

TRANSLATION OF EUROPEAN PATENT SPECIFICATION 0 212 653

Transport Tank With Anti-Slosh Elements

The invention concerns a transport tank of the kind specified in the first part of claim 1. Such a tank may be either a self-contained transport tank container or part of a tank truck.

5 There is a general tendency towards constructing transport tanks of maximum size, and for 20-foot containers the upper limit currently is at a capacity of about 27 m³ for an ISOstandardized length of about 6 m. On the other hand, the permissible total weight of such transport tanks is somewhat
10 in excess of 300 kN. When a large tank is loaded with heavy liquids, this weight limit is reached already when the tank is partially filled. Since there occur considerable eccentricities of the centre of gravity during the transport of partially filled tanks due to decelerations and while negotiating
15 bends, international rules require that a transport tank for transporting liquids, when filled to less than 80%, must be provided with slosh guard plates, wherein 70% of the cross-sectional area of the tank should be slosh-protected, though this value of 70% has not been sufficiently substantiated
20 either empirically or by calculation.

 In the journal "Maschinenmarkt - europa industrie revue" 3-70, pp. 20-22, Gerhard Krause deals with road tank trucks for transporting dangerous goods and presents a tank in said essay which is provided in its interior with slosh guard
25 plates extending transversely and longitudinally. These slosh guard plates are fixedly welded into the tank while the tank is being manufactured. Since columns of liquid act dynamically on either side in longitudinal and transverse directions, the plates themselves and their mounting to the inner wall circumference must be stable and fatigue-proof. Due to the fact
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1 that the slosh forces occur by jerks and jolts, long twin
fillet welds are required which cover the tank circumference
either completely or to a major extent. On the other hand,
5 openings are necessary in the top and bottom regions of the
slosh guard plates for deaerating and completely emptying the
tank. Expensive reinforcing plates must be provided at the
terminal points of said openings in order to reduce peak
stresses occurring thereat. Furthermore, it is not every tank
10 compartment formed by slosh guard plates that is provided with
a manhole, and a larger entry port is respectively required to
allow the carrying-out of inspection and cleaning work. There-
fore, structures of this type having fixedly welded slosh
guard plates are expensive to manufacture, hinder cleaning
15 work, increase the tare weight of the transport tank, and ex-
hibit considerable risks of fatigue and resulting leakage.
Apart from these facts, fixedly built-in slosh guard plates
only make sense when it can be predicted that the tank will
again and again be transported with a partial load.

A transport tank of the type referred to at the beginning
20 is known from US-A-3 795 204. To enable the installation of
the known slosh guard arrangement at a later date, the ar-
rangement consists of transverse walls composed of individual
parts and connected by interposed bars resembling lazy tongs.
The overall arrangement is resiliently supported with respect
5 to the tank bottoms, with all transverse walls contacting the
interior tank wall with at least a portion of their outer
edges. Slosh movements of the tank contents will cause a cer-
tain reciprocation of the anti-slosh walls with the resultant
danger of these walls scratching the possibly coated or
30 polished interior tank wall. There is the further danger of
sparks being generated, which would be catastrophic specific-
ally in case of explosive tank contents.

It is the object of the invention to provide a slosh
guard arrangement which may be installed into a transport tank
35 at a later date and which permits fixing the slosh guard ele-
ments as rigidly as possible, thereby providing a high anti-
slosh effect, at the same time avoiding contact between the
slosh guard elements and the interior tank wall.

1 This object is met by the invention characterized in
claim 1. Accordingly, the slosh guard arrangement is braced
relative to three points of the tank, wherein a wedge effect
5 resulting from the cuverture of the tank bottoms or knuckle
zones, respectively, is utilized for fixing purposes.

 The embodiments of the invention according to claim 2 and
3 are advantageous because they offer a simple and reliable
possibility of fixing the slosh guard elements to the retain-
ing means. When a cross profile including two transverse webs
10 in accordance with claim 3 is used, these webs should in the
assembled state be arranged vertically above each other so as
to impart maximum rigidity against flexure to the bar struc-
ture itself and also to allow laterally projecting slosh guard
elements to be secured with maximum stability.

