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(73) Titulaire(s):
ACCUMALUX – 1899 KOCKELSCHEUER (Luxembourg)

(72) Inventeur(s):
FLAMENT MICHEL – 5770 WEILER-LA-TOUR (Luxembourg), NOTHAR FELIX – 8190 KOPSTAL (Luxembourg)

(74) Mandataire(s):
OFFICE FREYLINGER S.A. –
8001 STRASSEN (Luxembourg)

(54) **Vent plug for lead acid batteries.**

(57) Abstract: The invention concerns a vent plug for a filling hole in a cover for a lead acid battery, said vent plug having an annular body with a head portion and a body portion, said body portion having a thread and a sealing ring on an outer surface of the body portion for mechanically engaging the vent plug in the filling hole in the cover, wherein the head portion of the vent plug has a smooth surface without any interlock possibility in which a tool could be engaged mechanically to screw or unscrew the vent plug. The invention also involves a cover for a lead acid battery comprising said vent plugs as well as a lead acid battery comprising said cover. Fig. 2 92927

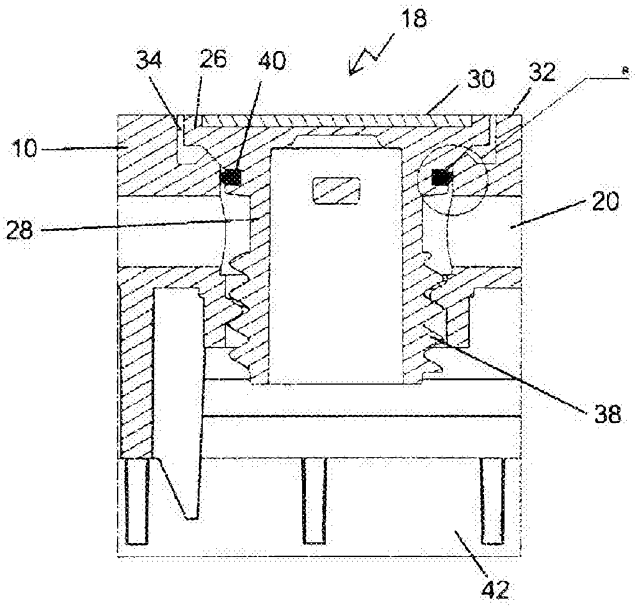

Fig. 2

VENT PLUG FOR LEAD ACID BATTERIES

Technical field

[0001] The present invention relates to a cover for lead acid battery and lead-acid batteries comprising such a cover as well as to vent plugs for the individual cells themselves, in particular the invention relates to lead acid batteries having a cover with a vent plug. The invention also relates to a process for manufacturing said lead acid batteries.

[0002] The invention is extendable to all screwed plug applications in sealed batteries in either vehicles or stand-by power systems.

Background Art

[0003] An electric storage battery such as a lead acid storage battery typically comprises a battery case with a rectangular open top case having a plurality of intercell partition walls. A plurality of battery plates are respectively received between the plurality of intercell partition walls for forming a plurality of battery cells. The plurality of battery plates between the plurality of partition intercell walls are interconnected by intercell connectors extending through the intercell partition walls. The intercell connectors connect the plurality of battery plates between the plurality of partition intercell walls in an electrical series configuration.

[0004] A positive and negative battery post extends upwardly from the battery plates disposed in the battery cells at opposed ends of the battery case for providing a positive pole at one end of the battery case and a negative pole on the other end of the battery case. The positive and negative battery posts extend above the level of the battery case.

[0005] Lead-acid cells and batteries include sulphuric acid as an electrolyte. The sulfuric acid is filed into each battery cell through the filling hole in the cover. The filing hole is then closed.

[0006] The sulfuric acid is a very corrosive acid and it must therefore be made sure that no sulfuric acid can escape or be spilled from the battery cells. Because sulphuric acid has a very low surface tension, it can readily pass through small orifices and cracks. The battery cells must therefore be closed tightly and firmly.

