Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2529075 C 2011/07/12

(11)(21) 2 529 075

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) Date de dépôt/Filing Date: 2005/12/09

(41) Mise à la disp. pub./Open to Public Insp.: 2007/06/09

(45) Date de délivrance/Issue Date: 2011/07/12

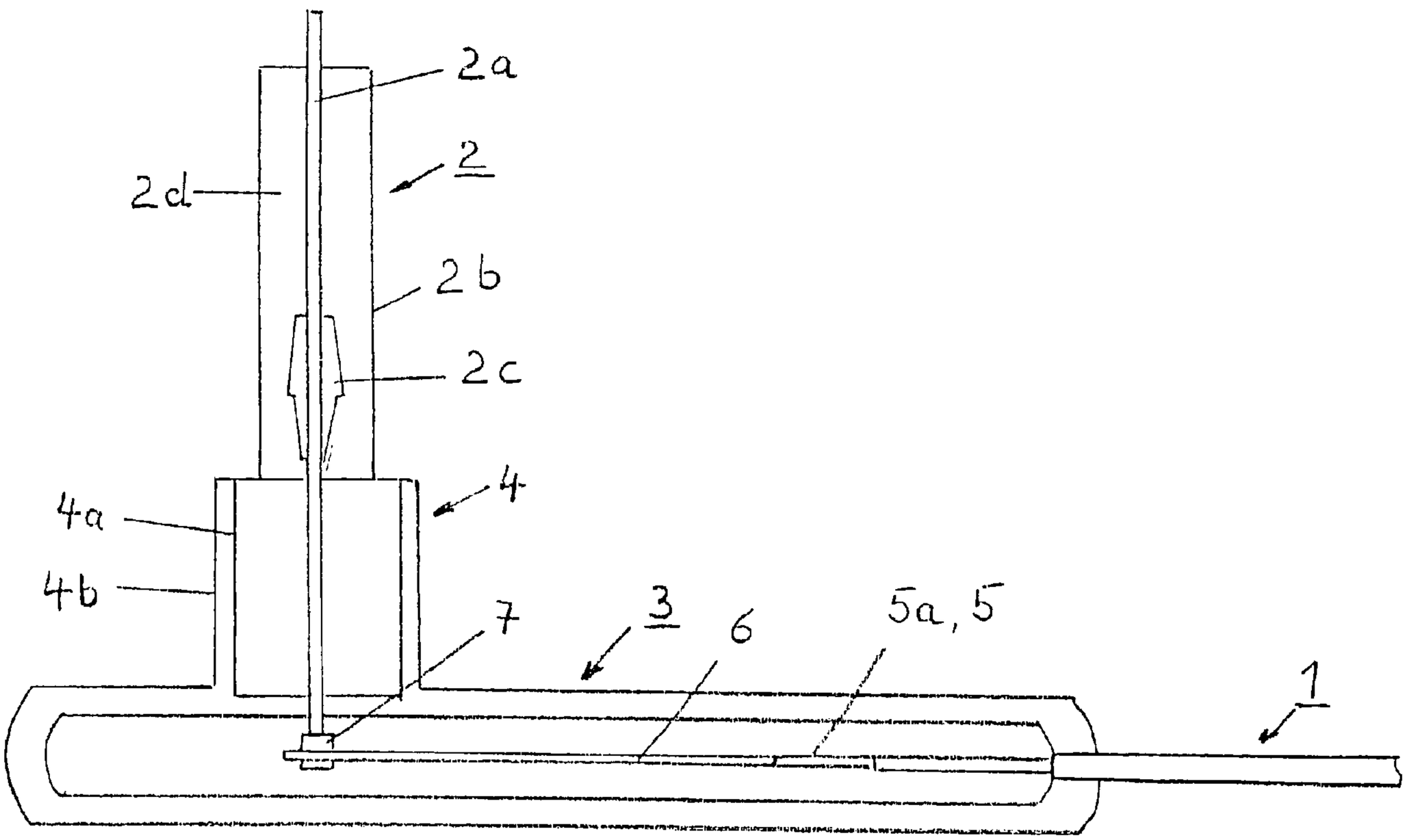
(51) Cl.Int./Int.Cl. *H01R 4/68* (2006.01), *H01B 12/00* (2006.01), *H02G 15/34* (2006.01)

