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HIGH VOLTAGE REED SWITCH RELAY		ממסר REED SWITCH למתח גבוה

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*** Conditions of the Patent as in attachment**

*** תנאי הפטנט ראה כמצורף**

HIGH VOLTAGE REED SWITCH RELAY

This invention relates to electric engineering and more particularly to reed switch relay with high voltage insulation used between the control winding and reed switch and can be used in systems for control, signaling and current protection of high voltage electric power installations in powerful electronic and electrophysical equipment.

Various reed switch relays with high voltage protection containing comprizing coaxially and permanently located reed switch, control coil and high voltage insulator inserted between them, whose free spaces are filled with epoxy compound formed as:

- vacuum cylinder shaped camera with a partition located in its center [1];
- long cylinder made from a dielectric material with a blind axial channel with reed switch inside a non-magnetic metal ample inserted into it, and the cylinder edge holding the reed switch inserted to the control coil [2].

The limitation of these devices is the unadjustable (uncontrolled) threshold of the reed relay response (activation), which is very important for the use as current relays in high voltage electric installations.

A well-known high voltage reed switch relay with controlled activation threshold comprizes a control coil and the reed switch permanently fixed relatively to each other, and a mobile permanent magnet threaded into the face side of the insulator which generates a adjustable magnetizing filed in the reed switch area [3]. The limitation of this device is its operation instability and the likeliness for reed switch sticking at the ambient temperature change.

In another well-known reed switch relay a fixed insulator comprizing a coil pressed into it and a mobile insulator formed as an elongated cylinder with a blind axial channel with a reed switch mounted in it. This cylinder is axially threaded into the inner space of the fixed insulator. Upon threading the mobile insulator with reed switch in and out its distance to the control winding and consequently the activation threshold are changed [4]. The drawback of this device is a rather big air space inside the high voltage construction which leads to an arc generation even at relatively low voltages and to considerable drop of allowed working voltage of the relay.

As a prototype a high voltage reed switch relay has been used that comprizes two high voltage insulators: a mobile and a fixed one formed as coaxial cylinders I which the free space is filled with an epoxy compound and the magnetomotive force (mmf) is formed with two rectangular coils on a common Π-shaped ferromagnetic core whose poles are located in the same plane. The short sides of the coils are adjacent to each other and are located by fixed insulator side. The mobile insulator is formed with two hollow eccentric channels which are located from two opposite sides of the insulator longitudinal axis, with the reed switch located in one of them and ferromagnetic shunt in the other one. The reed switch and the winding outputs are formed with a wire wrapped around with high voltage insulator. In this device the activation threshold is adjusted by turning the mobile insulator inside the fixed one. Moreover, because the eccentricity the reed switch is removed from the coils and replaced by a shunt formed as a ferromagnetic plate [5]. The drawback of this device is the air space between the mobile and the fixed insulators (i.e. inside the high voltage structure), which leads to substantial drop of the working voltage, and the inadequacy of the device for heavy-current circuits with currents of hundreds of Amp (power energy objects) because of limited cross-sections of winding wires of coils and connecting conductors in high voltage insulation.

The object of this invention is to extend the possible uses of the device by increasing the allowed working voltage and making it usable in heavy- current circuits with currents of about hundreds of Amp.

To attain the above object of the invention in the high voltage reed switch relay with adjustable activation threshold which comprizes a high voltage insulator, whose free space is filled with epoxy compound and the outputs from the inner space are formed with a wire wrapped with high voltage insulator, and a source of magnetomotive force (mmf) and a reed switch, the high voltage insulator is formed as a cylinder shaped glass made from high temperature dialectic with low coefficient of temperature expansion and good adhesion to epoxy compounds, such as radio frequency ceramic, with a flange protruding beyond its diameter at the bottom, and designated for full relay working voltage, with the mmf source and reed switch positioned from the both sides (inner and outer) of the mentioned glass bottom, while the glass surface at the bottom area is metallized from both sides and its inner surface shaped as semi half-sphere and the outer

one- as a plane, with external fixing elements positioned on the flanges and the said outputs from the inner space of high voltage insulator pass through an additional high-voltage insulator formed as a part of a thick-wall pipe with finned outer surface which protrudes beyond the glass through the central hole in dielectric cover over the glass.