92927

[0007] Traditionally, the filling holes of the batteries are closed by push vent plugs or by screw vent plugs. An opening of these vent plugs brings a serious risk of injury to persons through spilling of the contained hazardous substances or causes a significant reduction of the life cycle of the battery. For this purpose in order to prevent the opening of the filling holes, the vent plugs are ultrasonic or friction welded or clipped or screwed and sealed additionally by a label afterwards.

[0008] It is also known to close the holes of the battery cells by welded or clipped vent plugs that cannot be opened without damaging the surface of the vent plugs or the surface of the lid.

[0009] State of the art is that the geometry of the head of the screwed vent plug foresees an interlock for the screwdriver automat. Most common screw drive types are the slotted types or the one way type.

[0010] The geometry of the vent plug head where an interlock is foreseen strongly facilitates the opening of the vent plugs by non-authorized persons due to common available screw-drivers or tools which can be used for the transmission of the untightening torque.

[0011] When applying an interlock screw drive system the risk of injury to persons is at the highest level due to the possibility for unscrewing the vent plugs and spilling the hazardous substances out of the battery by the simple application of conventional tools used for the positive-locking.

[0012] When applying an interlock screw drive systems the vent plugs can be opened without damaging the surface of the vent plug or the surface of the lid. An opening of the battery can still strongly affect the functionality of the battery.

[0013] For safety reasons and in order to maintain the functionality of the battery, the filling holes of the battery cells can be closed by a ramp which is non-detachably connected to the battery cover or to the battery container by clipping or welding. The ramp can thus not be opened except by the authorized person for later recycling purposes. Due to their permanent joint with the battery cover or battery container, such ramps cannot be opened without damaging the battery.

[0014] It is also state of the art, for safety reasons and also in order to maintain the battery functionality to weld or clip a secondary lid over the primary lid which closes the battery. The main function of the secondary lid is to prohibit the access to

the vent plugs respectively to the filling holes of the battery cells, which are part of the design of the primary lid.

[0015] The vent plugs should be tamperproof so that they cannot be opened unnoticed.

[0016] A principal drawback in the use of the known methods is that they require special tools or further steps which are difficult to integrate in existing production lines.

Technical problem

[0017] It is an object of the present invention to provide a vent plug for a cover of a lead acid battery, which allows to close the battery cells in a tamperproof way, which needs no additional production steps on a standard battery assembly line.

General Description of the Invention

[0018] To achieve this object, the present invention proposes a vent plug for a filling hole in a cover made of plastic material for a lead acid battery, said vent plug having an annular body with a head portion and a body portion, said body portion having a thread and a sealing ring on an outer surface of the body portion for mechanically engaging the vent plug in the filling hole in the cover, wherein head portion of the vent plug has a smooth surface.

[0019] The word *smooth* is to be understood as a surface without any interlock possibility like projections, ridges, creases, corrugations, folds, slits, notches, cut outs etc in which a tool like a screw driver, nut driver or the like could be engaged mechanically to screw or unscrew the vent plug. In other words the vent plug comprises no interlock adaptation system for a screwing / unscrewing device.

[0020] The device for mechanically engaging the vent plug in the filling hole is preferably situated on the outer surface of the body portion of the vent plug.

[0021] The torque required to screw the vent plug into the filing hole of the cover is equal or smaller than the torque required to unscrew the vent plug from the filing hole. It is not possible to unscrew the vent plug without the same appliance that was used to screw the vent plug into the filling hole of the cover without damaging the cover or the vent plug.

92927

[0022] The vent plug is screwed in the filling hole with a predetermined torque and a predetermined speed so that the momentum is enough to engage the vent plug in the filing hole just a little i.e. so much that the vent plug cannot be unscrewed without damaging it. The vent plug is inserted into the filing hole with a certain velocity so that it is "squeezed in" the filing hole.

