This invention relates to so-called non-spill vent plugs which are designed to prevent the loss of electrolyte if the battery is tilted to any material extent from its normal upright position.

Many non-spill vent plugs have been proposed heretofore having valves which admit of the venting of the cell when the battery is in upright or substantially upright position but which when the battery is tilted a predetermined amount are closed by a weight which is supported for rocking movement either below or in the body of the vent plug.

The present non-spill vent plug is of the type wherein a valve actuating weight is mounted for movement within the vent plug body, and the principal object of the invention is to provide certain improvements which render this type of non-spill vent plug more satisfactory and efficient in operation.

The invention may be further briefly summarized as consisting in certain novel details of construction and combinations and arrangements of parts which will be described in the specification and set forth in the appended claims.

In the accompanying sheet of drawings where-in we have shown the preferred construction and a modified form thereof.

Fig. 1 is a perspective view of the upper part of a three-cell battery, each cell of which is provided with a non-spill vent plug embodying the present invention;

Fig. 2 is an enlarged vertical sectional view of the vent plug in its preferred form and showing by dotted lines a portion of the cell cover to which the vent plug is applied, the section being taken substantially along the line 2—2 of Fig. 4, the vent plug here being in upright position and the valve being open;

Fig. 3 is a similar view with the vent plug tilted and with the valve closed by the weight which is shown rocking to valve closing position;

Fig. 4 is a transverse sectional view substantially along the line 4—4 of Fig. 2;

Fig. 5 is a transverse sectional view substantially along the line 5—5 of Fig. 2;

Fig. 6 is a detached plan view of a baffle which is employed in the upper part of the vent plug body of Figs. 1 to 5; and

Fig. 7 is a view similar to Fig. 2 but showing a modification.

Referring now to the drawing, we have shown in Fig. 1 a three-cell battery but the number of cells is of course immaterial to the invention since each cell is provided with a vent plug embodying the invention. The battery here shown includes a case 10 provided with cell covers 11 with terminals 12 and cross-connectors 13 all of which parts may have any suitable construction and may be formed of the usual materials. As is customary, each cell cover 11 has a flanged opening 14 (see Fig. 2) internally threaded to receive the vent plug.

The vent plug includes a hollow cylindrical body 16 having at the bottom a reduced neck portion 18 which is externally threaded so that it may be screwed into the threaded opening 14. At the junction of the body portion 16 and the reduced portion 18 a shoulder 17 is provided which is adapted to engage a soft sealing gasket 19 resting on the upper flange of the body 16. If desired, the lower side of the shoulder 17 may be provided with a series of small annular gaskets or flutes 19 to facilitate the sealing action when the vent plug is screwed to its normal position.

At the bottom of the neck portion 18 of the vent plug body is a ledge 20 which defines an annular valve opening 21, the ledge having a flat lower face 22 constituting a valve seat and having a sloping upper face 23 which inclines downwardly and inwardly to the valve opening 21.

The top of the vent plug body 16 is closed by a cap 24 which in this instance has a notched peripheral flange resting on the top edge of the body 16, the flange fitting into the top portion of the body. The cap may be secured in place in any suitable manner, as by being cemented in place, or, if desired, by being screw-threaded in place as in the form of the invention shown in Fig. 7. The cap 24 has a vent opening 25 which extends through a central protuberance 26 formed on the underside of the cap and extending down a suitable distance into the upper part of the chamber formed by the body 16.

Inside the barrel or body 16 of the vent plug is a weight 27 which is formed of a suitable heavy material inert to battery electrolyte, such as lead. This weight is substantially frusto-conical in shape with its relatively large end at the bottom, this end being slightly smaller in diameter than the internal diameter of the vent plug body 16. Attached to the bottom of the weight 27 is a disk 28 which rests upon an internal shoulder 29 of the vent plug body 15 just above the reduced neck 16 thereof. The inner wall or surface of the reduced neck 16 from the shoulder 29 to the upper sloping wall 23 of the ledge 20 is shaped so as to facilitate the downward flow of any electrolyte which may by chance have passed the valve or which may have passed upwardly from the cell with the evolved gases. Preferably this wall, at least adjacent the shoulder 29, is curved downwardly and inwardly substantially as shown in Figs. 2 and 3. The disk 26, the vent plug body 16, the cap 24, and the baffle which is between the upper end of the weight and the cap 24 and is to be referred to presently will be formed of suitable plastic or plastics inert to battery electrolyte.