15 Embodiments of the slosh guard elements which are es-
pecially favourable from the viewpoint of manufacture, of in-
troduction thereof into the tank and of assembly inside the
tank are set out in the claims 4 to 7. The width of the ac-
cordingly provided strip material may exceed the maximum inner
20 diameter of the manhole and the material may be bent elas-
tically in longitudinal direction when being introduced into
the tank, so that a maximum slosh-inhibiting "sail" area is
provided in the tank interior. The Ω -shaped design according
to claim 5 is favourable not only from the viewpoint of as-
25 sembly but offers the additional advantage that two slosh
guard areas spaced one behind the other are obtained, which
produce correspondingly effective turbulences and thus twice
the amount of slosh consumption and are capable of elastic
absorption thereof in themselves.

30 In the preferred further embodiment of the invention ac-
cording to claim 8 the liquid flows about the slosh guard ele-
ments in the tank interior, whereby the formation of turbu-
lences and thus slosh consumption is promoted, on the one
hand, and damage to the tank inner wall by the slosh guard
35 elements is prevented, on the other hand. The embodiment ac-
cording to claim 9 represents a further means for highly ef-
ficient reduction of slosh forces in the entire tank interior.

 Preferred embodiments of the invention will be described

1 in detail below with reference to the drawings, in which

Figure 1 is a schematic longitudinal sectional view through a transport tank including built-in slosh guard elements,

5 Figure 2 is a cross-section through the tank of Figure 1 along the line II-II,

Figure 3 is a detail of Figure 1 illustrating the shape and mounting of slosh guard elements on a retaining means,

10 Figures 4 and 5 are cross-sections taken along the lines IV and V of Figure 3, and

Figure 6 is similar to Figure 4 illustrating a different cross-sectional shape of the bars of the retaining means.

15 The transport tank shown in Figures 1 and 2 comprises a circular cylindrical tank outer wall 10 closed at either end by an approximately basket arch-like tank bottom 12 welded thereto. The main portions of the tank bottoms 11 are spherically curved and join the cross-sectional shape of the tank outer wall 10 via a more strongly curved flange portion 12. At the topmost location the tank outer wall is provided ap-
20 proximately at the centre of its longitudinal extension with a manhole 13 closed by a cover, through which a workman may enter the tank interior for inspection purposes and for performing assembly work.

25 Two rails 14a, 14b extend along the transport tank and have a simple cross profile as illustrated in Figure 2. The inner ends of the two rails 14a, 14b are secured to the lower ends of generally V-shaped bars 20, with their outermost ends being each provided with an annulus or foot which - as indicated in Figure 1 - is supported by means of an elastic O-ring or lip 16 in the central region of the respective tank bottom
30 11.

35 The bars 20 in their turn are mounted with their upper ends on two diagonally opposite locations of a pipe socket 18 fitted into the manhole 13. The bars 20 may be welded to the pipe socket 18 and fitted into the manhole 13 in combination therewith. Furthermore, the V-shaped interior region of the bars 20 may be provided with a generally triangular plate 21 and the outside and bottom side may be provided with a plate

1 22, both plates 21 and 22 in the assembled condition being located in a cross-sectional plane of the tank and additionally forming slosh guard elements curved on one or two sides.

5 In the embodiment illustrated in Figure 1 a total of eight slosh guard elements 17 is mounted on the rails 14a, 14b. Each of said elements consisting of a strip of material generally bent to Ω -shape. As shown in Figure 1, four of these slosh guard elements 17 extend in horizontal and four in vertical direction, wherein two extend in the drawing plane to 10 the rear, two extend to the front, two extend upwards and two extend downwards. The strip of material may have a width slightly less than the diameter of the manhole 13. Each slosh guard element 17 may be made of relatively rigid material and may be rotated in preformed condition through the manhole 13 15 into the tank interior. Alternatively, it is also possible to employ a flexible strip of material whose width may be in excess of the manhole diameter; in that case the strip of material is introduced through the manhole 13 while being elastically bent about its longitudinal axis and is then bent to 20 the shown Ω -shape in the tank interior while being mounted on the respective rail 14a, 14b. In this way a correspondingly increased slosh-inhibiting area is obtained. The individual strips of material are dimensioned such that the assembled slosh guard elements do not contact the tank inner wall so as 25 to avoid any damage to the possibly coated or polished tank wall. On the other hand, the slosh guard elements extend outwardly as far as possible so as to offer maximum area to the occurring liquid flows. As illustrated in Figure 1, the slosh guard elements 17 in the longitudinal direction of the tank 30 are arranged alternately in horizontal and vertical extension so as to produce a strong slosh-inhibiting effect by maximum turbulences.

