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FILLING MECHANISM FOR DEFERRED-ACTION BATTERIES

Filed March 16, 1954

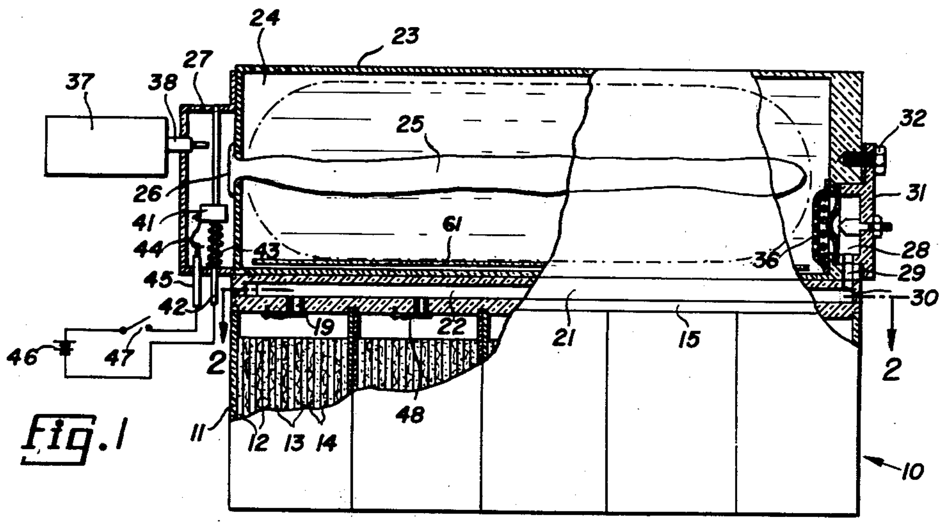

Fig. 1

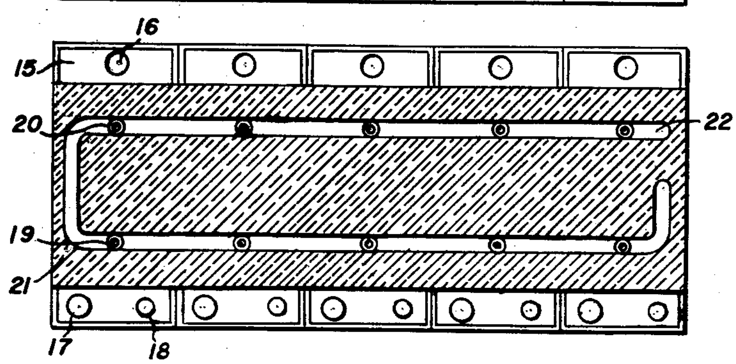

Fig. 2

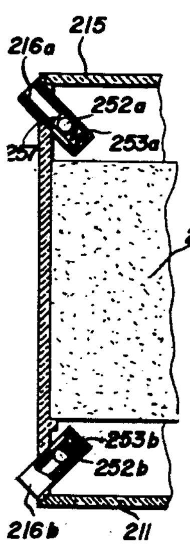

Fig. 6

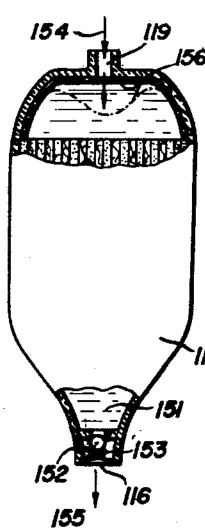

Fig. 5

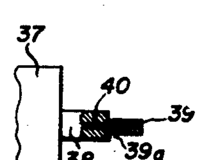

Fig. 4

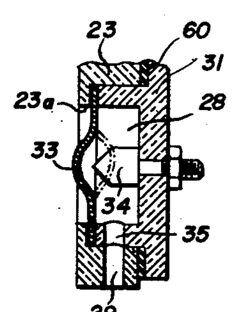

Fig. 3

INVENTORS:
EMANUEL COOPER
CHARLES M. GOLD

BY Karl F. Ross
AGENT

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FILLING MECHANISM FOR DEFERRED-ACTION BATTERIES

Emanuel Cooper, New York, and Charles M. Gold, Franklin Square, N.Y., assignors, by mesne assignments, to Yardney International Corp., New York, N.Y., a corporation of New York

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Our present invention relates to a mechanism for introducing a liquid electrolyte into a dry-charged or deferred-action electric battery or, preferably, into an array of such batteries serving as an instantaneously activable power source.

