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J. S. SAEMANN ET AL
VACUUM INDICATING CONNECTION FOR SURGICAL
WOUND-CLOSING APPARATUS
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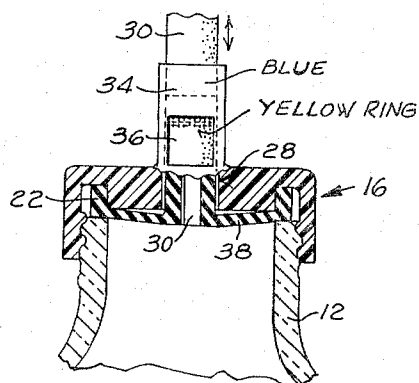
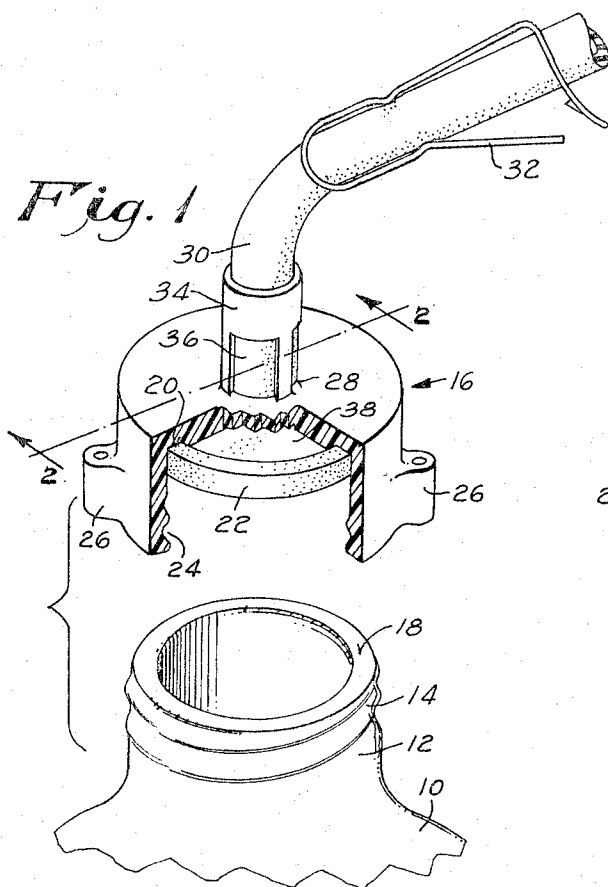


Fig. 2

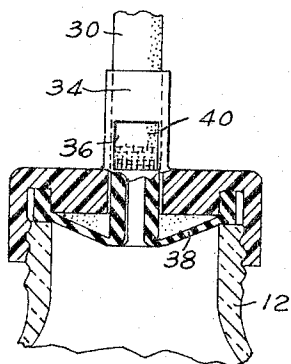


Fig. 3

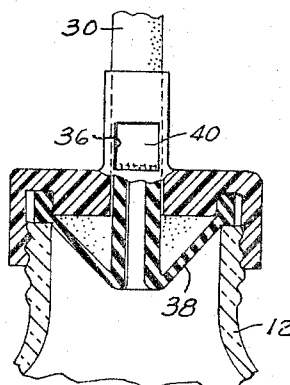


Fig. 4

1

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VACUUM INDICATING CONNECTION FOR SURGICAL WOUND-CLOSING APPARATUS

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ABSTRACT OF THE DISCLOSURE

A vacuum bottle for surgical wound drainage purposes has a flexible diaphragm held onto the bottle's neck by a cap, so that the margin of the diaphragm provides the usual vacuum seal, while a deflectable part of the diaphragm is connected to the external drainage tube to move the latter in response to the changes in internal vacuum conditions. Cooperating markings or formations on the cap and on the drainage tube therefore indicate directly the condition of the vacuum within the bottle.

This invention pertains to improvements in the manometric indicator which forms a part of vacuum wound closing apparatus constructed according to the teachings of M. Lamidey in French Patent 1,117,220 of Feb. 20, 1956.

