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CA 2920161 A1 2015/02/05

(21) 2 920 161

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) **Date de dépôt PCT/PCT Filing Date:** 2014/07/23
(87) **Date publication PCT/PCT Publication Date:** 2015/02/05
(85) **Entrée phase nationale/National Entry:** 2016/02/08
(86) **N° demande PCT/PCT Application No.:** EP 2014/065822
(87) **N° publication PCT/PCT Publication No.:** 2015/014689
(30) **Priorité/Priority:** 2013/07/31 (DE10 2013 012 684.3)

(51) **Cl.Int./Int.Cl.** ***B21D 19/08*** (2006.01), ***B21D 22/00*** (2006.01), ***B21D 37/16*** (2006.01), ***B21D 5/00*** (2006.01)

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(54) **Titre : DISPOSITIF PERMETTANT DE FACONNER DES METAUX**
(54) **Title: DEVICE FOR FORMING METALS**

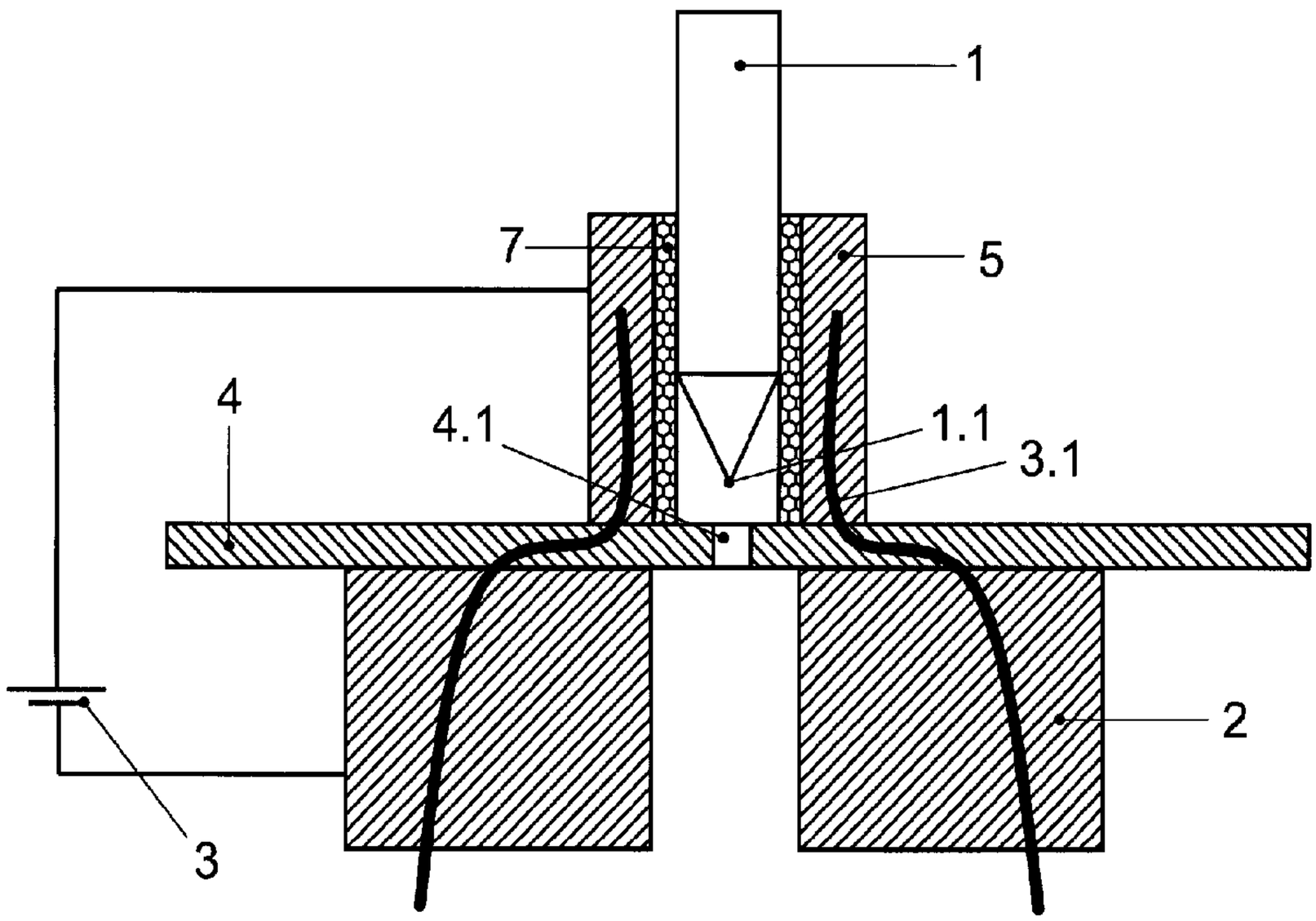

Fig. 1

(57) **Abrégé/Abstract:**
The invention relates to a device for processing a workpiece, said device comprising the following features: - a punch on the one side of the workpiece - a die on the opposite side of the workpiece; - a conductive electric heating system for generating an electric current that flows through the workpiece starting from a component situated on the one side of the workpiece outside of the punch to a component situated on the other side of the workpiece outside of the die.

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
Internationales Büro

(43) Internationales Veröffentlichungsdatum
5. Februar 2015 (05.02.2015)

WIPO | PCT

(10) Internationale Veröffentlichungsnummer
WO 2015/014689 A1

(51) Internationale Patentklassifikation:
B21D 19/08 (2006.01) *B21D 5/00* (2006.01)
B21D 37/16 (2006.01) *B21D 22/00* (2006.01)

(21) Internationales Aktenzeichen: PCT/EP2014/065822

(22) Internationales Anmeldedatum:
23. Juli 2014 (23.07.2014)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:
10 2013 012 684.3 31. Juli 2013 (31.07.2013) DE

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(54) Title: DEVICE FOR FORMING METALS

(54) Bezeichnung : VORRICHTUNG ZUM UMFORMEN VON METALLEN

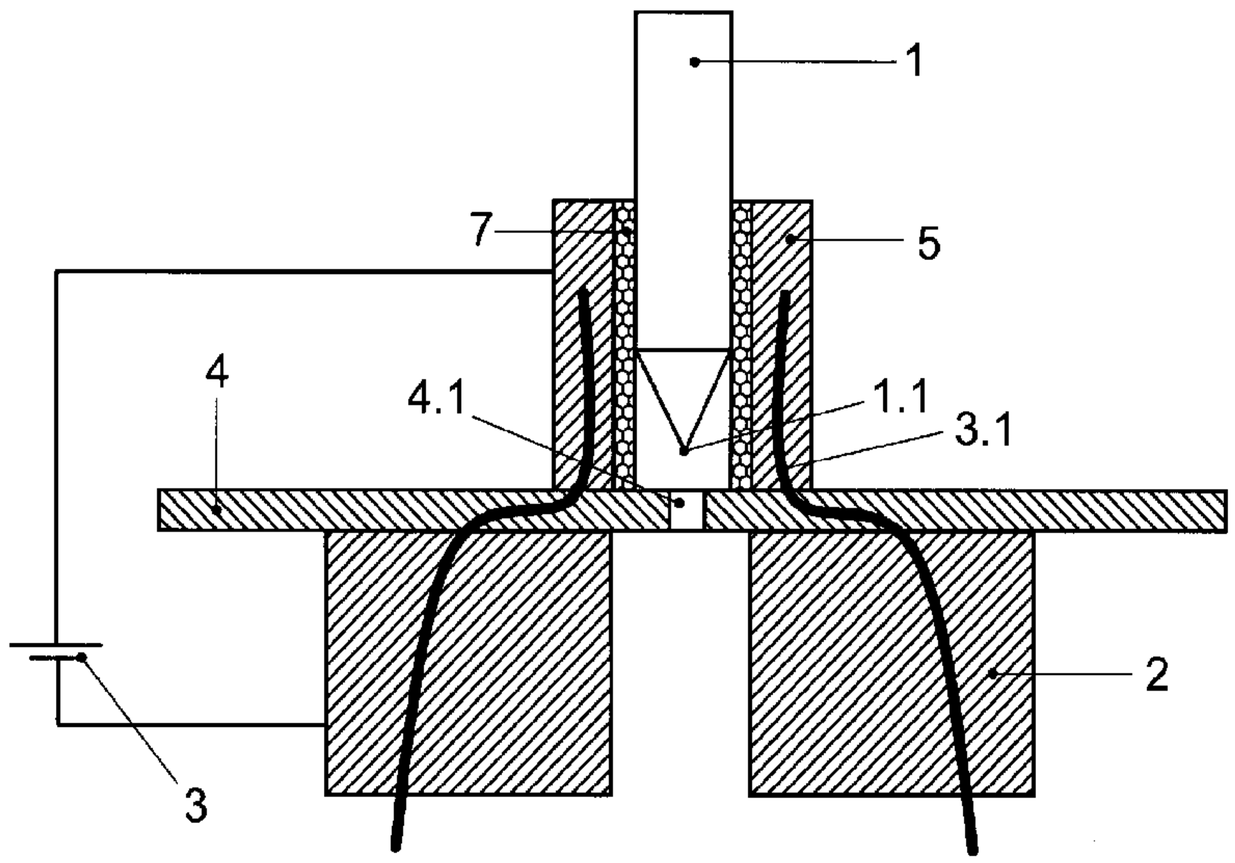

Fig. 1

(57) Abstract: The invention relates to a device for processing a workpiece, said device comprising the following features: - a punch on the one side of the workpiece - a die on the opposite side of the workpiece; - a conductive electric heating system for generating an electric current that flows through the workpiece starting from a component situated on the one side of the workpiece outside of the punch to a component situated on the other side of the workpiece outside of the die.

(57) Zusammenfassung:

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SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Veröffentlicht:

— *mit internationalem Recherchenbericht (Artikel 21 Absatz 3)*

Die Erfindung betrifft eine Vorrichtung zum Bearbeiten eines Werkstückes, umfassend die folgenden Merkmale: - eine Stempel auf der einen Seite des Werkstückes - eine Matrize auf der gegenüberliegenden Seite des Werkstückes; - eine konduktive elektrische Heizung zum Erzeugen eines durch das Werkstück hindurchfließenden elektrischen Stromes, ausgehend von einem auf der einen Seite des Werkstückes außerhalb des Stempels befindlichen Bauteil zu einem auf der anderen Seite des Werkstückes außerhalb der Matrize befindlichen Bauteil.

