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(54) **Rotary switch-disconnector**

(57) The subject of the invention is a rotary switch-disconnector with a double, serial clearance during the disconnection of electric contacts. A rotary switch-disconnector comprises a rotary shaft (1) with at least one bushing (2) with main movable contacts (12) and movable arcing contacts (13), located at the ends of the body (10) of the bushing (2). The frame (3) has attached to it at least one pair of piston insulators (6) containing main fixed contacts (14) placed on the line of revolution of the main movable contacts (12), and fixed arcing contacts (16). Each piston insulator (6) contains a cylinder (7) with a piston (8) which through a tension member (9) is connected in an articulated way with the body (10) of the bushing (2) in a way ensuring a simultaneous movement of the pistons (8) in the cylinders (7) with the revolution of the shaft (1). The inventive switch-disconnector is characterized in that the piston insulator (6) has attached to it a blow-out nozzle (17) comprising a blending chamber (19), a central channel (20) and at least one side channel (22) used to supply and swirl air in the blending chamber (19) when the switch-disconnector is being opened, which chamber is so situated in relation to the piston insulator (6) that the inlet(s) (W1) of the sides channels (22) is(are) connected with the outlet(s) (W3) of internal channels (23) which are connected with the inner surface of the cylinder (7) and are located outside the limits of the inlet (W4) of the movable arcing contact receiving channel (18) which is made in the piston insulator (6).

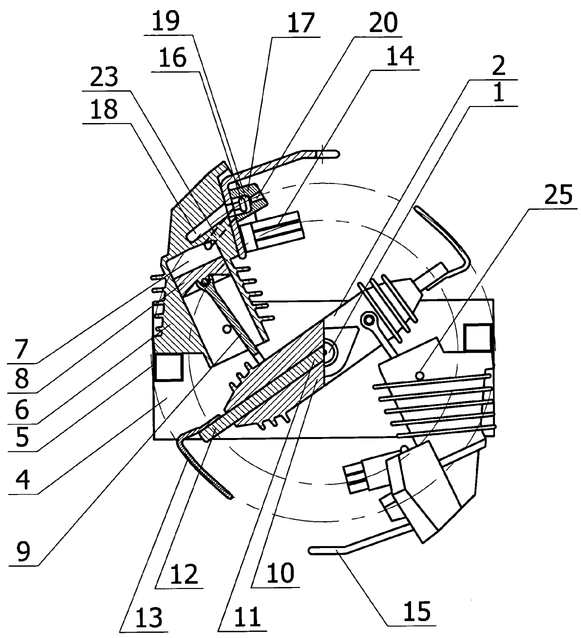

Fig. 2

Description

[0001] The subject of the invention is a rotary swich-disconnector with a double, serial clearance during the disconnection of the electric contacts, intended for multiple switching of currents in single-phase or three-phase electric circuits that are in a working status, and also for occasional, emergency connection of single-phase or three-phase electric circuits that are in a fault condition.

[0002] A rotary section switch-disconnector is known from the description of the Italian utility model nr ITM120000019 and from the catalogue of Italian company IMEQUADRI DUESTELLE SPA which manufactures it. The switch-disconnector is designed for disconnecting electric contacts. The switch-disconnector contains a frame in which a uniform body is rotationally fixed, the body containing three bushings spaced evenly and perpendicularly to the axis of rotation, each being intended for a single supply phase. At the same time, the axis of rotation of the insulator block divides individual bushings into two symmetrically arranged parts. At the ends of each of these parts there are movable electric contacts whose active parts are oriented according to the sense of rotation of the bushings. The switch-disconnector contains two rows of piston insulators fixed to the support frame on its opposite, upper and lower, sides, at intervals compatible with the arrangement of the bushings. The piston insulators contain a cylinder open on one side with a piston sliding inside the cylinder. The piston takes the lower position in the cylinder in the closed position of the switch-disconnector, and it takes the upper position in the open position of the switch-disconnector. A piston insulator forms a support for the fixed electric contacts which are secured to the piston insulator in its upper part. The fixed electric contacts function together with the movable electric contacts. The contact between the movable and fixed contact members occurs as a result of the revolution of the bushing body around its axis of rotation situated in the external frame, during closing. The pistons are coupled with the bushings, one pair of pistons and one bushing, so that during the revolution of the body, during switching-on of the contact, the movement of the piston inside the cylinder causes suction of air into the cylinder. Then, while the contact is being opened, the movement of the pistons causes compression of air and its blow-out in the zone where the electric arc is burning. The pistons are activated by means of the revolving body with the bushings and they are operationally coupled with the bushings in such way that each bushing is coupled with one pair of pistons arranged at the opposite sides of the revolving body. Additionally, in the presented solution, the piston is fitted with small valves which close in the phase of the disconnection of the electric contacts and open in the phase of the connection of the contacts. In practice, each small valve comprises a neoprene diaphragm which is fixed in openings drilled in the piston in such way that during the contact-disconnecting movement, the diaphragm presses against the piston openings causing them to close, and during the contact-connecting movement, air pressure strives to move away the diaphragm, uncovering the openings in the piston and eliminating the additional resistance of the pistons whose effect is lower connecting speed. Each piston insulator is provided with an air flow channel from the cylinder to the area where the arc burns, the main contact member responsible for conducting current in the closed state, and the auxiliary contact member, so called arcing contact through which current flows in arc condition. The shape of the air flow channel is selected to facilitate quenching of the arc forming when the switch-disconnector contacts are being disconnected. The placement of small neoprene valves in the pistons is effective in the case of a new switch-disconnector. In operating conditions, however, due to unfavorable environmental conditions, such as intensive dustiness or humidity, there is a significant risk that the resistance to the motion of the valves will increase, or even that they will be completely blocked. Blocking of the valves in the closed position will cause increased resistance to motion during opening of the contacts, which will result in a lower closing speed of the movable contacts and will worsen the fault current connecting parameters. Blocking of the valves in the open position will result in the worsening or loss of the ability to cut off the work currents of the switch-disconnector. In the rotary switch-disconnectors shown in IMEQUADRI DESTELLE SPA catalogue, current is connected or disconnected by means of arcing contacts. When using arcing contacts for connecting fault currents, just before the arcing contacts meet, a high-energy arc is initiated which burns also in the outlet channel of the insulator. This results in a pressure surge in the outlet channel and in the part joining the outlet channel with the cylinder, and also in the cylinder in which the piston moves. In the whole system, the piston, because of its cross area and delicate design, is subject to large loads. When the allowable pressure is exceeded, the piston and its elements get damaged and thus the switch-disconnector loses its ability to operate. In order to avoid unnecessary damage to the switch-disconnector, the use of an improved system of decompression in the cylinder is necessary. The maximum value of the pressure occurring in the cylinder of the piston insulator depends on many parameters, and among other, on the value of the short-circuit making currrent. The higher is the value of the fault current, the higher is the value of the pressure in the piston cylinder and the higher is the probability that the small valves in the piston get damaged. With earlier known designs of rotary switch-disconnectors it is not possible to obtain a connection making fault current of maximum values higher than 50 kA for the voltage of 12 kV and 40 kA for the voltage of 24 kV. Therefore there is a need to find another way of decompression in the piston insulators of a rotary switch-disconnector.