We prefer to employ the plastic known as polystyrene although any other suitable plastic or combination of plastics may be employed.

The disk 28 forms the base for the weight 27...
and is capable of rocking or tilting in any direction on the ledge 28. Its diameter is somewhat smaller than the internal diameter of the body 15, and the upper and lower edges of the disk are rounded as shown at 29 so as to facilitate the rocking action and also to prevent any tendency to bind or stick in the corner of the ledge or against the inner annular wall of the vent plug body.

The weight and disk may be secured together in any suitable manner but preferably by providing on the bottom of the weight a series of equally spaced lugs 30 which fit into similarly spaced openings 31 formed in the disk 28. In this instance, as shown in Figs. 2 and 3, the openings are flared downwardly and outwardly and the lugs are spread so as to lock the disk and the weight together. Of course the lugs and the openings may be straight and these parts may be locked together by peening over the lower ends of the lugs. As shown by dotted lines in Fig. 4, three sets of lugs 30 and openings 31 are employed. Between the openings 31 the disk is provided with a plurality of openings 32 and the lower end of the weight is provided with diagonally disposed openings 33 their lower ends being in alignment with the openings 32 and their upper ends at the lower peripheral surface of the weight. These openings 32 and 33 are preferably employed as indicated in Fig. 4 although the number may be changed as desired. These openings 32 and 33 are for the purpose of permitting the upward passage of gas produced in the cell and the return of any electrolyte which may remain on the valve at the lower end of the vent plug.

The tilting of the weight is adapted to actuate the valve which includes a stem 34 provided at its upper end with a head 35 having a freely moving ball and socket connection with the plastic base 28 of the weight. The head has a spherical surface which engages a spherical surface formed in the wall of an opening in the base 28 through which the head partially extends and in which it is seated. The upper part of the head projects into a cavity 36 formed in the lower part of the weight and the lower part of the head has a rounded portion which is close to but out of contact with the top wall of the cavity 36.

The stem extends downwardly from the weight and disk 28 through the valve opening 21 formed in the ledge 28 and the portion which extends through the valve opening is ribbed or fluted as shown at 37 so that it will have a guiding action in the opening and maintain the stem 34 substantially axially of the vent plug at all times. We find that three flutes or guide ribs are preferable as that number affords the proper guiding action, and, furthermore, we find that three ribs provide the most efficient construction for securing the return of any electrolyte which may have accidentally passed the valve at the lower end of the stem. If more flutes or guide ribs are used, the electrolyte may be blown up through the guide ribs and even to rise apparently by capillary action.

For the same reason it is desirable that the inner wall of the reduced portion 16 of the vent plug body 15 be curved for a substantial part of its length for otherwise the acid is not effectively returned to the cell.

At the bottom of the stem 34 beneath the ribbed portion 31 is a bottom enlargement 38 and between this and the ribs is a neck portion which is surrounded by a movable valve member in the form of a disk 39 which may be formed of soft rubber or equivalent soft plastic material. The diameter of the disk is of course somewhat greater than the diameter of the valve opening 21, and when the weight is tilted to a predetermined position, the bottom enlargement 38 of the valve stem pulls the disk up against the lower surface or seat 22 of the ledge 28 so as to close and seal the valve opening against the passage of electrolyte therefrom. It is quite important that a highly efficient valve seating action be obtained, i.e., that the valve member 39 firmly engage the valve seat 22 with substantially the same pressure all around. This result is obtained by providing at the lower end of the neck portion where it joins the lower enlargement 38 an annular filet 40.