Device for Forming Metals

The invention relates to a device for forming metals, in particular forming of parts, such as the forming of a collar.

The forming of a collar on a workpiece made of steel, for example a steel sheet plate made of the material of the plate, is an important branch. See DE 10 2006 029 124 B4 as well as DE 1 916 826, for example. The workpiece is placed on a die. The die comprises a bore, which is adjacent to the workpiece. A hole is then pressed into the workpiece by means of a tipped punch while material is drawn into the die bore out of the sheet metal plane. As a result, a collar is formed which remains part of the workpiece. The above principle is particularly used in the automobile industry.

The described forming process involves stress to the workpiece within the forming zone. As such, mainly tensile stress takes effect when raising the collar in the sheet metal edge. The reachable collar height is limited. The smaller the ratio between collar diameter to collar height, the higher is the risk of a breaking of the material in the collar region.

Forming failures are a big problem. Occasionally, this is recognized not before using the workpiece. Disassembly of defective parts and replacement with flawless parts is particularly elaborate in such a case.

It has already been attempted to optimize the drawing process by application of heat. For example, the punch was heated in order to apply heat to the forming zone of the workpiece, e.g. the sheet metal plate. However, this provides the disadvantage that the punch loses its strength because it is heated and thus only has a short service life.

The object of the invention is to provide a device for forming a collar on a workpiece made of sheet metal, particularly on a sheet metal plate or the like, by means of which the forming process is improved and the risk of a break of the collar is reduced but at the same time the tool elements involved keep their strength.

This object is achieved by means of the features of claim 1.

The inventors have recognized that they need to search for a solution that involves heating the forming region of the workpiece, however not the tool, particularly the punch. Thus, one had to search for a system according to the principle of “hot workpiece, cold tool”.

The solution according to the invention lies with the following:

Providing an inductive electric heating system for generating an electric current starting from the punch or another component situated above the sheet metal plate to the die or another component situated below the sheet metal plate.

There are two alternatives according to the invention: According to the first alternative, the punch is used as the upper component, and the lower component is formed by the die. In this case both the punch and the die are to be made of a high-strength but at the same time electrically well-conducting material. Here, the punch is preferably made of a material which is not only a good electric conductor but which also has a high strength even when heated.

According to an interesting embodiment, the punch may be made of two materials, namely an electrically conducting material which does not need to have a high strength, and a second material, which is electrically less well conducting but has a high strength instead. For example, the electrically well-conducting material may form the core of the punch, and the other high-strength material may form the jacket.

According to the second alternative, a sleeve made of an electrically well-conducting material surrounding the punch and which can be placed on the workpiece is used as the upper component; the sleeve serves as a blank holder. The lower component is a counterholder (6) made of an electrically well-conducting material inserted into the die bore.

The second alternative is particularly advantageous. Here, a heating of the punch is not effected, since the current is not guided through the punch but through said blank holder and the counterholder.

The invention solves the underlying object in an excellent manner:

- essentially only the workpiece is heated, also only in the forming region, thus focused on a narrow region. In contrast, the tool essentially remains cold.
- pre-cut parts and formed parts of high-strength thin sheet metal may be used, since the break risk when forming (drawing) the collar is reduced in the invention. This saves weight and costs as well.

Further interesting embodiments can be taken from the dependent claims as well as from the description of the figures.

The invention is explained in detail with reference to the drawing. The drawings specifically show in:

Figure 1 illustrates a first version. A punch as well as a die, a blank holder and further a workpiece may be discerned.

Figure 2 illustrates a second version. A punch, a die and a workpiece, further a sleeve surrounding the punch as well as a counterholder in the die may be discerned.

Figure 3 illustrates a first variant of Figure 2.

Figure 4 illustrates another variant of Figure 2.

Figure 5 illustrates the embodiment of Figure 4 after forming the collar.

Figure 6 illustrates the shearing of a sheet metal plate as a further application of the invention.

Figure 7 illustrates the chamfering of a sheet metal plate as a further application of the invention.

Figure 8 illustrates a bulging of a sheet metal plate as a further application of the invention.

Figure 9 illustrates a modified embodiment of Figure 8.

Figure 10 shows a device for cutting relatively large holes into a workpiece.

Figure 11 shows a device for cutting relatively small holes into a workpiece.

Figure 12 shows a device for manufacturing open cuts.

Figure 13 shows a device for forming a workpiece.

Figure 1 shows the following individual details:

The illustrated device comprises a punch 1 as well as a die 2. The latter further comprises a conductive electric heating system with a power supply 3. Punch 1 is surrounded by a sleeve-shaped blank holder 5. Between these two is provided a heat-insulating coating or a heat-insulating sleeve 7.

A sheet metal plate 4 made of high-strength steel is placed on the die 2.

The punch 1 consists of high-strength material. The punch 1 comprises a tip 1.1. Said tip penetrates a bore 4.1 in the sheet metal plate 4. The bore may have been formed in the sheet metal plate 4 prior to the forming process. However, it is also possible for the sheet metal plate 4 not to have a bore, so that only the punch 1 forms the bore when impressing the sheet metal plate 4. The punch 1 may also be blunt. The shape of the front punch end may also be adapted to the requirements of the forming process.

As illustrated, there is a current flow 3.1, starting from the electric power source 3 through the electrically well-conductive blank holder 5, further through a certain forming region of the sheet metal plate 4 and then to the die 2. Die 2 consists of an electrically well-conducting material such as copper.

In the illustration according to Figure 1, the forming process is in an initial stage. Upon completion of the forming process, the bore 4.1 is widened in order to have the shape of the desired collar – not shown here. Then, the collar has an interior width that is equal to the diameter of the punch 1. How this looks can be seen from Figure 5. A following interesting modification of Figure 1 has the following appearance (not shown here): Punch 1 is essentially made of hard, high-strength steel. However, it is passed through by electric conductors reaching from the upper end of the punch 1 all the way through the punch to the tip region and which are arranged such that they are in a conductive contact to the sheet metal plate 4 during the forming process. As a result, the main part of the punch is not heated or scarcely heated and thus keeps its strength. The said electric conductors may be arranged such that they are exposed at multiple points of the jacket surface of the punch so that there is always a conducting connection to the sheet metal plate 4 even in a downward movement of the punch 1, and thus also a current flow. The electric conductors may be electrically insulated against the punch 1.

In turn, in the embodiment according to Figure 2, the named components of Figure 1 are provided, namely punch 1 with punch tip 1.1, die 2 with die bore 2.1, an electric heating system 3. The sheet metal plate 4 may again be discerned having bore 4.1. Generally, a bore is not obligatory.

Here, a sleeve-shaped blank holder 5 is also provided. Said blank holder has three functions at once. On the one side, it serves as a blank holder, on the other side as a current conductor, and finally as a stripper.

Another difference to the embodiment of Figure 1 is a counterholder 6. Said counterholder is located in the bore 2.1 of the die. The counterholder 6 is displaceable in vertical direction, with or without the die 2.

The current flow runs through the blank holder 5 through the sheet metal plate 4 as well as through the counterholder 6.

In this embodiment, the punch 1 is also completely free of current flow and is thus not actively heated. Thus it may be a tool steel of common quality, or hot-work steel.

An air gap may be present between the punch 1 and the blank holder 5. However, this is not obligatory.

There is no need for the blank holder 5 to have a great strength. It may be made of copper. In any case, it should consist of an electrically well-conducting material. The same applies to the counterholder 6.

In this case, the material of the die 2 is insignificant. It may be any material – steel or copper, however better a less heat-conducting material so that the heat generated by the current remains restricted to the actual forming region.

The embodiment of Figure 3 again shows the punch 1, die 2, sheet metal plate 4. Here, illustration and effect of an electric heating system are dispensed with. Nevertheless, such a heating system is present.

The significant component in Figure 3 is an insulating coating 7. Said coating may be a sleeve or a pad.

The forming process is performed as follows:

First, the sheet metal plate 4 is placed on the die 2. The blank holder 5 moves down and rests on the sheet metal plate 4 so that a current flow is activated and the forming zone is heated. Then, the punch moves further down and the blank holder 5 springs inward. Just before the punch touches the sheet metal plate 4, the power is switched off and the counterholder 6 is controlled away. The collar is raised while being formed.

The significant component in the embodiment according to Figure 4 is a thread molder 1.2 on the punch 1. Punch 1 is equipped with a rotary drive (not shown). If it travels downward, punch 1 and thus the thread molder 1.2 are put in rotation. As a result, the developing collar (not shown) is formed with a thread through which a screw may be guided through.

In the embodiment according to Figure 5, one may discern the collar 4.2 for the first time – being formed integrally with the remaining sheet metal plate 4.

In this Figure, a thread molder 1.2 may again be discerned as in the embodiment according to Figure 4, and an insulating coating 7 as in the embodiment according to Figure 3.

If the forming capability of an existing collar for forming the thread is not sufficient, said collar may also actively be heated.

The embodiment according Figure 6 relates to shearing off a sheet metal plate 4. A cutting punch 10 on the one side of the sheet metal plate 4 and a cutting die 11 on the other side of the sheet metal plate 4 serve as tool.

The cutting edges of the cutting punch 10 and the cutting die 11 are disposed on opposite sides.

Further shown are two rails 12, 13 of an electrically well-conducting material, for example copper rails. Said rails are also disposed opposite to one another, namely mirror-inverted or point symmetric. The connection line between the cutting edges of the cutting punch 10 and cutting die 11 run through the center of a forming zone 14.

An electric heating system (not illustrated here) is provided, which generates a current flow from one copper rail to the other. The current flow again runs through the center of the forming zone 14. This allows cutting where the cutting impact and the cutting force are low.

Another embodiment is illustrated in Figure 7. This relates to the chamfering of a sheet metal plate 4. Shown are a sheet metal holder 15 as well as a die 2. The latter two are disposed opposite one another and clamp the sheet metal plate 4 between them. They may also be offset to one another. Further, a punch 1 and a counterholder 6 are cooperating.

The chamfered edge region of the sheet metal plate 4 is located between two electric contacts 16, 17. Contact 16 is insulated against the punch 1 by insulating material 7, namely at least relative to a heat transfer, but also relative to an electric current flow. The same may be provided between contact 17 and counterholder 6.

Here, the chamfering is facilitated as well by heating the sheet metal plate 4, respectively the edge region thereof.

The embodiment according to Figures 8 and 9 relates to the forming of a bulge in a sheet metal plate 4.

