(12) **PATENT**

(11) **347861** (13) **B1**

(19) NO

NORWAY (51) Int Cl.

H01F 7/02 (2006.01)

Norwegian Industrial Property Office

(21)	Application nr.	20210896	(86)	International Filing Date and Application Number
(22)	Date of Filing	2021.07.12	(85)	Date of Entry into National Phase
(24)	Date of Effect	2021.07.12	(30)	Priority
(41)	Publicly Available	2023.01.13		
(45)	Granted	2024.04.22		

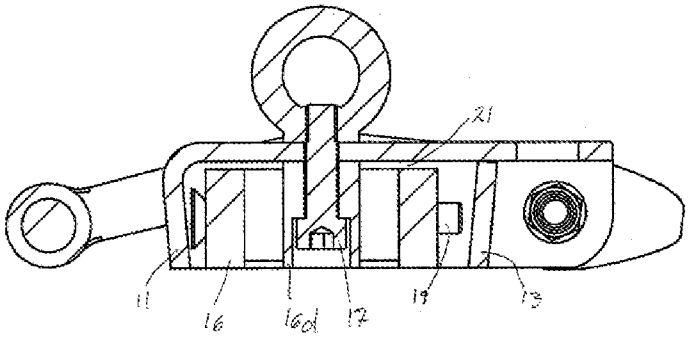
(73)	Proprietor	APEX TECHNOLOGY AS, c/o Lars Lind, Guvernørens vei 9B, 0284 OSLO, Norge
(72)	Inventor	Lars Lind, Guvernørens vei 9 B, 0284 OSLO, Norge Emil S Jahren, Steinborgveien 23 B, 0678 OSLO, Norge
(74)	Agent or Attorney	BRYN AARFLOT AS, Stortingsgata 8, 0161 OSLO, Norge

(54) Title **Holding magnet and a method of manufacturing holding magnets**

(56) References Cited: US 2013/222091 A1, US 5711515 A, US 2009/133246 A1

(57) Abstract

The invention relates to a holding magnet comprising a magnet core (16), such as a magnet or a sandwiched stack of magnets, a housing (2) defining an open ended cavity (15), said magnet core (16) being received in said cavity (15) and at least partially retained within said cavity (15) by a filler material. The cavity (15) has a smaller cross-sectional area closer to said open end of said cavity (15) than further away from the open end. The invention further relates to a method of manufacturing a holding magnet having a housing and a magnetic core.



HOLDING MAGNET AND A METHOD OF MANUFACTURING HOLDING MAGNETS

Technical Field

[0001] The present invention relates to holding magnets, in particular corrosion protected holding magnets. Such magnets are often used in marine environments and intended to be attached to ferromagnetic surfaces to provide an anchoring point for various purposes, such as holding equipment, an ROV or a diver in position and prevent these from being caught by a water current and float away. The present invention also relates to a method of manufacturing a holding magnet.

Background Art

[0002] The attachment of the holding magnet may be over a shorter or longer time. Especially in a marine environment there are high requirements to the magnet and its capability to maintain the holding force over a prolonged time. The holding magnets are meant to be reusable and should not deteriorate even if attached and released multiple times.

[0003] Holding magnets are provided in various sizes and with a range of holding capabilities depending on the need for holding force. They comprise a permanent magnet or magnetic core that is fixed to a housing and a release handle. They may also comprise an attachment eye or similar. When being used, the ferromagnetic surface to which the holding magnet is to be attached, is, if necessary, first cleaned by scraping away any marine growth and debris to reveal a smooth surface. Then the holding magnet is placed on the surface. Due to the magnetic force of the permanent magnet or magnetic core, it will adhere to the surface and it will take a substantial force to pull it away from the surface. The holding force will depend on the distance between the magnet or magnetic core and the surface. This distance should be as short as possible as the holding force diminishes by the square of the distance.

[0004] A particular operation of a holding magnet of this kind, is when the holding magnet is to be removed from the surface, the handle is turned. The handle is coupled to a lug that presses against the surface and lifts the holding magnet from the surface at one end thereof. As soon as the distance from the surface has been sufficiently increased, the magnet or magnetic core can be pulled away from the

surface. This levering mechanism will reduce the force needed for removal enough for the magnet to be capable of removal by hand.

[0005] Another possible operation of such a holding magnet is to use a screw instead of the handle to lift the magnet or magnetic core sufficiently from the surface.

[0006] The permanent magnet commonly is a so-called sandwiched structure, where magnets are sandwiched between ferromagnetic armatures, such as for instance mild steel or ferritic stainless steel. This provides a strength that multiplies the force that can be achieved by the magnet alone. To further increase the strength, several magnets can be stacked together with a steel armature between each magnet and at the outside of both outermost magnets. One or more bolts may extend through the stack to hold it firmly together.

[0007] A general problem with permanent magnets is that they contain iron and thus are susceptible to corrosion. Hence, the magnets must be covered to avoid contact with water. This is commonly done by embedding the magnets in epoxy.

[0008] In known marine magnets, such as magnets sold by Miko Marine and Bear Paw Magnetic Tools, the magnets, such as a sandwich stack, are placed in a cavity formed by a rectangular housing. The housing is comprised by a top plate and four right angled, completely vertical walls. In addition, the prior art solutions often require an extra fixation between magnet core and the housing, such as fasteners or welding, with negative effects such as increased size, increased cost or reduced holding force. This to prevent the magnet core from unintendedly releasing from the housing and thus risk failure as the bond between the housing epoxy and magnet core are commonly not considered to be sufficient bond to keep the magnet core fixed to the housing over time.

[0009] The cavity of the housing is filled with epoxy to cover the magnets. The steel armature commonly extends a little beyond the magnets towards the open end of the housing. Consequently, the steel will have an exposed surface while the magnets are fully covered. This will ensure good contact between the magnetized steel armature and the surface to which the holding magnet is attached.

[0010] US 2 954 257 describes a magnet where the housing in which the magnet is placed, have a narrow opening to prevent the magnet from falling out. However, the

magnet is deliberately arranged loose in the housing so that it can accommodate to the surface it is attached to. A loose magnet means that if the device is used under water, water will easily find its way in between the housing and the magnet. The magnetic material is highly corrosive, and hence the water will result in aggressive corrosion. Consequently, this holding magnet is not suitable for use under water.

[0011] GB 865 502 shows a similar device as the above where the magnet is placed loose in the housing.

[0012] DE 296 18 217 shows a magnet device where a distance disc is placed between magnet and the housing at the bottom of the cavity. At the sides and the front, the magnet is surrounded by a plastic material that may be injected. The distance disc is held in place by protrusions. These protrusions are not continuous along the housing.

[0013] In another embodiment the distance disc is replaced by a thicker bottom of the housing. In both cases there is no filler between the housing and the magnet. The aim is to ensure good magnetic contact between the housing and the magnet. The lack of filler material between the housing and the magnet makes the device more susceptible to water ingress.

[0014] DE 28 02 537 show a holding magnet where filler material has be injected at the lateral sides of the magnet. These is no filler material at the bottom of the cavity in the housing or at the front of the magnet. Hence, this device is not suitable for underwater use.

[0015] Holding magnets are also known from CN 103928209, US2954257 and US2013/0271247. US5711515 and US 2009/133246 show holding magnets not designed for maritime purposes.

[0016] DE 195 07 506 and DE 198 10 612 show the use of magnets in creating apertures in concrete slabs during forming. None of these are suitable to be used as underwater holding magnets.