The surgical technique of wound-closing by depression (that is, by internally applied suction) basically involves burying within the wound of a perforated tube which is connected to an evacuated bottle, or similar source of suction, so as simultaneously to provide drainage and to utilize the ambient air pressure to help maintain the healing tissues in intimate contact with one another. The Lamidey apparatus facilitates the application of this technique by providing a vacuum bottle, conveniently of about 600 ccm. volume, with a manometric indicating stopper so that as the vacuum is reduced to a point where the bottle ought to be changed or re-evacuated, the attendant will learn of this fact by means of the visible signal. Otherwise, the loss of suction or vacuum will go unobserved, and the advantages of the technique will be lost.

According to Lamidey, the stopper of the vacuum bottle is made of a relatively soft and distensible rubber or equivalent material, and is provided with an internal chamber whose only communication with the outside air is via a transparent indicating tube analogous to a water-glass. To put the apparatus into use, the indicating tube and its chamber have to be carefully filled with a liquid such as water (colored water is preferred for good visibility), all air bubbles being eliminated as by massaging the stopper body while the filling is carried out. Thereafter, when the stopper is inserted into the neck of the vacuum bottle and the latter is evacuated by the tube connection that will later be extended into the wound insert, the vacuum within the bottle exerts a pulling effect on the stopper sides and bottom, expanding the internal chamber and causing the indicating liquid to drop within the transparent tube. The stopper is dimensioned so that, when the maximum desired vacuum (greatest pressure drop within the bottle) of about 600 mm. of mercury has been reached, the liquid level in the indicating tube is below the top of the stopper, and the disappearance of the same will be clearly indicative of the fact that the bottle is ready for use. During use, the pressure within the bottle gradually rises, and when the indicating liquid rises into the indicating tube, and approaches the upper end of the tube, the need for renewing the vacuum is clearly manifested to the patient and attendant or nurse.

2

For good sensitivity, and to minimize evaporation, the indicating tube or tubulation is a fairly small-diameter tube, making it difficult to fill the tube and the chamber with the indicating liquid. Even when a hypodermic needle or the like is employed for this purpose (being used as a dropper), air bubbles in the tube and in the stopper chamber are difficult to remove in their entirety. Massaging the stopper while filling it is inconvenient, and would usually destroy the sterility of the apparatus; moreover, the operator could never be sure that all air bubbles had been eliminated from the internal chamber. Finally, a bottle employing this kind of indicating stopper could not be shipped in pre-evacuated condition, as the indicating liquid would spill, or evaporate, and could not practically be replaced or supplied at the point of use because of the stopper manipulations required to be performed.

It is a principal object of the present invention to provide a device which forms the connection between the vacuum bottle and its external tube, and which will provide the desired indication of the degree of vacuum without requiring any liquid-filled indicator with its disadvantages as set forth above. Not only does the improved connection provide a simplified indicator having fewer parts and of easier manufacture than heretofore, but it makes it unnecessary for the surgical nurse or other user of the equipment to perform any preliminary operations related to vacuum indication at the time a new vacuum bottle is first put into use. That is, the elimination of a liquid type of indicator makes it feasible to ship the bottles in evacuated condition, so that when unpacked for use, the indicator is already functioning, and the evacuated bottle is ready for immediate use. This allows the user to eliminate all the previously required evacuating and indicator-preparing operations in the case of a new bottle. From the viewpoint of the usually over-taxed surgical nurse, or surgeon, this advantage is a particularly significant one.

In general, the invention achieves its objects by means of a one-piece combination vacuum seal, vacuum indicator, and external tubulation. This one-piece unit provides a distensible diaphragm of resilient and sterilizable rubber, or equivalent synthetic, having a thickened rim which constitutes the gasket between the lip of the vacuum bottle and the inner face of a cap which preferably screws onto the bottle neck, but which may also be a part of a permanent non-resuable seal diaphragm. The external tubulation constitutes a flexible and resilient tube extending from a central region of the diaphragm, and passing through and axially directed "cage" which is connected to or integral with the bottle cap, these parts being sized so that the tube is loose within the cage. Portions of the cage are cut away to expose the surface of the tube, which moves in the axial direction when the diaphragm portion is distended into the neck of the bottle due to the vacuum therein. This vacuum-relation motion of the tube is caused to give the desired indication, simply by making (preferably coloring) a part of the tube surface to provide a visible indication of its position, by reason of the openings in the cage.