First, reference will be made to the embodiment according to Figure 8. During or after the punch 15 and the die 2 are pushed together, the conductors 18, 19, 20 spring into the punch 15, respectively the die 2. Die 2 is insulated against conductor 18 by means of a sleeve 7, predominantly against a heat transfer. Similar sleeves may surround the conductors 19 and 20 in order to achieve an insulation of the punch 15. The inward spring motion may also be controlled by force. In the processed state. i.e. after the forming, the sheet metal plate has the shape predetermined by the contour of the die 2 and the sheet metal holder 15.

In the embodiment according to Figure 9, again a punch 1, a die 2 as well as a sheet metal holder 15 may be discerned. A sheet metal plate 4 has already been formed between said components.

Again, two upper conductor rails 21, 22 as well as a lower conductor rail 23 may be discerned. The lower conductor rail is shielded off against the sheet metal holder 15 my means of an insulation 24.

The device shown in Figure 10 serves for cutting comparatively great holes or slots. Once again, the workpiece in the form of a sheet metal 4 may be discerned. A tappet 100 is located on the upper side of the sheet metal. A copper block 24 is fixedly connected to said tappet. Springs 25 are arranged between the tappet 100 and the copper block 24. The cutting die 26 is surrounded by a copper ring 27. Accordingly, again an insulation (not illustrated here) is located between the cutting die 26 and the copper inlet 27.

A cutting die 26 is located on the opposite side of the sheet metal. Said die is surrounded by a counterholder 6, for example a gray cast iron body. A cutting die 26 is located next to a ceramic ring 28, further a counterholder 6 made of grey cast iron as well as a copper inlet 27, which is inserted into the counterholder 6.

The device may serve for cutting either a hole or a slot. If a hole is to be formed, both the cutting punch 1 and the cutting die 26 are annular, the same applies to the copper inlet 27.

When moving down the tappet 100, the spring-loaded copper block 24 is pushed against the sheet metal 4. This enables an electric contact from the copper block 24 to the copper inlet 27. If the latter two are connected to a power source, there will be a current flow,

which heats the cutting zone of the sheet metal 4. The heating takes place during the further downward movement of the tappet 100, wherein the copper block 24 springs inward. Just before the cutting punch 1 touches the sheet metal 4, the power is switched off and the sheet metal is cut.

In the embodiment according to Figure 11, once again a sheet metal 4 may be discerned. A reciprocating tappet 100 is located above the sheet metal 4. A cutting punch 1 is mounted thereon.

Further, copper electrodes 28 may be discerned. Springs 25 are arranged between the tappet 100 and the copper electrodes 28.

A cutting die 26 is located on the lower side of the sheet metal, which die is configured such that the punch 1 may run into the bore of the die. The cutting die 26 is surrounded by a ceramic ring 30. The ceramic ring 30 is embedded into a counterholder 6, which may again be made of gray cast iron, for example. In the state shown, the sheet metal rests on the cutting die 26, the copper ring 30 as well as on the counterholder 6.

When moving down the tappet 100, the spring-loaded copper electrodes 28 are pressed against the sheet metal 4, and a voltage is applied so that there is a current flow from one electrode to the other. Here, the ceramic ring surrounding the cutting die 26 prevents a current flow through the cutting die 26 or the surrounding cast body 6. Thus, only the sheet metal 4 is locally heated. If the tappet 100 moves down further, the sheet metal 4 is further heated. Just before the cutting punch 1 touches the sheet metal 4, the power is switched off and the sheet metal 4 is cut.

Figure 12 shows the following details:

Again, a sheet metal 4 may be discerned. A blank holder 5 is located above the sheet metal, and a cutting die 26 is located below said sheet. On the right side, a cutting knife 31 may be discerned above the sheet metal 4, further an electrode 28. A counterholder 6 is located below the sheet metal.

Said embodiment is provided for open cuts. The sheet metal 4 is clamped between the cutting die 26 and the blank holder 5. The blank holder 5 consists of electrically well-conducting material. Here, the sheet metal 4 also rests on the counterholder 6. Electrode 28 is connected to the tappet 100 through a spring 29. The cutting die 26 is supported on a press table 101. The counterholder 6 is connected to the press table 101 through a spring 25.

When the tappet 100 is moved down, first the spring-loaded electrode 28 gets in touch with the sheet metal 4. Here, the required counter force is provided by the counterholder 6. Now, the power is switched on and current flows from the electrode 28 to the counterholder 6. This results in heating the cutting zone of the sheet metal 4. While the tappet 100 further moves down, the zone is further heated and the electrode 28 bears against the sheet metal 4 in a spring-loaded manner. Just before the cutting knife 31 hits the sheet metal, the power is switched off. The sheet metal is cut and the likewise spring-loaded counterholder 6 is displaced by the cutting knife 31.

The embodiment according to Figure 13 relates to a forming of the sheet metal 4. A die 2 is located above the sheet metal, and a punch 1 is located below. In a similar manner to the embodiment according to Figure 8, in this case again two electrodes are provided, namely a positive electrode 19 and a negative electrode 20.

Ceramic inserts 33 and 34 are located above the sheet metal – embedded in die 2.

First, sheet metal 4 rests on the electrodes 19, 20. When the tappet (not illustrated here) is moved down, the sheet metal 4 is clamped between the die 2 and the punch 1. A current flow is activated; current flows from one electrode to the other. The forming zone is heated, and the power is switched off again. Here, the ceramic inserts 33, 34 impede that the current flows through the die 2.

For all embodiments described, either direct current (DC) or a low-frequency alternating current (AC) may be used for heating.

In all illustrations, individual elements of the device may be replaced by one another, e.g. punch and die. The working direction of the punch is not limited to the vertical.

The basic idea underlying the invention is that exclusively or predominantly the workpiece is heated.

In contrast, the tool is not heated, or heated only to a minor extent, so that its strength is reduced only insignificantly.

Reference Numeral List

1.	punch
1.1	punch tip
1.2	thread molder
2.	die
2.1	die bore
3	power source
3.1	current flow
4	sheet metal plate
4.1	bore
4.2	collar
5	blank holder
6	counterholder
7	insulating coating
10	cutting punch
11	cutting die
12	copper rail
13	copper rail
14	forming zone
15	sheet metal holder
16	electric contact
17	electric contact
18	upper conductor
19, 20	lower conductors
21, 22	upper conductor rails
23	lower conductor rail
24	copper block
25	spring
26	cutting die
27	copper inlay
28	copper electrode
29	springs
30	ceramic ring

	31	cutting knife
	32	electrode
	33	ceramic inlay
	34	ceramic inlay
5	100	tappet
	101	press table

Patent Claims

1. A device for processing a workpiece (4), comprising the following features:

1.1 a punch (1) on the one side of the workpiece (4);

1.2 a die (2) on the opposite side of the workpiece (4);

1.3 a conductive electric heating system (3) for generating an electric current, which completely or predominantly flows through the workpiece (4) starting from a component situated on the one side of the workpiece outside of the punch (1) to a component situated on the other side of the workpiece outside the die (2).

2. The device according to claim 1, characterized in that the punch (1) is made of high-strength steel and passed through lengthwise by electric conductors, and in that the electric conductors are heat and/or electrically insulated against the high-strength steel.

3. The device according to claim 1, characterized by the following features:

3.1 the one component is a sleeve (5) made of an electrically well-conducting material surrounding the punch (1) and can be placed on the workpiece (4);

3.2 the other component is a counterholder (6) made of an electrically well-conducting material insertable into the die bore (2.1);

3.3 the counterholder (6) can be displaced downward corresponding to the downward movement of the punch.

4. The device according to claim 2, characterized in that an annular air gap is located between the punch (1) and the sleeve (5) and/or between the die (2) and the counterholder (6).

5. The device according to any one of the claims 1 to 4, characterized in that the soffit of the die bore (2.1) is lined with electrically insulating and/or heat insulating material (7).

6. The device according to any one of the claims 1 to 5, characterized in that the soffit of the sleeve (5) is lined with heat-insulating or electrically insulating material.

7. The device according to any one of the claims 1 to 6, characterized in that the punch (1) can be driven around its longitudinal axis and comprises a thread molder (1.2) for forming a thread in the soffit of the collar (4.2).

8. The device according to any one of the claims 1 to 7, comprising the following features:

8.1 a cutting punch (10) on the one side of the sheet metal plate (4), and a cutting die (11) on the other side of the sheet metal plate (4);

8.2 cutting punch (10) and cutting die (11) are offset relative to one another transversely to a forming zone (14);

8.3 a first current-conducting rail (12) which is disposed opposite the cutting punch (10);

8.4 a second current-conducting rail (13) which is disposed opposite the cutting die (11).

9. The device according to any one of the claims 1 to 7, comprising the following features:

9.1 a sheet metal holder (15) as well as a die (2), the forming faces of which each have the contour of the bulge;

9.2 contact elements (15), such as rods (18, 19, 20) made of electrically conducting material, are provided, which are guided in the die (2) and the sheet metal holder (15), which at least temporarily rest against the workpiece (4) with their face-sided ends in a contacting manner and which can be displaced perpendicularly relative to the workpiece (4);

9.3 the contact elements (18, 19, 20) are heat-insulated against the sheet metal holder (15) as well as against the die (2).