An object of our invention is to provide a filling mechanism of compact construction whose overall dimensions do not materially exceed those of a storage chamber required to hold the volume of liquid prior to activation of the associated battery or batteries.

Another object of our invention is to provide a filling mechanism which will be operative regardless of the relative position of the storage chamber and the batteries (or other receptacles) to be filled therefrom.

A further objection of our invention is to provide a filling mechanism of the above character by means of which predetermined amounts will be introduced with a small margin of tolerance into a large number of battery casings or other receptacles.

Still another object of our invention is to provide improved means for venting battery casings or other receptacles at the time the liquid is introduced into same.

Yet a further object of our invention is to provide a novel and improved liquid-tight seal for the storage chamber which can be rapidly and irreversibly disabled at the time when the liquid is to be expelled from the chamber.

A feature of our invention resides in the provision of means for substantially simultaneously inactivating a seal at the outlet of a storage chamber and activating a piston for expelling a liquid inside the chamber through said outlet.

According to a more specific feature of our invention, the seal is of a pressure-sensitive type responding to activation of the piston to open the path for the expulsion of the liquid.

According to a still more specific feature of our invention, the seal comprises a closure member with inherent toggle action which will normally occupy a first or blocking position and which, in response to a certain minimum pressure from within the chamber, will instantaneously snap into a second or unblocking position. A particularly simple and effective realization of this principle involves the use of an inwardly bulging disk or diaphragm in combination with a cutting point adapted to rupture the disk when the same is suddenly inverted by piston pressure.

The piston employed in a mechanism according to the invention is preferably of a type comprising an inflatable bladder which is initially collapsed and into which a compressed gas is admitted when the liquid is to be expelled from the chamber. Such a piston requires a minimum of additional space and insures substantially complete emptying of the chamber in a short time and without the development of frictional resistance.

The above and further objects, features and advantages of our invention will be more fully apparent from the following detailed description of certain embodiments, reference being had to the accompanying drawing in which:

FIG. 1 is a side elevation, partly in section, of a filling mechanism according to the invention and an array of associated batteries;

FIG. 2 is a section taken on the line 2—2 of FIG. 1;

FIG. 3 is an enlarged sectional view of a liquid seal forming part of the mechanism of FIG. 1;

FIG. 4 is an enlarged detail view of part of the mechanism of FIG. 1;

FIG. 5 is an end view, partly in section, of a modified type of battery usable in combination with said filling mechanism; and

FIG. 6 is a fragmentary sectional view of a battery casing similar to those of FIGS. 1 and 2 but provided with special venting means.

The batteries 10, FIGS. 1 and 2, are each shown schematically to comprise a casing 11 and an electrode assembly including negative plates 12 (containing metallic zinc, for example) and positive plates 13 (containing silver peroxide, for example) alternating with permeable inter-electrode spacers 14, e.g. of paper. A common cover plate 15, suitably recessed at its underside to receive the upper edges of casing 11, is provided with a vent hole 16, a negative terminal 17, a positive terminal 18 and a pair of inlet openings 19, 20 for each battery. The terminals 17 and 18 are connected by leads (not shown) to the plates 12 and 13, respectively, of the corresponding electrode assembly.

Cemented from above onto the cover plate 15 is a manifold plate 21 formed with a U-shaped distributing channel 22. Channel 22 has two arms communicating with the holes 19 and 20, respectively, in cover plate 15. The plate 21 supports a substantially cylindrical receptacle 23 defining a storage chamber 24 for a liquid electrolyte, such as a concentrated aqueous solution of potassium hydroxide, this chamber containing a collapsed bladder 25, of polyethylene or equivalent elastic material, opening at 26 into an antechamber 27. Receptacle 23 is recessed at 28, opposite antechamber 27, to form an outlet duct communicating with channel 22 by way of aligned bores 29, 30.

In practice, the recess 28 may be formed (as best seen in FIG. 3) by a socket member 31 inserted into a corresponding opening of an end wall of receptacle 23 and fastened in place by a screw 32 (FIG. 1). This insert bears upon a resilient washer 60 and serves to clamp a sealing disk 33, having a central bulge inwardly curved toward chamber 24, between itself and a shoulder 23*a* on the receptacle wall.

The insert 31 also carries a knife point 34 aligned with the center of disk 33 and is provided with an outlet bore 35 registering with bores 29, 30. Disk 33 may be a plastic diaphragm, e.g. of polystyrene.

A screen 36, shown in FIG. 1, is cemented or otherwise secured to the inner wall of chamber 24 in front of recess 28 to protect the bladder 25 from the point 34 when the bladder is expanded and the disk 33 ruptured in the manner presently to be described.