When the soft valve member or washer 39 is placed around the neck portion of the valve stem between the enlargement 38 and the ribs 31, the filet 40 prevents the washer from seating flush with the top surface of the enlargement 38, but when the valve stem is lifted due to the tilting of the weight 27, the valve member 39 is forced against the valve seat 22 by pressure exerted by the enlargement 38 as the valve stem 34 is moved upwardly, but also by the tension or stress set up in the soft valve member 39 by the filet 40. By using a soft rubber valve member or washer 39 and the filet 40, a uniform valve seating action is obtained notwithstanding the fact that when the weight is tilted and the valve stem moves up, the pressure or pulling action may not be exactly centered with respect to the axis of the valve. The bottom enlargement 38 is slightly smaller in diameter than the valve seat 22 which aids the filet in securing a good valve seating action, for there is a tendency for the bottom member to push the soft rubber washer or valve member 39 up into the valve opening when the weight is tilted and the valve stem is pulled up. When the weight returns to substantially upright position, the parts of the valve including the valve member 39 are restored to the position shown in Fig. 2.

It is important, of course, that the valve member 39 be prevented from sticking to the valve seat 22 when in the upright position. The valve member may stick to the valve seat 22 when the valve is closed and actuated to hold the valve in closed position. Thus there is a pressure or perhaps a stickiness that must be overcome and that necessitates a blow on the top of the valve stem rather than a mere push. It should also be noted that when the valve is closed up the valve stem 24 and the ribs 37 are out of contact with the soft rubber valve member. When the valve stem is struck by the weight in returning to its normal upright position, the ribs move against the rubber valve member with something of a blow and thus break the valve seal. In other words, we are relying on the adhesion of the rubber valve member against the valve stem to transmit the moving force in the valve stem to the rubber member but we use the action of the ribs 37 in striking against the valve member.
Provided also in the vent plug between the top of the weight and the protuberance 26 on
the cap 24 is a baffle 41. This baffle is preferably supported in an inclined position on an
internal shoulder 42 formed on the inner cylindrical wall of the vent plug body 15, and it is provided with
two openings 43 and 44, one preferably located at the lower part of the inclined baffle and one
at the top, as indicated in Figs. 2 and 6. In the event any electrolyte passes through the valve
opening 21, it may pass through the openings 43 and 44 and then through one or both of the
openings 43 and 44 of the baffle particularly if the battery is substantially or wholly inverted in
which case the electrolyte collects in the pocket on the underside of the cap 24 around the
protuberance 26. When the battery is righted, the electrolyte will return through the lower opening
43 and possibly a portion through the higher opening 44, but, in any event, the opening 44 is
counteracting to take care of and to permit the venting of any collected gas. This construction
prevents the surging of any gas through the vent opening 25 at the time that the electrolyte
is returning and thus avoids the likelihood of electrolyte being carried out through the top of
the vent plug.

The degree of tilting of the battery to cause the weight 27 to rock in the vent plug and bring
about the closing of the valve at the lower end of the vent plug will depend upon the height of
the weight 27. The higher the center of gravity of the weight the sooner the weight will rock to a
position to close the valve as the battery is tilted from normal upright position. This may
be termed the critical angle and may be varied as desired. It is generally preferable, however,
that this angle of battery tilt be not less than 20° and in most instances it will be sufficient if
the weight rocks in the vent plug and the valve closes when the battery has been tilted approxi-
mately 30° to 35° from normal position.

With the construction illustrated, the valve will close when the battery is tilted approximately 30°
from normal.

It is desirable that the construction be such that the surface of the weight at no time contact
the inner cylindrical wall of the vent plug body, and that result is accomplished by the con-
struction illustrated. It will be obvious also that the proper closing of the valve at the lower end
of the vent plug will occur regardless of the di-
rection in which the weight is tilted.

The modified construction illustrated in Fig. 7 operates on the principle of the vent plug first
described and therefore only a brief description of the modification will be necessary.

The vent plug of Fig. 7 is provided with a body 45 closed at the top by a cap 46 in this instance
screwed into the top of the body 45 and provided with a vent opening 47 extending through
an inwardly projecting protuberance. Beneath the cap is a baffle 48 which rests upon an internal
shoulder of the vent plug body and may be se-
cured in place in any suitable manner as by
cementing. The main portion of the baffle is in
the form of an inverted cone with an opening 49
at the bottom and with one or more openings 50
in the conical wall and somewhat above the open-
ing 49. Generally one opening 50 will be suffi-
cient. The body 45 has at the bottom a reduced
portion 45a which is externally threaded and is
adapted to be screwed into the flanged opening
in the cover. At the bottom of the reduced por-
tion is a ledge 45b having a valve opening 45c
therein, the lower surface of the ledge forming a
double seat as before.