Fig. 1

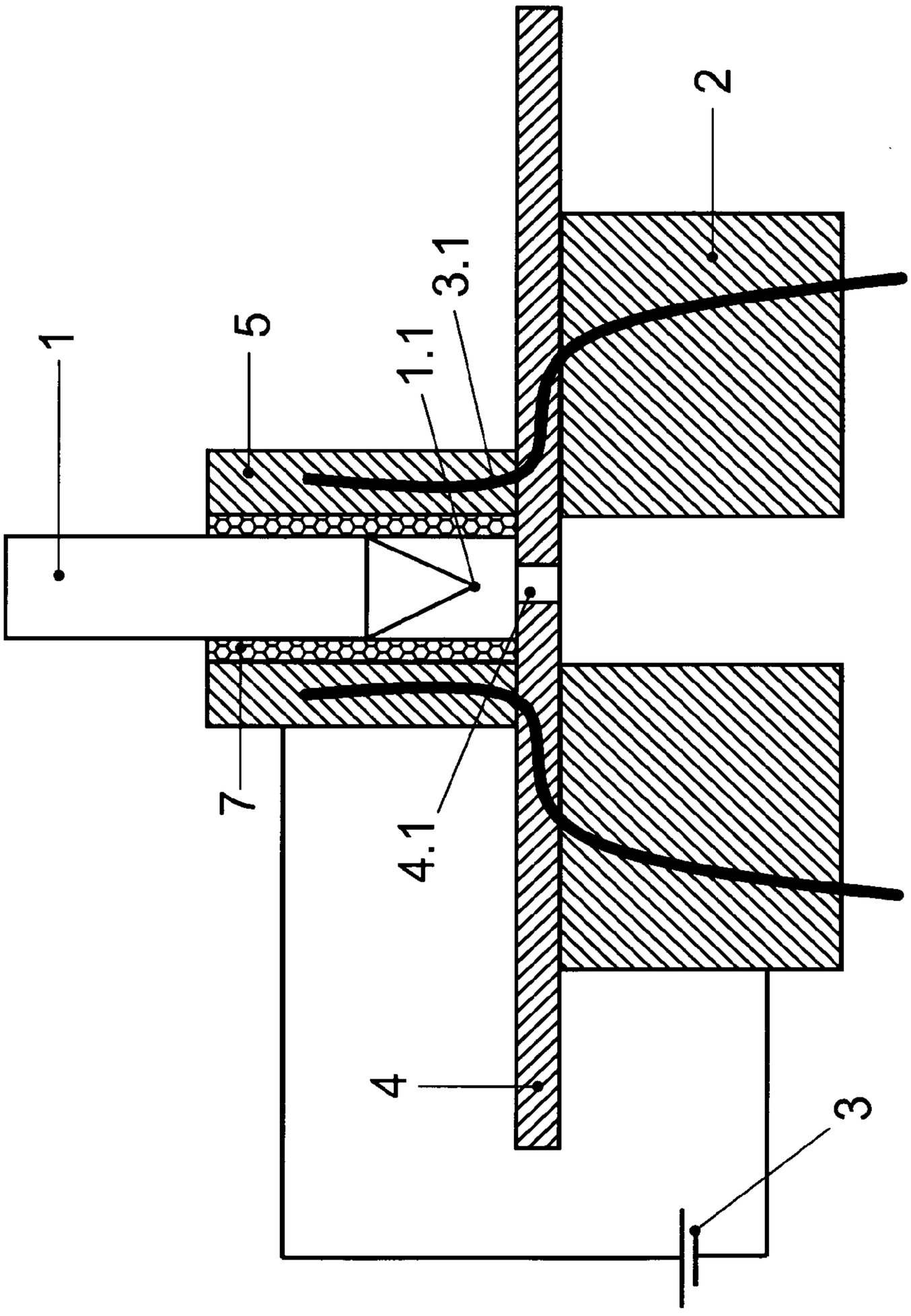


Fig. 2

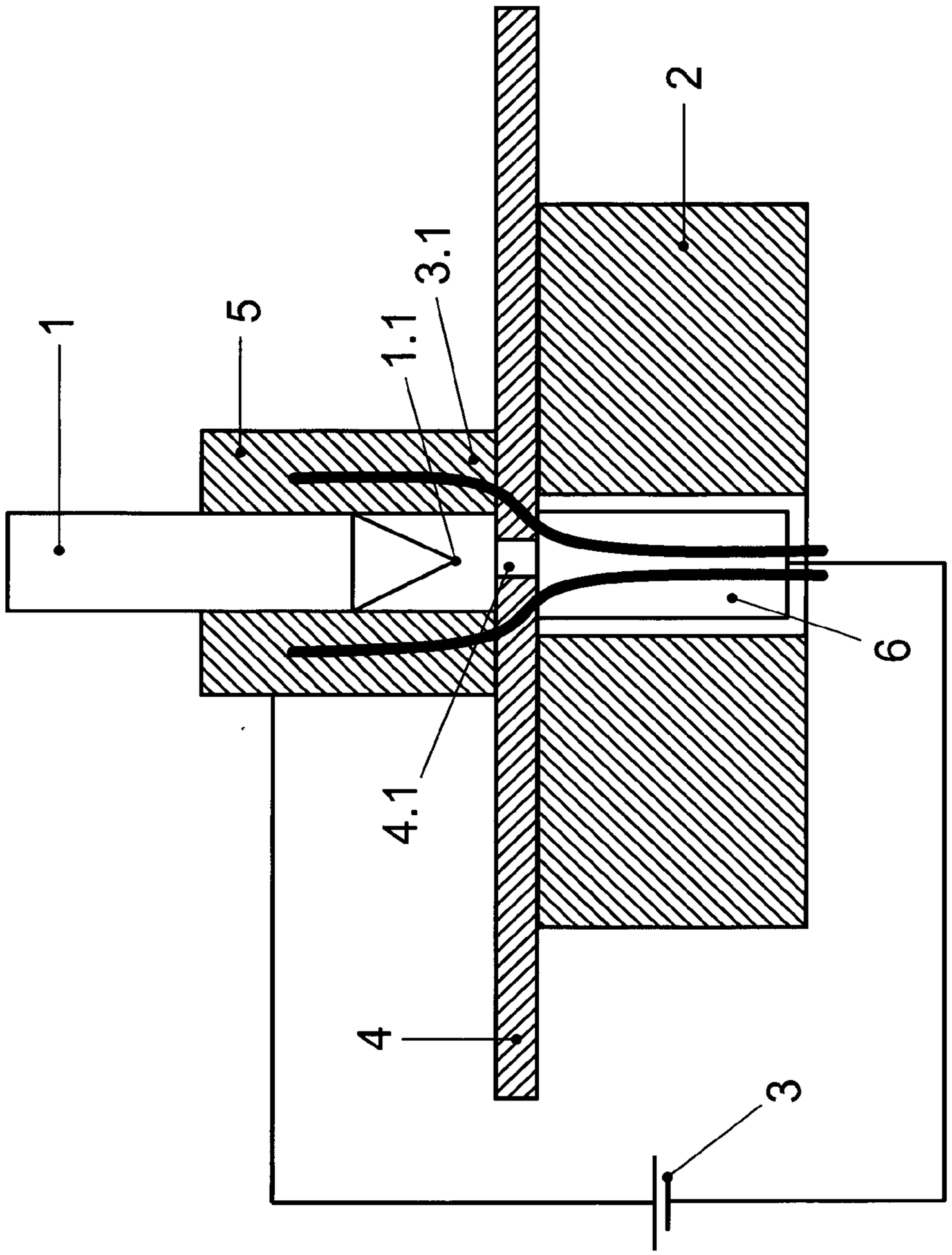


Fig. 3

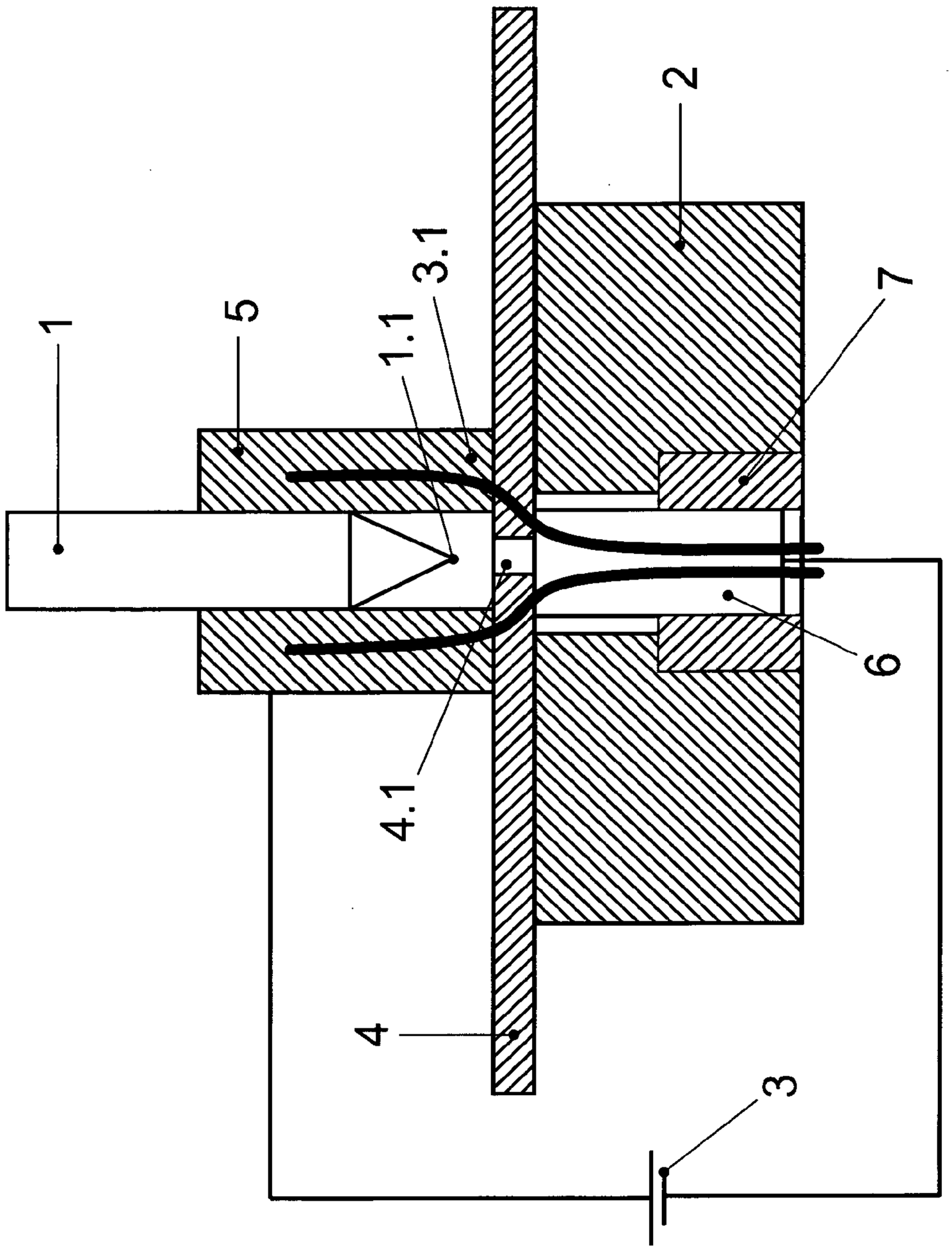
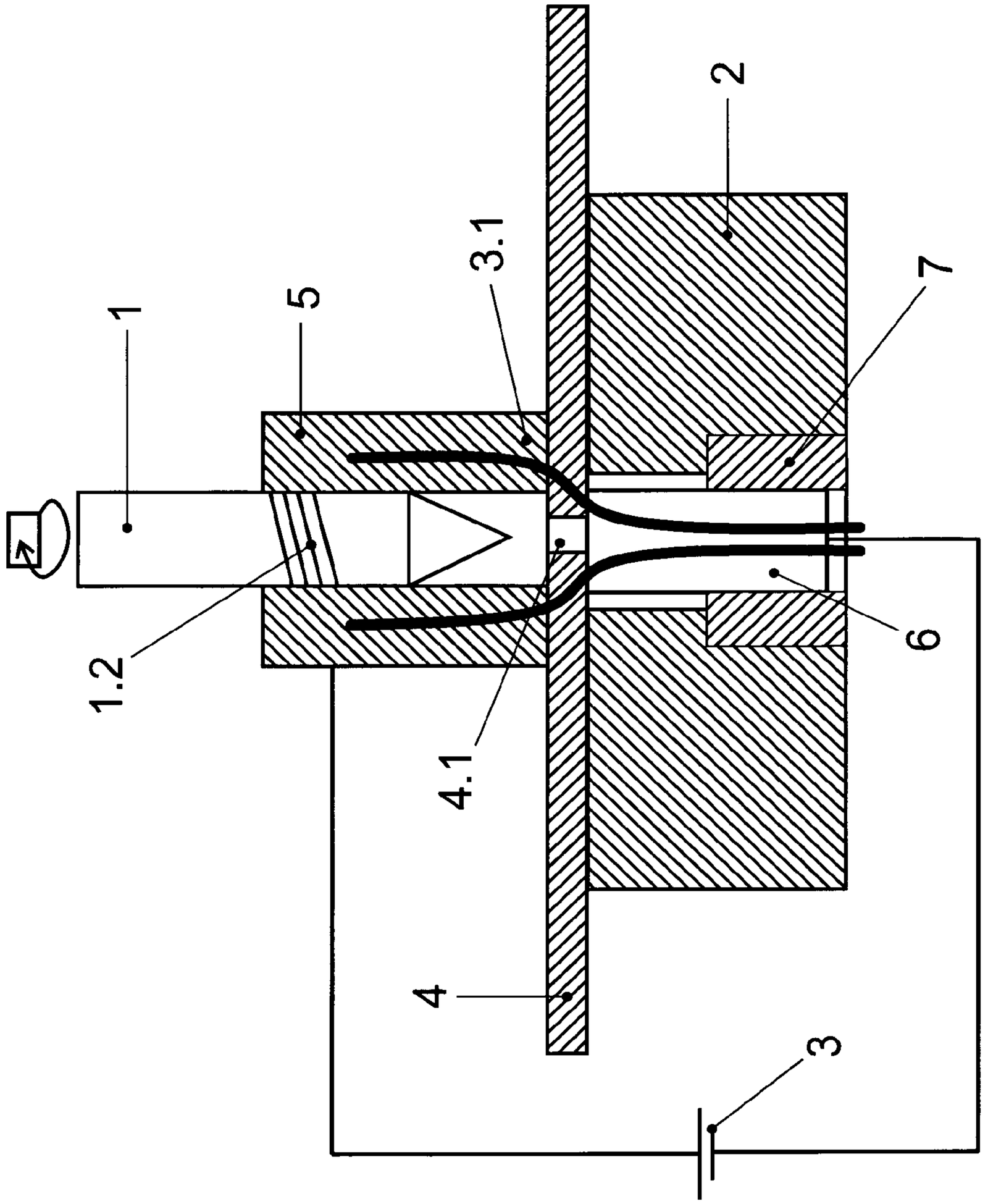