[0017] US 2013/222091 describes a system for detaching a magnetic structure from a ferromagnetic material. It shows in one embodiment a magnet which is received in an aperture in a plate. Both the magnet and the aperture are conical. To prevent the magnet from falling out of the aperture, a second plate is attached to the first plate to

close the aperture at its widest end. This known solution is not suitable for use as a corrosion protected holding magnet, such as in the maritime area.

[0018] The attachment eye is commonly attached to the housing and the stack by a bolt going through both parts. The bolt will transfer some of the force, but as it is in contact with the magnet stack in a single point, the risk would be great for the stack to disintegrate if this had been the only means for transferring the loads. In addition, there is a risk that the user of the magnet will remove the eye and bolt during operation.

[0019] The filling of epoxy and arrangement of the magnetic core and housing according to the present invention provides an effectively way of keeping the magnet within the holding magnet. Without this, bolt(s) or welding would be mandatory requirements to maintain the magnet within the cavity of the holding magnet. As the holding magnet usually will be handled by hand by a diver, it is a desire to reduce the volume and weight of the holding magnet, while at the same time maintaining its holding strength and increasing the reliability.

The holding magnet according to the invention thus provides a compact, lightweight, cost efficient holding magnet.

It further provides an easier assembly of the parts, requires lesser footprint both in that it may be arranged in a smaller housing, but also in that it maintains the holding strength with reduced overall size compared to prior art holding magnets.

Summary of invention

[0020] The above objective is met by a holding magnet with an internal cavity and shape of the magnet or magnet core that facilitates the bonding of the magnet or magnet core through the filler material, such as epoxy, ensuring good mechanical coupling between the magnet core and the filler material, and providing good corrosion protection for the magnet material.

[0021] The holding magnet according to the invention thus fixes the magnet or magnet core to the housing through the shape of the epoxy, instead of the epoxy bond.

[0022] According to the invention, the holding magnet that has an internal cavity of the housing that has a smallest width and length that are larger than the width and length of the magnetic core and is shaped to have a smaller cross-sectional area closer to the opening of the housing than further away from the opening.

[0023] The holding magnet has a magnetic core that is shaped in such way that it becomes locked inside the epoxy even without relying on any frictional bond or glued connection.

[0024] The fastening mechanism of the magnet core to facilitate the bonding between the magnet core and the epoxy may for instance be: that at least one of the sides of the magnet core having a protrusion, such as a bolt extending from the sides, or a notch. Alternatively, through a horizontal hole or socket in the sides or the magnet core, through the entire magnet core or only partially, or alternatively having a declined cross-sectional area towards the open end of said cavity.

[0025] More specifically the objective is met by a holding magnet as set out in claim 1 and the method of manufacturing a holding magnet according to claim 8.

[0026] Preferable embodiments are set out in the accompanying dependent claims.

Brief description of drawings

[0027] The invention will now be explained in detail, referring to exemplary embodiments, which are shown in the accompanying drawings, in which:
Figure 1 shows an isometric view of a holding magnet according to an embodiment of the invention,

Figure 2 shows an isometric exploded view of the holding magnet of figure 1 from a first direction,

Figure 3 shows an isometric exploded view of the holding magnet of figure 1 from a second direction,

Figure 4 shows a planar view of the holding magnet of figure 1 from the underside,

Figure 5 shows a cross-section through the magnetic core of figure 1, and

Figures 6-9 illustrate various alternative shapes of the cavity of the housing of the holding magnet.

Detailed description of the invention

[0028] In the following description the term “holding magnet” will be used to denote the whole device comprising the subsequently described elements. The term “magnet core” or “core” will be used instead of magnet in the following to denote the element containing the magnetic material, i.e. the magnet and any steel or ferritic stainless steel armature arranged in a stack with the magnet, as well as any bolts holding the magnet core together as a unit. Instead of a sandwiched structure the magnet core may have other designs eg Halbach array, pot magnet or a simple magnet block. The magnetic material may for instance be ferritic, AlNiCo, SmCo or NdFeB. The term “housing” will be used to denote the element having a cavity to receive and retain the magnet. The term “handle” will be used to denote the lever arm that is used to pull the holding magnet away from the surface to release it. The term “attachment eye” or “eye” will be used to denote an element adapted for attachment of equipment, such as a hook, ROV manipulator handle or other equipment to the holding magnet. The eye may be eye-shaped but may alternatively be formed otherwise to be suitable for attachment of special tools.

[0029] Figure 1 shows an isometric view of an embodiment of the holding magnet 1. Here can be seen an outer surface of the housing 2, the handle 3, which comprises a handle bar 4 and two levers 5, 6 firmly attached to the handle bar 4 at one end and hingedly attached at 7 to the housing 2 close to the second end. The levers 5, 6 have a section 5a, 6a (se also figures 2 and 3) that extend beyond the hinged attachment 7 to the housing 2. When the handle 3 is turned, the sections 5a and 6a will be lowered down to the surface onto which the holding magnet 1 has been magnetically attached and lift one end of the holding magnet 1 so that it can be detached from the surface by hand. Alternatively, this may be performed by a screw mechanism or in other ways in order to lift the holding magnet 1 sufficiently away from the surface to diminish the attachment force.

[0030] Figure 1 also shows an attachment eye 8 that may be bolted to the housing 2. The eye 8 may also be welded, glued or otherwise firmly fixed to the housing 2. As

mentioned above, the eye 8 may also have other shapes that are compatible with the equipment to be fixed to the holding magnet. The attachment eye 8 is however not a mandatory requirement for the invention.

[0031] Figures 2 and 3 show the holding magnet 1 in exploded views seen from two different directions. The housing 2 has a top surface 9, which is generally planar, and four side walls 10, 11, 12 ,13 protruding from the to surface 9. At least one wall is set typically in an angle less than 90°to the top surface 9 to form an inclined, inwardly sloping wall. Three of the walls 10, 11, 12 join the top surface 9 at the edge thereof, while the fourth wall 13 is displaced to a position distant from the closest edge. This creates a pocket 14 that is open at two sides.

[0032] At the opposite side of the wall 13 from the pocket 14 is a cavity 15. This cavity 15 accommodates the magnet core, which is denoted by 16. The magnet core 16 may be held in place by a bolt 17 that extends through a hole 18 in the magnet core 16 and connects firmly with the eye 8. The bolt 17 is however not mandatory for the invention to function.

[0033] The magnet core 16 has side surfaces 16f, 16g, 16h, 16i as illustrated in fig. 3. The magnet core may further have bolts 19 that hold the sandwiched core 16 together. The bolt being defined as fastening mechanism.

[0034] Figures 1 and 2 also show an aperture 20. The aperture 20 may be arranged in as a through hole in the housing as indicated in the figure 1 and 2. The aperture provides an extra attachment area for hook, rope or similar, such as carabiner hook etc.

[0035] Figure 4 shows the holding magnet in a planar view from the underside. It shows the housing 2 with the cavity 15 and the magnet core 16. As can be seen here, the magnet core 16 comprises two magnets 16a, 16b and three steel armatures 16c, 16d and 16e, which are arranged alternatingly in the sandwiched structure. The steel armatures 16c, 16d and 16e protrude slightly beyond the surface of the magnets 16a, 16b, so that when the cavity 15 is filled with epoxy the outer surfaces of the steel armatures are exposed, while the magnet core 16 are fully covered by the epoxy.