[0003] A solution, where the problem of excessive pressure in the piston cylinder of a high-voltage switch-disconnector was solved by making longitudinal grooves on the inner surface of the piston insulator, which form a gap between the surface of the piston and the cylinder, is known from Polish patent description No. 147271. The length of the grooves in the cylinder is such that the piston reaches the cylindrical grooveless surface at the moment of the switch's contacts separation. In the case of the closed position of the switch-disconnector when the surface of the pistons touches the surface of the cylinder in the place where the longitudinal grooves are situated, deformations of the side surface of the pistons can occur after a longer period of the switch-disconnector operation and, as a consequence, the operating conditions of the switch-disconnector can get worse. Additionally, when the switch-disconnector is switched on, a stream of post-arc gases flows along the insulator axis and if there is a larger number of longitudinal grooves in the piston insulator, the dielectric resistance of the insulator can be reduced, which may result in a breakdown between the frame to which the piston insulators are attached and the contacts of the switch-disconnector, and a earth fault may occur. For the proper reduction in the pressure rise in the piston cylinder the cross-section of the groove or grooves through which air is evacuated outside the cylinder should be large enough, which, in the case of the solution known from the Polish patent description No. 147271 may cause disturbance in the proper operation of the piston.

The inventive switch-disconnector presented in claims 1 through 12 does not have the above mentioned disadvantages or inconveniences.

[0004] The rotary switch-disconnector contains a rotary shaft with at least one bushing with movable main contacts and movable arcing contacts. The rotary shaft is fixed rotationally inside an immovable support frame to which there is fixed at least one pair of piston insulators containing fixed main contacts placed in the line of revolution of the movable main contacts and fixed arcing contacts. Each piston insulator contains a cylinder with a piston which is connected in an articulated way with the body of the bushing by means of a tension member in a way ensuring a simultaneous travel of the pistons in the cylinders of each pair of piston insulators together with the revolution of the shaft, which generates a blow of air flowing from the cylinders when the switch-disconnector is being opened thus cooling the electric arc produced during the opening of the switch-disconnector. The essential feature of the rotary switch-disconnector according to the invention is that the piston insulator has a blow-out nozzle connected to it, which nozzle contains a blending chamber, a central channel and at least one side channel used to supply and swirl air in the blending chamber while opening the switch-disconnector, and which is so situated with relation to the piston insulator that the inlet or inlets of the side channels of the nozzle is or are connected with the outlet or outlets of the internal channels of the piston insulator which are connected with the inner surface of the cylinder and are outside the limits of the inlet of the channel receiving the movable arcing contact made in the piston insulator.

[0005] Preferably the channel receiving the movable arcing contact is made in the form of a channel closed at one end.

[0006] Preferably, the blow-out nozzle contains two side channels which are arranged non-axially in relation to each other, and their inlets are situated on the opposite sides of the blending chamber.

[0007] Preferably, in the wall of the piston insulator cylinder there is at least one decompression opening to reduce excessive pressure inside the cylinder at the moment when the piston moves towards the longitudinal beam of the support frame while making under the earth faults condition.

[0008] Preferably, the decompression opening is situated in the cylinder perpendicularly to the longitudinal axis of the cylinder.

[0009] Preferably, the combined minimum cross-section of the decompression openings is 100 mm^2.

[0010] Preferably, on the inner side of the cylinder there is a single unwater channel situated to ensure gravitational drainage of water collected inside the cylinder.

[0011] Preferably, the unwater channel is situated parallel to the longitudinal axis of the cylinder.

[0012] Preferably, the unwater channel is located near the base of the piston insulator cylinder.

[0013] Preferably, the blow-out nozzle is made of a material gassing on exposure to high temperature.

[0014] Preferably, in the blow-out nozzle there is a fixed arcing contact electrically connected with a terminal fixed to the piston insulator.

[0015] Preferably, three bushings are fixed in series to the rotary shaft, and three pairs of piston insulators are fixed to the support frame, separately for each phase of the three-phase power supply of the switch-disconnector, each pair of piston insulators functioning together with only one bushing.

[0016] In the inventive switch-disconnector, the side channel or channels are arranged in the blow-out nozzle in such way that air compressed in the cylinders of the piston insulators is supplied to the blending chamber of the nozzle directly into the space in which the arc burns, omitting the channel which receives the arcing contact and omitting the immediate surroundings of the fixed arcing contacts.

[0017] The rotary switch-disconnector as per the invention is presented as an embodiment in the drawing, where:

fig. 1 - shows schematically the switch-disconnector fixed in the support frame, top view,

fig. 2 - the switch-disconnector in half view and in half section in the open position, without showing the front wall of the support frame,

fig. 3 - the switch-disconnector in half view and in half section in the closed position, without showing the front wall of the support frame,

fig. 4 - the piston insulator in cross-section shown in

the plane of revolution of the bushing,

fig. 5 - the piston insulator with two internal channels, in cross-section shown in a plane perpendicular to the plane of rotation of the bushing,

fig.6 - the piston insulator with two internal channels, in front view,

fig. 7 - the blow-out nozzle in perspective projection,

fig. 8 - the blow-out nozzle in a view from the side where it is fixed to the piston insulator in the first embodiment of the invention with one side channel,

fig. 9 - the nozzle from fig. 8 in A-A section,

fig. 10 - the blow-out nozzle in a view from the side where it is fixed to the piston insulator in the second embodiment of the invention with two side channels,

fig. 11 - the nozzle from fig. 10 in B-B section,

fig. 12 - the blow-out nozzle with the terminal in a side view,

fig. 13 - the blow-out nozzle with the terminal from fig. 12 in a cross-section along line C-C, showing the fixed arcing contact of the switch-disconnector.