(72) Inventeurs/Inventors:
SCHMIDT, FRANK, DE;
ALLAIS, ARNAUD, DE;
MIREBEAU, PIERRE, FR;
GAHUNGU, FRANCOIS, FR;
LALLOUET, NICOLAS, FR

(73) Propriétaire/Owner:
NEXANS, FR

(74) Agent: ROBIC

(54) Titre : STRUCTURE TERMINALE
(54) Title: TERMINAL STRUCTURE



(57) Abrégé/Abstract:
A terminal structure (2) for a superconducting cable (1) is described. It consists of a conductor (2a) and an insulator (2b) that surrounds the conductor (2a), wherein the superconducting cable (1) has a core with a superconducting conductor (5) and a layer of insulation that surrounds the conductor (5), and wherein the core is arranged in such a way that it can move longitudinally in a cryostat. The conductor (2a) of the terminal structure (2) is electrically connected with the superconducting conductor (5) or with a normal conductor (6) that is connected with the superconducting conductor (5) by means of a tubular part (7) made of an electrically conductive material, wherein the superconducting conductor (5) or the normal conductor (6) can slide in the part (7) in the direction of the superconductor.

ABSTRACT

A terminal structure (2) for a superconducting cable (1) is described. It consists of a conductor (2a) and an insulator (2b) that surrounds the conductor (2a), wherein the superconducting cable (1) has a core with a superconducting conductor (5) and a layer of insulation that surrounds the conductor (5), and wherein the core is arranged in such a way that it can move longitudinally in a cryostat. The conductor (2a) of the terminal structure (2) is electrically connected with the superconducting conductor (5) or with a normal conductor (6) that is connected with the superconducting conductor (5) by means of a tubular part (7) made of an electrically conductive material, wherein the superconducting conductor (5) or the normal conductor (6) can slide in the part (7) in the direction of the superconductor.

TERMINAL STRUCTURE

Field of the Invention:

The invention concerns a terminal structure for a superconducting cable.

Background:

The ends of superconducting cables require devices by means of which current and voltage make the transition from the low temperature of the cable to ambient temperature.

In this regard, a problem arises when the conductor of the superconducting cable, which conductor is arranged inside a cryostat in such a way that it can move freely in the longitudinal direction, contracts during the cooling process to the temperature at which the superconducting material makes the transition to the superconducting state and also when the cable warms up to ambient temperature, and the conductor expands during this process.

EP 1 283 576 A1 describes a terminal structure for a superconducting cable, in which the end of the conductor of the superconducting cable opens in an electrically conductive bushing, which is rigidly connected by a pipe section with the conductor inside the terminal structure.

Objects and Summary of the Invention:

The objective of the invention is to find a solution which, while maintaining

electrical contact, allows movement of the conductor of the superconducting cable or of a normal conductor connected with the end of the superconducting cable.

In accordance with one aspect of the invention, there is provided a terminal structure for a superconducting cable, comprising a conductor and an insulator that surrounds the conductor, the superconducting cable having a core with a superconducting conductor and a layer of insulation that surrounds the superconducting conductor, and the core being arranged within a cryostat in such a way that it can move longitudinally in the same,

- wherein a normal conductor is connected to the superconducting conductor within the terminal structure,
- wherein the conductor of the terminal structure is electrically connected to the normal conductor by means of a tubular part made of an electrically conductive material such that the normal conductor can slide in the tubular part in the direction of the superconducting cable, and

wherein the tubular part has a plurality of radially flexible ribs on any one of its inner surface, its outer surface or both surfaces, such that the inwardly directed ribs rest on the surface of the normal conductor.

An advantage of the inention is that expensive alternative solutions to the problem can be avoided and that it is possible to go back to a commercially available product, namely, the tubular part. Another advantage of the invention is that the tubular part always guarantees contact, even in the case of radial expansion or contraction, due to its flexible ribs.

Brief Description of the Drawings:

The invention is explained in greater detail below with reference to the embodiments schematically illustrated in Figures 1 to 3.

-- Figure 1 shows a lateral section through a system for connecting a

superconducting cable 1 with a terminal structure 2. The superconducting cable 1 is of a type that in itself is already well known and consists of a cable core and a cryostat surrounding the cable core.