[0036] Figure 5 shows a longitudinal section through the holding magnet 1. It reveals the details of the magnet core 16, which is held in place inside the housing by the bolt through the central steel armature 16d. As can be seen in this figure, the central armature 16d protrude slightly beyond the remaining parts of the sandwiched structure also towards the bottom of the cavity 15. Thereby a good contact will be achieved against the housing 2 in the vicinity of the bolt 17. It will also create a crevice 21a between the rest of the magnet core 16 and the housing 2, which can be filled with epoxy. The magnet core 16 is preferably arranged centrally within the cavity 15 with approximately the same distance to all the side walls. The gap between the magnet core 16 and each side wall should be large enough to fill the gap with a sufficient amount of epoxy to form a strong bond between the epoxy and the magnet core 16 and the housing, i.e. about 1-6 mm. A further possible limitation of the gap may be 1-2 mm.

[0037] Before the magnet core 16 is placed in the cavity 15, the cavity may be partially filled with epoxy to ensure that a sufficient amount of epoxy is introduced at the bottom of the cavity 15. Then the magnet core 16 is placed in the cavity, the bolt 17 is firmly tightened. This will squeeze epoxy out from the crevice 21a and ensure that there are no air pockets in the epoxy.

[0038] After the bolt 17 has been tightened, and possibly also after the epoxy at the bottom of the cavity has cured, the outer part of the cavity 15 is filled with epoxy. Epoxy is also applied on the outer surface of the magnet core 16. After the epoxy has cured, the outer surface will be grinded to remove epoxy on the steel armatures. Due to crimping of the epoxy, it may be necessary to apply more epoxy after it has cured, to compensate for the crimping.

[0039] The epoxy will bind to the surfaces of the housing 2 and the magnet core 16.

[0040] The figure 5 further shows the bolt 19 extending through the stack. The bolt 19 is protruding from two opposite side surfaces of the magnet core 16 to increase the bonding between the magnet core 16 in the epoxy. This illustrates one alternative way of fixing the magnet core 16 within the housing 2.

[0041] Although epoxy is the preferred material to be used for filling the cavity 15 around the magnet core 16, other types of filler may also be used, such as various other polymers, resins, and rubber. The filler material may be fibre reinforced.

[0042] As can be seen in figure 5, the walls 11 and 13 are slightly inclined towards the cavity 15, so that the opening of the cavity 15 is slightly smaller than the cross-section of the cavity at the bottom of the cavity 15.

[0043] When the cavity 15 is filled with epoxy and this has been allowed to cure, the epoxy will have a wedge shape that assists in preventing any release of the bond between the epoxy and the housing. Consequently, there will be a much stronger connection between the magnet core 16, which is encapsulated in the epoxy, and the housing. The stronger connection will prevent the magnet core 16 from escaping the housing and also prevent any creation of fissures in the epoxy or between the epoxy and the housing. Such fissures would otherwise be subjected to water entrainment and corrosion.

[0044] Similarly, there may be provided a stronger connection between the magnet core 16 and the epoxy to prevent the magnet core 16 to be released from the epoxy in the cavity 15. Possible alternatives for the sidewall and the side of the magnet core 16 are listed and illustrated in the figures 6-9. It is to be noted that the design of the sidewalls and the side of the magnet core 16 are unrelated in the figures and may be combined in any suitable ways.

[0045] Figures 6 – 9 show different alternative shapes of a side wall 11 of the housing 2. It further also shows different alternative shapes of the magnet core 16. In the figure 6 the side wall 11 has been bent slightly inwards. The magnet core 16 is further anchored to the epoxy and held together by the bolt 19 similar to the bolt 19 described in figure 4 and 5.

[0046] In figure 7 the side wall 11 has been welded at an angle to the top surface 9. The magnet core 16 is also in this figure anchored to the epoxy and held together by the bolt 19 or similar fastening arrangement.

[0047] In figure 8 the side wall 11 has a thicker portion 11a closer to the open side of the cavity 15. The magnet core 16 in this embodiment has a wedge shape 21. This wedge shape 21 is indicated in the figure as a stepped curve oriented to a smaller cross-section towards the outer surface of the cavity 17.

[0048] In figure 9, the side wall 11 has an inwardly bent outer portion 11b. The magnet core 16 has in this arrangement wedge portion inclined such as the cross-

sectional area of the inner part of the magnet core 16 is larger than the cross-sectional area of the outer part facing the surface of the magnet core 16. Other alternative shapes that result in a smaller cross-sectional area closer to the opening of the housing than further away from the opening are also possible. For instance, the narrowest cross-section does not need to be at the outer edge of the side walls 11. It may also be somewhere between the outer edge and the bottom.

[0049] Further, the magnet core 16 itself may preferably have a surface 21 that prevents the magnet core 16 from leaving the epoxy even if there is no frictional bond or glued connection between the epoxy and the magnet core/housing. This may be as indicated above by a protruding bolt 19 which is to be embedded in the epoxy. Further alternative may be that the magnet core 16 has an inclined side surface 21 with narrower cross section towards the opening. It is also possible to provide a notch or socket (not shown) in the side of magnet core 16 or a horizontal hole in the sides or the magnet core 16, through the entire magnet core 16 or only partially, to fill up the spacing with epoxy. All of these alternatives and further possible alternatives to maintain the magnet core 16 being referred to as fastening arrangements arranged on at least one side surface of the magnet core 16.

[0050] It is within the ambit of the invention that only one side wall and/or the sides of magnet core 16 is shaped to provide a narrower cross section area. A further possibility is that at least two opposing walls together creates a narrower cross section. Alternatively, all four walls or sides of the magnet core 16 may contribute to the narrower cross section area.

[0051] The whole length of the side wall may be shaped to provide a smaller cross-sectional area or alternatively only a portion of the length.

[0052] The difference between the widest cross section area and the narrowest cross section area does not need to be great. It is sufficient if the difference in length across the opening is in the order of 1-8 mm, for instance between 1-2 mm.

[0053] The housing may also create a cavity that locks the epoxy in place by other means than inclined walls, such as inward protrusions, holes in the side walls – through the entire wall thickness or only partially – or any other shape that prevents the epoxy from leaving the housing when cured.

[0054] The magnet core 16 may, as shown, be a sandwiched structure, such as comprising neodymium magnets and 430 stainless steel, but for smaller holding magnets it may also be a unitary core of magnet. The magnet may also be a Halbach array or a pot magnet or other magnets that are suitable to be used in a holding magnet according to the invention.

[0055] The magnet core 16 may be fixated in the housing only by the epoxy, omitting the bolt 17 fixation. In that case the core 16 is preferably squeezed against the epoxy by a vise or a clamp before curing of the epoxy.

[0056] The housing 2 is preferably made of a stainless-steel plate, or another non-magnetic corrosion protected sheet metal, which is bent or welded to create the side walls. One or more of the side walls may also be separate stainless-steel plates that are welded to the rest of the housing.

[0057] Alternatively, the housing 2 may be made from a block of metal where the cavity is milled or lathed out. In that case, the housing 2 and magnet core 16 may be of a circular shape.

