through assembly suitable for electronic devices implantable in a human body comprising
   1. a titanium coupler including an annular skirt portion open at one end, an annulus integrally formed with the other end of said annular skirt having an inner diameter less than the inner diameter of said annular skirt, and an annular flange integrally formed with said annulus having a larger outer di-

ameter than that of said annulus and having an inner diameter for its opening that is greater than the inner diameter of said annulus to define therebetween a shoulder,

2. an alumina sleeve having an outer diameter equal to the inner diameter of said annular flange and having one end thereof received within the opening of said annular flange and bearing against said shoulder,

3. liquid-tight and gas-tight compression joint means formed between said annular flange and the end of said alumina sleeve received therein and including the inner surface of said annular flange, the outer surface of said alumina sleeve received within said annular flange, and a braze material,

a. said braze material being selected from the group consisting of gold, gold-nickel alloys, and gold-palladium alloys,

4. a platinum wire extending through said alumina sleeve and projecting out of the other end thereof and extending through said titanium coupler and projecting out of the open end of said annular skirt portion, said wire being spaced from said titanium coupler and the inner surface of said annular portion, but fitting closely within said alumina sleeve.

5. a nickel film on the inner surface of said annular skirt portion, and

6. a liquid-tight, gas-tight joint means formed between said wire and said alumina sleeve and including the surface of said wire, the inner surface of said alumina sleeve, and a braze material,

a. said braze material being selected from the group consisting of gold, gold-nickel alloys, and gold-palladium alloys.

3. An electrical feed-through assembly suitable for electronic devices implantable in a human body comprising

1. a titanium coupler including an annular skirt portion open at one end, an annulus integrally formed with the other end of said annular skirt having an inner diameter less than the inner diameter of said annular skirt, and an annular flange integrally formed with said annulus having a larger outer diameter than that of said annulus and having an inner diameter for its opening that is greater than the inner diameter of said annulus to define therebetween a shoulder,

2. an alumina sleeve having an outer diameter equal to the inner diameter of said annular flange and having one end thereof received within the opening of said annular flange and bearing against said shoulder,

3. first liquid-tight and gas-tight compression joint means formed between said annular flange and the end of said alumina sleeve received therein and including the inner surface of said annular flange, the outer surface of said alumina received within said annular flange and a braze material,

a. said braze material being selected from the group consisting of gold, gold-nickel alloys and gold-palladium alloys,

4. a titanium cap having a central opening received on the other end of said alumina sleeve with a skirt portion of said cap engaging the outer surface of said alumina sleeve in the vicinity of said other end, said skirt portion terminating spaced from said annular flange,

5. a platinum wire extending through said alumina sleeve and projecting out of the opening in said cap, and extending through said titanium coupler and projecting out of the open end of said annular skirt portion, said wire being spaced from said titanium coupler and the inner surface of said annular skirt portion,

6. a nickel film on the inner surface of said annular skirt portion,

7. second liquid-tight and gas-tight compression joint means formed between the other end of said alumina sleeve and said cap received thereon and including the outer surface of said alumina sleeve in the vicinity of said other end, the inner surface of the skirt portion of said cap, and a braze material,

a. said braze material being selected from the group consisting of gold, gold-nickel alloys and gold-palladium alloys,

8. said first and second compression joint means being spaced apart to be physically and electrically isolated, and

9. liquid-tight and gas-tight means sealing said platinum wire in said opening to said cap.

4. An electrical feed-through assembly as defined in claim 3 wherein said braze material is pure gold.

5. An electrical feed-through assembly as defined in claim 3 wherein the plane of said annular flange lies normal to the axis of said coupler with one face thereof nearer said annular skirt and the other face thereof remote from said annular skirt, and a V-burr is integrally formed on the face of said annular flange nearer said annular skirt.

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