35 The Ω -shaped slosh guard elements 17, which are secured in vertical extension to the rails 14a, 14b, are not arranged in offset relationship along the respective rail 14a, 14b such that the tank interior is most effectively divided by slosh guard elements. As illustrated, the various slosh guard elements 17 may have different sizes. They should establish a

1 maximum slosh-inhibiting area in the respective available
space. Although any contact relative to the tank inner wall is
undesirable, mutual supporting of adjacent slosh guard ele-
ments 17 may be appropriate for reinforcing purposes.

5 Figures 3 to 5 illustrate the mounting of the generally
 Ω -bent metallic or plastics slosh guard elements 17 on the
rails 14 and 14a, 14b, respectively, wherein it is assumed in
contrast with Figure 2 that the profile of said rails is a
double cross ("cross of Lorraine") comprising an upwardly ex-
10 tending web 23, a downwardly extending web 24, two rightwardly
extending webs 25, 26 in parallel relationship one above the
other, two leftwardly extending webs 27, 28 in parallel re-
lationship one above the other, and a central web 29. As il-
lustrated in Figure 4, the vertically extending slosh guard
15 elements 17 are each provided in their inward portion with a
central slot 30 which is engaged by the upper web 23 or the
lower web 24, respectively, of the rail 14. As will be appar-
ent from the top of Figure 3, the inward portions of these
generally Ω -bent slosh guard elements 17 are initially bent
20 outwards and then again inwards. Inside of their inward bend
they are fixed by bolts 31 each of which passes through one of
a plurality of holes 32 formed in the upper web 23, and are
supported with their lowermost ends on the topmost horizontal
webs 25 and 27 of the rail 14. In this way resilient fixing of
25 the slosh guard elements 17 is achieved. As illustrated in
Figure 4, the length of the bolts 31 corresponds approximately
to the width of the slosh guard elements 17.

The lower portion of figure 3 illustrates a somewhat
different embodiment, in which the ends of the approximately
30 Ω -bent slosh guard elements 17 are no longer bent back inwardly
but meet the lower webs 26, 28 of the rail 14 approximately
vertically, so that also in this case elastic mounting is
achieved by means of fixing with bolts 31.

35 The right-hand portion of Figure 5 shows that the hori-
zontally extending slosh guard elements 17 are provided in
those regions where they are mounted on the rail 14 with two
parallel slots 30 which are engaged by the two lateral webs
25, 26 of the rail 14. For the rest, the lateral slosh guard

1 elements 17 are designed and secured in a way similar to that
illustrated in the upper or the lower portion of Figure 3. As
will be apparent from the left-hand portion of Figure 5, it is
also possible to provide in place of the slots 30 lateral cut-
5 outs 33 whereby there remains a central portion 34 that fits
between the two lateral webs 27, 28 of the rail 14.

When using a double-cross profile according to Figures 4
or 5 it is appropriate to mount the rails 14a, 14b in the tank
in such a way that the two webs 23 and 24 extend vertically
10 while the four remaining webs 25 to 28 extend horizontally, so
that the bolts 31 for fixing the laterally projecting slosh
guard elements 17 engage in corresponding holes in two opposed
webs to thereby result in improved anchoring of the lateral
slosh guard elements relative to gravity.

15 Figures 4 and 5 show that the ends of all of the webs 23
to 28 are located on a circle (indicated in dashed lines) the
diameter of which is smaller than the diameter of the manhole
13 by such an amount that the rails 14 can be inserted into
the tank in the required oblique orientation. Since the rail
20 14 is intended not only to carry the slosh guard elements but
also to serve itself as a slosh guard element for reducing
slosh forces which act transversely to the tank axis, the
profile of the rail should be maximum while allowing intro-
duction of the rail through the manhole 13.

25 According to Figure 6, the cross profile of the rail 14
is obtained by four discrete rails 36 each having L-cross-sec-
tion, said rails being joined to one another by means of a
plurality of junction plates 37 and being dimensioned and ar-
ranged such that all of the eight outer edges of the discrete
30 rails 36 lie on the above-mentioned circle 35 (also indicated
in dashed lines in Figure 6). For securing both the vertically
and the horizontally extending slosh-guard elements 17, the
embodiment of Figure 6 respectively includes two mutually
spaced webs in which holes for the passage of bolts 31 there-
35 through are formed. Figure 6 shows a further modification of
the inner ends of the discrete slosh guard elements 17 in
which, instead of the two slots 30 provided in the right-hand
portion of Figure 5, an internal recess 38 of U-section is

1 provided the two mutually parallel sides of which engage the
outer surfaces of the webs formed by the discrete rails 36.

