

[54] **VACUUM TIGHT HIGH-FREQUENCY
COAXIAL LEAD-THROUGH CAPABLE
OF HANDLING HIGH POWER**

[75] Inventor: Andre Besson, Massy, France

[73] Assignee: Societe de Traitements Electrolytiques et Electrothermiques

[22] Filed: Aug. 16, 1971

[21] Appl. No.: 172,136

[52] U.S. Cl. 174/15 BH, 174/31 R, 174/50.55,
174/50.61, 174/152 GM

[51] Int. Cl. H01b 17/26

[58] Field of Search 174/15 BH, 16 BH, 17.05, 18,
174/31 R, 50.55, 50.56, 50.59, 50.6, 50.61,
50.63, 151, 152 R, 152 E, 152 GM

[56] **References Cited**

UNITED STATES PATENTS

1,905,751 4/1933 Rankin 174/15 BH X
2,135,883 11/1938 Dallenbach 174/152 E X

2,863,934 12/1958 Tudbury 174/15 BH X
3,125,698 3/1964 Persson 174/152 GM UX
3,377,531 4/1968 Lindsay 174/50.61 UX

FOREIGN PATENTS OR APPLICATIONS

443,017 2/1936 Great Britain 174/15 BH

Primary Examiner—Laramie E. Askin

Attorney—Cushman, Darby & Cushman

[57]

ABSTRACT

A vacuum-tight, coaxial, high-frequency lead-through with high power handling capability, cooled by circulation of a liquid, including: an outer and a central copper conductor vacuum-tightly connected together by means of a ceramic cylindrical component, whose one end is brazed to a sleeve integral with a disk-shaped copper component vacuum-tightly attached to the central conductor, and whose other end is brazed to a sleeve integral with another disk-shaped copper component attached to the external conductor.