[0058] It is also possible to attach a thin plate of around 1 mm thickness at the open end of the cavity. Such a thin plate will reduce the holding force significantly less than a thicker plate required to provide structural strength. In that case the housing may have an open top, through which the magnet core is inserted and placed against the thin plate. After the cavity 15 has been filled with epoxy, the epoxy has cured and any surplus epoxy has been milled away, a top plate is welded to the housing. Thereby the magnet core is completely encapsulated within the housing 2. The plate is illustrated in figure 8 and 9 with reference number 22.

Claims

1. A holding magnet comprising a magnet core (16), such as a magnet or a sandwiched stack of magnets, a housing (2) defining an open ended cavity (15), said magnetic core (16) being received in said cavity (15) and at least partially retained within said cavity (15) by a filler material, said cavity (15) having a smallest width and length which are larger than the width and length of the magnetic core (16), the magnet core (16) being encapsulated by said filler material at all sides of said magnet core (16) that are facing said housing (2), **characterised in** that said cavity (15) has a smaller cross-sectional area closer to said open end of said cavity (15) than further away from the open end, and that the magnetic core (16) having side surfaces (16f, 16g, 16h, 16i) facing the sides of the cavity extending towards the open end, at least one of the side surfaces (16f, 16g, 16h, 16i) having fastening mechanism (19, 21, 22) in order to keep the magnetic core (16) retained at least partly within the cavity (15) by the filler material.

2. The holding magnet according to claim 1, **characterised in** that the smaller cross-sectional area is created by at least one side wall (10,11, 12, 13) next to said cavity (15) being inclined towards said cavity (15).

3. The holding magnet according to claim 1, **characterised in** that said smaller cross-sectional area is created by at least one side wall (10, 11, 12, 13) next to said cavity (15) having a portion with a greater thickness.

4. The holding magnet according to claim 1, **characterised in** that said smaller cross-sectional area is created by at least one side wall (10, 11, 12, 13) next to said cavity having a portion that is bent towards said cavity.

5. The holding magnet according to any of the preceding claims, **characterised in** that a width difference between widest cross section of the cavity and the narrowest cross section is about 1-8 mm.

6. The holding magnet according to claim 5, **characterised in** that the magnetic core (16) has a raised contact portion, next to where a bolt (17) extends through the magnetic core (16), that forms a seat against the housing (2) and creates a crevice between the magnetic core (16) and the housing (2).

7. A method of manufacturing a holding magnet having a housing and a magnetic core, **characterised in** the following steps:

a. forming said housing (2) with a cavity (15) that has a smaller cross-sectional area closer to an open end of said cavity (15) than further away from the open end,

b. partially filling said cavity (15) with a filler material,

c. providing said magnetic core (16) with a fastening mechanism arranged in the at least one side surface of the magnetic core (16)

d. placing said magnetic core (16) within said cavity (15) and squeezing said magnetic core (16) against said filler material,

e. filling the remaining cavity (15) with said filler material,

f. letting said filler material cure, and

g. removing any surplus filler material,

h. wherein said fastening mechanism keep the magnetic core (16) retained at least partly within the cavity (15) by the filler material

8. The method of claim 7, **characterised in** placing said core (16) at approximately equal distance from all side walls (10, 11, 12, 13) and flush with the edges of said side walls (10, 11, 12, 13).

Patentkrav

1. En holdemagnet omfattende en magnetkjerne (16), slik som en magnet eller en lagvis stabel av magneter, et hus (2) som definerer en kavitet (15) med en åpen ende, der magnetkjernen (16) mottas i kaviteten (15) og i fastholdes i det minste delvis inne i kaviteten (15) av et fyllmateriale, idet kaviteten (15) har en minste bredde og lengde som er større enn bredden og lengden til magnetkjernen (16), der magnetkjernen (16 er innkapslet i fyllmaterialet på alle sider av magnetkjernen (16) som vender mot huset (2), **karakterisert ved** at kaviteten (15) har et mindre tverrsnittsareal nærmere den åpne enden av kaviteten (15) er lenger bort fra den åpne enden, og at den magnetiske kjernen (16) har sideoverflater (16f, 16g, 16h, 16i) som vender mot sidene av kaviteten (15) som strekker seg mot den åpne enden, der minst én av sideoverflatene (16f, 16g, 16h, 16i) har en festemekanisme (19, 21, 22) for å holde magnetkjernen (16) fast i det minste delvis inne i kaviteten (15) ved hjelp av fyllmaterialet.

2. Holdemagneten ifølge krav 1, **karakterisert ved** at det mindre tverrsnittsarealet er dannet ved at minst én sidevegg (10,11, 12, 13) inntil kaviteten (15) er skrådd mot kaviteten (15).

3. Holdemagneten ifølge krav 1, **karakterisert ved** at det mindre tverrsnittsarealet er dannet ved at minst én sidevegg (10, 11, 12, 13) inntil kaviteten (15) har en del med større tykkelse.

4. Holdemagneten ifølge krav 1, **karakterisert ved** at det mindre tverrsnittsarealet er dannet ved at minst én sidevegg (10, 11, 12, 13) inntil kaviteten (15) har en del som er bøyd mot kaviteten (15).

5. Holdemagneten ifølge et hvilket som helst av de foregående krav, **karakterisert ved** at breddeforskjellen mellom det videste tverrsnittet av kaviteten og det smaleste tverrsnittet er omtrent 1-8 mm.

6. Holdemagneten ifølge krav 5, **karakterisert ved** at magnetkjernen (16) har et løftet kontaktavsnitt, inntil der hvor en bolt (17) strekker seg

gjennom magnetkjernen (16), som former et sete mot huset (2) og danner en spalte mellom magnetkjernen (16) og huset (2).

7. Fremgangsmåte for å fremstille en holdemagnet som har et hus og en magnetkjerne, **karakterisert ved** følgende trinn:

   a. utforme huset (2) med en kavitet (15) som har et mindre tverrsnittsareal nærmere en åpen ende av kaviteten (15) en lenger bort fra den åpne enden,

   b. delvis fylle kaviteten (15) med et fyllmateriale,

   c. utstyre magnetkjernen (16) med en festemekanisme anordnet på minst den ene sideflaten av magnetkjernen (16),

   d. plassere magnetkjernen (16) inne i kaviteten (15) og presse magnetkjernen (16) mot fyllmaterialet,