[0023] The top surface of the plug is configured to enable the transfer by friction of the required tightening torque.

[0024] This invention may be thus applied to any vent plug having a flat – level - smooth head portion respectively top surface and/or any plug without any adaptation system for a screwing / unscrewing system composed of one or more different components in any geometric form on the surface of the plug. The dimensions, geometry and materials used with regard to vent plugs may vary widely. The present vent plugs may be used in any screwed vent plug application in sealed batteries in vehicles or in stand-by power systems.

[0025] The advantage of this kind of vent plug is that tamperproof batteries may be produced on a conventional battery assembly line. The cells of said batteries however cannot be reopened once the vent plugs are placed without visible damage of the plug and/or the cover. It is thus the first time that such "maintenance free" batteries can be produced using a standard cover and without any modification on the production lines. There is provided a technical solution which allows to screw a flat / smooth vent plug into a filing hole of a standard battery cover using a predefined torque. Once the vent plug is screwed into the cover, it becomes impossible to unscrew the plug without damaging and/or destroying the plug and/or the cover.

[0026] The device for mechanically engaging the vent plug in the filing hole comprises a thread and a sealing ring on said outer surface of the body portion of the vent plug. .

[0027] In a preferred embodiment, the head portion of the vent plug comprises a top surface with a roughness between Ra=0.1 and Ra=30 µm. The roughness of the top surface is enough to allow the vent plug to be screwed into the filing hole and obtain enough momentum to deform the sealing ring.

92927

[0028] The top surface of the head portion of the vent plug is either made of the same material as the vent plug or the top surface is fully or partially covered by a material which is different from the material of the vent plug material.

[0029] The top surface of the head portion of the vent plug is covered by at least two different materials.

[0030] The vent plug is made of a thermoplastic material like polypropylene, the sealing ring is made of thermoplastic elastomer or rubber.

[0031] According to a further aspect, the invention also concerns a lead acid battery as well as a cover for a lead acid battery comprising at least one vent plug as described above.

[0032] According to a further aspect, the invention also concerns a process for sealing a lead acid battery using a vent plug as described above.

[0033] The vent plugs described herein may be used in conventional production lines only by adapting the screwing head. The torque that is required to screw the vent plug into the filing hole of the battery cover is transmitted from the tool to the vent plug by friction only. Since the transmission of the tightening torque is obtained by friction only, the finishing of the surfaces respectively the material types of the top surface of the plug is important.

[0034] It has been found that the applied torque should range between 100 N*cm to 250 N*cm and is applied by friction in comparison to the conventional positive-locking. The applied axial force on the top of the plug should range from: 150 to 350 N with preferred rotational speeds of between 550 to 650 RPM.

[0035] The screwing head comprises preferably a rubber surface or a roughened steel surface.

[0036] In case the top of the vent plug comprises a rubber surface, the screwing head consists preferably of a roughened steel surface. The roughened steel surface should preferably mate dimensionally with the rubber surface on the top of the plug. The roughness of the steel surface may vary between Ra=0.1 µm and Ra=30 µm. Such a roughness will provide enough grip to transmit the required forces to insert the plug.

92927

[0037] In case the top of the vent plug is made of a thermoplastic polymer, the screwing head either comprises a rubber surface or a roughened steel surface.

[0038] The final selection of the type of screwing head depends on the application environment. Indeed, a roughened flat vent plug can be processed with a rubber screwing tool when the vent plug screwing machines are located in a dry environment with no risk of contamination with acid between the plug and the screwing tool.

[0039] If the surface of the plug and/or the screwing tool is contaminated with acid, this acid is acting as lubricating agent and is thus significantly reducing the friction coefficient between the vent plug and the screwing head. It has been found that the friction coefficient between the vent plug and the screwing head is reduced by a factor of 3 to 10 when their interface is contaminated with battery acid. This reduction depends on the type of plug in combination with the type of screwing head.