Fig. 4



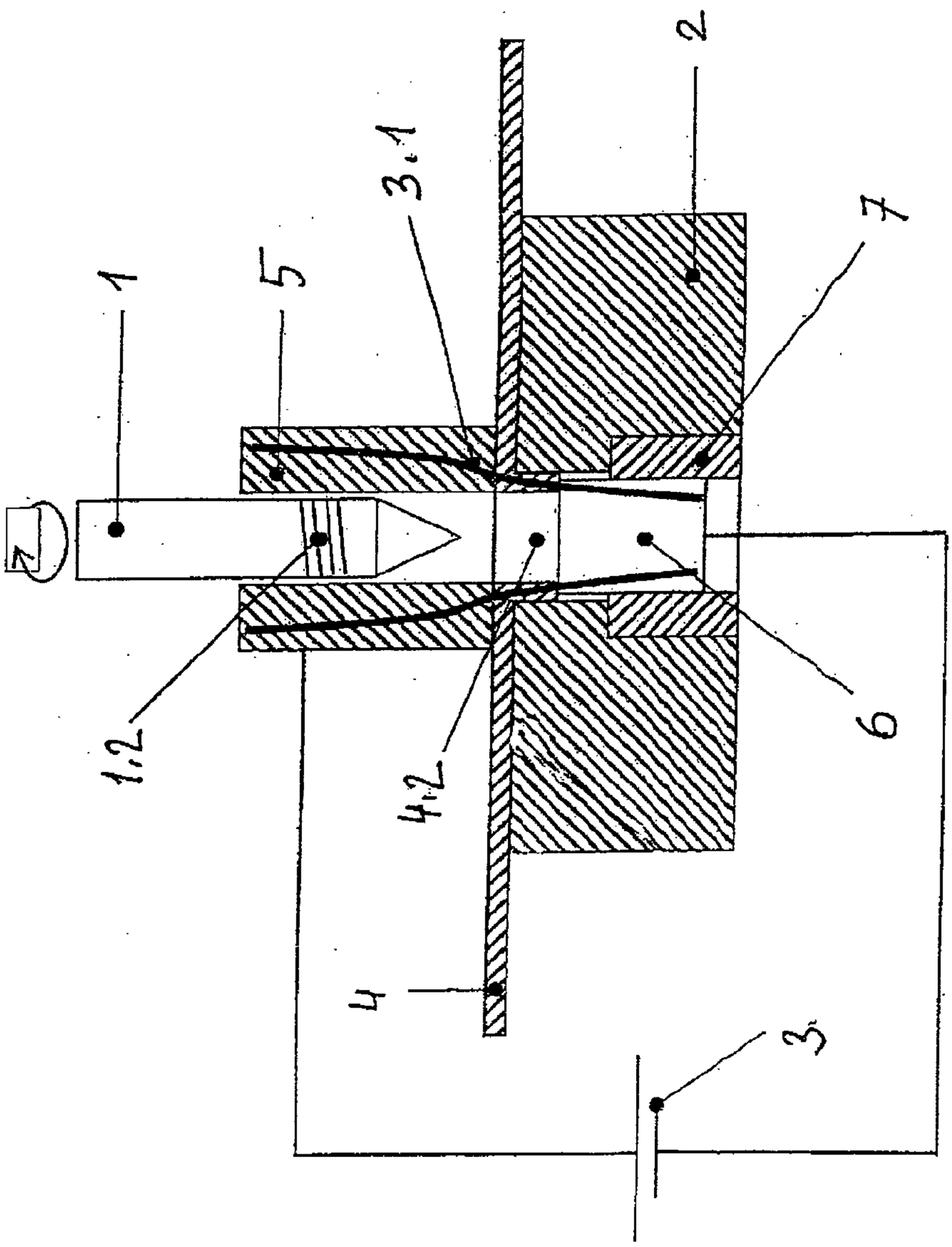
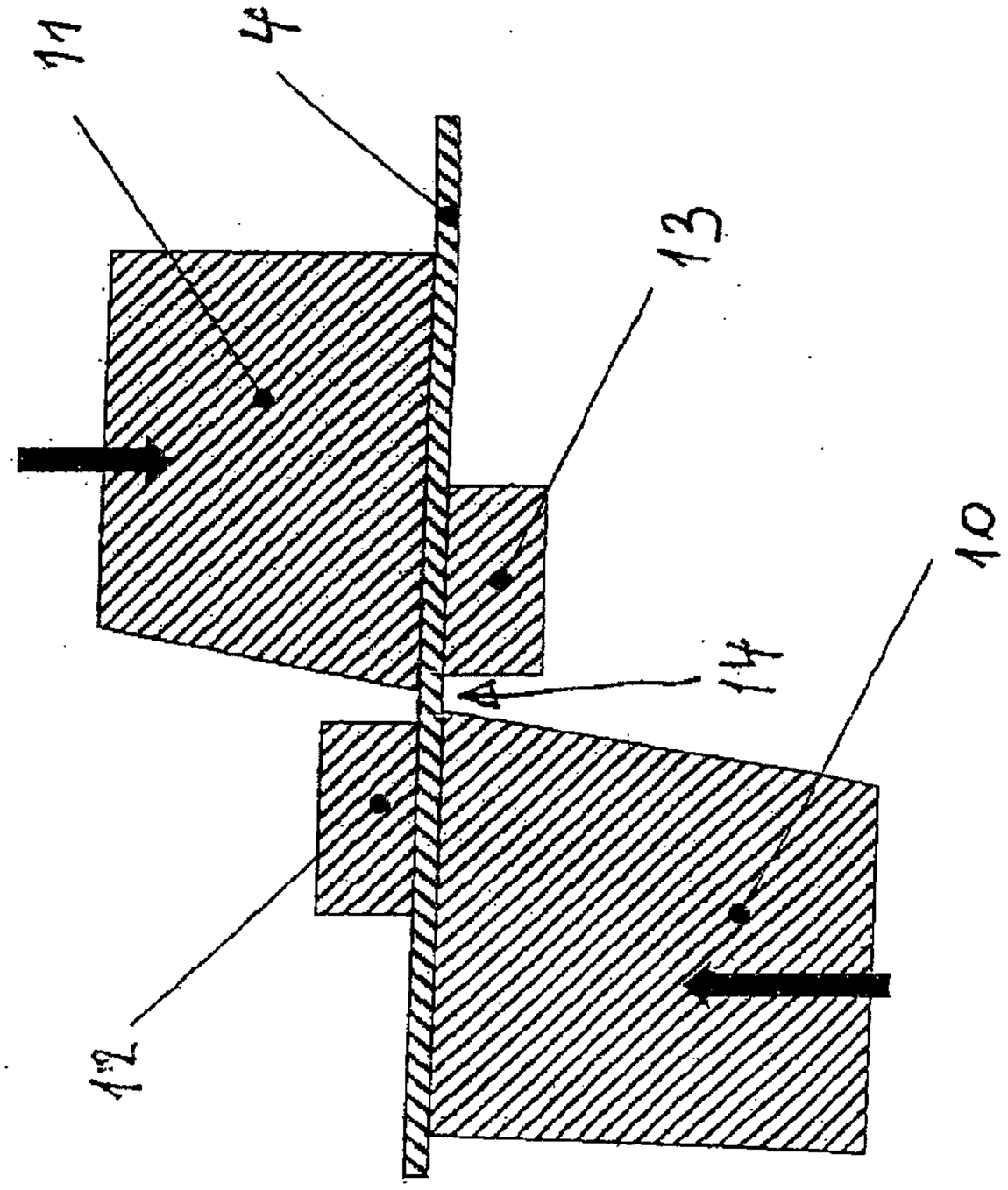