-- Figure 2 shows a section through the region of the tubular part 7, which is shown only partly in section.

-- Figure 3 shows a lateral section in the region of the tubular part.

Detailed Description:

The cable core consists of a conductor and a dielectric surrounding the conductor. A superconducting cable of this type is known from WO 2002/015203 A1

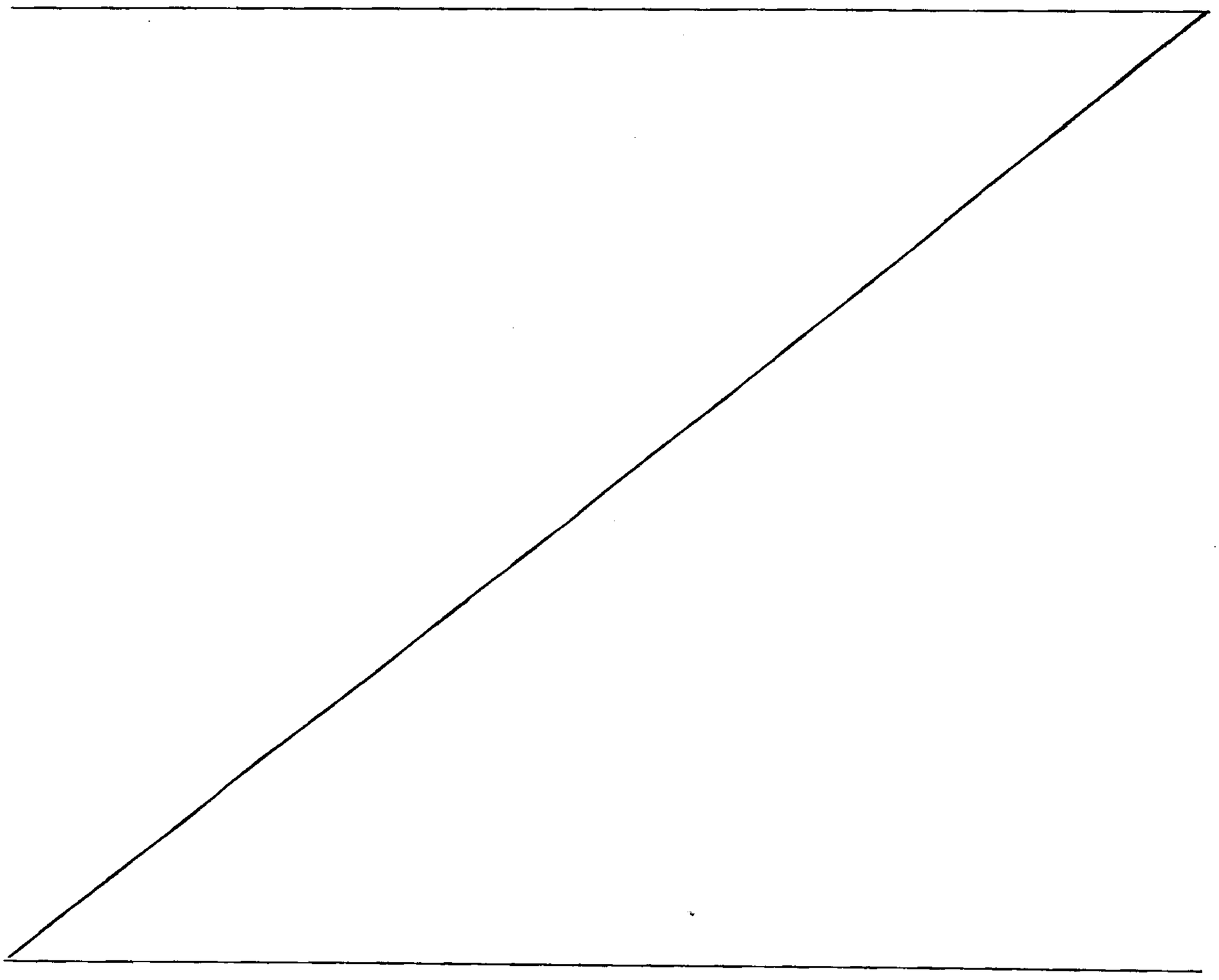
The terminal structure 2 consists of a conductor 2a, an insulator 2b surrounding the conductor 2a, and a field control element 2c. It is advantageous for the interior 2d of the insulator 2b to be filled with insulating oil.