Further, the device can be provided with an additional glass shaped body which is not a high voltage insulator, and flange protruding beyond the diameter at the edge, whose flange is fastened to the high voltage insulator flange.

Further, the mmf source in the device can be formed as two rectangular or oval coils mounted close to each other with their longer to short side ratio about 2:1 and provided with П-shaped ferro-magnetic core with poles pointing to the bottom of the high voltage insulator.

Further, coils with П-shaped ferro-magnetic core can be mounted at the inner side of the high voltage insulator bottom and connected to the outputs in the high voltage insulation, and yet the reed switch - in the additional glass shaped body, which is not a high voltage insulator provided with an element for reed switch turning at an angle of about 90°, as well as an element used to fixed its position.

Further, the reed switch position fixation element comprises a disk formed with a threaded side surface matching the threads on the inner surface of the extended additional glass shaped body and a hole in the center used to convey the mentioned additional insulator of the reed output.

Further, an additional miniature winding can be winded on the said reed switch which is connected to the stabilized signal source of the external control system.

Further, the reed switch outputs are conveyed through a tube-shaped additional insulator extending beyond the body of the reed switch rotation element, whose inner end grades into an oval plate coating the reed switch with a conducting outside coating.

Further, the coils with П-shaped ferromagnetic core can be mounted from the outside of the high voltage insulator bottom of the said body which is not a high voltage insulator, in which an element for turning coils with core at an angle of about 90° around

their common symmetry axis, perpendicular to the high voltage insulator bottom plane, element for their fixing in place, moreover the reed switch is positioned at the inner side thereof with its longitudinal axis parallel to the bottom plane and its electrodes connected to the outputs of high voltage insulation.

Further, when high voltage carrying bus used as a source of mmf, the external fixing element of the relay can be formed as cylindrical bowl with threaded internal surface and a flange protruding beyond the bus edged at the bottom at the outer surface, which made as saddle, dressed on bus and which is used for its permanent fixing on the bus with its conducting plated inside and outside surface bottom, and the dielectric glass bottom is inserted into this bowl so that its flange is forced into the bowl by a dielectric ring formed with external thread screwed.

Further, the lower layer of epoxy compound which fills the dielectric glass with the reed switch to the level of the glass inside surface plating is made conducting, say, on the expense of copper powder added to epoxy compound to the extent of about 50 - 60 % of its volume.

Further, in the inner space of high voltage insulator with a reed switch, controlled from the mmf source formed as a current-carrying bus, in addition an electron converter of reed switch signals, which vibrates with frequency twice as that of the mmf source field to other type signals can be built-in.

Attaining the set up object regarding the increase of working voltage is enabled even though the two parts in the structure move one relative to the other (similarly to the prototype) the entire working voltage is applied only to one high voltage insulator (rather than to two as in the prototype), which does not have air spaces. Moreover, the offered design of the high voltage insulator enables to preserve the device volume and at the same time to increase the radius of the curvature of the parts with different potentials in comparison with the prototype, which allows for essential decrease of the electric field intensity in the relay.

Attaining the set up object regarding the use of the device in heavy current circuits was enabled for the same high voltage insulator can be installed directly on the

current-carrying bus with currents reaching hundreds of Amp. There is no such an option in the prototype.

Hence, the offered technical solution enables to design an universal high voltage reed switch relay with a small number of elements.

Fig. 1 shows a design of high voltage reed switch relay with mmf source formed as a coil designated for low current circuits with activation current ranging from fraction of amperes to several tens of amperes.

Fig. 2 shows a design of high voltage reed switch relay with mmf source formed as a bus designated for heavy current circuits with activation currents of hundreds of amperes.

Fig. 3 shows a design of coils with a ferromagnetic Π-shaped core.