10 Claims, 4 Drawing Figures

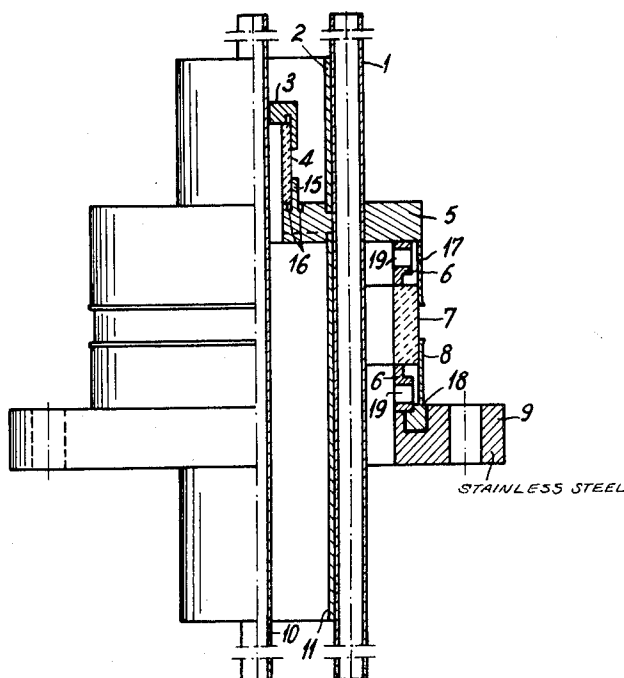


FIG.1

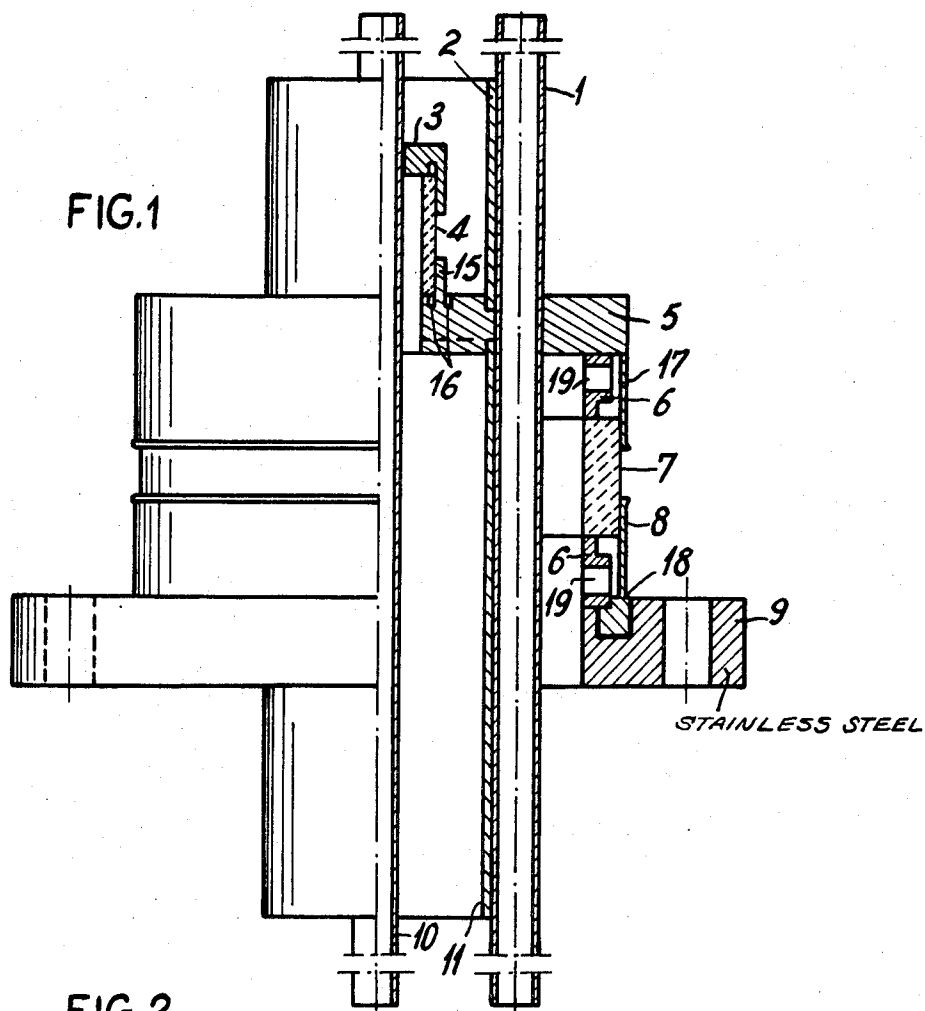


FIG.2

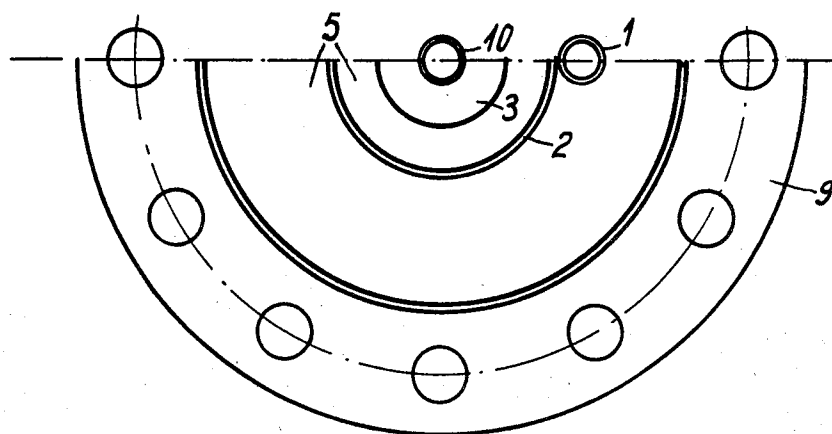


FIG. 3

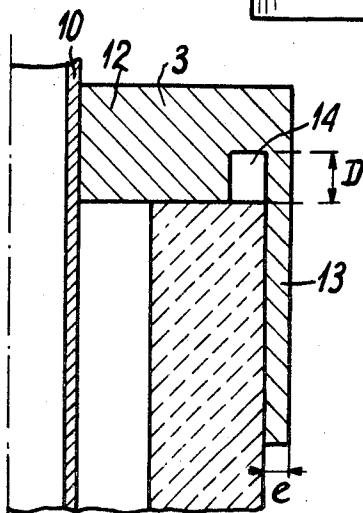
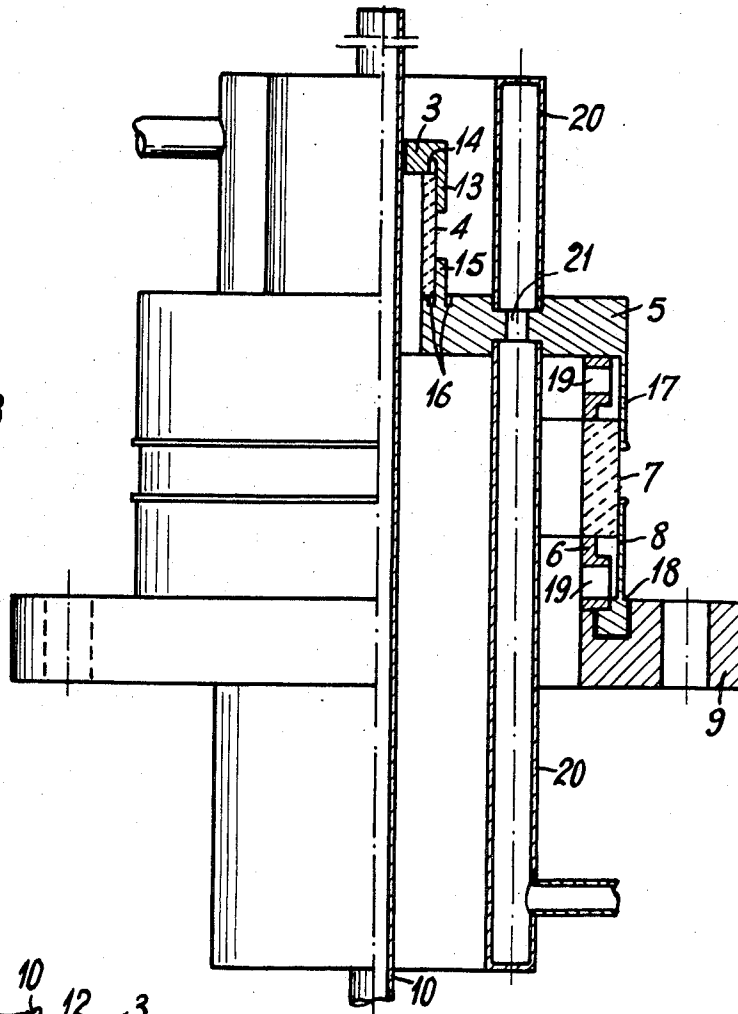


FIG. 4

VACUUM TIGHT HIGH-FREQUENCY COAXIAL LEAD-THROUGH CAPABLE OF HANDLING HIGH POWER

BACKGROUND OF THE INVENTION

The present invention relates to coaxial high-frequency feed-or lead-throughs capable of handling high power which provide an effective seal for high and ultra-high vacuum devices, and relates, more particularly, to lead-throughs of this kind which are cooled by the circulation of a liquid such as water.

In devices of this kind, the conductors are generally made of a metal or alloy having a coefficient of thermal expansion at least approximately equal to or very close to that of the insulator being used. The vacuum-tight connection of the insulator, generally a ceramic or glass, to a conductor of this kind is obtained by brazing the surfaces of the ceramic insulator to the conductors, said surfaces having been previously metallized.

However, alloys of this kind, which generally comprise iron (Fe), nickel (Ni) and cobalt (Co), are ferromagnetic and have a very high electrical resistivity. For these reasons it is impossible to use metals and alloys of this kind for the production of conductor elements for a high-power, high frequency lead-through.

It has equally been proposed that the conductor element of this kind of lead-through should be made of a metal presenting good electrical conductivity, such as copper (Cu), although this metal has a coefficient of thermal expansion ($180 \times 10^{-7} \text{ }^\circ\text{C}^{-1}$) which is very much higher than that of ceramic ($60 \times 10^{-7} \text{ }^\circ\text{C}^{-1}$), and this metal is generally connected to the ceramic by means of intermediate components of a different alloy of metals having a coefficient of thermal expansion close to that of the ceramic, such as Kovar as was shown in U.S. Pat. No. 2,895,110 filed Aug. 16, 1956. However, this method has the drawback that it requires two separate brazing operations which have to be carried out at radically different temperatures; in particular, a first brazing operation to connect the conductor elements of copper to the intermediate components of said alloy, and a second brazing operation to connect the intermediate components of said alloy to the metallized surfaces of the ceramic insulator.

SUMMARY OF THE INVENTION

The device in accordance with the invention does not present the abovedescribed drawbacks. In this device a vacuum-tight bond is achieved between the copper and the ceramic with the help of copper components of a particular shape.