A housing 3, which is evacuated, surrounds the end of the cable and the junction between the conductor 5 of the cable 1 and the conductor 2a. A pipe socket 4, which concentrically surrounds the conductor 2a, is fitted on the housing 3. The pipe socket 4 is designed with two shells 4a and 4b, and the space between the two shells is filled with superinsulation and evacuated. The space between the conductor 2a and the inner shell 4a is filled with an insulating material, preferably a cellular plastic.

An especially advantageous design of a junction between the conductor of the cable and the conductor 2a will now be described.

The layer of insulation, which is not described in further detail, is removed from the end 5a of the superconducting conductor 5, which consists of a central element, e.g., a compressed cable of copper wires, and several strips of superconducting material wound onto the central element. The end 5a of the superconducting conductor 5 is connected with a copper pin or tube 6, e.g., by soldering. The ends of the individual strips of superconducting material are electrically connected with the surface of the tube or pin 6.

A tubular part 7, in whose opening the pin or tube 6 can slide longitudinally, is electrically connected to the lower end of the conductor 2a. The tubular part 7 has a large



number of radially inwardly flexible and/or radially outwardly flexible ribs.

-- Figure 2 shows a section through the region of the tubular part 7, which is shown only partly in section. The tube or pin 6 that is connected with the conductor 5 of the cable 1 is positioned inside the tubular part 7. The tubular part 7 is electrically connected with an adapter 8, which in turn is electrically connected with the conductor 2a. The tubular part 7 can have both inwardly projecting ribs 7a and outwardly projecting ribs 7b, which rest flexibly on the tube or pin 6 in the radially inward direction (ribs 7a) and rest flexibly in the drill hole of the adapter 8 in the radially outward direction (ribs 7b). The ribs 7a and 7b provide for constant contact between the tube or pin 6 and the adapter 8 even during a displacement of the tube or pin 6 in the longitudinal direction of the cable 1. The ribs 7a and 7b also absorb a radial dilation or contraction when the cable is taken out of operation or put into operation, i.e., when the cooling of the cable is switched off or switched on. It is advantageous for the tubular part 7 to be made of copper and for its surface to be coated with a thin layer of silver.

-- Figure 3 shows a lateral section in the region of the tubular part.

The tubular part 7 is fixed in the adapter. In this embodiment, the tubular part 7 has only inwardly projecting ribs 7a, which ensure electrical contact between the pin or the tube 6 and the tubular part 7 and thus an electrically conductive connection with the adapter 8 and the conductor 2a, including during the warming and cooling phase of the cable 1, during which the tube or pin 6 slides in the tubular part 7.

WHAT IS CLAIMED IS:

1. Terminal structure for a superconducting cable, comprising a conductor and an insulator that surrounds the conductor, the superconducting cable having a core with a superconducting conductor and a layer of insulation that surrounds the superconducting conductor, and the core being arranged within a cryostat in such a way that it can move longitudinally in the same,
   - wherein a normal conductor is connected to the superconducting conductor within the terminal structure,
   - wherein the conductor of the terminal structure is electrically connected to the normal conductor by means of a tubular part made of an electrically conductive material such that the normal conductor can slide in the tubular part in the direction of the superconducting cable, and
   - wherein the tubular part has a plurality of radially flexible ribs on any one of its inner surface, its outer surface or both surfaces, such that the inwardly directed ribs rest on the surface of the normal conductor.