   e. fylle resten av kaviteten (15) med fyllmateriale,

   f. la fyllmaterialet herde, og

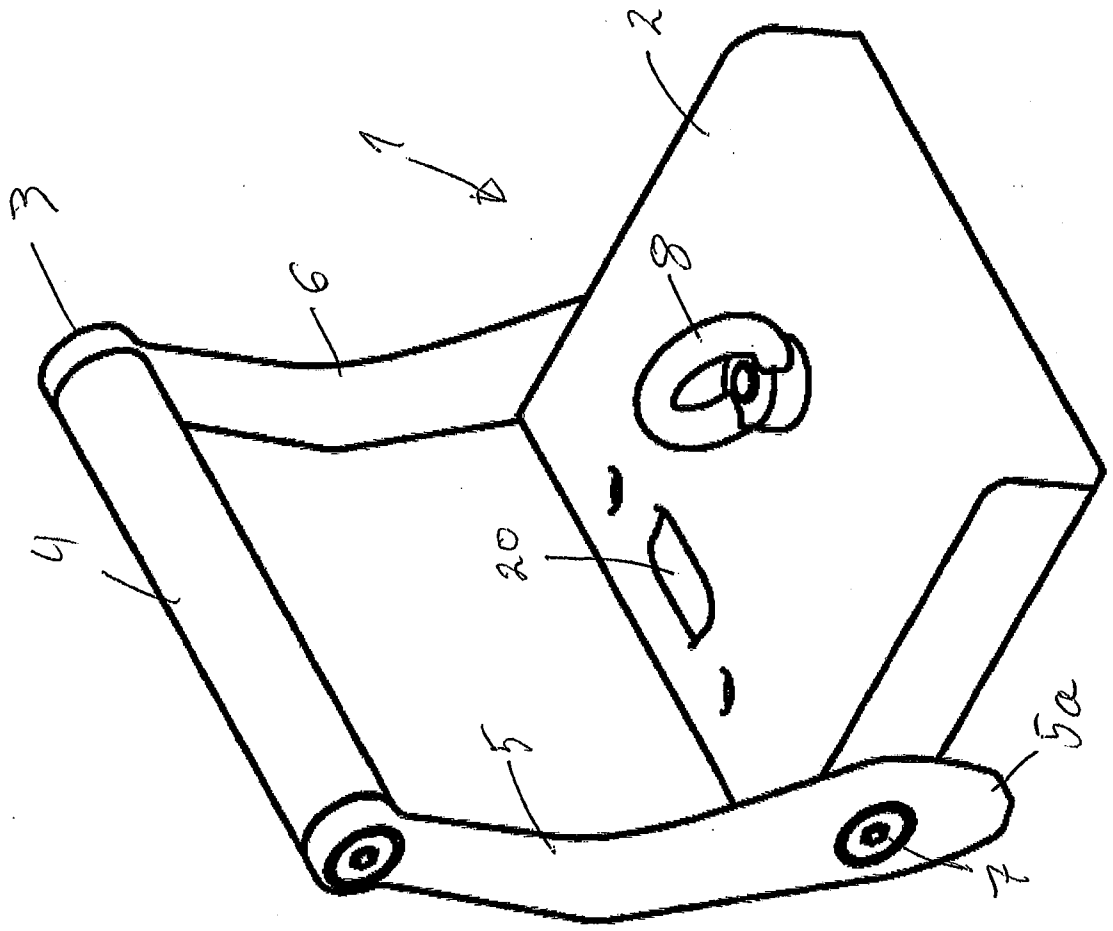
   g. fjerne eventuelt overskuddsfyllmateriale,

   h. der festemekanismen holder magnetkjernen (16) i det minste delvis i kaviteten (15) ved hjelp av fyllmaterialet.

8. Fremgangsmåten ifølge krav 8, **karakterisert ved** å holde magnetkjernen (16) på plass inne i kaviteten (15) ved hjelp av en festemekanisme anordnet på minst én overflate av magnetkjernen (16).

9. Fremgangsmåten ifølge krav 8 eller 9, **karakterisert ved** å plassere kjernen (16) med omtrent lik avstand fra alle sideveggene (10, 11, 12, 13) og i flukt med kanten på sideveggene (10, 11, 12, 13).

