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PATENT SPECIFICATION

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(54) FLEXIBLE CONTAINER FOR THE TRANSPORTATION AND STORAGE OF BULK MATERIAL

(71) We, NORSK HYDRO a.s., a Norwegian Body Corporate, of Bygdøy Allé 2, Oslo 2, Norway, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
This invention concerns a flexible container for transportation and storage of bulk material, especially freeflowing pulverulent or granular material.
Several known types of containers for transportation of freeflowing bulk material are known. Some are of the one-trip-type and others are intended to be used several times. Such containers are usually called Intermediate Bulk Containers.
United States Patent No. 3,973,609 describes a flexible container which can be lifted when filled. This container is provided with a special lifting device which comprises a rope, one end of which is secured to its top. The other end of the rope runs through the centre of the container and is secured to its bottom, for instance to a plate below the bottom. In this way the stress is better distributed when the container is lifted. Although this lifting device distributes the stress somewhat better than do other flexible containers, its construction is rather complicated, thus increasing the cost of manufacturing the container. Another drawback is that the container is made of a number of different components and the total quantity of material per container is large.
Further, Danish Patent No. 132,877 describes a flexible container having a squarish bottom section with a discharge opening that is covered by a loose piece of material. This piece is cut before discharging. Before refilling the container, a new cover-piece is placed in it. The container is equipped with lifting loops secured thereto, and its upper section has a lid with a filling opening that can be closed. This rather complicated container which consists of several components that have to be joined together requires a complicated apparatus for its manufacture that accordingly makes it expensive. Such a con-

tainer is consequently intended to be used several times. The four separately fastened loops result in an uneven distribution of the vertical stresses in the container's fabric which thus must be made from strong and expensive material.
The present invention is the result of further development of the flexible container disclosed in United Kingdom Patent No. 1,475,019. That container is made from a single piece of material that is folded and sewn together along its sides and bottom. Approximately at the middle of the folded edge there is a slit which constitutes the filling opening of the container. The side seams terminate some distance from the folded edge thus providing two lifting loops which extend from the slit to the point of intersection between the imaginary extension lines of the side seams and the folded edge. The container has proved to be well suited for transportation of bulk material. It is cheap and can therefore be used as a one-trip container.
By destructive, dynamic testing it has been found that the stress distribution during lifting of the container disclosed in Patent No. 1,475,019 is not optimal due to the design of the bottom of the container. The object of the present invention is therefore to develop an improved base design that can be adapted to a container that has already proved to be a success. Another aim is to design a bottom which also is suitable for flexible containers similar to the ones described above.
According to the invention, a flexible container for transportation and storage of bulk material comprises a woven fabric formed into a tube having a closed end, which end is closed by lengths of said woven fabric extending from opposed wall portions of the tube to form a plurality of base webs traversing each other across said end, at least one of the webs consisting of two said lengths joined at their free ends. The container can be formed from a single piece of material such as a length of tube in which the flaps are formed by cutting the tube substantially parallel to the axis thereof. A length of tube may also be used

to form a container according to the invention wherein the height of the container is determined by the tube diameter rather than its length, as is described below.

- 5 A container of the invention can be equipped with lifting loops fastened to it and with means for closing its upper section. The lifting loops may be integral with the material of the container and constitute extensions of the sidewalls as in Patent No. 1,475,019. A container which may employ a base design as described herein and includes such integral lifting loops is described and claimed in our copending Application No. 7909859 (Serial No. 1580577) to which reference is directed.

- 10 A preferred container according to the invention includes four base flaps of equal size which are joined together in pairs at their free edges such that the joints cross each other perpendicularly substantially centrally of the container base. It will though be appreciated that more than four flaps might be used, the flaps being joined together in pairs at their lower edges in such a way that the seams thereby formed cross each other at one point.

- Containers according to the invention with four base flaps have a base of squarish form when the container is filled. The bottom is not completely closed as the flaps are joined together only at their edges remote from the respective sidewalls. This results in a particularly good stress distribution because the overlapping flaps constituting the base can shift somewhat relative to each other, thereby giving a stronger base. Because the base is in fact a double one, the load on the bottom seams is halved. Similar advantages result where the base comprises for example, six or eight flaps, the crossing angles of symmetrically arranged flaps being 60° and 45° respectively.

- In some embodiments of the invention, it can be advantageous to sew the flaps together also at their side edges with elastic or weak thread, thereby allowing the joined flaps to shift relative to each other. By doing this, a completely closed bottom is obtained and an inner bag can be omitted.

- 50 The container is applicable for bulk material in quantities from 100 kg up to several tons. It is made from a woven fabric, woven polypropylene being particularly preferred. The construction of the container according to the invention is independent of the container material as long as this is suitable for the actual use. The container is preferably fitted with an inner bag of an impervious material, for instance plastics or paper.

- 60 A flexible container according to the invention will now be described, by way of example, and with reference to the accompanying diagrammatic drawings, in which:

Figure 1 shows a circular woven piece of

material in the form of a transversely cut hose whose upper opening forms the filling opening of the container;

Figure 2 shows another transversely cut hose whose openings are joined together to constitute the side seams of the container; and

Figure 3 is an enlarged perspective view, showing the base of a container formed from the hose of Figure 1 or Figure 2.