2. Terminal structure according to claim 1, wherein the normal conductor is a tube or a pin.

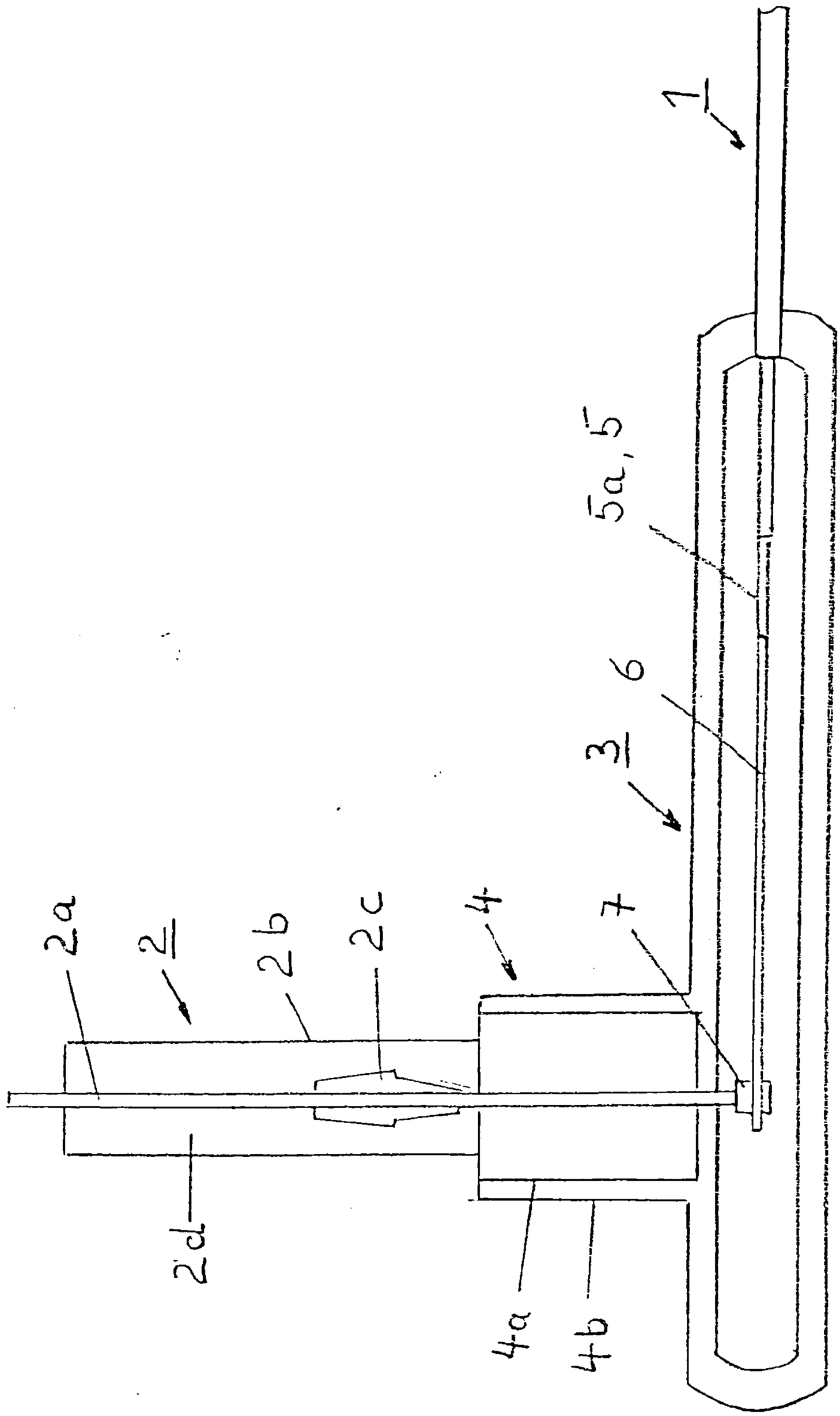


Fig 1

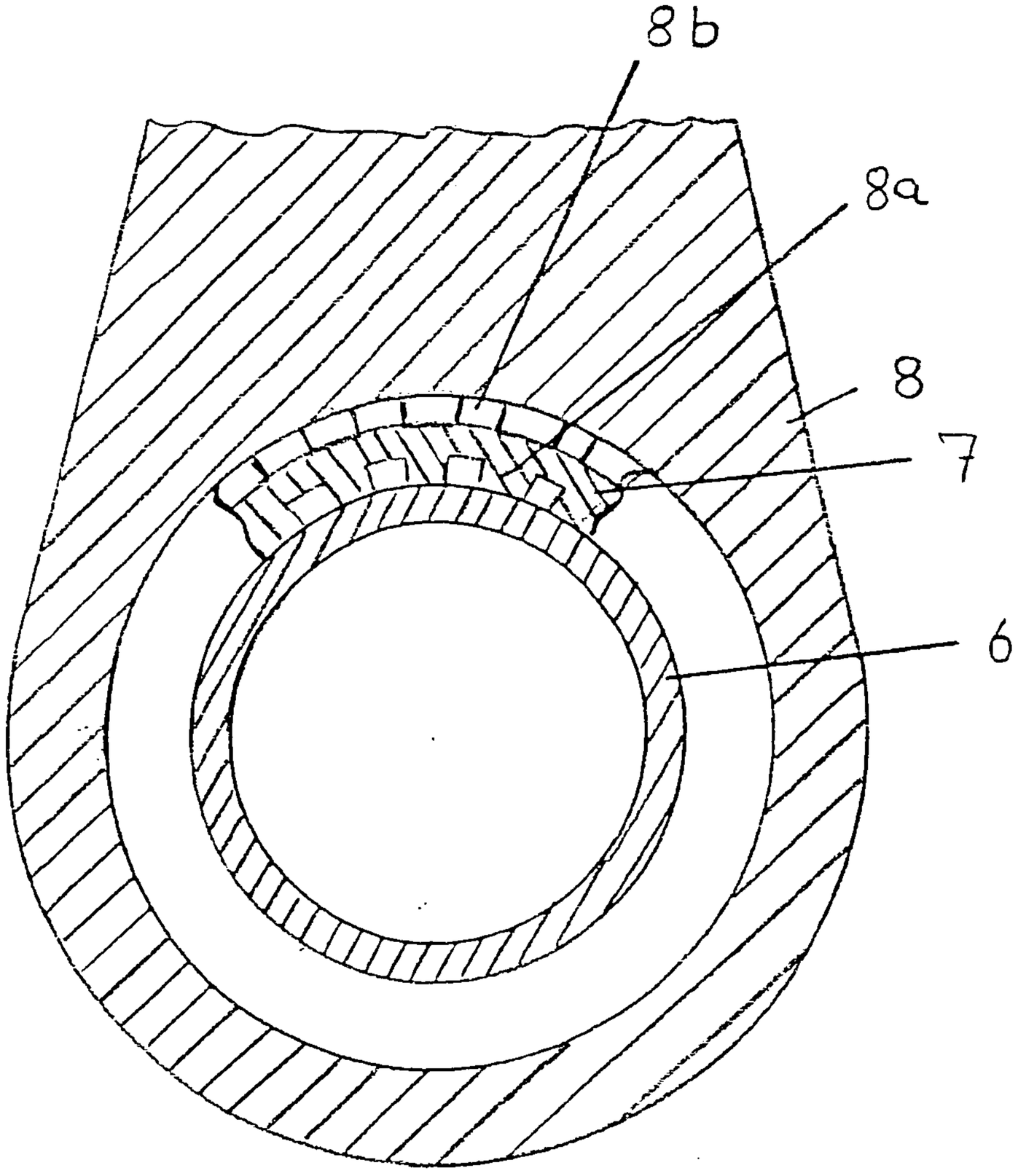


Fig 2