High voltage reed switch relay for low current circuits (Fig.1) comprizes high voltage insulator 1 formed as a cylinder-shaped glass with the bottom smoothly changing into walls made from a high temperature dielectric with low coefficient of linear extension and good adhesion to epoxy compounds, for example radio frequency ceramic; control winding 2 with ferromagnetic Π-shaped core 3; reed switch 4; outputs 5 from the inner part of the insulator formed as a wire wrapped into a high voltage insulator; additional high voltage insulator 6 formed as a part of a pipe with finned outer surface; epoxy compound 7 filling the entire free space inside the high voltage insulator; cover 8; fastening flanges 9; additional cylinder shaped body 10 which is not a high voltage insulator whose flange is fastened to flange 9 of high voltage insulator (this element 10 also can be formed as an additional thin walled dielectric glass with grading into the bottom and mating with the inner surface of cylinder-shaped glass 1 and conducting platted inside surface), additional dielectric glass 12 with conducting platted outside surface 11 (element 11 can be also conductive grease). Reed switch outputs 13 are conveyed through additional insulator 14 formed as a tube extending beyond reed rotation element body 12. The lower end of this tube is graded into oval plate 15 covering

the reed formed with conducting external coating. Additional wire 16 is connecting this conducting coating to external grounding circuit. The reed switch position fixation element is formed as disk 17 with threaded side surface and a central hole with insulator 14 conveyed through it. External attachment of the device is effected with dielectric nut 18. Lower layer 19 of epoxy compound filling the main insulator to the control winding is executed conducting as by adding copper powder (60-70% of the volume). The rest of the filling compound 7 has been made dielectric. Element 12 is filled with the same dielectric epoxy compound 20.

Reed switch 4 fixed with its fixed outputs on supports 14 while the free space in which it is installed is filled with epoxy compound 20.

Winding 2 can be formed as two rectangular or oval coils located close to each other with their longer to short side ratio equal to about 2:1. For such ratio between the sides the total cross-section of the winding is square-shaped, inscribed into a round cross-section of high voltage insulator. This allows for the best matching of insulating and volume parameters of the insulator (semi-spherical bottom) with energy parameters of magnetic system (maximal cross-section area and minimal length of a winding loop).

When a device for transmission of control commands from earth potential to executive elements subjected to high voltage is used (for example in electro-physical equipment), reed switch 4 with elements 14, 15 is mounted inside high voltage insulator 1, coils 2 with core 3 - is mounted in element 12.

In high voltage relay option designated for mounting on current carrying bus 21 the elements arrangement is similar, Fig. 2. Insulator 1 is fixed in bowl 22 with dielectric nut (ring) 23. Bowl 21 with saddle 24 fastened on bus 21 by non ferromagnetic plate 25 and screw 25.

In one of the versions of the device design, a PCB 27 of electron converter of reed switch signals that vibrate at activation with double frequency of the mmf source to different type signals can be used instead packing gasket 15. For example, an impulses extender yielding “step” type signals upon reed switch activation can be used; or a timer providing time delay required in accordance with selectivity conditions.

The device operation is based on the action of magnetic field from mmf source (winding or bus), that threats the bottom of high voltage insulator 1, on reed switch 4. When the reed switch threshold magnetic flux value is attained the last is activated and effects switching in the external circuits of the equipment. The reed switch activation threshold is controlled by changing its position in the space relative to the mmf source.

This change is effected either by turning element 12 (with reed switch 4) at an angle of up to 90° relatively to the poles of the fixed winding located inside the high voltage insulator (Fig.1), or by turning the winding (located in similar element 12) relatively to fixed reed switch mounted in the high voltage insulator, or by turning the high voltage insulator together with reed switch relatively to the longitudinal axis of the bus (Fig. 2). The fixation of the location of the mobile part of the design relative to the fixed one is effected by their forcing one against the other with coupling elements 17 (Fig. 1) or 23 (Fig. 2).