Besides its other advantages, as noted above, it will be observed that the construction described reduces the number of parts to two, namely the screw cap and the integral gasket, diaphragm and tube unit. This makes the assembly, after its original use, easier to disassemble, easier to clean and sterilize, easier to re-assembly and re-evacuate for re-use, and minimizes the loss or mislaying of parts.

The invention will now be described in connection with a specific and preferred embodiment, with the under-

standing that its details are given by way of explanation rather than limitation. In the accompanying drawings:

FIG. 1 is an exploded perspective view, with a portion of the bottle cap broken away, of the improved connection and indicator as applied to a screw-cap type of closure.

FIG. 2 is a vertical section, taken along line 2—2 of FIG. 1, showing the position of the diaphragm and indicator for essentially atmospheric pressure (no vacuum) within the bottle.

FIG. 3 is a view similar to FIG. 2, indicating the condition for an intermediate degree of evacuation of the bottle.

FIG. 4 is another view of the same kind, with the parts indicating practically complete or maximum evacuation of the bottle.

Referring first to FIGS. 1 and 2 of the drawings, numeral 10 designates a conventional surgical vacuum bottle having the neck 12 to whose threaded portion 14 the cap (indicated as a whole by numeral 16) is to be connected. The bottle 10 is entirely conventional, and is usually made of glass or plastic for cleanliness, visibility and sterilization purposes, and is of adequate strength to sustain its evacuation. In place of the "stopper" of prior apparatus of this kind, pressure-tight sealing between the upper surface 18 of the bottle neck, and an internal annular face 20 of the cap 16, is accomplished by the relatively thick peripheral rim 22 which is an integral part of the diaphragm and tubulation assembly to be described. As mentioned above, a permanently sealed diaphragm may substitute for the screw-cap securing arrangement.

When the cap 16 is threaded onto the neck of the bottle, its thread formations 24 will compress the rim 22 against the annular face 18, to provide the desired tight connection. Lugs 26 of the cap provide a good grip for the hand, and may be apertured as shown to receive a suspending bracket or like support. Other hand-grip lugs may also be provided around the rim of the cap. Conveniently, near the center of the main top surface of the cap 16, it is apertured as at 28 to pass the tube 30, which affords a fluid connection with the interior of bottle 10, and extends either to the remainder of the wound-closing equipment, or to a vacuum line or pump when necessary for evacuation of the bottle. A conventional shut-off clamp is indicated by numeral 32.

Cap 16 is provided, extending upwardly from its aperture 28, with a cage and tube guide 34, through which passes the tube 30. The inner diameter of 34 is, like aperture 28, sized for a loose fit with the outer diameter of tube 30. Also, cage 34 is provided with windows as indicated at 36, in about the lower half of its axial length, to expose for viewing the underlying surface of the elastic tube. This cage 34 is preferably molded integral with the body of the cap 16, but may be made as a separate part.

As better shown in FIG. 2, the end of tube 30 within the cap is integral with a preferably circular central diaphragm portion 38 which is, in turn, integral with the circumferential thickened rim 22. These parts constitute a one-piece element formed of sterilizable rubber or other elastic material, as already described.

FIG. 2 shows the condition of the parts when the bottle has not been evacuated. The diaphragm 38 lies substantially against the under surface of the interior of the cap 16, or more generally speaking, is flat, and the ring-like portion of tube 30 which is visible at the top window 36 is shown as colored (yellow is preferred) on its surface, thus providing a danger signal to the user by contrast with the cage color (preferably blue) to indicate that the bottle is not now evacuated, or has lost substantially all its vacuum. The portion of tube 30 above the yellow colored ring portion is preferably natural color or uncolored, but may be colored on its surface with a distinguishing color such as red or green, to provide a dis-

tinctly different signal. Such distinctive color would in the FIG. 2 condition be masked by the opaque upper half of the cage 34. However, a ring of a single color affords by its position relative to window 36 a satisfactory indication.