A cartridge 37 containing a compressed gas (e.g. carbon dioxide) is provided with a nozzle 38 entering the antechamber 27. The nozzle 38, as best seen in FIG. 4, is formed with a reduced, closed extension 39 partly traversed by a continuation of the nozzle bore 40 and provided with a nick or incision 39*a*. It will thus be apparent that removal of this extension, by means to be described, will open the nozzle 38 so as to let the contents of cartridge 37 escape into the antechamber 27.

A weight 41, slidably held on a rod 42 within antechamber 27, is under upward pressure from a spring 43 but is originally restrained from yielding to this pressure by a fusible link 44. Weight 41, rod 42 and a mounting pin 45 for link 44 are all metallic to form a path for an activating current impulse adapted to be emitted by an auxiliary power source 46 upon closure of a switch 47. When this occurs, weight 41 is catapulted upwardly on rod 42 against nozzle extension 39 which is broken off by the impact. Compressed gas from within cartridge **37** now escapes into the antechamber **27** and tends to inflate the bladder **25**; the pressure thus exerted upon the stored liquid causes an instantaneous inversion of disk **33**, as illustrated in dot-dash lines in FIG. 3. Disk **33** is thereby forced against knife point **34** which penetrates the disk; the resulting rupture is immediately enlarged by the liquid under pressure which now rapidly reaches channel **22** as the bladder **25** continues to expand in the manner shown in dot-dash lines in FIG. 1. A baffle **61** prevents the trapping of liquid in the left-hand portion of cylinder **23** by the expanding bladder.

The liquid thus entering the distribution channel or manifold **22** will now find its way into the casings **11** of the batteries **10**. The amount of liquid passing into each casing depends, of course, on the size of the orifices **19** and **20** leading to the interior of the batteries; if all of these orifices are identical in cross section, each casing will be filled to roughly the same level. It has been found, however, that a certain back pressure will develop at the end of the distribution channel remote from its inlet **30**, as a result of which the casings **11** closer to this inlet will receive less liquid than those located at a greater distance from it. This deficiency can be remedied to a large extent by the provision of a **U**-shaped distribution channel **22**, as shown, from whose lower branch (as viewed in FIG. 2) some liquid will reach the casings in the order from right to left, by way of orifices **19**, and from whose upper branch some additional liquid will enter these casings in the reverse order, by way of orifices **20**. It will be understood that further adjustments in the relative levels of the various battery casings may be made by varying the cross section of channel **22** and/or the total cross-sectional area of orifices, such as **19** and **20**, leading to any casing from this channel. The provision of a plurality of filling orifices for each battery casing has, moreover, the advantage of reducing the likelihood that any battery **10** might be deprived of electrolyte by accidental clogging of its inlet.

If, however, the system shown in FIG. 1 is subject to substantial acceleration and/or tilting, additional precautions may be required to insure substantially uniform distribution of the liquid. Thus, valve members **48** in the form of resilient tongues may be used at each orifice **19**, **20** for the purpose of preventing residual liquid within the manifold **22** and chamber outlet **28** from entering some of the battery casings **11** after the bladder **25** has been fully expanded and actual filling has ceased.

Such excess filling might lead to the formation of electrolyte bridges between adjacent battery casings which would be objectionable if these batteries are connected in series. The valve members **48** preferably consist of or are coated with insulating material so as effectively to disrupt any electrolytic connection betwene different batteries **10**.

Another problem arising with non-stationary systems is the venting of the battery casings. Thus, if the system is tilted during the filling operation, electrolyte might escape through the vent holes **16** designed for the evacuation of air from the casings. We shall now describe various means for overcoming this difficulty.

FIG. 5 shows a modified battery casing **111** formed with an outlet **116** at a location opposite inlet orifice **119**. The casing is initially filled with an inactive fluid **151** preferably of low wetting power, e.g. a silicone oil, having a specific gravity similar to that of the electrolyte in chamber **25**. A check valve at outlet **116**, comprising a ball **152** and a spring **153**, normally prevents the outflow of the fluid **151** and, by impeding the entrance of air at that point, also inhibits the escape of the fluid through orifice **119** when the casing is tilted or inverted. A porous membrane **156**, e.g. of paper, may normally overlie the inlet **119**.