Fig. 1



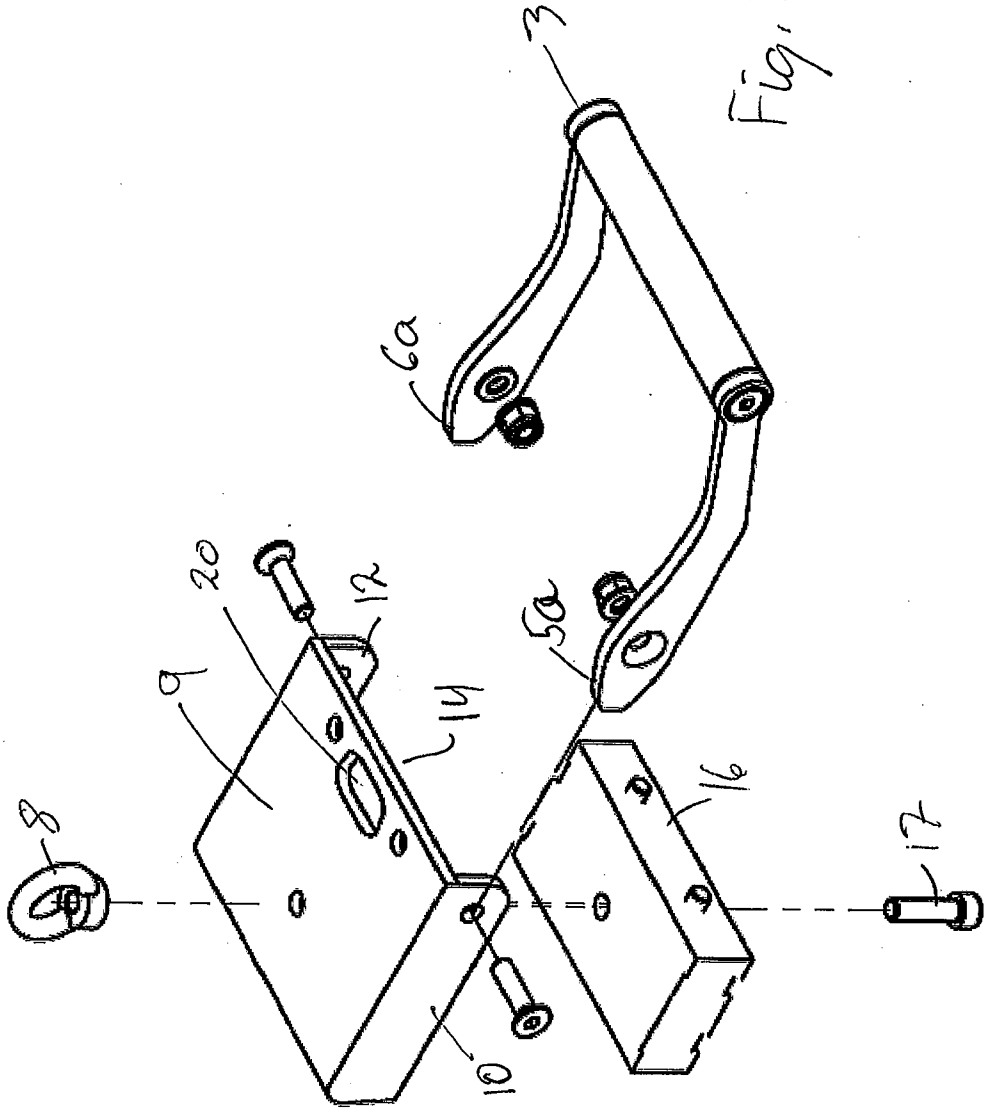


Fig. 2

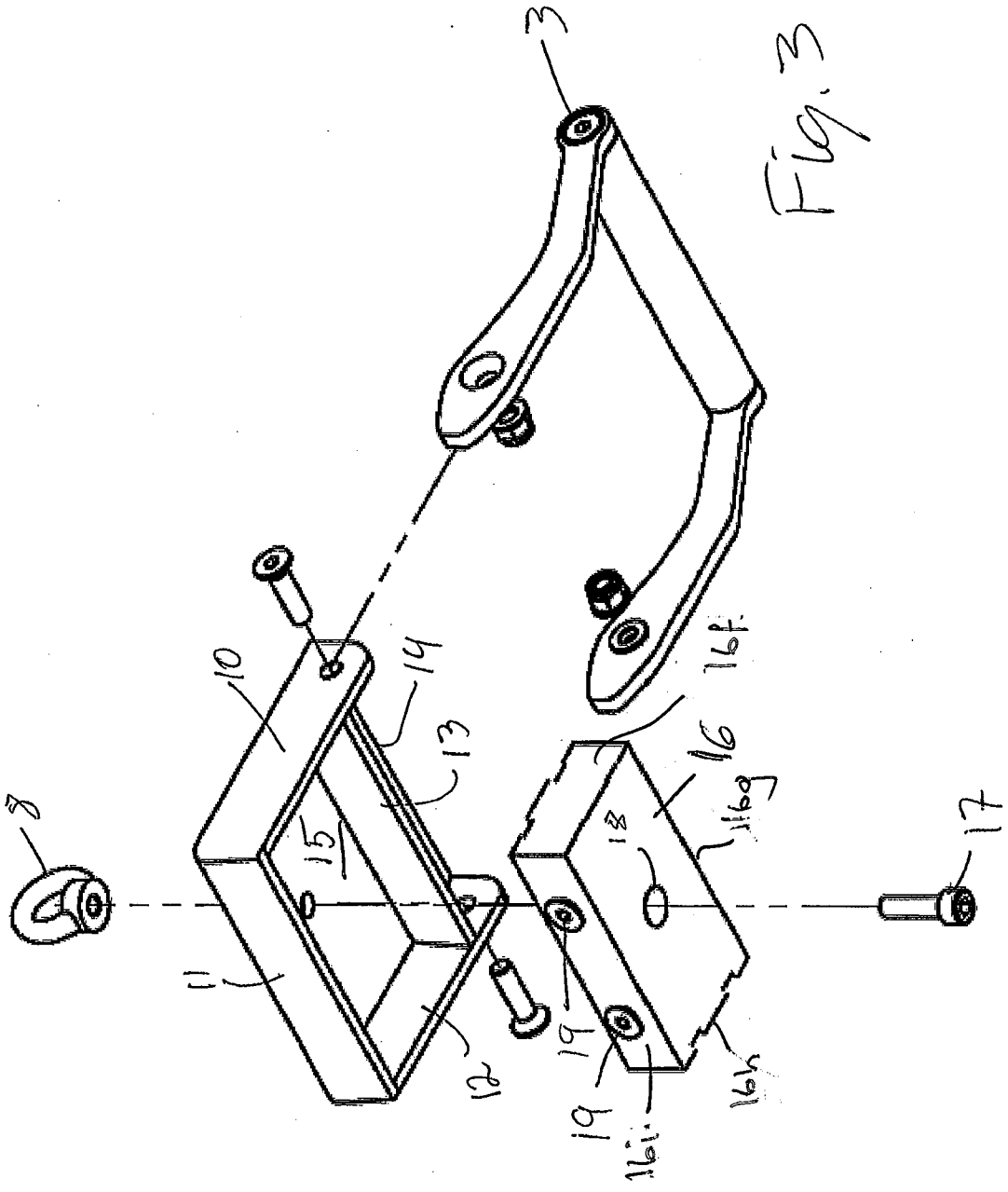
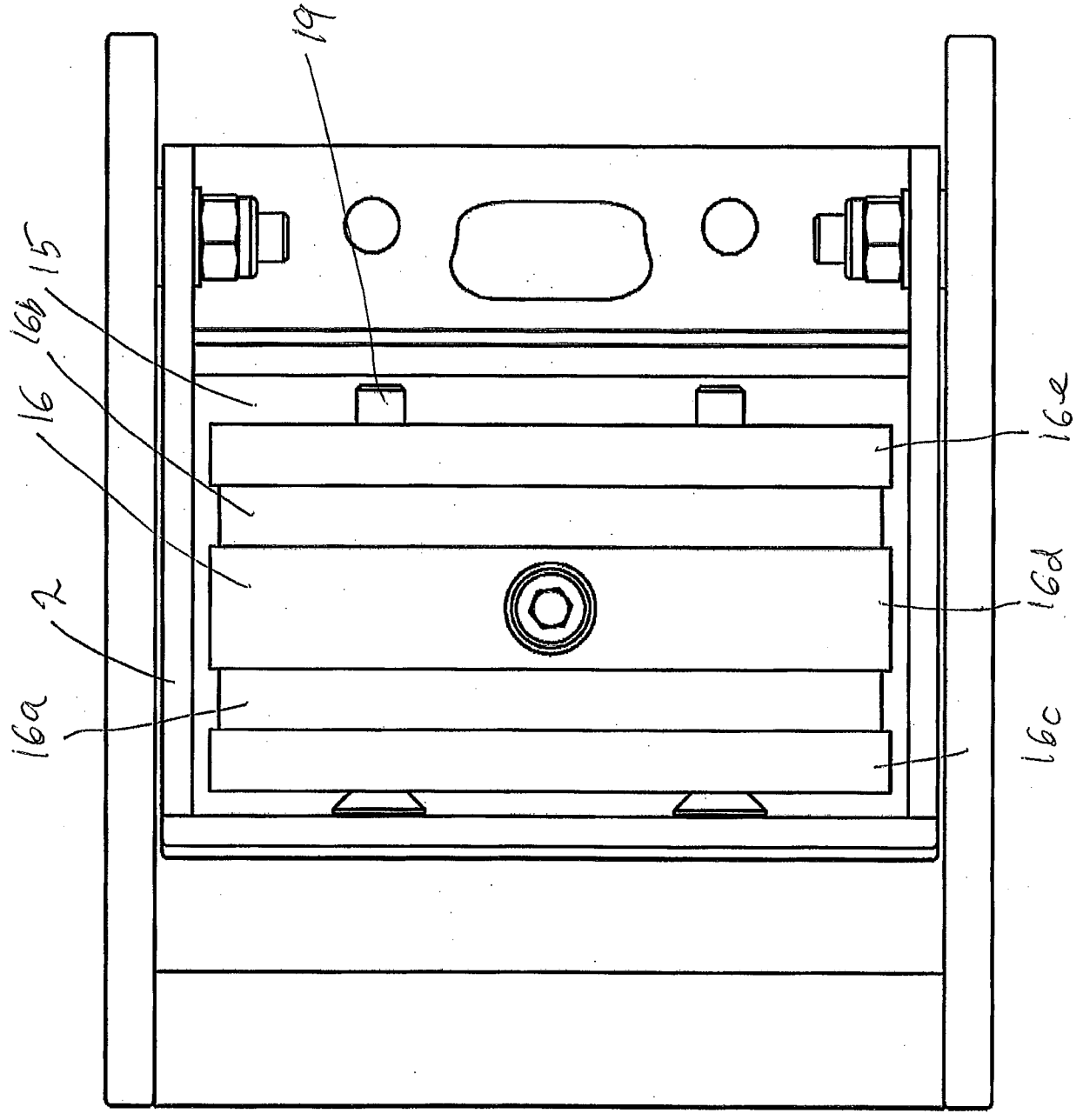