It will be noted in FIG. 2 that the rim 22 of the diaphragm is tightly clamped in sealing condition between the top of the bottle neck and an undersurface of cap 16; specifically, lying within an annular groove in the cap. Since the tube 30 has a loose sliding fit in cage 34 and aperture 28, the upper side of diaphragm 38 is exposed to the atmospheric pressure outside the bottle 10, while the underside of the diaphragm is exposed to the pressure or vacuum condition within the bottle. Hence, with the cap in place and the bottle undergoing evacuation (or partly evacuated by reason of its usage), a condition such as indicated in FIG. 3 will result. The reduced pressure in the container has deflected the central portion of diaphragm 38 downward into the neck of the bottle, thereby moving tube 30 axially downward and causing the yellow colored area or ring to lie centrally in the window. The supervening contrasting portion 40 has thus been brought partly into view in the cage window, and in FIG. 3 actually toward the bottom of the window, to provide a clear indication of the reduced pressure condition in the bottle.

When the bottle is substantially completely evacuated, the diaphragm 38 will be deflected to a maximum position indicated in FIG. 4, moving the tube downward enough to cause nearly complete concealment of the yellow ring signal, and almost filling the window 36 with the other distinctive color or marking lying above the yellow ring. The user is thus apprised at all times of the conditions within the bottle, and of any approaching need for re-evacuating it or effecting a replacement. As indicated in FIG. 1, the cage construction provides in actuality several windows about the lower periphery of the guide 34, for visibility no matter what orientation the bottle may assume about a vertical axis or otherwise. If the upper part of guide 34 is opaque, the "windows" may be transparent, rather than physical openings in the cage or guide.

When it is desired to ship bottles in pre-evacuated condition, the connection tube 30 is blocked by a shut-off such as 32 as shown in FIG. 1, or with some equivalent releasable tube blocking means, and the bottle can be put into use as soon as it is removed from its packing, sterile or otherwise, without need for evacuation at the point of use, or any preparation such as the filling of a liquid-type indicator. For re-use, the minimum number of parts makes sterilization and re-assembly very simple and self-evident.

The cap 16, including the cage element 34, is preferably molded of a suitably strong and rigid plastic, which is desirably opaque (at least in the upper portion of 34) so as to provide the signal-occluding action described above. The rim 22, diaphragm 38, and connection tube 30 are desirably one-piece molded of rubber or the like, at least the diaphragm portion 38 being dimensioned with reference to the thickness thereof, the exposed area, and its stiffness coefficient, so as to provide the proper range of deflection for signaling the over-all range of evacuation levels. It will be obvious that the signaling may involve other markings than mere surface colors on tube 30, so long as they indicate the axial motion of the tube in response to changes in the vacuum.

Other variations in the details of construction will occur to those skilled in the art, and it is not intended to limit the invention to the details given herein, except as may be required by the scope of the claims.

What is claimed is:

1. A combined vacuum line and vacuum-indicating connection for a surgical vacuum bottle, comprising a cap formed for secure physical connection with the neck of such a bottle, said cap having an aperture for passing a vacuum-connecting tube, an upstanding tube-guiding

5

cage integral with said cap and apertured in its lateral wall to expose a surface portion of such tube; a vacuum-distensible elastic diaphragm within said cap and adapted to be edge-sealed by said cap against the bottle neck, with its central portion free for deflection in response to evacuation of the bottle, and a tube secured integrally to said central portion and extending loosely through said cap aperture and said cage, for axial motion in response to the vacuum-induced motion of the free portion of said diaphragm; the outer surface of the tube portion lying within said cage being distinctively marked so as to provide a visible indication of the degree of distention of said diaphragm, and thereby of the condition of evacuation of the bottle.

2. The combination of claim 1, in which said cap is internally threaded for connection to a threaded bottle neck.

3. The combination of claim 1, in which said diaphragm and said tube constitute a one-piece integrally molded element.

4. The combination of claim 1, in which said diaphragm has a relatively thicker rim portion for sealing between the bottle neck and an inner surface of said cap.

5. A pressure-differential indicating fluid connection for receptacles, comprising an elastic diaphragm, means for clamping said diaphragm, solely about its peripheral mar-

6

gin, over an orifice of said receptacle; a connection tube connected to another portion of said diaphragm for axial movement in accordance with the deflection of said diaphragm, and cooperating position-indicating indicia on said tube and said clamping means whereby said tube both affords communication with the interior of said receptacle, and by its position indicates the pressure differential between said interior and the surrounding atmosphere.

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