In accordance with the invention, there is provided a coaxial, high-frequency, high-power and vacuum-tight lead-through including:

- a cylindrical central conductor of a high-conductivity metal;
- a cylindrical shielding coaxial with said conductor and made of said metal;
- an insulating hollow ceramic cylinder having the outer surfaces of its two extremities metallized for allowing the making of metal to ceramic junctions and an inner diameter greater than that of the central conductor and an outer diameter smaller than that of said shielding;
- a first component, referred to as lead-through base, made of said metal and comprising:

a disk shaped portion having a central aperture vacuum-tightly joined to said central conductor, a peripheral cylindrical first sleeve portion of predetermined thickness, integral with and extending perpendicularly to said disk portion and having an inner diameter substantially equal to the outer one of said cylinder, said first sleeve portion being vacuum tightly joined to one of said metallized surfaces of said latter, and

an annular groove of predetermined depth formed in said disk portion at its junction with said first sleeve portion for providing said latter with an elastic portion; and

a second component made of said metal comprising: an annular solid disk-shaped portion vacuum tightly joined to said shielding and having a central opening whose diameter is approximately equal to the inner one of said cylinder,

a cylindrical second sleeve portion, having the same shape as said first sleeve, integral with and extending perpendicularly to said annular disk portion and having an inner diameter substantially equal to the outer one of said cylinder, said second sleeve portion being vacuum-tightly joined to said latter, and

two annular grooves of predetermined depths formed in said annular disk portion at both sides of its junction with said second sleeve portion for providing said latter with an elastic portion;

whereby said first and said second sleeves ensure a vacuum-tight metal to ceramic seal and their elastic portions ensure compensation for the difference in thermal dilatation of said metal and said ceramic.

BRIEF DESCRIPTION OF THE DRAWINGS.

The foregoing and other objects, features and advantages of the invention will be more fully understood by reference to the appended claims and to the following detailed description when read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a partially sectioned view of an embodiment of a lead-through in accordance with the invention;

FIG. 2 is a plan view of the device of FIG. 1;

FIG. 3 is a partially sectioned view of another embodiment of a lead-through in accordance with the invention; and

FIG. 4 is an enlarged view of a fragment of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS.

In FIG. 1, the reference numeral 1 indicates a hollow copper tube forming the external or outer conductor together with a cylindrical copper shielding 2 and 11 electrically connected and integrally secured thereto. A central conductor 10 disposed coaxially in relation to the shielding 2 and 11 is likewise made in the form of a hollow tube. The two tubes 1 and 10 form part of a cooling circuit through which a liquid such as water, for example, flows. The central conductor 10 is connected integrally to a solid component 3 referred to as the lead-through base and shown in a more detailed manner by FIG. 4. Component 3 comprises a portion 12 of disk shape and a relatively thin outer cylindrical sleeve 13 (thickness e) integral with 12 for connection

by brazing to a cylindrical ceramic insulator 4 so that the sleeve 13 surrounds its metallized surface and lower face of disk 12 is in contact with it. The lead-through base 3 furthermore comprises, at the base of the sleeve 13, an annular groove 14 (see FIG. 4) formed in the disk-shaped portion 12 providing a certain degree of elasticity to the sleeve 13 at the part thereof which neighbors the groove 14. The depth (D) of the groove 14 and the thickness (e) of the sleeve 13 are chosen as a function of the diameter (ϕ) of the latter in order to allow compensation of the differences in thermal expansion between the lead-through base 3 of copper and the ceramic insulator 4 by deforming the portion of sleeve 13 facing the groove 14. By way of example, for a given diameter ϕ excellent results have been obtained with a depth of groove D equal to or greater than 0.06 ϕ and a thickness equal to or less than 0.02 ϕ and generally not over 4 mm.

The copper skirt 13 is brazed to the external metallized surface of a ceramic insulator 4 in the form of a hollow cylinder. This brazing will be carried out with the help of a hoop element surrounding the skirt externally and having a coefficient of thermal expansion slightly smaller than that of the ceramic. The brazing or flux metals used here will preferably be a metal alloy having a low vapor pressure (gold, copper and silver); this will allow the lead-through to operate under molecular vacuum conditions. Advantageously, the brazing metal used will be decarbonized eutectic copper-silver (Cu-Ag) alloy.