Fig. 3

Fig. 4



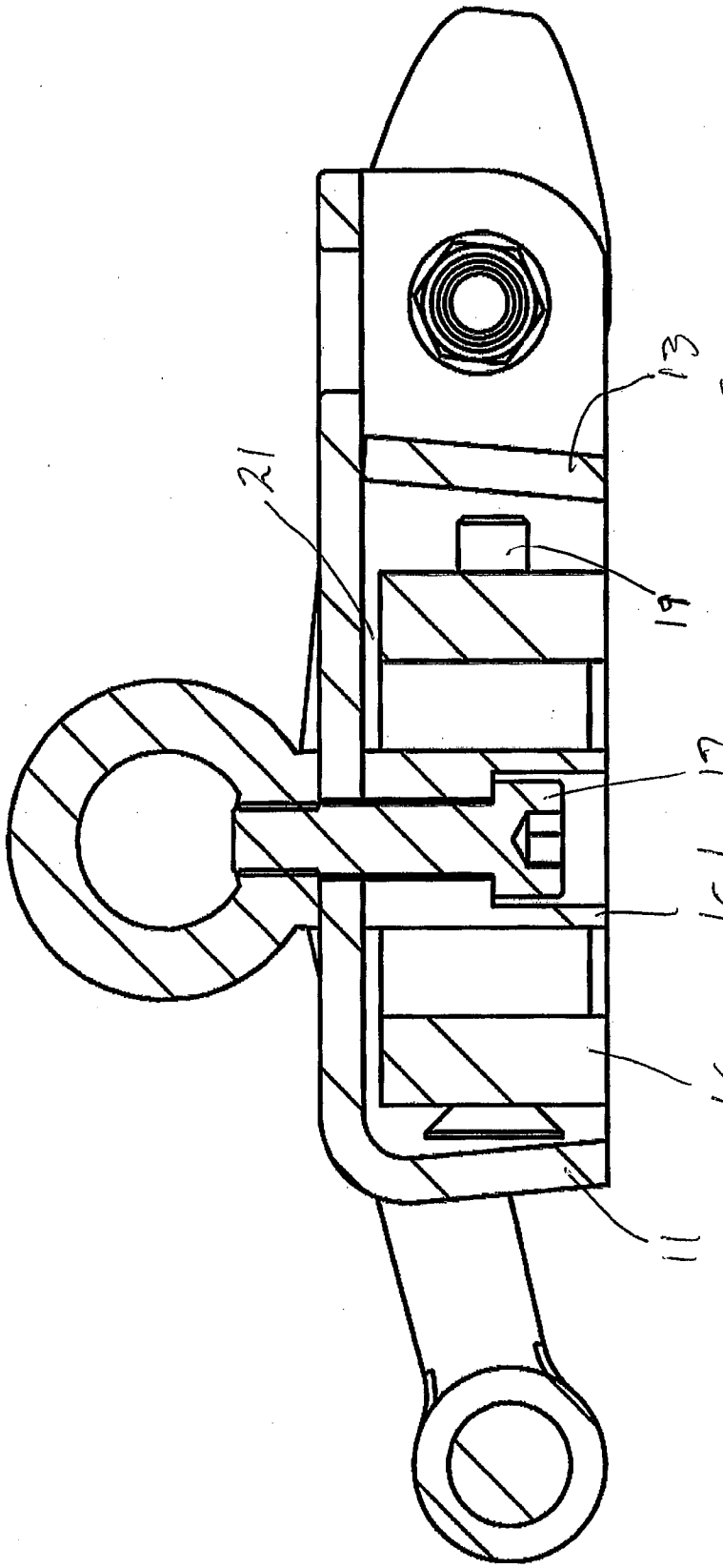


Fig. 5

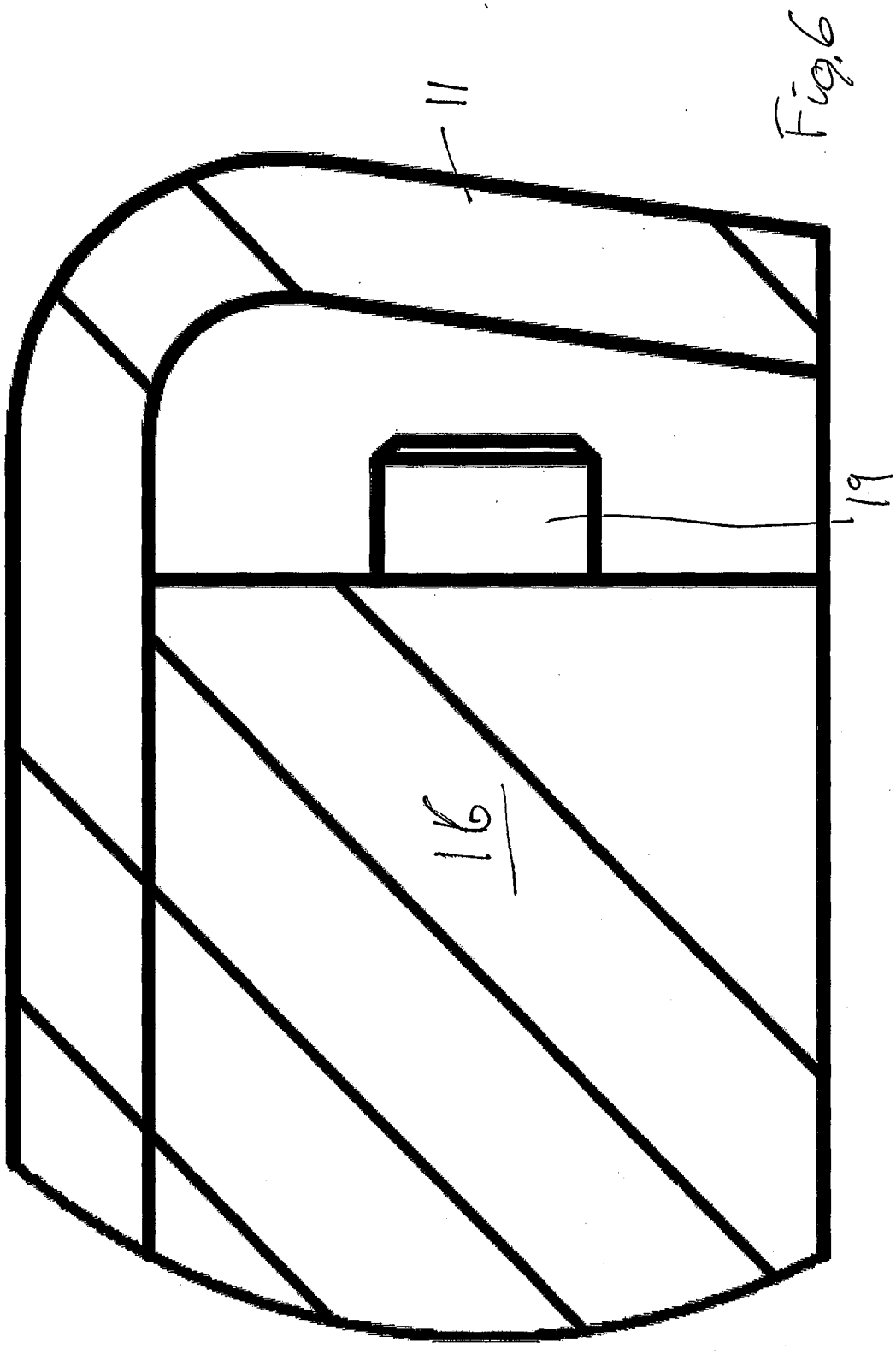