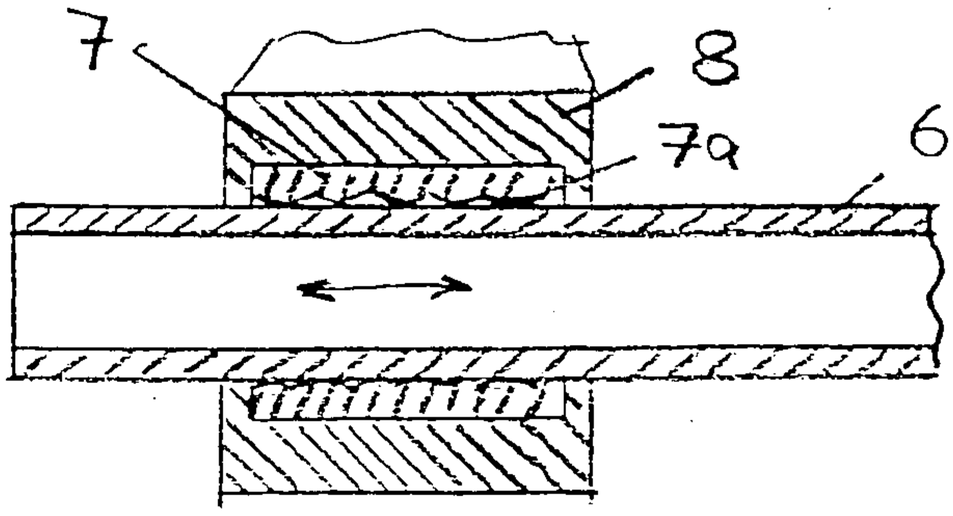
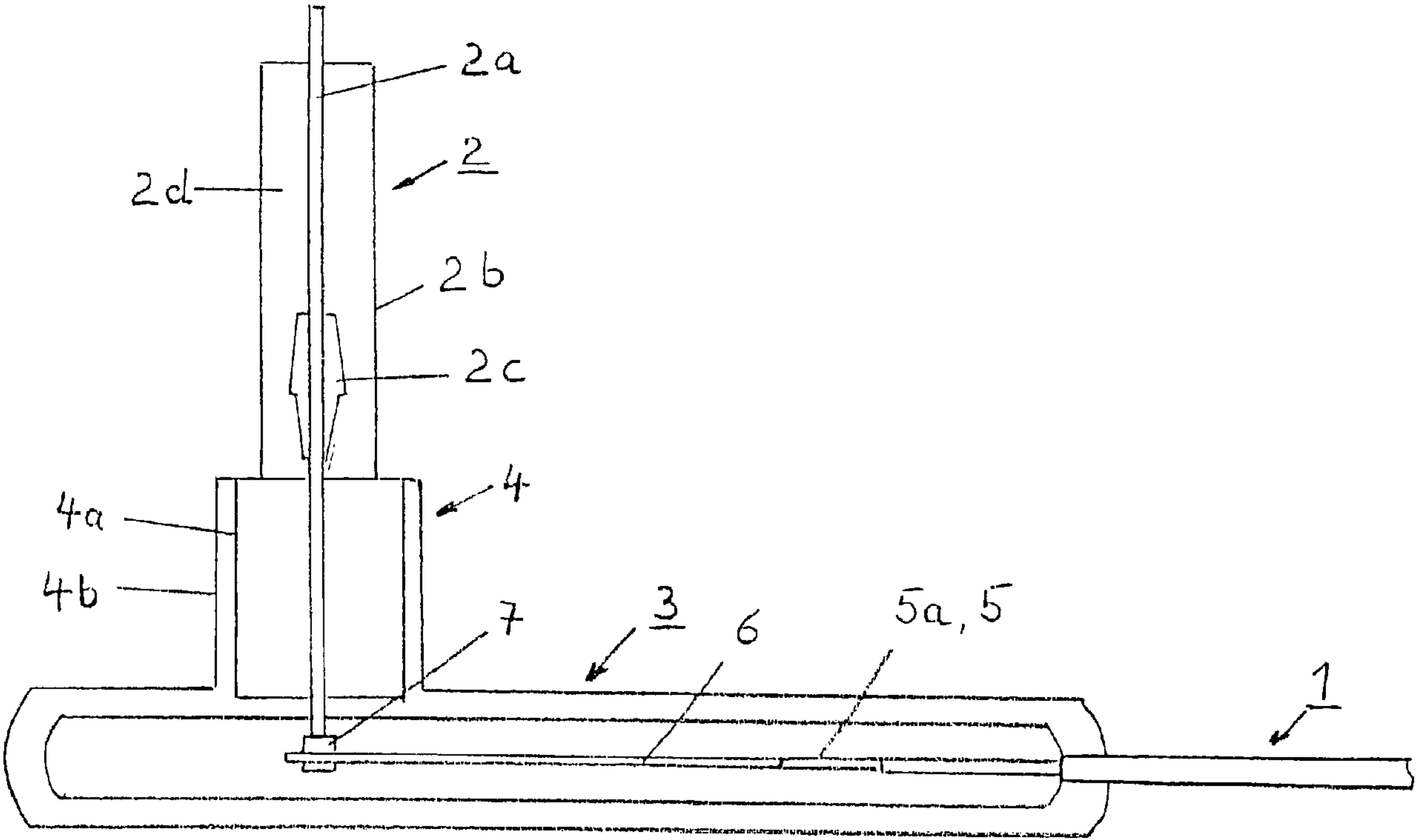


Fig 3


2a
2
2d
2b
2c
4
4a
4b
7
3
6
5a, 5
1