The vent plug body is a weight 51 of lead or equivalent material which will be shaped so
that it will not engage the inner wall of the vent plug body when the battery is tilted any amount in
any direction. The weight has at the bottom an annular reduced portion 52 having a groove
53 next to the flat bottom of the weight and it is supported by a plastic base 54 with a disk-like
lower portion 55 which rests upon an internal shoulder 56 formed at the top of the reduced portion
45b of the vent plug body and provided with a rounded margin so as to facilitate the
smooth rocking of the weight in any direction.

The disk-like lower portion 55 of the base has a number of openings such as shown at 55a to per-
nit venting and the return of electrolyte. The
base 54 has a central upstanding tubular portion
57 which is secured to the reduced portion 52 of
the weight, the latter extending into the top of the tubular portion 57 which has a bead project-
ing into and filling the groove 53. The weight
and the plastic base may be assembled or fitted together when the base is hot and somewhat pli-
able and extensible, and after these parts are as-
sembled the top of the pliable base 51 is pinched
inward while it is still in a heated state so as to
grip the reduced portion or lower extension of
the weight.

The lower part of the cavity formed in the base
54 is spherical in shape and receives a spherically-
shaped head 58 of the valve stem 59 which extends down through the valve opening 45, the
portion of the stem passing through the opening having guide ribs 61 as before. Supported on
the stem between the guide ribs 61 and the bot-
tom enlargement 62 of the stem beneath the
ledge 45b is a valve member 63 which, as before,
is formed of soft rubber or equivalent plastic
material. It might be here stated that the valve
plug body 45, the cap 46, the baffle 48, and the
base 54 of the weight will be formed of suitable
plastics, such as polystyrene, hard rubber,
or the like. If necessary, the enlargement
58 may be fitted into the spherically shaped cavity of the base 54 when the latter is in a heated and extensible condition.

With this modified form of vent plug, like with the form first described, when the battery is tilted through a predetermined angle from normal posi-
tion (which may be varied by varying the height of the center of gravity of the weight), the weight
51 and the plastic base 54 will rock the spheri-
der 56 and thus pull up the valve stem and cause the soft valve member 63 to close and seal the
valve opening 45c at the lower end of the vent plug.

When the battery lifts back, as soon as the vertical line passing through the center of
gravity of the weight again passes through the
bottom flange 55 of the plastic base, the weight will rock back to its normal position, again un-
seating the valve member 63.

Preferably the clearance between the upper end of the stem enlargement 58 and the bottom of the lower extension 52 of the weight is such that if, when the weight returns to normal posi-
tion, the valve member 63 tends to stick against the valve seat, the lower end 52 of the weight
will strike the top of the enlargement 58 of the stem and positively move the stem to its lower
normal position shown in Fig. 7.

Also, if desired, the distance between the ribbed portion 61 and the lower enlargement 62 of the
stem may be made somewhat greater than the
4. Thickness of the valve member 63, and the neck portion of the stem which is surrounded by the valve member 63 may have a fillet as in the construction first described so as to insure a tight and even sealing action between the valve seat and the valve member all around the latter.

While we have shown the preferred construction and a modified construction, we do not desire to be limited to the precise details illustrated and described but aim in our claims to cover all modifications which do not involve a departure from the spirit and the scope of the invention.

Having thus described our invention, we claim:

1. A non-spill vent plug comprising a hollow body having a vent orifice at the top and provided with a reduced lower end adapted to be fitted into an opening of a battery cell cover and provided at the bottom thereof with an inwardly extending ledge defining an annular valve opening, the lower side of the ledge forming a valve seat, said vent plug body having an internal shoulder above the reduced portion, a weight in the body having an annular base engaging said guide portion and adapted to rock on said internal shoulder, a valve stem having a ball and socket connection with the base of the weight and extending downwardly therefrom, said stem having a fluted or ribbed guide portion extending through the valve opening and having an enlargement below the latter, a substantially flat valve member between said guide portion and the lower enlargement of the stem and adapted to be drawn up against said valve seat when the weight is rocked due to tilting of the vent plug.