When an existing tank is to be provided with slosh guard
elements, i.e. when it is to be transported partially loaded,
5 the rails 14a, 14b are initially introduced through the man-
hole 13 into the tank, where they are assembled and secured in
the tank interior as illustrated in Figures 1 and 2. When
suitable dimensions are chosen, bracing relative to the tank
wall may be achieved which in the toggle-like embodiment of
10 Figure 1 is achieved by a final vertical displacement of the
pipe socket 18 prior to anchoring thereof in the manhole 13.
Thereupon the various material strips are introduced through
the manhole 13 and fixed to the rails in the manner shown in
Figures 3 to 6.

15 As has been explained by means of Figures 4 to 6, the
profile of the rails 14 and 36 illustrated therein may be cir-
cumscribed by a circle 35 which is smaller than the manhole 13
by such an amount that the assembled rail can be introduced
through the manhole into the tank interior. On the other hand,
20 in the embodiment shown in Figure 7 the bars carrying the
slosh guard elements 17 are constructed of three discrete bars
39 which are introduced one by one through the manhole 13 and
are aligned in parallel to each other in the tank interior and
are detachably inter-connected by means of triangular junction
25 plates 40. Each of said bars 39 has cross-like cross-section,
respective pairs of the individual legs of said bars extending
normal to each other and in parallel to the boundary edges of
the slosh guard elements 17. In Figure 7, the three bars 39
constitute an equilateral triangle the length of the edges
30 thereof is slightly larger than the width of the slosh guard
elements 17 which may themselves - as explained above - be
wider than the diameter of the manhole 13. In this way the
total cross-sectional area of the bar structure constituted by
the three bars 39 becomes relatively large whereby the rigidi-
35 ty is improved. Moreover, the ends of said bar structure de-
fine correspondingly large bearing surfaces so that upon as-
sembly e.g. according to Figure 1 the risk of displacement of
the bar structure from its desired axial position is further
reduced.

Claims

1. A transport tank for liquids having a manhole (13) and being internally provided with slosh guard elements (17) the size of which is so dimensioned that they can be introduced through the manhole (13) and which are detachably secured to a bar structure (14, 14a, 14b) which is also dimensioned such that it can be introduced through the manhole (13),

characterized in that the bar structure (14, 14a, 14b) is made up of two parts which, in the assembled position, are interconnected by a toggle joint, which are supported by a structural member (18) adapted to be inserted in the manhole (13), and which are braced between the curved portions or in the knuckle zones (12) of the two tank end bottoms (11).

2. The transport tank of claim 1, characterized in that the bar structure comprises rails (14, 14a, 14b) of a cross profile.

3. The transport tank of claim 2, characterized in that the cross profile of the bar structure (14) includes two webs (25, 26, 27, 28) in at least one of the two mutually perpendicular cross-sectional directions. (Figs. 7, 8, 9)

4. The transport tank of any one of claims 1 to 3, characterized in that the slosh guard elements (17) include parts of flexible strip material.

5. The transport tank of claim 4, characterized in that the parts of strip material are adapted to be secured to said bar structure (14) in a generally Ω -shaped manner.

6. The transport tank of claim 5 as dependent on claim 2, characterized in that the ends of the parts of strip material are provided with slots (30) or cut-outs (33, 38) for fitting therein at least one web (23...28) of the cross profile of the bar structure. (Figs. 7, 8, 9)



7. The transport tank of claim 5 or 6, characterized in that the ends of the parts of strip material are adapted to be resiliently clamped to said bar structure (14).

8. The transport tank of any of claims 5 to 7, characterized in that the parts of strip material have their lengths so dimensioned so that they do not contact the inner tank wall in the assembled condition.

9. The transport tank of any of claims 1 to 8, characterized in that the slosh guard elements (17) are adapted to be mounted in a plurality of cross-sectional planes of the tank and in a staggered manner as viewed in the longitudinal direction of the tank.

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