[0040] In order to apply the required torque from the screwing head to the vent plug, the following physical effects take place when there is a layer of acid between the plug and the screwing head:

- Part of the layer of acid is pressed out of the interface between the top of the plug and the screwing head due to the applied pressure
- A layer of acid is pressed between the asperities on either the screwing tool or the top of the plug. The asperities are related to the roughness of the tool or on the top of the plug. The volume of acid is determined by the sum of free volumes resulting from the rough surface(s).
- An increase of roughness of either the screwing tool or the top of the vent plug increases the contact surface between the vent plug and the screwing tool. The increase of the contact surface in combination with a steel screwing head and a soft rubber material on the vent plug increases the friction and thus the torque that can be transmitted.

[0041] When the vent plug is inserted into the filing hole, the sealing ring is deformed and the vent plug closes the filing hole tightly .The deflected rubber sealing ring in the screwed in position is working as an additional unscrewing safety due to:

- Deflection of the sealing which needs to be surmounted

- Frictional connection between the plug and the lid.

[0042] In a preferred embodiment, the head portion of the vent plug comprises a top surface with a roughness between Ra=0.1 µm and Ra=30 µm. The roughness of the top surface is enough to allow the vent plug to be screwed into the filing hole and obtain enough momentum to deform the sealing ring.

Brief Description of the Drawings

[0043] A preferred embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

Fig. 1: is a perspective view (side elevation view) of a battery cover using a vent plug illustrative of the present invention,

Fig. 2: is a cross-section view of an illustrative embodiment of a vent plug of the present invention for use in a lead acid battery

Fig. 3: is a partial enlargement of Fig. 2.

Fig. 4 and Fig 5: are perspective views of two different illustrative embodiments of a vent plug of the present invention,

Fig. 6, show a further illustrative embodiment of the top surface of the head portion of a vent plug of the present invention,

Further details and advantages of the present invention will be apparent from the following detailed description.

Detailed Description of the Drawings

[0044] As is shown in FIG. 1, the cover 10 of a lead acid battery comprising a positive and a negative terminal 12, 14 and six filing holes 16. In three of the filing holes, a vent plug 18 is inserted. The filing holes 16 are connected to each other by a venting channel 20 which ends in a venting hole 22 in the sidewall 24 of the cover 10.

[0045] Fig. 2 shows a cross-section view of a vent plug 18 fully inserted in a filing hole 16 of the cover 10. The vent plug 18 has a head portion 26 and a body portion 28. When the vent plug 18 is fully inserted in the filing hole 16, the top surface 30 is flush with the top surface 32 of the cover 10 surrounding the filing hole 16. The vent plug and the filing hole are configured such that only a very narrow gap 34

subsists between the filling hole 16 and the head portion 26 of the vent plug 18. 92927
Typically the gap between the cover and the vent plug is between 0.2mm and 1 mm. It is thus impossible to insert a tool which could grab/grip/seize the circumferential surface 36 of the head portion of the vent plug to unscrew the vent plug 18 from the cover, because the gap 34 is too narrow. If such an attempt was made, the insertion of a tool into the gap 34 would leave traces on the cover 10 and/or plug 18.

[0046] The body portion 28 of the vent plug 18 comprises a device for mechanically engaging the vent plug 18 in the filing hole 20. In this particular embodiment, this device is situated on the outer surface of the body portion 28 of the vent plug 18 and comprises a thread 38 and a sealing ring 40.

[0047] The body portion 28 of the vent plug 18 is hallowed out so that any gases from the battery cell 42 can be evacuated through-holes 44 (cf. Fig. 4) in the sidewall of the body part 28 of the vent plug 18 and the venting channel 20 and the venting hole 22 in the cover 10.

[0048] Fig. 3 shows a partial enlargement of Fig. 2. On this figure, it is shown that the sealing ring 40 is deformed slightly as it is pushed against the inside of the filing hole when the vent plug is inserted into the filing hole.