Fig. 5

Fig. 6



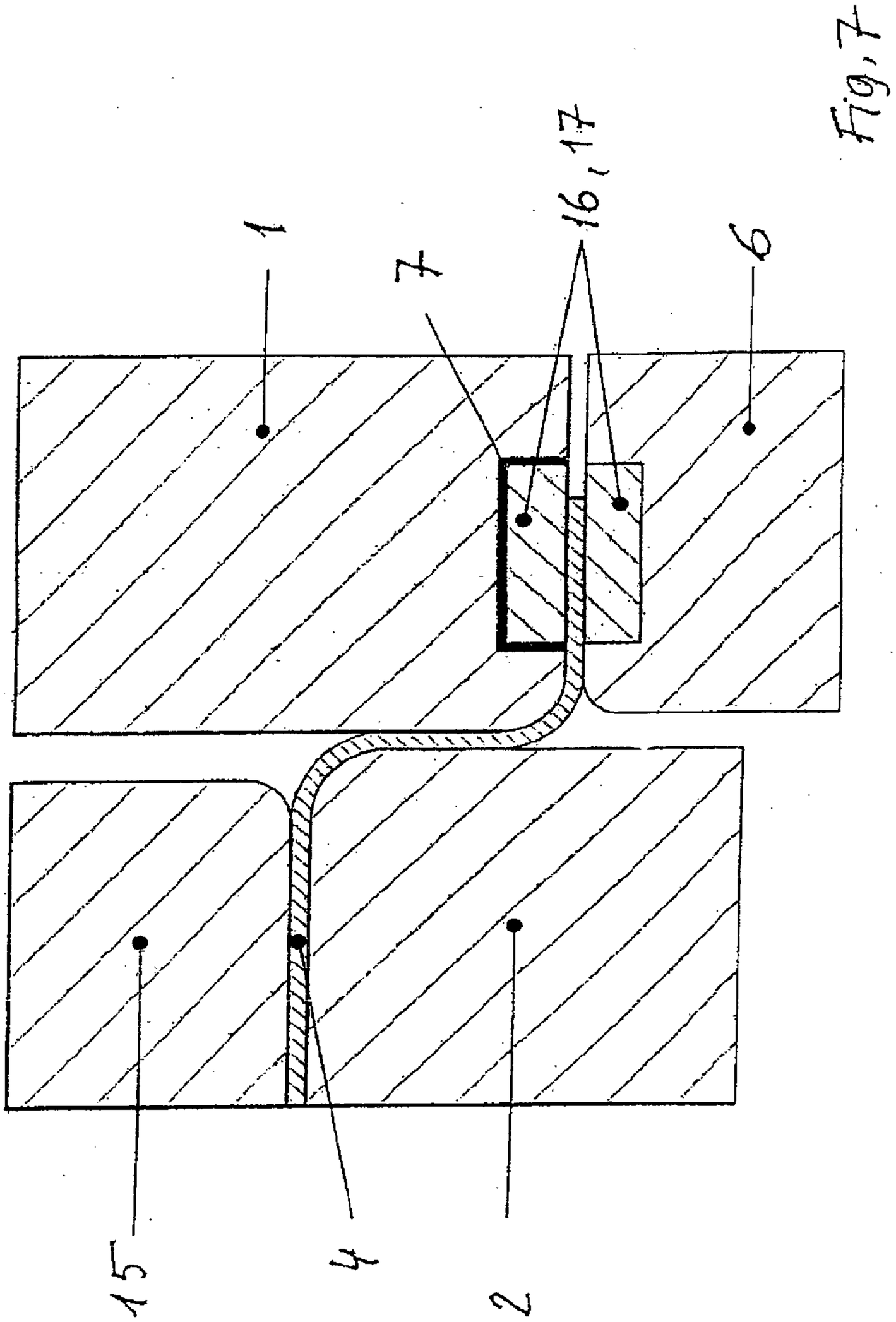


Fig 7
16, 17
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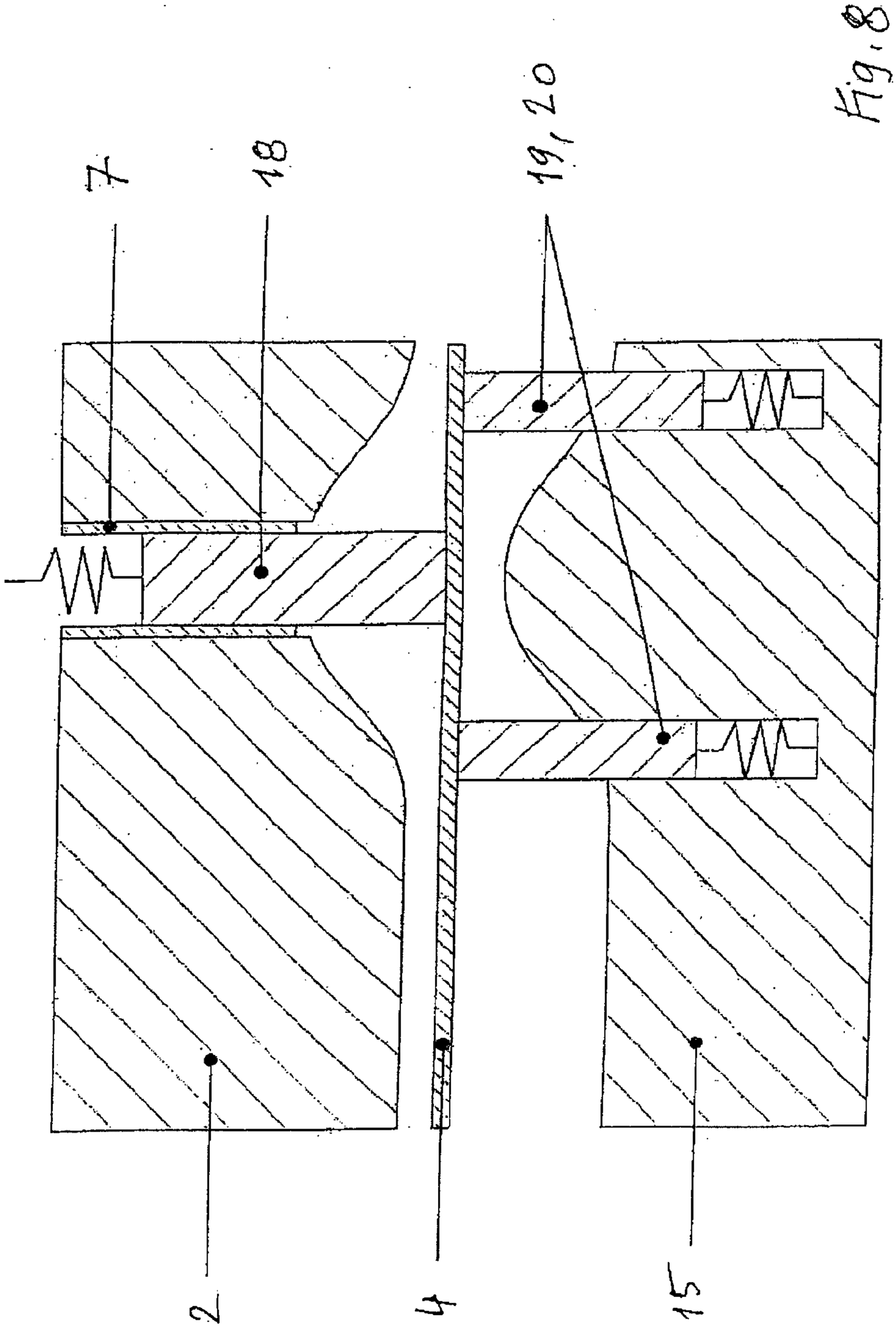