Figure 1 shows a single piece of material 1 in the form of a circular woven, transversely cut hose. However, flat fabric having one or more vertical side seams can also be used. The container shown can be closed by lashing or bunching and lifted by a clamping hook, a strap with a noose or similar device. A bead 7, made by folding and sewing the upper edge, prevents the grip from slipping out. Separate loops can also be fastened to the container's top section. Four base flaps 4 are formed by cutting slits 2 substantially parallel to the axis of the hose. The free ends 5 of the flaps 4 are then joined to close the container base as shown more clearly in Figure 3 and described below.

Figure 2 shows another design made from a cylindrical woven piece of material in the form of a transversely cut hose. Cuts for a filling opening 3 are made at the centre of its upper edge and the cuts for the flaps 4 are made at the lower edge, so that $a = a' = \frac{1}{2} b$, as shown in the drawing. The hose is cut along the edges a and a' , the side edges 6 are joined together as indicated by the dotted lines 8 and finally the flaps 4 so formed are joined together at their lower edges to form a container base as described below. On either side of the filling opening 3 the material is continuous and forms lifting loops.

As shown in Figure 3, the base of a container formed from the piece of material illustrated in Figure 1 is generally square and comprises two layers of material formed by the flaps 4. One pair of opposed flaps are joined along a seam 10 while the other pair are joined along a seam 12. The pair of flaps joined by seam 12 are on the outside of the container while those joined by seam 10 are on the inside, thereby forming two layers, and the side edges of the flaps are sewn to the adjacent sidewalls by flexible threads 14. By this means, the layers are able to shift relative to each other while being loosely held in place.

The base of a container formed from the piece of material illustrated in Figure 2 will be essentially the same as that shown in Figure 3 except that one of the seams 10 or 12 will be missing as the entire uncut length b will form one continuous layer of material.

Experimental results:

Flexible containers according to British Patent Specification No. 1,475,019 and the present invention were tested dynamically.

The container was hoisted up on a stand by means of a hook attached to a chain. A strain gauge for measuring the load on the container was coupled between the chain and the stand. During the tests the containers were filled with 800 kg of freeflowing bulk material and they were allowed to fall a distance, in the following table called the maximum drop height, corresponding to the height to which the lower end of the chain was hitched up before being suddenly released. At the end of the free fall the container was stopped abruptly by the chain. The effective weight of the load at the end of each free fall was measured by the gauge and registered on a recorder. The containers were tested as the drop height was

increased between each test until failure of the container occurred.

The maximum drop height and maximum load given in the table show the drop height and corresponding recorded load to which the container was exposed before failing. Apart from a few cases where the seams had failures, the containers ruptured somewhat below the top. This means that the base of the container can take up higher loads than the container fabric itself. The flexible containers were manufactured by two companies identified only by numbers I and II in the table. This explains to some extent the scatter in the test results.

TABLE

Container Design	Manufacturer	Test No:	Max. Drop height mm	Max. Load kg
According to British Specification No: 1,475,019	I	1	160	3040
		2	220	4000
		3	220	4240
		4	280	4720
	II	5	205	3360
		6	250	3840
		7	295	4080
		8	250	3240
Average Values			235	3815
According to the invention	I	9	325	5360
		10	415	6240
		11	295	5480
	II	12	385	4640
		13	475	5400
		14	415	5360
		15	475	5680
Average Values			397,8	5451

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It is evident from the experiments that the new base design makes it possible to expose a filled container according to the invention to greater load than the previously known one according to the above mentioned specification. Calculated on the basis of drop height and recorded maximum load, the new container can absorb 69% more impact energy and withstand 43% higher dynamic loads.

10 The flexible container according to the invention therefore is not only stronger than conventional previously known ones, but can also be made by a simple method and the new bottom design does not require higher consumption of material than the container according to British Specification No. 1,475,019.

WHAT WE CLAIM IS:—

- 20 1. A flexible container for transportation and storage of bulk material comprising a woven fabric formed into a tube having a closed end, which end is closed by lengths of said woven fabric extending from opposed wall portions of the tube to form a plurality of base webs traversing each other across said end, at least one of the webs consisting of two said lengths joined at their free ends.
- 25 2. A container according to Claim 1 made of a single piece of material.
- 30 3. A container according to Claim 2 wherein the piece of material is cut from a length of tube, said lengths of fabric being formed by cutting the tube substantially parallel to the axis thereof.

4. A container according to any preceding Claim, the bottom including four base flaps of equal size which are joined together in pairs at their free edges such that the joints cross each other perpendicularly substantially centrally of the container base.

5. A container according to Claim 2 wherein a portion of the peripheral edge of each end of the tube is sewn to itself to form a fold in the tube wall; wherein two circumferential slits are cut in the tube symmetrical about the fold and about a line perpendicular thereto equidistant from the sewn peripheral edges; and wherein the tube wall is cut axially along the fold from the sewn peripheral edges to the slits to form two flaps containing a portion of the sewn edges centrally thereof; and wherein the free edges of the flaps are sewn together, the container so formed having four walls and four corners extending from the ends of the slits, and a base comprising a portion of material comprising an integral extension of two opposed walls and the two flaps.

6. A container according to any preceding Claim including an inner bag of impervious material.

7. A flexible container substantially as described herein with reference to and as illustrated by the accompanying drawing.

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