[0018] The rotary switch-disconnector for a three-phase power supply circuit, presented schematically in fig. 1, contains a rotary shaft 1 with bushings 2 arranged in one row with equal spaces between them. The shaft 1 is fixed rotationally in a support frame 3 to its transverse walls 4 which are connected with one another by longitudinal beams 5.

[0019] Piston insulators 6 are fixed to the longitudinal beams 5 in pairs in such way that one of the piston insulators is fixed to one of the longitudinal beams 5, and the other insulator of each insulator pair is fixed to the other longitudinal beam 5, and the piston insulators of each pair are turned in relation to each other by an angle of 180° in the plane of revolution of the bushing 2.

[0020] Each piston insulator 6 contains a hollow piston cylinder 7 in which there is a piston 8 which by means of a tension member 9 is connected in an articulated way with the body 10 of the bushing 2 in a way ensuring a simultaneous movement of the pistons 8 in the cylinders 7 of each pair of piston insulators 6 with the revolution of the shaft 1.

[0021] Inside the body 10 along its longitudinal axis there is located a conducting rod 11 whose ends are main movable contacts 12. Movable arcing contacts 13 are fixed to the main contacts.

[0022] The main movable contacts 12 function together with main fixed contacts 14 fastened to the insulator 6 and electrically connected with a terminal 15.

[0023] The movable arcing contacts 13 function together with fixed arcing contacts 16 located in blow-out nozzles 17 and electrically connected with the terminal 15.

[0024] The movable arcing contacts 13 are arranged in relation to the planes of revolution of the bushings 2 in such way that during closing of the switch-disconnector they move towards the location of the fixed arcing contacts 16 and towards the channel that receives a movable arcing contact 18, made in the piston insulator 6, which channel is connected through a blending chamber 19 with the central channel 20 of the blow-out nozzle 17 fixed to the insulator 6. The blow-out nozzle 17 is connected to the piston insulator 6 by means of screws, not shown in the picture, placed in centering holes 21 made in the nozzle. Preferably the channel receiving the movable arcing contact 18 is made in the form of a channel closed at one end. The main movable contacts 12 are arranged in relation to the planes of revolution of the bushings 2 in such way that during closing of the switch-disconnector they move towards the position of the main fixed contacts 14 and during the state of complete closing of the switch-disconnector they form the main contact system. The blow-out nozzle 17 in addition to the central channel 20 and the blending chamber 19 contains at least one side channel 22 used to supply and swirl air in the blending chamber 19. In the first embodiment of the invention presented in fig. 8 and fig. 9, the nozzle 17 is furnished with one side channel 22 with an inlet W1 and an outlet W2. In the second embodiment of the invention presented in fig. 10 and fig. 11 the nozzle 17 is furnished with two side channels 22 provided with inlets W1 and outlets W2, the outlets W2 being arranged non-axially in relation to each other and situated on the opposite sides of the blending chamber 19. The blow-out nozzle 17 is situated in relation to the piston insulator 6 in such way that the inlet(s) of the side channels W1 is(are) connected with the outlet(s) W3 of internal channels 23 made in the piston insulator 6, which are connected with the inner space of the cylinder 7 and which are located outside the limits of the inlet W4 of the channel receiving the movable arcing contact 18.

[0025] The central channel 20 of the nozzle 17 is connected with the blending chamber 19 through a throat 24 whose diameter corresponds to the diameter of the movable arcing contact 13.

[0026] The side channels 22 of the nozzle 17 are made of a part parallel to the longitudinal axis of the central channel 20 and a part perpendicular to this axis, which causes that compressed air enters the blending chamber 19 by a turbulent movement.

[0027] These channels can be also made of a part situated at a slant to the longitudinal axis of the central channel and of a second part, also situated at a slant to this axis, which is not shown in the drawing. The turbulent movement of air compressed in the cylinder 7 is strengthened in the nozzle 17 by the non-axial situation of the side channels 22 in relation to each other, which causes a reduction in the temperature of the electric arc while the switch-disconnector is switching off and while the current is breaking. The use of the nozzle 17 with one or two side channels 22 makes it possible to supply air compressed in the cylinders 7 to the blending chamber 19 and into the direct space where the arc is burning, omitting the arcing contact-receiving channel 18, which eliminates the preliminary heating of air by the fixed arcing contacts 16 and helps to lower the temperature of the electric arc. In the embodiments of the invention, the nozzle 17 with one or two side channels was used, but in operating conditions it is possible to use the nozzle 17 with a bigger number of side channels, which is not shown in the drawing.

[0028] The nozzle 17 is made of a material gassing on exposure to high temperature generated in the immediate vicinity of the electric arc. Due to ablation, the produced gasses additionally help to reduce the temperature of the arc column. Preferably the gassing material is polyacetal C POM-C.

[0029] There are two decompression openings 25 in the wall of the piston cylinder 7, which are preferably situated orthogonally to the longitudinal axis of the cylinder and opposite to each other. The purpose of the decompression openings 25 is reducing excessive pressure inside the cylinder 7 at the moment when the piston 8 moves toward the longitudinal beam 5 during the occurrence of the short-circuit making current. The situation and dimensions of the decompression openings 25 in the wall of the piston cylinder 7 depend on the value of the expected fault current, the arc duration and the working volume of the cylinder 7. It is assumed that, for the proper decompression of gases when closing the switch-disconnector with the fault current of $50kA_{peak}$ and for a voltage of $24kV_{RMS}$, the decompression openings 25 are situated at such height of the cylinder 7 that they are freed not earlier than at the moment of ignition of the arc, and not later than at the moment when the main contacts 12 and 14 touch each other. The minimum combined cross-section of the decompression openings 25 for the above mentioned parameters should be not less than 100 mm^2. These openings should be situated in such way that the blow-out of ionized gases is not directed to the area of elevated electric field intensity, which could lead to insulation breakdown or reignition of the arc during the disconnection process.

[0030] On the inner surface of the cylinder 7 of the piston insulator 6 there is a single longitudinal channel for draining water 26, situated to ensure gravitational drainage of water accumulated inside the cylinder 7. The accumulation of water inside the cylinder 7 may be caused by, among other things, condensation of water vapor inside the cylinder 7.

