This invention relates particularly to collapsible tubes of the type having a screw-threaded neck and a cap therefor, the neck initially having an integral thin wall or diaphragm which must be broken to form a discharge opening in the neck through which the contents of the tube can be discharged. Collapsible tubes of this type generally are formed of relatively hard metal such as aluminum and the caps are provided with pointed extensions that are utilized for puncturing said wall or diaphragm. Sometimes considerable difficulty is encountered in breaking the diaphragm.

One object of the invention is to provide a collapsible tube of this type wherein the diaphragm shall be so constructed that it may be easily and quickly broken or ruptured to form a discharge opening.

Another object is to provide a novel and improved method of and means for making such a diaphragm whereby the diaphragm can be produced quickly and at low cost.

Other objects, advantages and results of the invention will be brought out by the following description in conjunction with the accompanying drawings in which

Figure 1 is a composite side elevational and longitudinal sectional view through a collapsible tube having the known type of diaphragm in the neck thereof;

Figure 2 is an end elevational view of the tube;

Figure 3 is a composite sectional side elevational view showing the means for and the method of making the easily rupturable diaphragm of the invention;

Figure 4 is an enlarged end elevational view of the plunger shown in Figure 3, looking in the direction of the arrows on Figure 3;

Figure 5 is an enlarged fragmentary vertical sectional longitudinal view through the tube and portions of the parts of the means for forming the diaphragm, showing the parts in the positions assumed during one step of the method;

Figure 6 is a similar view of the positions of the parts at the next step of the method;

Figure 7 is a similar view showing the parts in the positions at the next succeeding step of the method;

Figure 8 is an enlarged end elevational view of the tube having a diaphragm constructed in accordance with the invention;

Figure 9 is a fragmentary vertical sectional view through the neck portion of the tube, showing the manner of breaking or rupturing the diaphragm to open the tube, with the cap which is shown in side elevation; and

Figure 10 is a fragmentary end elevational view of the tube with the diaphragm broken and the discharge or pouring opening formed.

Specifically describing the illustrated embodiment of the invention, the reference character A designates a collapsible tube of generally known type before filling of the tube, the tube having one end open, as indicated at 1, through which the tube is filled, and the other end of the tube having a shoulder 2, and exteriorly threaded discharge neck 3 in which is an integral diaphragm 4 which initially is of uniform thickness, for hermetically sealing the neck.

The tube is formed by an extruding operation in a known manner and after filling of the tube, the end 1 is folded and sealed and a cap B is screwed onto the neck 3 for closing the neck after breaking of the diaphragm to initially open the tube.

As shown, the cap B has a pointed extension 5 for puncturing the diaphragm.

In accordance with the invention the diaphragm is constructed so that it may be easily and quickly broken with a minimum of force applied to the cap and with a minimum of tearing of the diaphragm so as to reduce the possibility of broken fragments of the diaphragm contaminating the contents of the tube. In treating the diaphragm to make it easily breakable, the tube is fitted on a mandrel 6 that has a reduced end portion 7 to nicely fit the interior of the neck with its end which is flat in abutting relation to the inner side of the diaphragm 4 as shown in Figure 1. A reciprocating plunger 8 of a diameter slightly less than the interior diaphragm of the neck outwardly of the diaphragm has a plurality of radial ribs 9 on one end, said ribs being preferably square in cross section. The mandrel 6 and rod 8 are mounted for relative reciprocation in coaxial relation and are actuated so that the ribbed end of the rod or hammer 8 is pressed tightly against the side of the diaphragm opposite the mandrel extension or anvil 1 as shown in Figure 6. This operation results in the formation of radial grooves 10 in the outer surface of the diaphragm so that the diaphragm at the bases of the grooves is of substantially less thickness than the other portions of the diaphragm, the plunger having space between the ribs for the metal that is displaced incident to the formation of the ribs as indicated at 11. Thus the portions of the diaphragm between the ribs are slightly greater in thickness than the original diaphragm while
the diaphragm at the bases of the grooves is of substantially less thickness than the original diaphragm. To break the diaphragm, the point of the extension 5 of the cap is simply inserted in the center of the diaphragm, being guided by the depression at the intersection of the grooves 10, whereupon the cap B is pressed toward the neck of the tube. This results in the splitting of the diaphragm along the grooves and the bending of the metal of the diaphragm between the grooves inwardly against the wall of the neck.

The outer ends of the grooves 10 are spaced from the inner wall of the neck outwardly of the diaphragm a distance approximately equal to the thickness of the portions 11 of the diaphragm between the grooves, as shown in Figures 8 and 9; and an annular portion 12 of the diaphragm projects inwardly from the inner wall of the neck a distance approximately equal to the thickness of said portions 11. Preferably the pointed extension 5 of the cap will be of a diameter approximately equal to the inner diameter of the annular portion 12. This construction insures an easy rupturing or puncturing of the diaphragm and free bending of the portions 11 to form a pouring opening and at the same time reduces the possibility of particles of the diaphragm dropping into the contents of the tube.

Modifications and changes in the shape and location of the grooves 10 as well as in the steps of the method will occur to those skilled in the art as within the spirit and scope of the invention.

We claim:
A collapsible tube having a discharge neck and having a thick wall and a relatively thin integral perforable diaphragm closing said neck and formed with radial zones of a thickness substantially less than the thickness of the diaphragm between said radial zones, said radial zones terminating short of the inner surface of the wall of said neck a distance approximately equal to the thickness of the portions of the diaphragm between said zones, said diaphragm having an annular zone extending inwardly from the inner surface of the wall of said neck a distance approximately equal to the thickness of said portions of the diaphragm between said radial zones, so that the diaphragm may be broken along said radial zones and said portions of the diaphragm between said radial zones may be bent into and against the wall of said neck by a tool pressed against the diaphragm and having a diameter approximately equal to the inner diameter of said annular zone.

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