INFORMATION SOURCES

1. USSR Inventor's license # 836704, H01H51/28, 1981
2. USSR Inventor's license # 1101920, H01H51/28, 1984
3. USSR Inventor's license # 1130916, H01H51/28, 1984
4. Gurevich V. I., Yakovlev A. I. reed switches with controlled activation threshold - Electric engineering industry, series "High voltage apparatus, transformers, power condensers", Moscow, 1984, edit. 9 (155), p. 4 - 5
5. USSR Inventor's license # 1379827, H01H51/28, 1987

What is claimed is:

1. High voltage reed switch relay with adjustable (controlled) response (activation), is constructed to comprize high voltage insulator, whose free space is filled with epoxy compound and the outputs from the inner space are formed as a wire wrapped in high voltage insulation and a source of magnetomotive force (mmf) and reed switch **distinguished by that** the high voltage insulator is formed as a cylinder shaped glass made from high temperature dielectric with low coefficient of temperature expansion and strong adhesion to epoxy compounds, for example radio frequency ceramic with a flange protruding beyond the diameter of thereof by the bottom and designated for full working voltage of the relay, and the mmf source and reed switch located from the both sides (outer and inner) of the said glass bottom, moreover the glass surface in its bottom area is coated from its both sides with a layer of electric conducting material, for example metiallzed and is semi-spherical form the inner side, and flat form outside, external relay fastening elements are located on the flanges with said outputs in the inner space of high voltage insulator are passed through an additional high voltage insulator formed as a piece of thick-wall pipe with finned outer surface which protrudes beyond the glass through the central hole in dielectric cover covering the glass.

2. High voltage reed switch relay according to claim 1, **distinguished by that** it is provided with an additional glass shaped body which is not a high voltage insulator, and flange protruding beyond the diameter at the edge, whose flange is fastened to the high voltage insulator flange.

3. High voltage reed switch relay according to claims 1 and 2 **distinguished by that** the mmf source in the device can be formed of two rectangular or oval coils mounted close to each other with their longer their longer to short side ratio about 2:1 and provided with П-shaped ferro-magnetic core with poles pointing to the bottom of the high voltage insulator.

4. High voltage reed switch relay according to claims 1, 2 and 3 **distinguished by that** the coils with Π-shaped ferro-magnetic core can be mounted at the inner side of the high voltage insulator bottom and connected to the outputs in the high voltage insulation, and yet the reed switch - in the additional glass shaped body, which is not a high voltage insulator provided with an element for reed switch turning at an angle of about 90°, as well as an element used to fixed its position.

5. High voltage reed switch relay according to claims 1, 2, 3 and 4 **distinguished by that** the reed switch position fixation element comprises a disk formed with a threaded side surface matching the threads on the inner surface of the extended additional glass shaped body and a hole in the center used to convey the mentioned additional insulator of the reed output.

6. High voltage reed switch relay according to claims 1, 2, 3, 4 and 5 **distinguished by that** the additional miniature winding can be winded on the said reed switch which is connected to the stabilized signal source of the external control system.

7. High voltage reed switch relay according to claims 1, 2, 3, 4 and 5 **distinguished by that** reed switch reed switch outputs are conveyed through a tube-shaped additional insulator extending beyond the body of the reed switch rotation element, whose inner end grades into an oval plate coating the reed switch with a conducting outside coating.

8. High voltage reed switch relay according to claim 1, **distinguished by that** coils with Π-shaped ferromagnetic core can be mounted from the outside of the high voltage insulator bottom of the said body which is not a high voltage insulator, in which an element for turning coils with core at an angle of about 90° around their common symmetry axis, perpendicular to the high voltage insulator bottom plane, element for their fixing in place, moreover the reed switch is positioned at the inner side

there of with its longitudinal axis parallel to the bottom plane and its electrodes connected to the outputs of high voltage insulation.

9. High voltage reed switch relay according to claims 1 and 8, **distinguished by that** when high voltage carrying bus used as a source of mmf, the external fixing element of the relay can be formed as cylindrical bowl with threaded internal surface and a flange protruding beyond the bus edged at the bottom at the outer surface, which made as saddle, dressed on bus and which is used for its permanent fixing on the bus with its conducting plated inside and outside surface bottom, and the dielectric glass bottom is inserted into this bowl so that its flange is forced into the bowl by a dielectric ring formed with external thread screwed.

10. High voltage reed switch relay according to claims 1 and 9, **distinguished by that** the lower layer of epoxy compound which fills the dielectric glass with the reed switch to the level of the glass inside surface plating is made conducting, say, on the expense of copper powder added to epoxy compound to the extent of about 50 - 60 % of its volume.