[0049] Fig. 4 and Fig 5 are perspective views of two different illustrative embodiments of a vent plug of the present invention.

[0050] The two vent plugs differ firstly from the mechanical device on the outer surface of their respective body portions 28 and secondly from their top surface 30 of their respective head portions 26.

[0051] As can be seen, the body portion 28 of the vent plug 18 of Fig. 4 comprises a thread 38, one sealing ring 40 and a through-hole 44. Such vent plugs are typically used for SLI-types automotive batteries that power the starter motor, the lights and the ignition system.

[0052] The body portion 28 of the vent plug 18 of Fig. 5 comprises a thread 38 and two sealing rings 40, a through-hole 44 between the two sealing rings. Such vent plugs are used for valve-regulated lead-acid batteries.

92927

[0053] The vent plugs of Fig. 4 and 5 have different top surfaces on the head portion of the vent plug. The top surface of the vent plug of Fig. 4 is uniform and made of the same material as the vent plug i.e. polypropylene.

[0054] The top surface of the vent plug of Fig. 5 has two different zones, an outer zone and an inner zone. These two zones have different surface properties, i.e. one zone may be rougher i.e. provide more grip than the other or may be made of different material which is more tacky than the other material, like rubber.

[0055] Fig. 6 shows a further embodiment of the top surface of a vent plug. As can be seen on the Fig. 6, the top surface comprises 3 different, concentric zones with different surface properties each. The different surface properties may be due to different materials or different surface roughness. The surfaces depicted herein are examples only and are applicable for all types of vent plugs independent of the battery type. Those skilled in the art will easily come up more varieties, different patterns etc.

92927

Legend

10	cover
12	positive terminal
14	negative terminal
16	Filling hole
18	Vent plug
20	Venting channel
22	venting hole
24	sidewall
26	head portion
28	body portion
30	top surface of the head portion of the vent plug
32	top surface of the cover
34	gap
36	circumferential surface of the head portion
38	thread
40	Sealing ring
42	battery cell
44	through-holes

P-ACCUM-009/LU

REVENDICATIONS

1. Bouchon d'aération pour un trou de remplissage dans un couvercle pour une batterie au plomb-acide, ledit bouchon d'aération ayant un corps annulaire avec une partie de tête et une partie de corps, ladite partie de corps comprendant un filetage et une bague d'étanchéité. pour engager mécaniquement le bouchon d'aération dans le trou de remplissage dans le couvercle, dans lequel la partie de tête du bouchon d'aération a une surface lisse sans possibilités de verrouillage dans laquelle un outil pourrait être engagé mécaniquement pour serrer ou desserrer le bouchon d'aération.

2. Bouchon d'aération selon la revendication 1, dans lequel le dispositif pour engager mécaniquement le bouchon d'aération dans le trou de remplissage est situé sur la surface extérieure de la partie de corps du bouchon d'aération.

3. Bouchon d'aération selon l'une quelconque des revendications précédentes, dans lequel la partie de tête comprend une surface supérieure avec une rugosité entre Ra = 0,1 µm et Ra = 30 µm.

4. Bouchon d'aération selon l'une quelconque des revendications précédentes, dans lequel la surface supérieure de la partie de tête du bouchon d'aération est constituée du même matériau que le bouchon d'aération.

5. Bouchon d'aération selon l'une quelconque des revendications 1 à 3, dans lequel ladite surface supérieure est soit totalement, soit partiellement, recouverte par un matériau qui est différent du matériau du bouchon d'aération.

6. Bouchon d'aération selon l'une quelconque des revendications 1 à 3, dans lequel la surface supérieure de la partie de tête est recouverte par au moins deux matériaux différents.

7. Bouchon d'aération selon l'une quelconque des revendications 1 à 3, dans lequel le bouchon d'aération est constitué d'un matériau thermoplastique.

8. Couvercle pour une batterie au plomb-acide comprenant au moins un bouchon d'aération selon l'une quelconque des revendications 1 à 7.