2. A non-spill vent plug provided with a hollow body having a vent opening at the top and having a reduced lower end adapted to be fitted into an opening of a battery cell cover, said reduced portion having a ledge at the bottom with a valve opening formed therein, an internal shoulder adjacent the top of said reduced portion, a weight in said body, a stem having a universal connection with the bottom of the weight, the weight having at the bottom a chambered portion receiving the upper end of the stem, the stem extending downwardly through and below said valve opening and provided with a shoulder at its lower end, and a washer-like soft valve member surrounding said stem above the shoulder, the construction being such that when the vent plug is tilted a predetermined amount from normal upright position the weight will be rocked on said internal shoulder of the body pulling the stem upward and causing the valve member to engage the lower face of said ledge around said opening, the stem having immediately above said shoulder at its lower end a fillet adapted to be drawn up into the bore of the valve member and to press into and stress the valve member when the latter is moved by the stem to valve closing position.

3. A non-spill vent plug comprising a hollow body having a top with a vent opening and provided at the bottom with a reduced portion adapted to be fitted into an opening of a battery cell cover, said reduced portion having at the bottom an inwardly extending ledge with a valve opening, the body having an internal shoulder above said reduced portion, a weight in said body having a base in the form of a separate member formed from a non-metallic material and securely joined to the lower end of the weight, and a valve stem having a connection with said base adapted to permit universal relative movement between said base and stem, said base having an aperture through which the stem extends and having an enlarged head above the aperture, the stem extending down through the aperture of said base and through the valve opening and having an enlargement of its lower end and a valve stem adapted to be drawn upwardly against the lower side of said ledge by the rocking of the weight so as to close said valve opening.

4. A non-spill vent plug comprising a hollow body having a vent orifice at the top and provided with a reduced lower end adapted to be fitted into an opening of a battery cell cover and provided at the bottom thereof with an inwardly extending ledge defining an annular valve opening, the lower side of the ledge forming a valve seat, said vent plug body having a ball and socket connection with the base of the weight and extending downwardly therefrom, said stem having a fluted or ribbed guide portion extending through the valve opening and having an enlargement below the latter, a substantially flat valve member between said guide portion and the lower enlargement of the stem and adapted to be drawn up against said valve seat when the weight is rocked due to tilting of the vent plug, and a perforated baffle between the weight and the top of the vent plug body.

5. A non-spill vent plug comprising a hollow body having a vent orifice at the top and provided with a reduced lower end adapted to be fitted into an opening of a battery cell cover and provided at the bottom thereof with an inwardly extending ledge defining an annular valve opening, the lower side of the ledge forming a valve seat, said vent plug body having an internal shoulder above the reduced portion, a weight in the body having an annular base engaging and adapted to rock on said internal shoulder, a valve stem having a ball and socket connection with the base of the weight and extending downwardly therefrom, said stem having a fluted or ribbed guide portion extending through the valve opening and having an enlargement below the latter, and a substantially flat valve member between said guide portion and the lower enlargement of the stem and adapted to be drawn up against said valve seat when the weight is rocked due to tilting of the vent plug, the base of the weight having one or more openings for normal venting purposes and for the return of the electrolyte.

6. A non-spill vent plug comprising a hollow body having a vent orifice at the top and adapted to be fitted into the opening of a battery cell cover, said body having near its lower end an internal shoulder and at its lower end a valve opening, a weight in the body formed from metallic material having secured to its lower end a base member formed from a plastic inert to the battery electrolyte, the marginal portion of said plastic base engaging and adapted to rock on said internal shoulder of the body, and a valve provided with a stem having a ball and socket connection with the plastic base of the weight and provided at its lower end with a valve member adapted to close said valve opening when the stem is drawn upwardly as said weight is rocked when the vent plug is tilted a predetermined amount from its normal upright position.

CARL F. OESTERMeyer.
LEO E. PUCHER.