Key to the drawing:

[0031]

1 - the rotary shaft
2 - the bushing
3 - the support frame
4 - the transverse wall
5 - the longitudinal beam
6 - the piston insulator
7 - the piston cylinder
8 - the piston
9 - the tension member
10 - the body
11 - the conducting rod
12 - the main movable contacts
13 - the movable arcing contacts
14 - the main fixed contacts
15 - the terminal
16 - the fixed arcing contacts
17 - the blow-out nozzle
18 - the arcing contact receiving channel
19 - the blending chamber
20 - the central channel
21 - the centering hole
22 - the side channel
23 - the internal channel
24 - the throat
25 - the decompression opening
26 - the unwater channel
W1 - the side channel inlet
W2 - the side channel outlet
W3 - the internal channel outlet
W4 - the inlet of the movable arcing contact-receiving channel

Claims

1. A rotary switch-disconnector comprising a rotary shaft (1) with at least one bushing (2) with main movable contacts (12) and movable arcing contacts (13), which is fixed rotationally inside an immovable support frame (3) to which there is attached at least one pair of piston insulators (6) containing main fixed contacts (14) situated in the line of revolution of the main movable contacts (12) and fixed arcing contacts (16), and each piston insulator (6) contains a cylinder (7) with a piston (8) which through a tension member (9) is connected in an articulated way with the body (10) of the bushing (2) in a way ensuring a simultaneous movement of the pistons (8) in the cylinders (7) of each pair of piston insulators (6) with the revolution of the shaft (1), which, while the switch-disconnector is being opened, causes the creation of a blow of air flowing out of the cylinders (7), thus cooling the electric arc initiated when opening the switch-disconnector, **characterized in that** the piston insulator (6) has attached to it a blow-out nozzle (17) comprising a blending chamber (19), a central channel (20) and at least one side channel (22) used to supply and swirl air in the blending chamber (19) when the switch-disconnector is being opened, which chamber is so situated in relation to the piston insulator (6) that the inlet(s) (W1) of the sides channels (22) is(are) connected with the outlet(s) (W3) of internal channels (23) which are connected with the inner surface of the cylinder (7) and are located outside the limits of the inlet (W4) of the movable arcing contact receiving channel (18) which is made in the piston insulator (6).

2. A rotary switch-disconnector as per claim 1, **characterized in that** the channel receiving the movable arcing contact (18) is made in the form of a channel closed at one end.

3. A rotary switch-disconnector as per claim 1 or 2, **characterized in that** the blow-out nozzle (17) contains two side channels (22) which are arranged nonaxially in relation to each other, and their outlets (W2) are situated on the opposite sides of the blending chamber (19).

4. A rotary switch-disconnector as per claims 1 through 3, **characterized in that** the wall of the cylinder (7) of the piston insulator (6) has at least one decompression opening (25) for reducing excessive pressure inside the cylinder (7) at the moment when the piston (8) moves toward the longitudinal beam (5) of the support frame (3) while making under the earth faults conditions.

5. A rotary switch-disconnector as per claim 4, **characterized in that** the decompression opening (25) is located in the cylinder (7) perpendicularly to the longitudinal axis of the cylinder.

6. A rotary switch-disconnector as per claim 4 **characterized in that** the combined minimum cross-section of the decompression openings (25) is 100 mm^2.

7. A rotary switch-disconnector as per claims 1 through 3, **characterized in that** the inner surface of the cylinder (7) has a single unwater channel (26) situated to ensure gravitational drainage of water accumulated inside the cylinder (7).

8. A rotary switch-disconnector as per claim 7, **characterized in that** the unwater channel (26) is parallel to the longitudinal axis of the cylinder (7).

9. A rotary switch-disconnector as per claim 7, **characterized in that** the unwater channel (26) is located near the base of the cylinder of the piston insulator (6).

10. A rotary switch-disconnector as per claims 1 through 9, **characterized in that** the blow-out nozzle (17) is made of a material gassing on exposure to high temperature.

11. A rotary switch-disconnector as per claims 1 through 10, **characterized in that** the blow-out nozzle (17) houses a fixed arcing contact (16) electrically connected with the terminal (15) attached to the piston insulator (6).

12. A rotary switch-disconnector as per claims 1 through 11, **characterized in that** three bushings (2) are attached in series to the rotary shaft (1), and three pairs of piston insulators (6) are attached to the support frame (3), separately for each phase of the three-phase power supply of the switch-disconnector, each pair of piston insulators functioning together with only one bushing (2).