9. Couvercle selon la revendication 8 dans lequel il y a un espace entre le couvercle et le bouchon d'aération d'entre 0,25 mm et 1 mm.

0. Batterie au plomb-acide comprenant au moins un bouchon d'aération selon l'une quelconque des revendications 1 à 7.

11. Procédé d'étanchéisation d'une batterie au plomb-acide utilisant un bouchon d'aération selon l'une quelconque des revendications 1 à 7, dans lequel le bouchon d'aération est inséré dans le trou de remplissage d'un couvercle de batterie et dans lequel le couple requis pour insérer le bouchon d'aération dans le couvercle est transmis entre un outil et le bouchon d'aération par frottement uniquement.

12. Procédé selon la revendication 11, dans lequel le couple est dans la plage entre 100 N*cm à 250 N*cm.

13. Procédé selon la revendication 11 ou 12, dans lequel une force axiale est appliquée sur le sommet du bouchon d'aération dans la plage de 250 à 350 N.

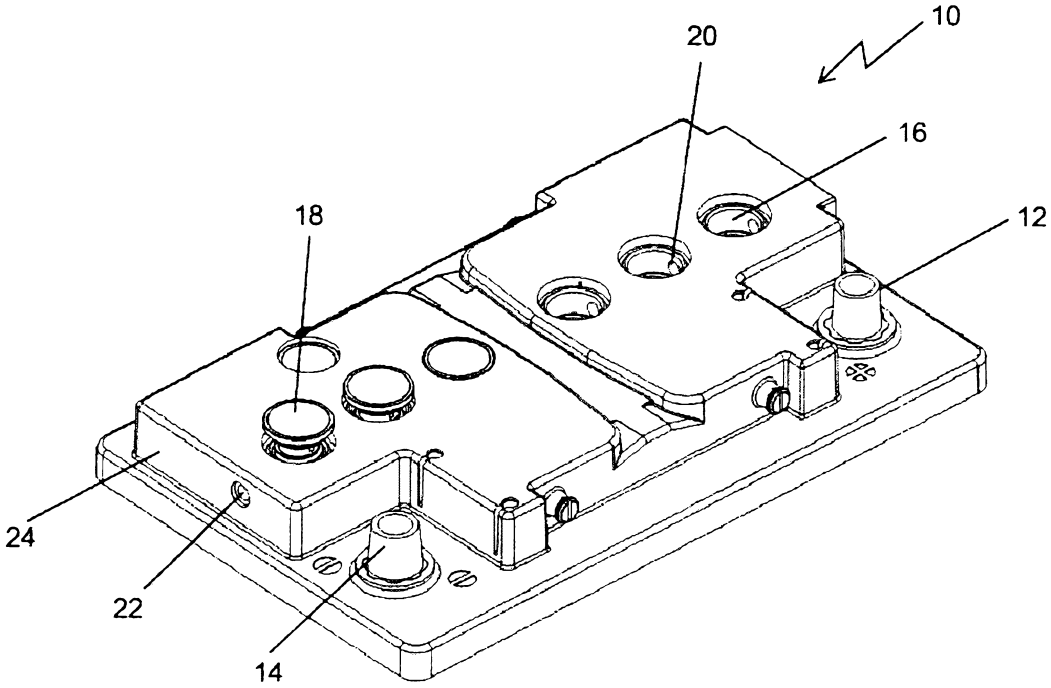

Fig. 1

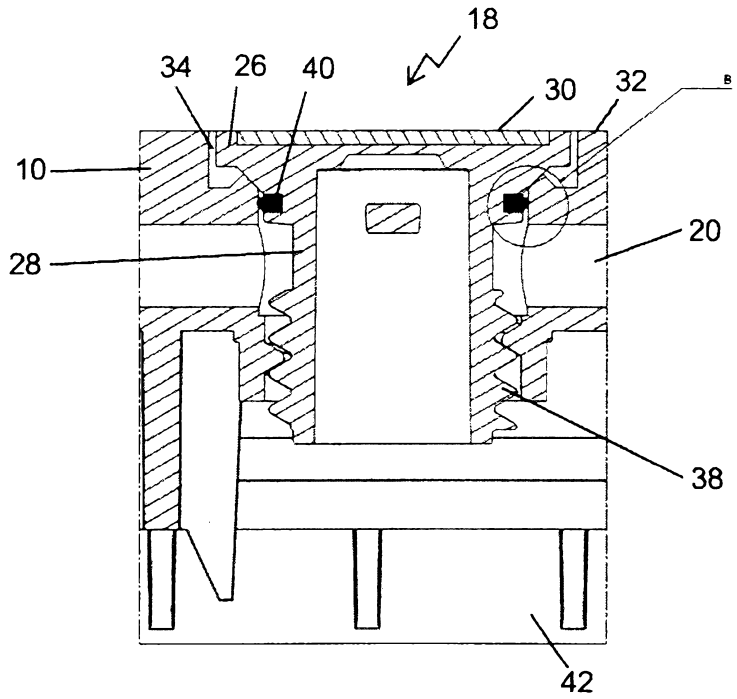

Fig. 2

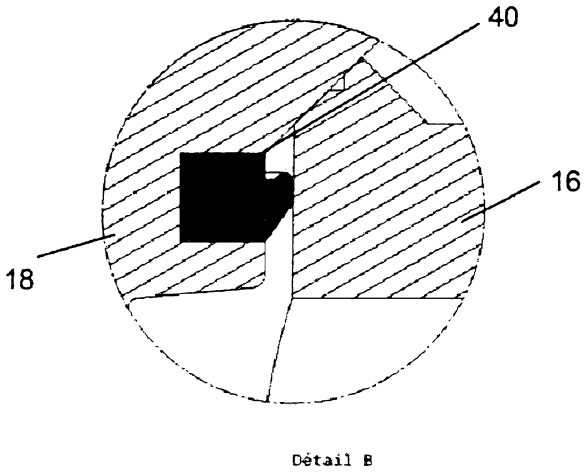

Fig. 3

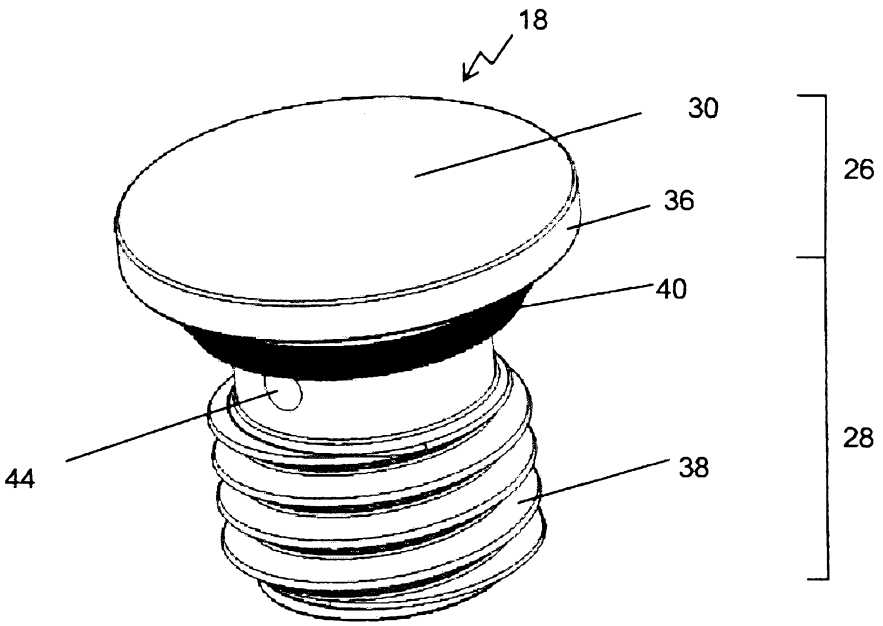

Fig. 4

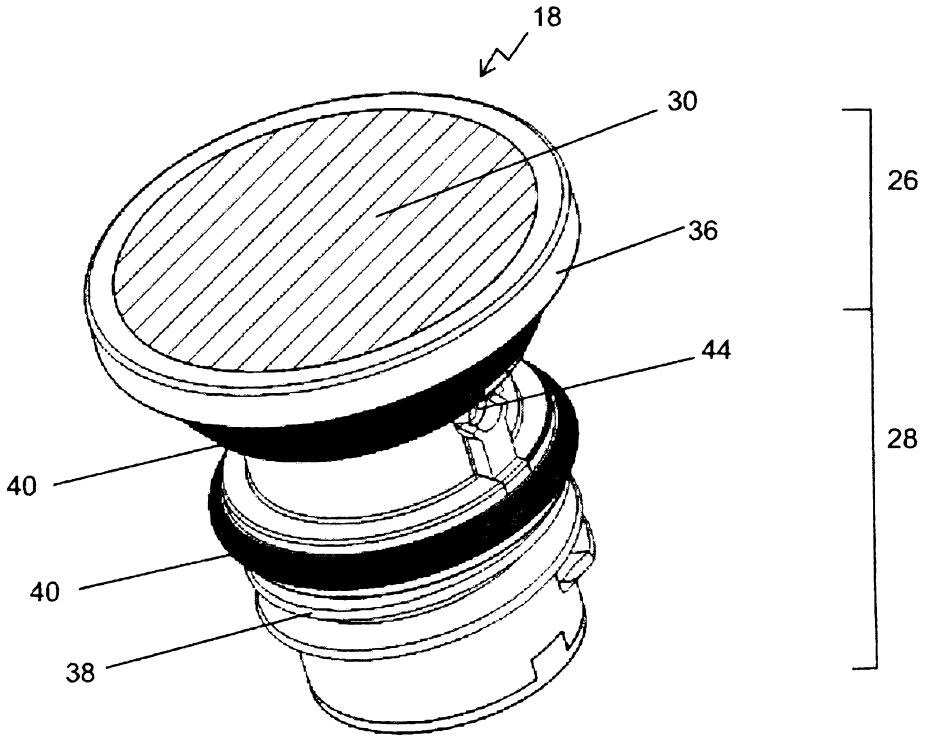

Fig. 5

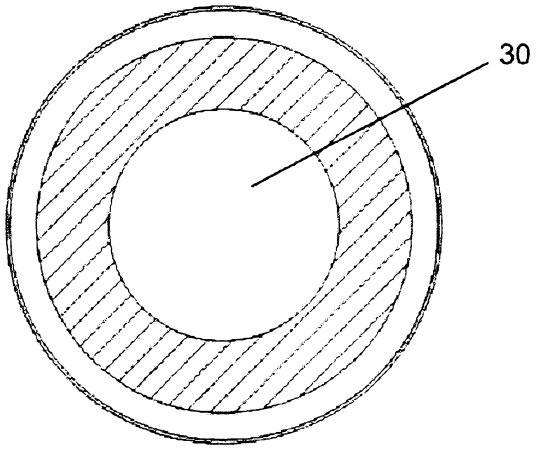

Fig. 6

Abstract

The invention concerns a vent plug for a filling hole in a cover for a lead acid battery, said vent plug having an annular body with a head portion and a body portion, said body portion having a thread and a sealing ring on an outer surface of the body portion for mechanically engaging the vent plug in the filling hole in the cover, wherein the head portion of the vent plug has a smooth surface without any interlock possibility in which a tool could be engaged mechanically to screw or unscrew the vent plug. The invention also involves a cover for a lead acid battery comprising said vent plugs as well as a lead acid battery comprising said cover.

Fig. 2