Fig

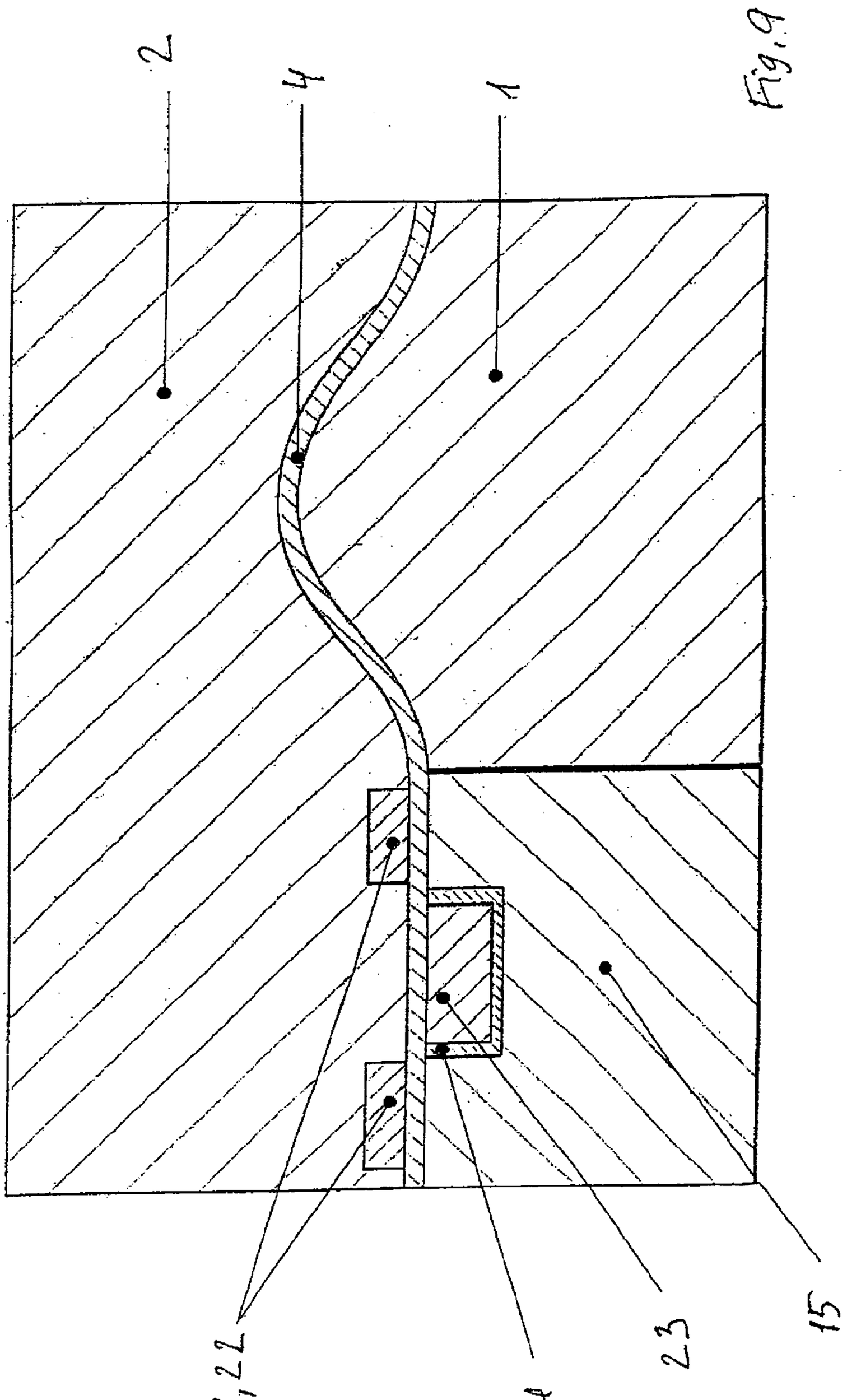

Fig. 9

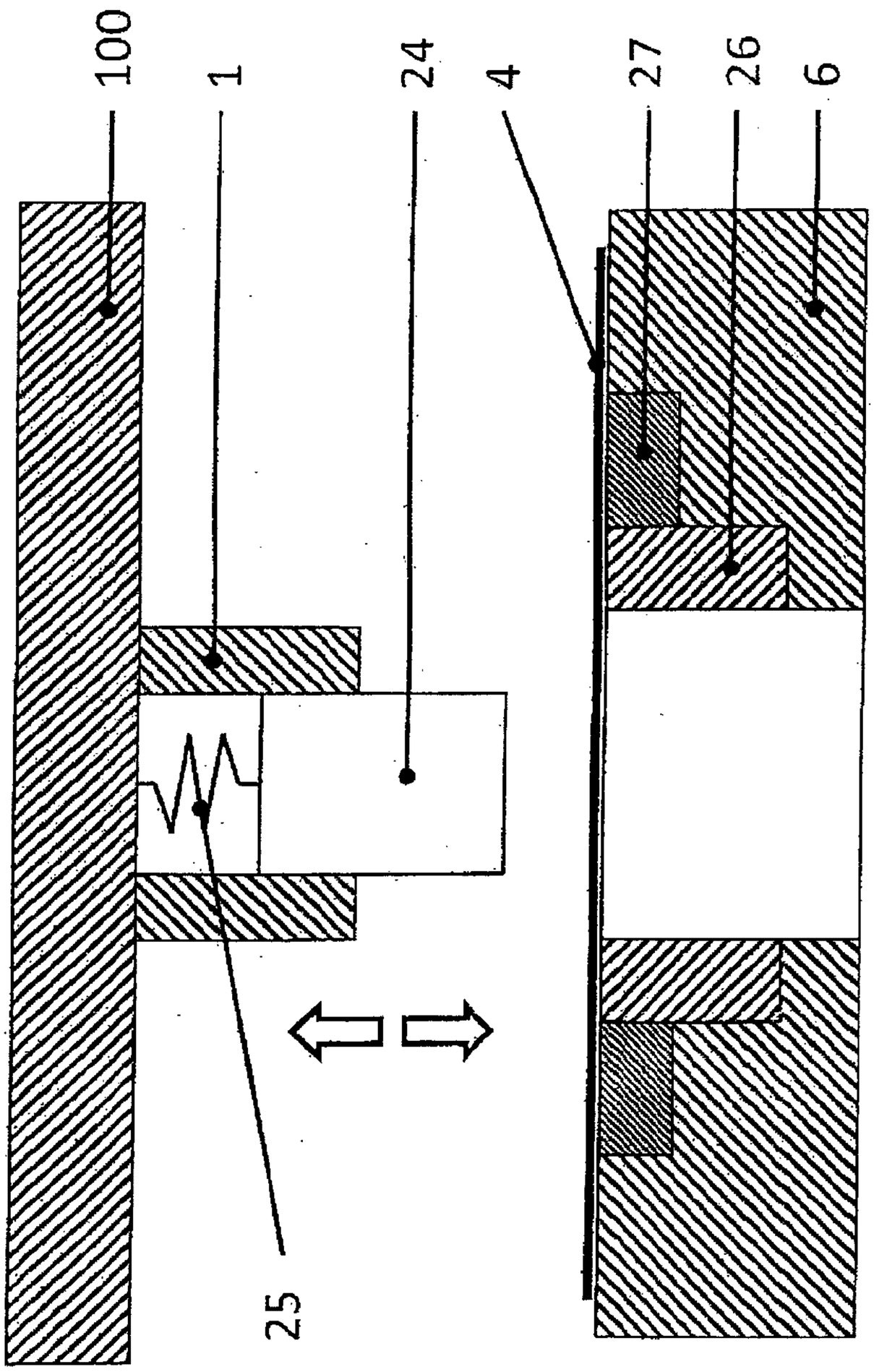

Fig. 10

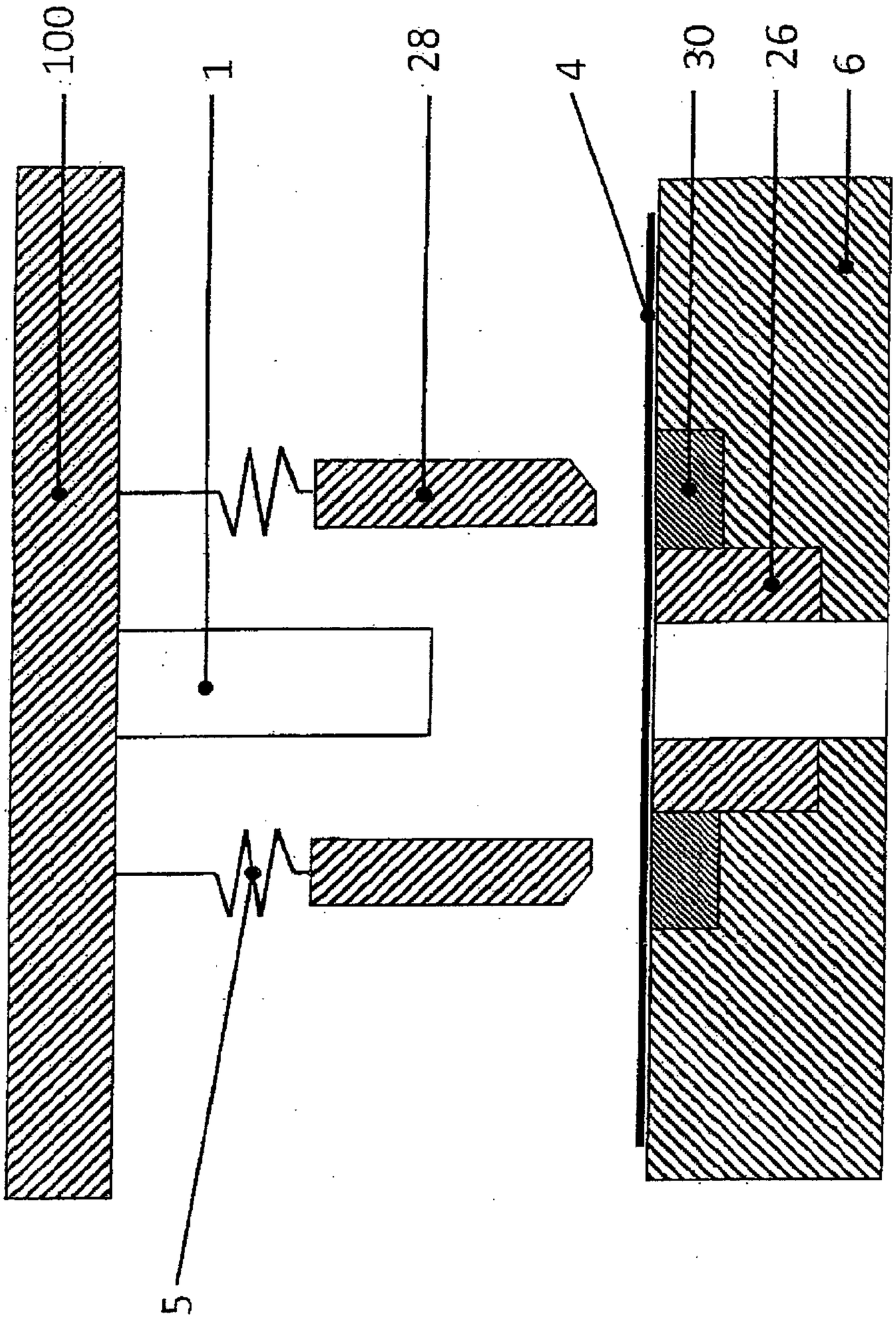

Fig. 11