Fig. 6

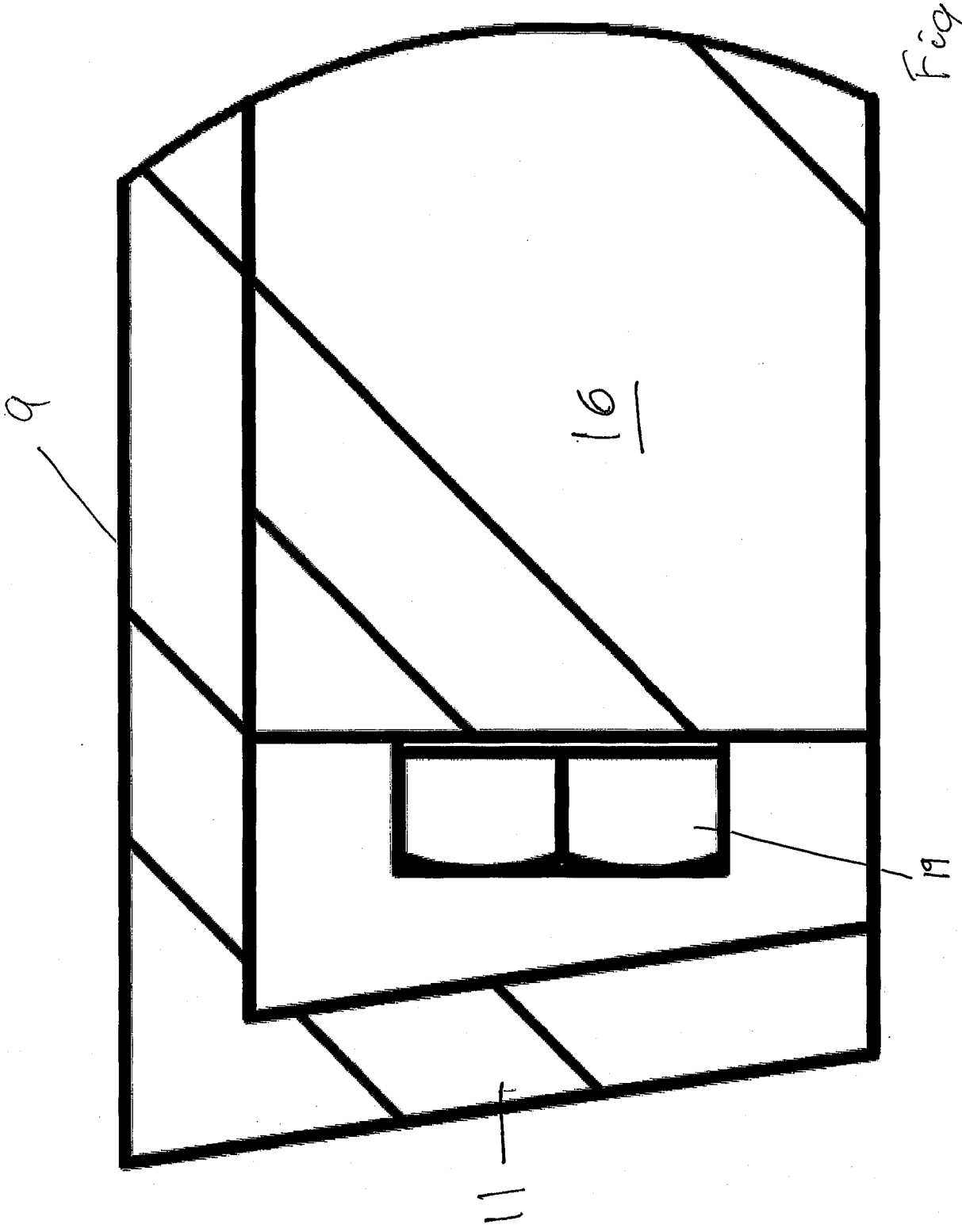


Fig. 7

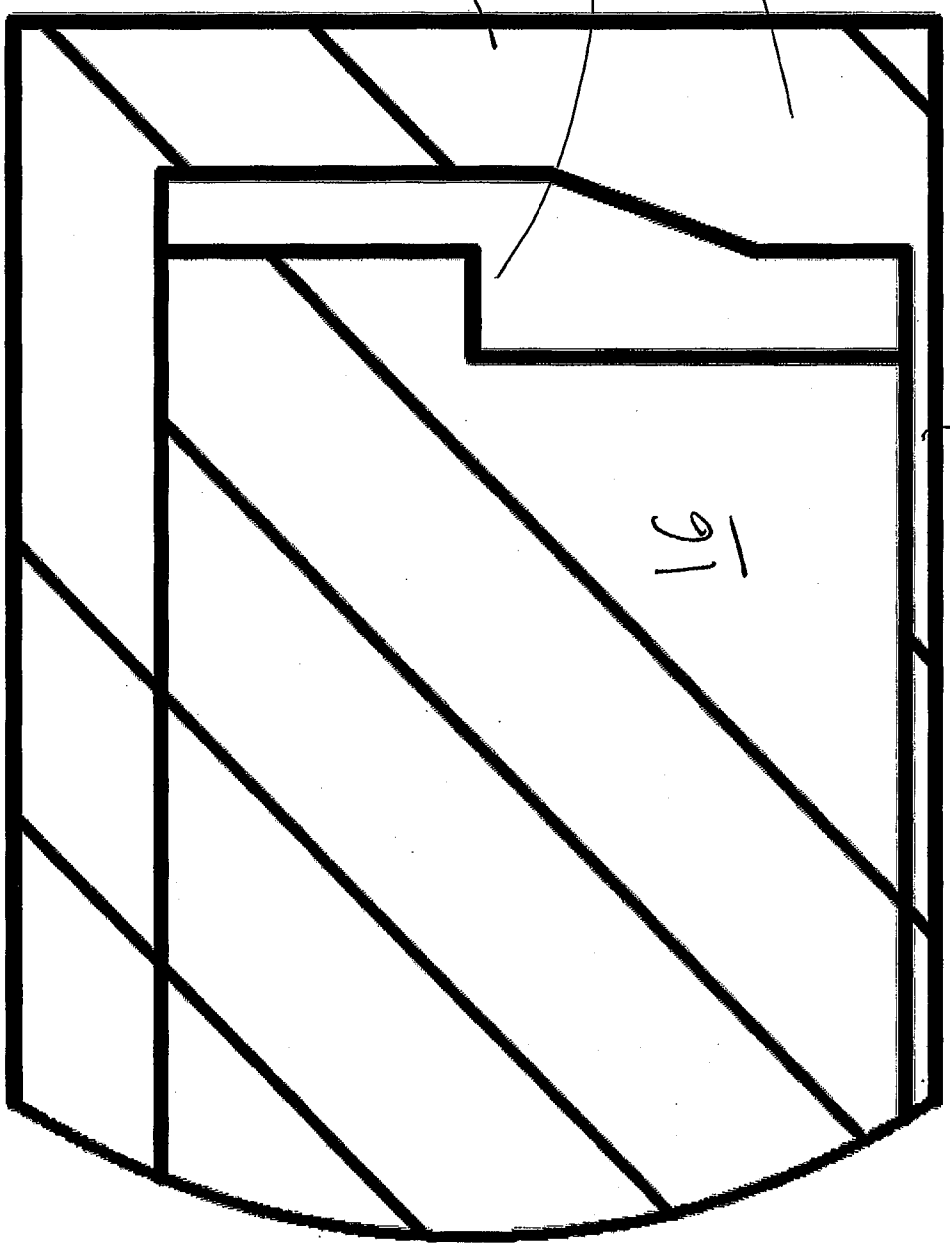


Fig. 8

Fig. 9