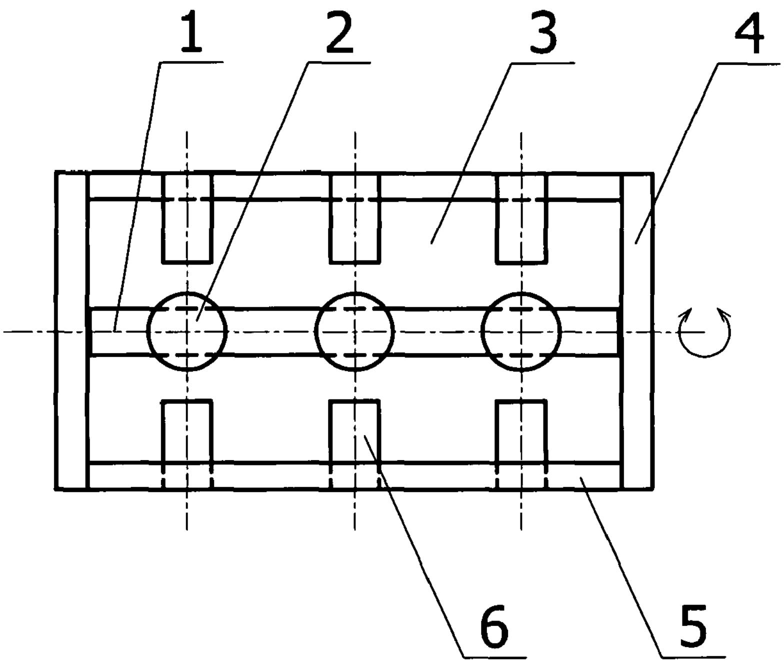

Fig. 1

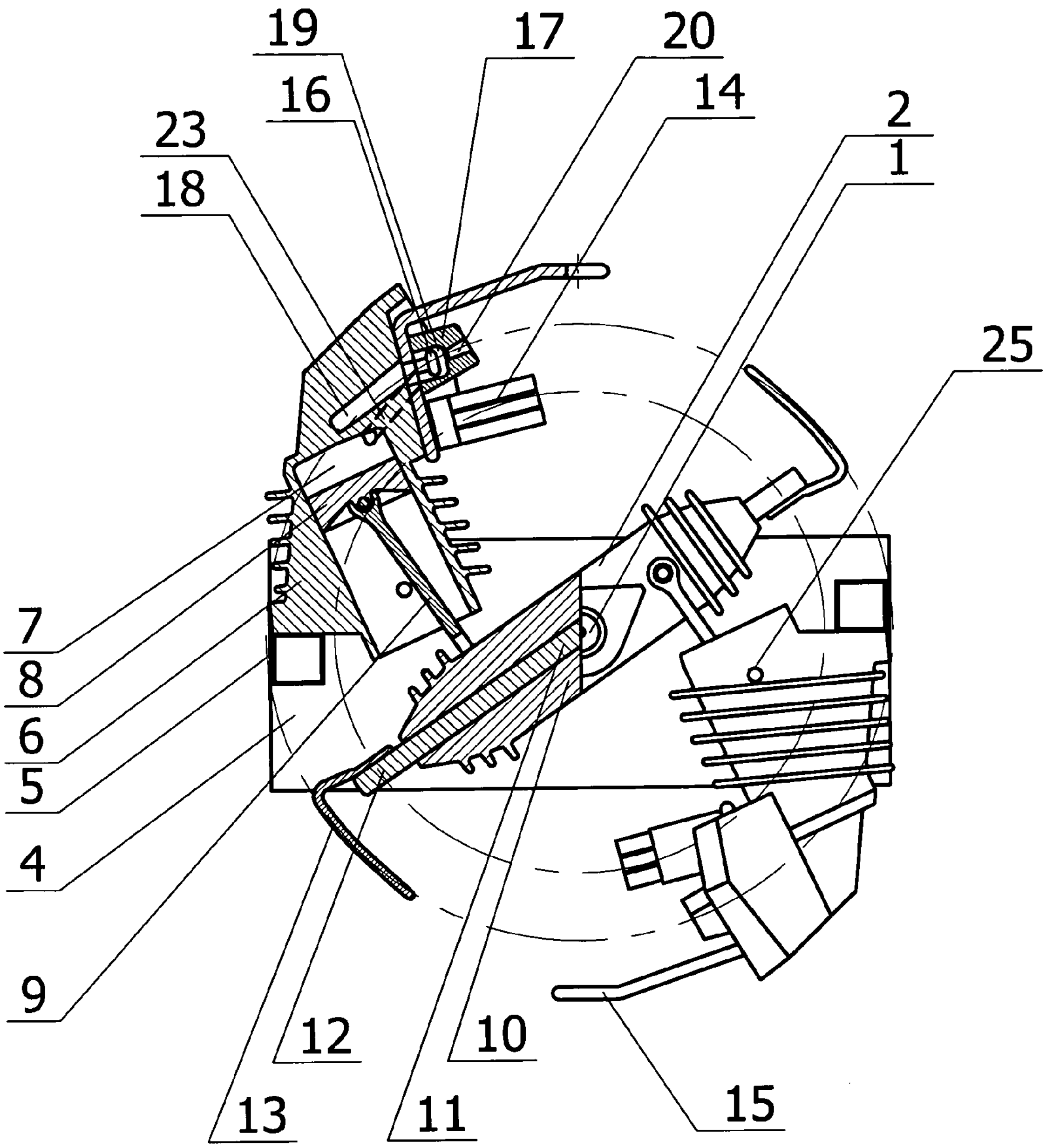

Fig. 2

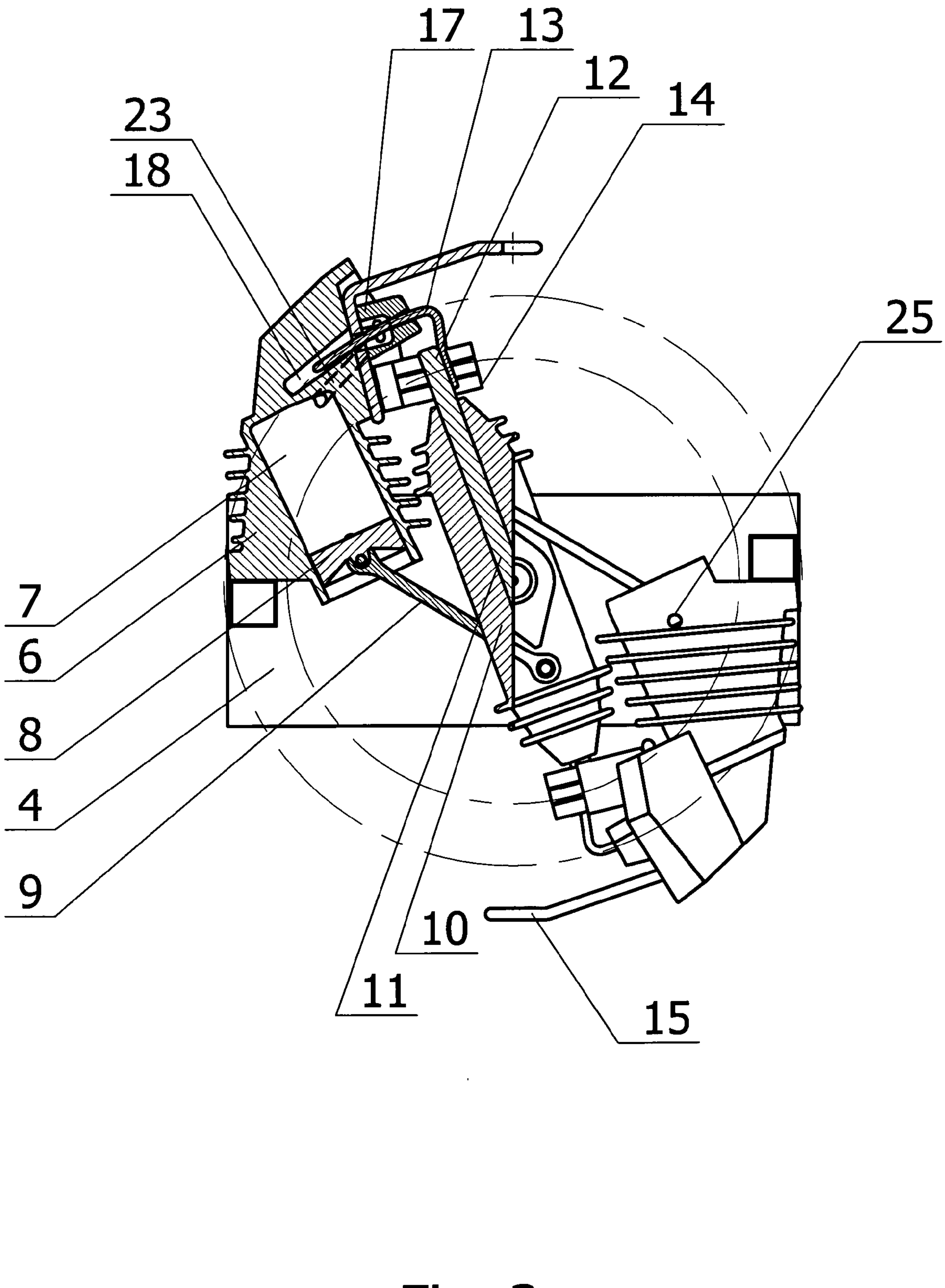

Fig. 3

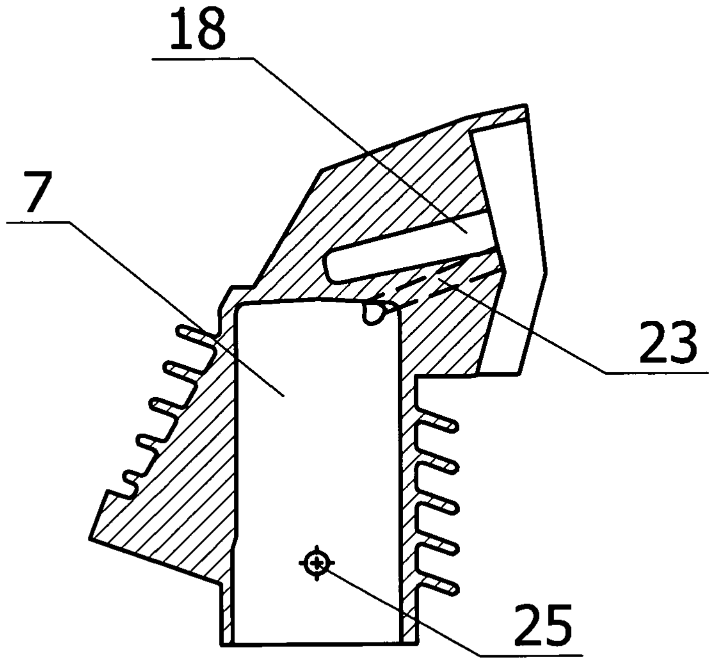

Fig. 4

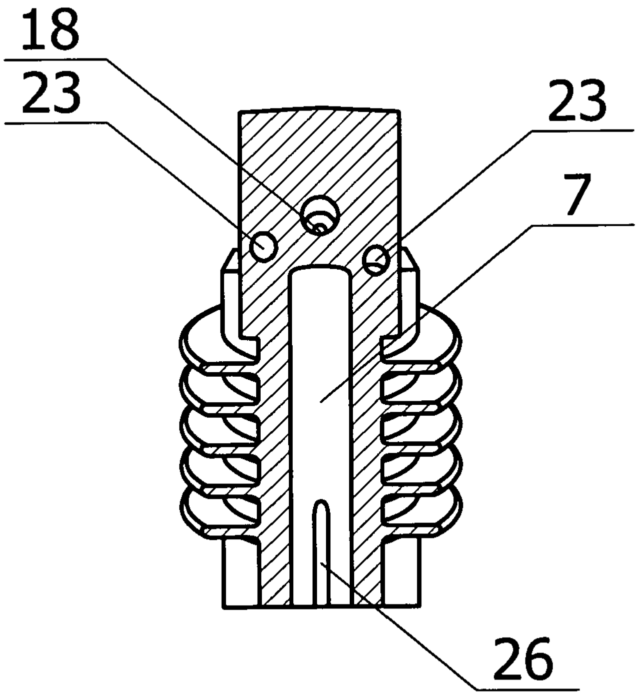

Fig. 5