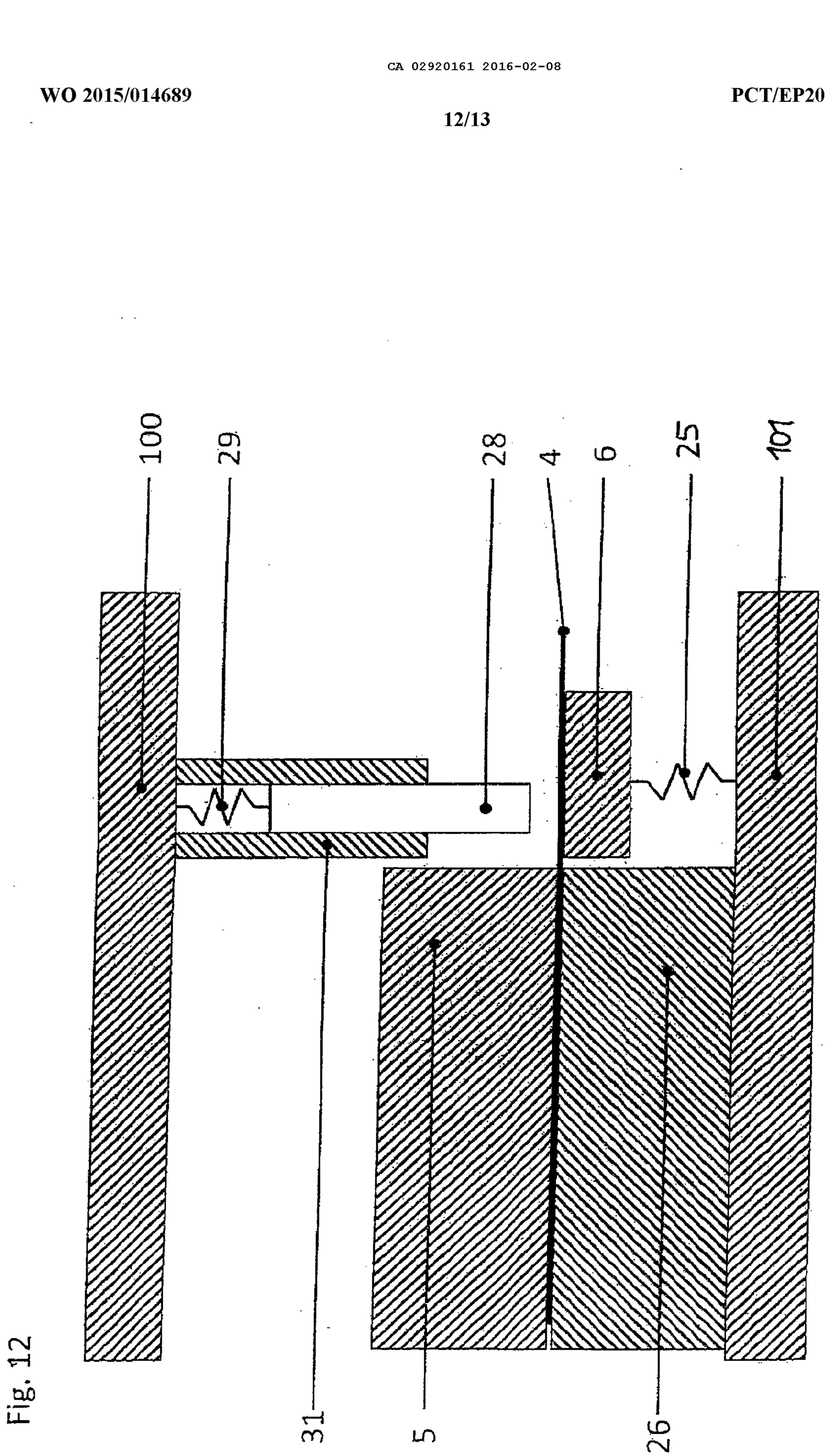

Fig. 12

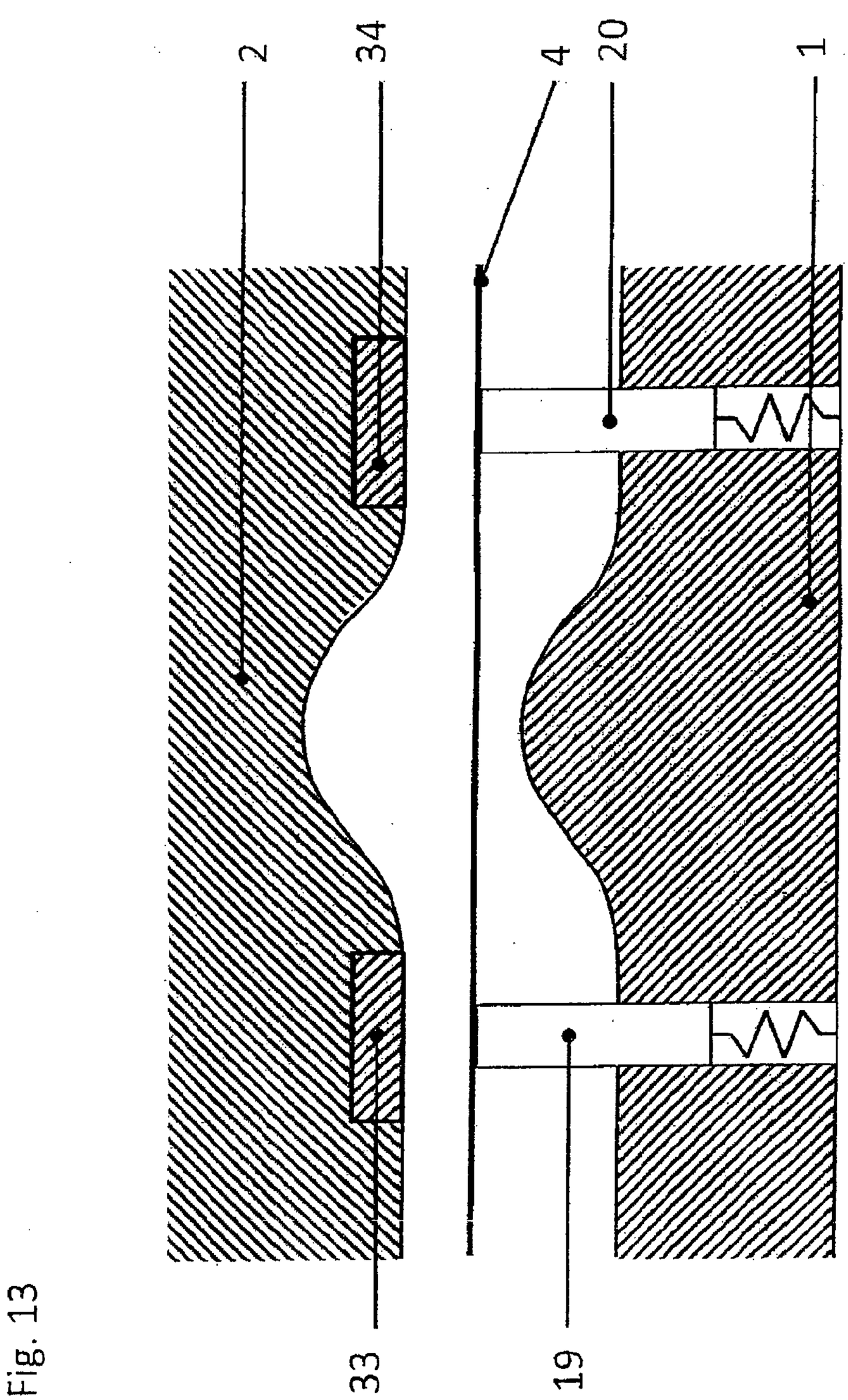

Fig. 13

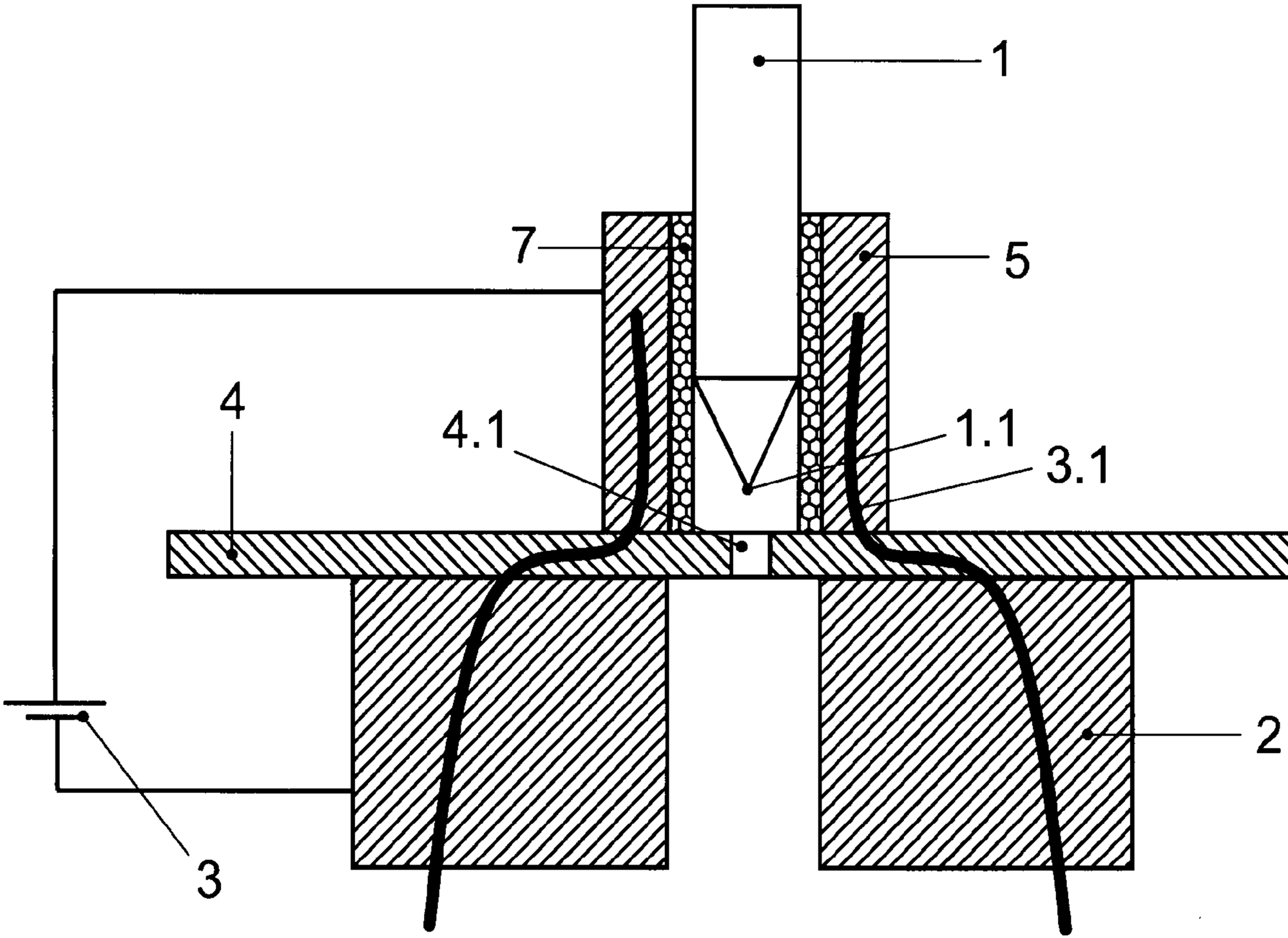

Fig. 1