The insulating ceramic cylinder 4 is attached at its other end to a sleeve 15 forming part of a solid annular disk-shaped copper component 5 having a central circular opening whose diameter is substantially equal to the inner diameter of ceramic cylinder 4 and which is vacuum-tightly joined to the external conductor, that is to say to the shielding 2 and 11, and to the tube 1, for example by brazing. The disk 5 likewise contains grooves 16 formed therein at both sides of the base of sleeve 15 and having the same profile and function as the groove 14 described earlier. The component 5 can be attached directly in a vacuum tight fashion to a flange which enables the lead-through to be vacuum-tightly assembled with the envelope of the vacuum-chamber, if the latter and the external conductor 1, 2 and 11 have been earthed (single-pole lead-through). If this is not the case, it is possible to use another cylindrical insulator element 7 between the external conductor and the flange.

In FIG. 1, the component 5, here referred to as the lead-through center, likewise comprises a thin skirt 17 integral therewith designed for attachment to one end of the ceramic cylindrical insulating component 7. The cylindrical component 7 is, at its other end, attached by brazing to a sleeve 8 which forms an integral part of an annular component 18, of copper, which is referred to as the brazing lip. This intermediate component 18 between flange 9 and insulator 7 is used to make all junctions with the insulator of the same kind, i.e. ceramic to copper, as this allows simultaneous brazing of all of them.

The annular component 18 is separately brazed to a flange 9 (preferably of stainless steel) with a flux metal having a higher fusion temperature than that of the ceramic to copper junction. This flange 9 allows the

aforedescribed lead-through to be assembled upon the vacuum-chamber in a vacuumtight manner.

The brazing of sleeve 17 of the disk 5 to the ceramic component 7 on the one hand, and the brazing of the ceramic component 7 to the sleeve of annular component 18, on the other, are carried out in the same way as the brazing of the lead-through base 3 to component 4 hereinbefore described. However, because of the large diameter ϕ of the sleeves 17 and 18, the distance D between the disk 5 and the component 7, on the one hand, and on the other hand between the flange 9 and the component 7, are substantial and it is necessary to interpose annular metal components 6 called wedges, between these elements in order to withstand the thrust, due to atmospheric pressure, exerted by the component 5 upon the ceramic component 7, since the thin sleeves do only ensure a vacuumtight seal and not mechanical rigidity. These wedges 6 allow the reduction of the thickness of the disk-shaped portion of component 5 and of the flange 9, as this thickness, which has to be greater than the depth of the groove D if the latter is formed within the component itself would make its weight excessive. These wedges 6 are integral neither with the components 5 and 18 or 9, nor with the ceramic insulator 7, and are designed in fact in such a fashion that they have no contact with the metallized surfaces of the ceramic components and that they permit relative displacements stemming from the differential expansion between components 5 and 7. They comprises one or more openings 19 in order to enable the interior of the sleeves 8 and 17 and the space between these latter and the wedges 6, to be degassed and pumped.

It should be borne in mind that a lead-through of this kind has a preferred direction of operation, that is to say that the bottom part (considered in the figures) should have a lower pressure than the top part, because in this direction it will withstand pressure difference of several tens of bars whilst in the opposite direction it will only withstand about 5 bars.

FIG. 2 illustrates a plan view of the lead-through of FIG. 1.

FIG. 3 illustrates another embodiment of the lead-through in accordance with the invention, in which the external conductor is made up from a single hollow cylindrical element 20, closed and traversed by a cooling liquid, this element replacing the tube 1 and the screen 2 and 11, of FIG. 1. The walls of this element 20 are brazed to the component 5 in the same manner as the shielding 2 and 11 was in FIG. 1, however this time the component 5 contains holes 21 facing parts 20, which allow the water to circulate between the interior and exterior of the enclosure.

Lead-throughs of this kind have a very rigid solid basis which will nevertheless withstand temperature difference and gradients of an extremely high order, such as are encountered in high-frequency furnaces or ovens, with cooled conductors.

Moreover, this rigidity provides excellent mechanical attachment of the central and outer conductors, on the one hand, in relation to one another and, on the other, in relation to their respective ceramic locations. This excellent fixing ensures high accuracy in the axial positioning of the two elements, this making it possible to reduce the radial interval between them and also to

achieve a low inherent impedance and maximum length in the conductors and shielding arrangements at either side of the lead-through.

The lead-through can be operated in all cases where high powers have to be transmitted at high frequency (up to 2000 Amp. at 10 KV between environments which are sealed off from one another and have different prevailing pressures; and, particularly, towards the interior of a chamber which may even be at a vacuum of molecular order).