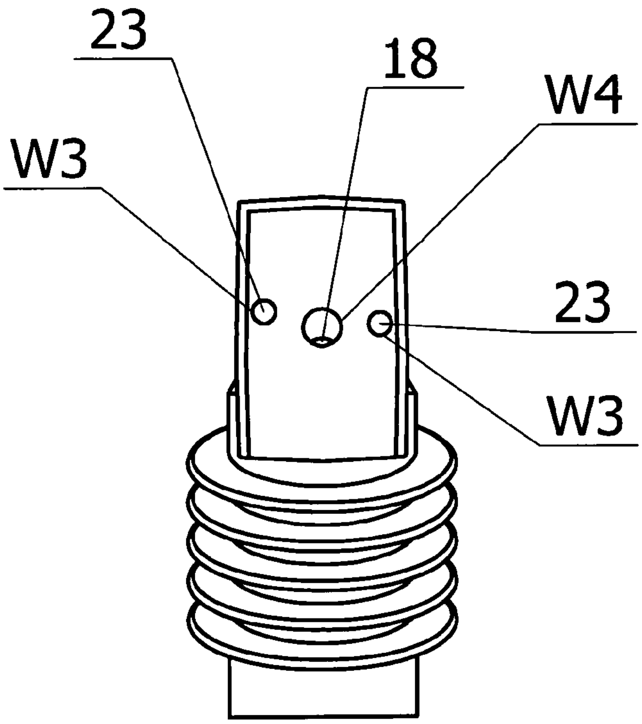

Fig. 6

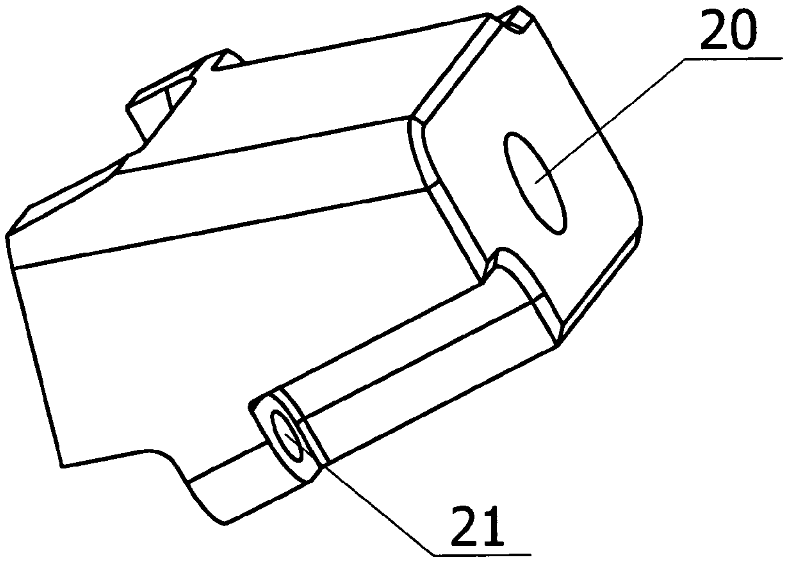

Fig. 7

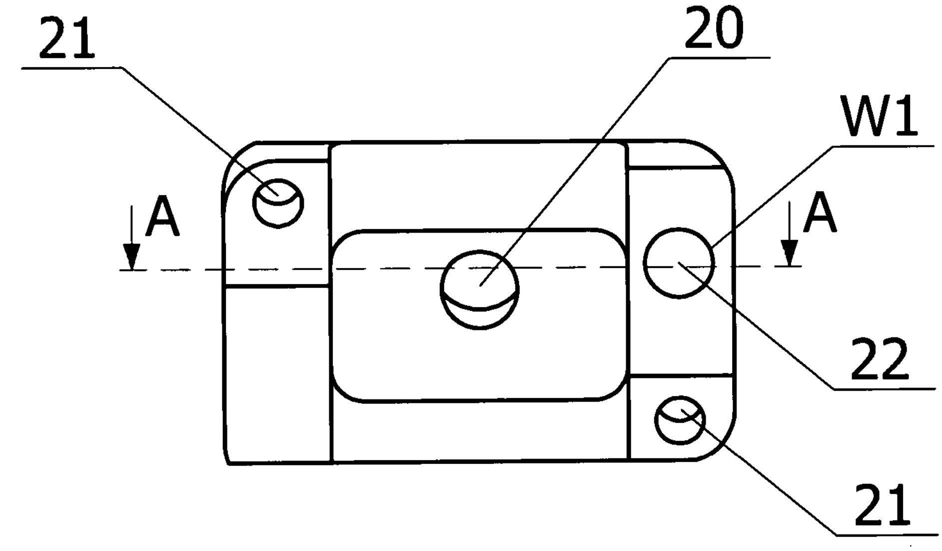

Fig. 8

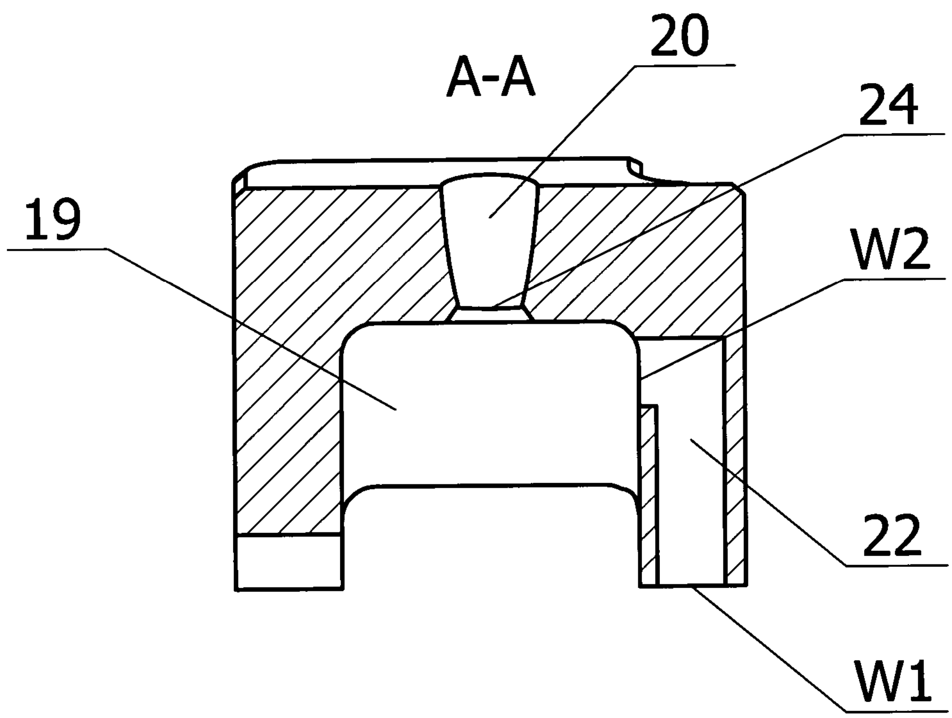

Fig. 9

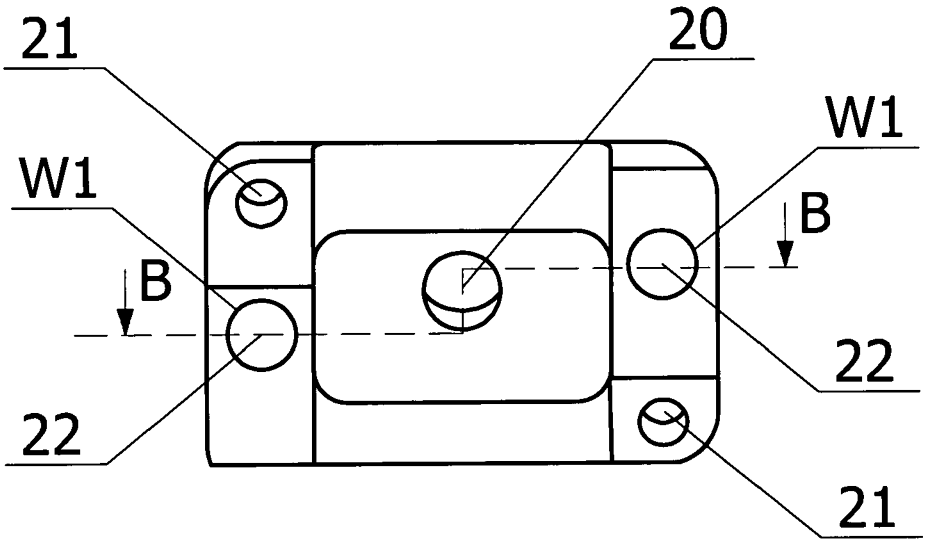

Fig. 10