11. High voltage reed switch relay according to claims 1 and 9, **distinguished by that** in the inner space of high voltage insulator with a reed switch, controlled from the mmf source formed as a current-carrying bus, in addition an electron converter of reed switch signals, which vibrates with frequency twice as that of the mmf source field to other type signals can be built-in.

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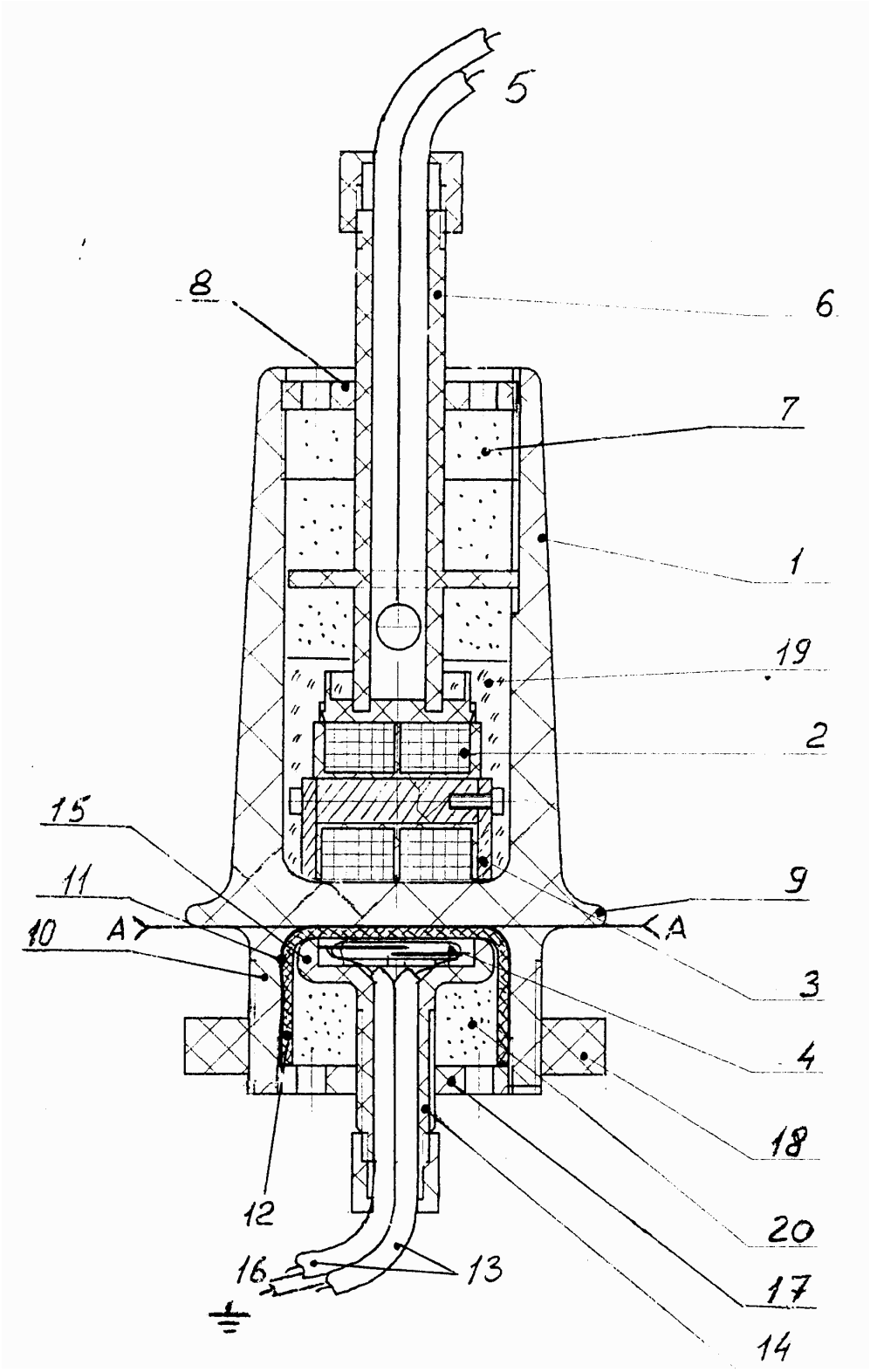
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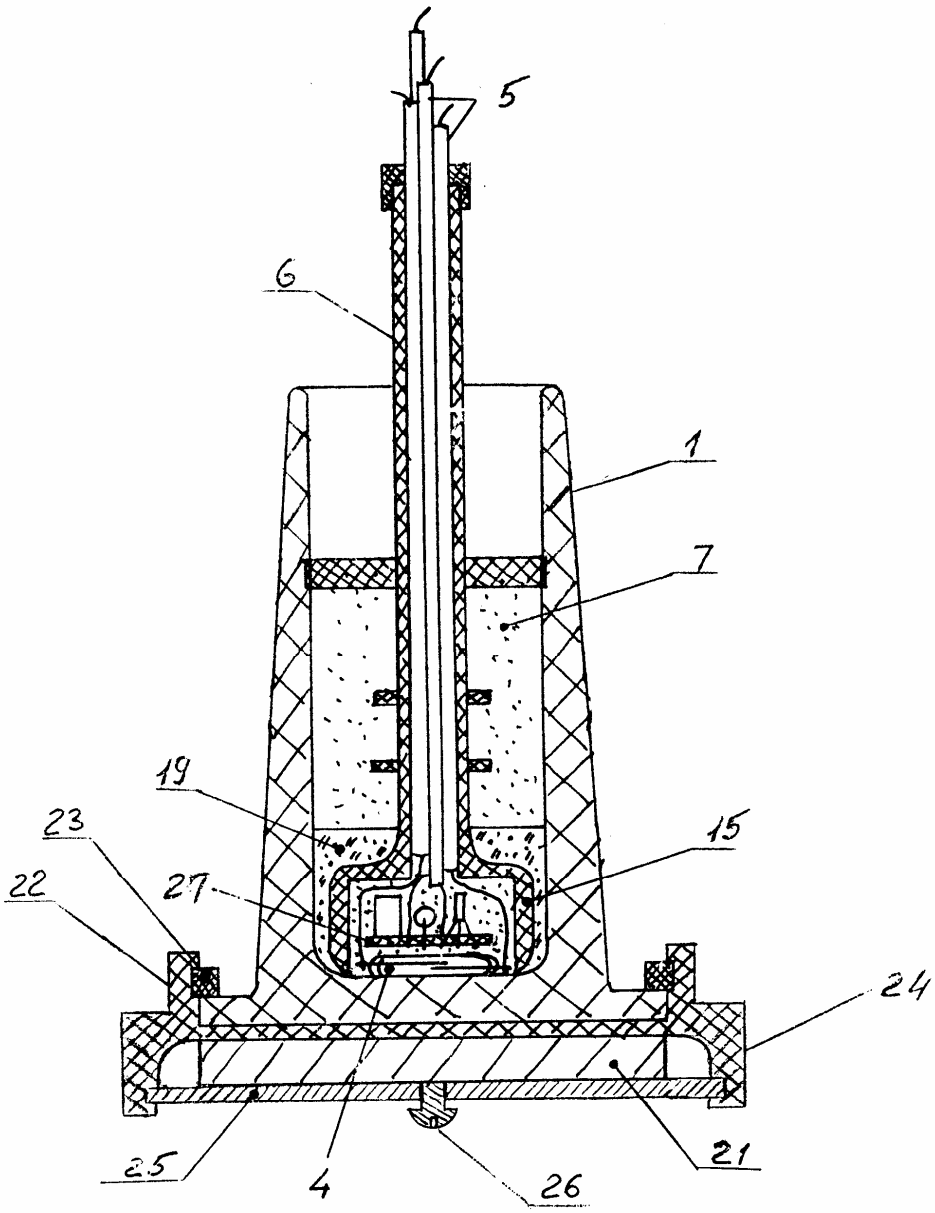

Fig. 2.