While in this description of the invention only certain presently preferred embodiments have been illustrated and described by way of example, many modifications will occur to those skilled in the art and it therefore should be understood that the appended claims are intended to cover all such modifications as fall within the true spirit and scope of the invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A coaxial, high-frequency, high power and vacuum-tight lead-through including:

a cylindrical central conductor of a high-conductivity metal;

a cylindrical shielding coaxial with said conductor and made of said metal;

an insulating hollow ceramic cylinder having the outer surfaces of its two extremities metallized for allowing the making of metal to ceramic junctions and an inner diameter greater than that of the central conductor and an outer diameter smaller than that of said shielding;

a first component, referred to as lead-through base, made of said metal and comprising:

a disk shaped portion having a central aperture vacuum-tightly joined to said central conductor,

a peripheral cylindrical first sleeve portion of predetermined thickness integral with and extending perpendicularly to said disk portion and having an inner diameter substantially equal to the outer one of said cylinder, said first sleeve portion being vacuum tightly joined to one of said metallized surfaces of said latter, and

an annular groove of predetermined depth formed in said disk portion at its junction with said first sleeve portion for providing said latter with an elastic portion; and

a second component made of said metal comprising:

an annular solid disk-shaped portion vacuum tightly joined to said shielding and having a central opening whose diameter is approximately equal to the inner one of said cylinder,

a cylindrical second sleeve portion, having the same shape as said first sleeve, integral with and extending perpendicularly to said annular disk portion and having an inner diameter substantially equal to the outer one of said cylinder, said second sleeve portion being vacuum-tightly joined to said latter, and

two annular grooves of predetermined depths formed in said annular disk portion at both sides of its junction with said second sleeve portion for providing said latter with an elastic portion;

whereby said first and said second sleeves ensure a vacuum-tight metal to ceramic seal and their elastic portions ensure compensation for the dif-

ference in thermal dilatation of said metal and said ceramic.

2. Lead-through as claimed in claim 1, wherein said central conductor is hollow and wherein said lead-through further comprises a second hollow cylindrical conductor of said metal, parallel to said central conductor, traversing said annular disk portion and electrically and mechanically connected to the outer surface of said shielding, whereby providing said lead-through and elements eventually connected thereto with means for cooling by circulation of a liquid through said hollow central and second conductors.

3. Lead-through as claimed in claim 1, wherein said central conductor is hollow and therein said shielding forms the inner wall of a closed hollow cylindrical vessel whose outer wall is coaxial therewith, said vessel being provided with inlet and outlet tubes for cooling said lead-through by circulation of a liquid through said hollow central conductor and said vessel.

4. Lead-through as claimed in claim 1, wherein the thickness of said sleeve portions is equal to or less than one-third of the depth of said grooves

5. Lead-through as claimed in claim 1, further comprising a flange for vacuum-tight mounting to a vacuum-tight chamber, said flange being vacuum-tightly joined to said second component.

6. Lead-through as claimed in claim 5, wherein said flange is made of stainless steel.

7. Lead-through as claimed in claim 5, wherein said metal is copper.

8. Lead-through as claimed in claim 1, of the type in which said shielding is insulated from ground, said lead-through further comprising:

a second ceramic insulating cylinder having the outer surfaces of its two extremities metalized for allowing the making of metal to ceramic junction and an inner diameter greater than the outer one of said shielding;

a third cylindrical sleeve portion of said metal and of predetermined thickness formed integrally with and extending perpendicularly to said annular disk portion, at the periphery of said latter and opposite to said second sleeve portion, said third sleeve portion having an inner diameter approximately equal to the outer one of said second cylinder and being vacuum-tightly joined to one of said metalized surfaces;

a first annular component of predetermined height, referred to as wedge, made of said metal and having an inner diameter approximately equal to and an outer diameter smaller than that of said second cylinder, said first wedge, having at least one radial opening being inserted between said annular disk portion and the adjoining extremity of said second cylinder;

a flange for connecting said lead-through to a vacuum chamber;

a fourth cylindrical sleeve portion of said metal and of said thickness forming part of a second annular component integral with said flange, said fourth sleeve, having the same shape as said third one, being vacuum-tightly joined to the other metalized surface of said second cylinder; and

a second wedge identical to said first one inserted between said flange and the adjoining extremity of said second cylinder.

9. Lead-through as claimed in claim 8, wherein said metal is copper.

10. Lead-through as claimed in claim 8, wherein said flange is of stainless steel.

* * * * *

5

10

15

20

25

30

35

40

45

50

55

60

65