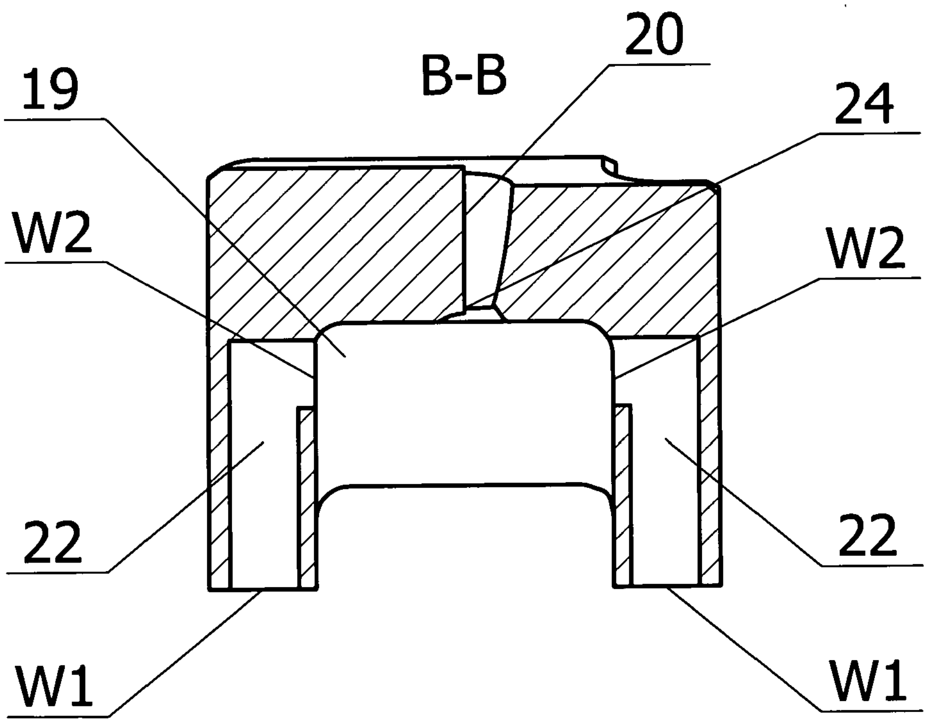

Fig. 11

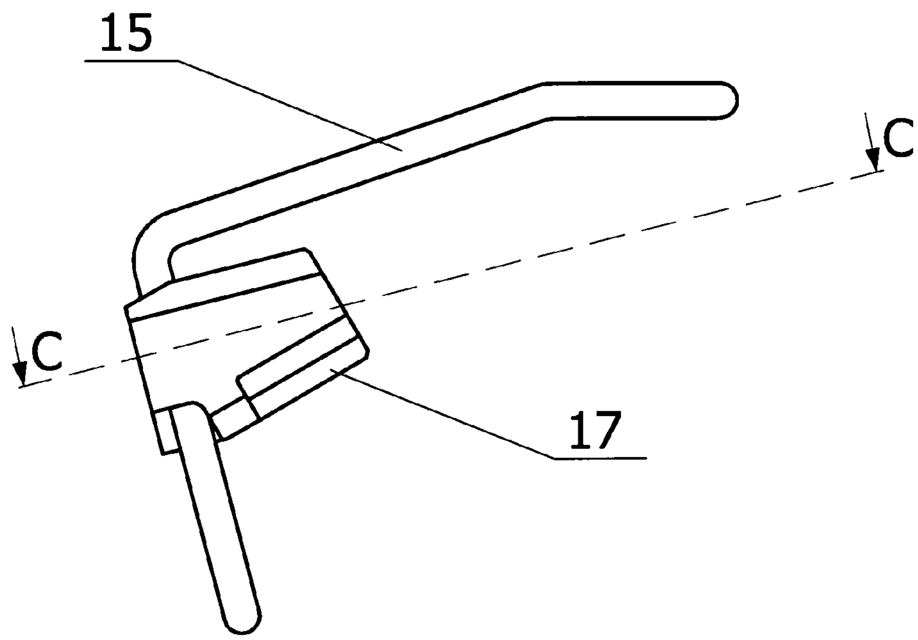

Fig. 12

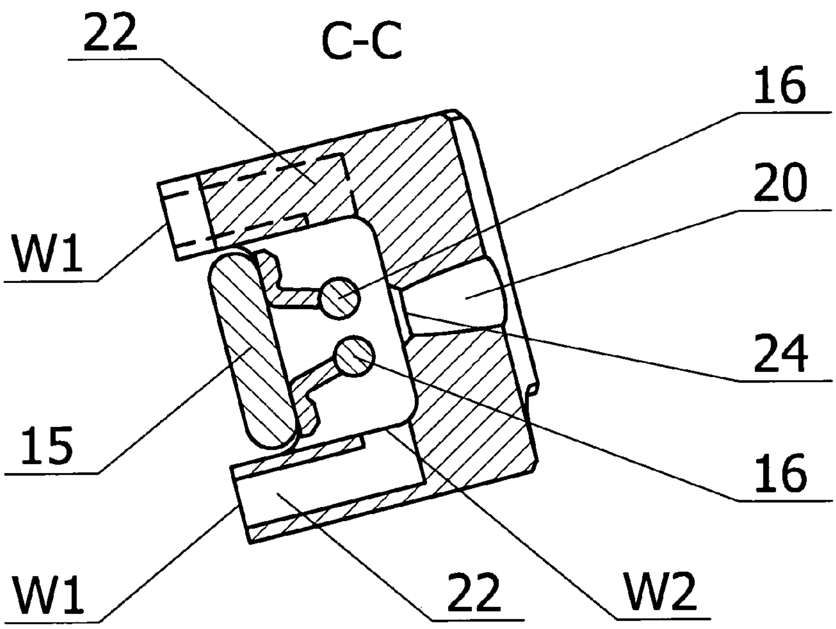

Fig. 13

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 09 46 0044

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	FR 1 367 073 A (CEM COMP ELECTRO MEC) 17 July 1964 (1964-07-17) * page 2, left-hand column; figure 3 * -----	1-12	INV. H01H33/12 H01H33/70 H01H33/91 ADD. H01H31/16 H01H33/77
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