When the liquid electrolyte from chamber **24** is forced into orifice **119**, as indicated by the arrow **154**, the resulting pressure, partially equalized by the membrane **156** over the cross section of casing **111**, acts upon the fluid **151** to expel a certain portion thereof, corresponding to the volume of the entering electrolyte, by way of check valve **152**, **153** and outlet **116** (arrow **155**). The membrane **156**, which may undergo some deflection as indicated in dot-dash lines, will be rapidly penetrated by the electrolyte displacing the fluid **151**. In view of the similarity of the specific gravities of the two fluids, this process is largely independent of the geometrical orientation of the system.

FIG. 6 illustrates special means for controlling the venting of a battery casing in different angular positions. As shown, the casing **211** containing an electrode plate **212** (which is representative of an assembly as shown at **12**, **13**, **14** in FIG. 1) is provided at each corner with a short tube **216***a*, **216***b* (only two visible). Each of these tubes, leading from the interior of the casing into the atmosphere, is inwardly provided with a shoulder, such as **257**, against which a ball **252***a*, **252***b* is urged by a spring **253***a*, **153***b*, respectively. The inclinations of all the tubes **216***a*, **216***b*, etc. toward the vertical and toward the horizontal, in the normal position of the casing, is about 45°.

The pressure of springs **253***a*, **253***b* is insufficient to force the ball **252***a* or **252***b*, respectively, against the corresponding shoulder **257** as long as the position of the tube departs from the vertical by an angle not much greater than 45°. Each tube is suitably apertured so that air may pass through it as long as the ball valve clears the shoulder **257**, which will be the case only when the tube is at or near the top of the casing, as shown for tube **216***a* in FIG. 6. If the casing **211** is tilted counterclockwise, the component of the weight of ball **252***a* counteracting the force of spring **253***a* will be reduced and the valve will be closed in the manner shown for tube **216***b*. This tendency to close will, moreover, be enhanced when the liquid level within the casing reaches the valve and floats the ball.

If only rotation about the main axis of the assembly of FIG. 1 (a line perpendicular to the plane of the paper in FIG. 6) is to be considered, then a total of four tubes **216***a*, **216***b* etc. will be sufficient for proper venting in every position, the remaining two tubes being mirror-symmetrical to those illustrated. If tilting in any direction is to be guarded against, then it will be necessary to provide a total of eight tubes, one for each corner of the parallelepipedic casing; each tube will have to enclose an angle of roughly 45° with each of the surfaces of the casing. It will be apparent that with this arrangement the momentarily topmost tube or tubes will always enable the escape of air while leakage of electrolyte will be prevented by the closure of the remaining tubes.

It may be mentioned that the problem of venting will also be simplified if it is possible to bring centrifugal forces into play to supersede the gravitational forces, as by rapidly rotating the system of FIG. 1 about the axis of cylinder **23** during the filling operation. In such event it will also be possible to cluster two or more rows of batteries **10** in different angular positions around the cylinder **23**, all with their vents **16** and orifices **19**, **20** facing inwardly toward the cylinder axis. Again, it may be desirable in some cases to dispense with all vent holes and to maintain the battery casings and the manifold in an initial state of partial or total evacuation, in which event a connection to the atmosphere may replace the cartridge **37**.

It will also be apparent that more than one cylinder **23** and bladder **25** may be used to fill a set of battery casings **11** in the manner herein disclosed. Thus, in such case, the two branches of distribution channel **22** may be separated from each other and connected each to the outlet of a respective chamber **24**, the connections to the two channels being preferably made at opposite ends of the battery assembly for reasons previously pointed out.

The invention, accordingly, is not limited to the specific embodiments described and illustrated but is susceptible of numerous modifications and adaptations without departing from the spirit and scope of the appended claims. Thus, the toggle principle embodied in the device **33**, **34** may be utilized in a safety valve for relieving excess pressures of a gas or a liquid not necessarilly intended to be directed into a battery casing or other type of container.

We claim:

1. A mechanism for introducing a liquid into a container, comprising a chamber filled with said liquid, said chamber having an outlet leading to said container, seal means in said outlet normally preventing the escape of said liquid from said chamber, said seal means comprising a diaphragm member having a preshaped central bulge of reversible curvature, said bulge curving inwardly toward said chamber and being adapted to snap into an outwardly curved shape in response to greater-than-normal pressure from said liquid, fixed diaphragm-piercing means in said outlet so positioned adjacent said member as to rupture same upon inversion of its bulge, and means for exerting sufficient pressure upon said liquid to invert the bulge of said member.

2. A mechanism for developing a sudden increase in pressure within a chamber, comprising a source of fluid under pressure higher than that of said chamber, said source being provided with a tubulation terminating within said chamber and having a closed end, a spring-loaded weight member poised adjacent said tubulation, fusible link means normally retaining said weight member in an inoperative position, electric circuit means for fusing said link means, thereby releasing said weight member, and guide means directing the so released weight member against said tubulation, thereby breaking off said closed end thereof and admitting said fluid into said chamber.

3. A mechanism for introducing a liquid into a container, comprising a chamber filled with said liquid, an antechamber free from said liquid adjacent said chamber, an inflatable bladder within said liquid having an inlet opening into said antechamber, a source of fluid under pressure higher than that of said chamber, said source being provided with a tubulation terminating within said antechamber and having a closed end, a spring-loaded weight member poised adjacent said tubulation, fusible link means normally retaining said weight member in an inoperative position, a connection between said chamber and said container, electric circuit means for fusing said link means, thereby releasing said weight member, and guide means directing the so released weight member against said tubulation for breaking off said closed end thereof, thereby admitting said fluid into said bladder and forcing at least part of said liquid through said connection into said container.

4. A mechanism for introducing a liquid into a container, comprising a chamber filled with said liquid, an antechamber free from said liquid adjacent said chamber, an inflatable bladder within said liquid having an inlet opening into said antechamber, a source of fluid under pressure higher than that of said chamber, said source being provided with a tubulation terminating within said antechamber and having a closed end, a spring-loaded weight member poised adjacent said tubulation, fusible link means normally retaining said weight member in an inoperative position, a connection between said chamber and said container, seal means in said connection normally blocking the escape of said liquid from said chamber, said seal means being transformable to a non-blocking condition by greater-than-normal pressure from said liquid, electric circuit means for fusing said link means, thereby releasing said weight member, and guide means directing the so released weight member against said tubulation for breaking off said closed end thereof, thereby admitting said fluid into said bladder and exerting pressure upon said liquid sufficient to render said seal means non-blocking.

5. In combination, a plurality of battery casings each having a filling aperture near its top, a chamber filled with liquid electrolyte, a manifold plate overlying said casings and formed with a distributing channel communicating with said apertures, a connection between said chamber and said channel, rupturable blocking means in said connection, and means for rupturing said blocking means and driving said electrolyte from said chamber into said casings, said manifold plate supporting said chamber.

6. In combination, a plurality of battery casings, a manifold plate overlying all of said casings and provided with at least one channel, said plate having apertures connecting said channel with each of said casings, a receptacle supporting said plate and communicating with said channel, a liquid electrolyte in said receptacle, frangible seal means at the entrance to said channel, and means for discharging said electrolyte from said receptacle and through said channel into all of said casings.

7. The combination according to claim 6, wherein each of said apertures is provided with valve means preventing the establishment of electrolyte bridges between said casings.

8. A mechanism for introducing a liquid into a plurality of containers, comprising a reservoir chamber filled with said liquid, said chamber having an outlet and manifold means leading from said outlet to said plurality of containers, seal means in said outlet normally preventing the escape of said liquid from said chamber, said seal means comprising a diaphragm member having a central bulge curving inwardly toward said chamber and adapted to assume an outwardly curved shape in response to greater-than-normal pressure from said liquid, fixed diaphragm-piercing means in said outlet so positioned adjacent said member as to rupture same upon inversion of its bulge, and means for exerting sufficient pressure upon said liquid to invert the bulge of said member.

9. A mechanism according to claim 8, wherein said manifold means comprises a plate overlying said plurality of containers and provided with a substantially U-shaped channel having two branches, said plate having apertures connecting each of said branches with each of said containers.

10. In combination, a plurality of battery casings arranged in a row, a manifold plate overlying all of said casings and provided with a substantially U-shaped channel having two branches, said plate having apertures connecting each of said branches with each of said casings, a reservoir filled with a liquid electrolyte and supported on said plate, means forming a passage between said reservoir and said channel, and means for injecting said electrolyte from said reservoir into said channel by way of said passage.

11. A deferred-action battery having a plurality of cells initially free of electrolyte and each having a filling aperture, a manifold in direct communication with each of said filling apertures, a chamber containing the liquid electrolyte for said cells, a flow connection between said chambers and said manifold, rupturable means normally closing said flow connection and preventing flow of said electrolyte to said cells, means for rupturing said rupturable means for transfer of said electrolyte from said chamber through said flow connection and said manifold into said cells, and means adapted to transmit differential pressure to said electrolyte to drive said electrolyte from said chamber into said cells.

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