TECHNICAL REPORT 9172

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Continuous mechanical handling equipment — Safety code for screw conveyors — Examples of guards for trapping and shearing points

Engins de manutention continue — Code de sécurité des transporteurs à vis — Exemples de protection des points de coincement et de cisaillement

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ISO/TR 9172 was prepared by Technical Committee ISO/TC 101, *Continuous mechanical handling equipment.*

The reasons which led to the decision to publish this document in the form of a technical report type 3 are explained in the Introduction.

0 Introduction

This Technical Report supplements the various safety standards for conveyors for loose bulk materials. It gives examples of the many kinds of hazards connected with screw conveyors at trapping and shearing points; it incorporates illustrative examples which show in principle how sufficient safety can be achieved, without excluding other methods which give the same level of safety.

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1 Scope and field of application

This Technical Report gives examples of the kinds of hazards associated with screw conveyors at danger points, in particular trapping and shearing points located between the moving screw and the fixed parts of the conveyor or surrounding structures.

It describes different safety devices, illustrated by examples of design sheets, capable of meeting safety requirements specified in ISO 1819 and ISO 7149.

2 References

ISO 1819, *Continuous mechanical handling equipment — Safety code — General rules.*

ISO 7149, *Continuous mechanical handling equipment — Safety code — Special rules.*

3 Danger points

3.1 Trapping points

Trapping points occur where the outer edge of the screw approaches a fixed part with a steadily decreasing distance; examples of danger points where this hazard occurs are given in 3.1.1 to 3.1.5.

3.1.1 Between screw and trough

As the distance between the outer edge of the screw blade and the trough decreases down to the operating clearance, there is a danger of limbs being pulled in (see figure 1). In the case of large screw conveyors, the whole body may be pulled in.

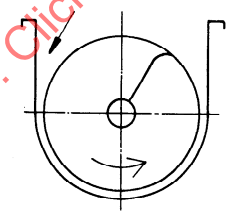


Figure 1

3.1.2 Between screw and screw protection plate

A trapping point will occur on the running area under the protection plate (usually made from angle steel or shaped like a roof) if the clearance c (see figure 2) is less than 50 mm.

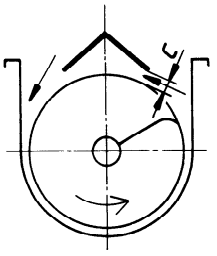
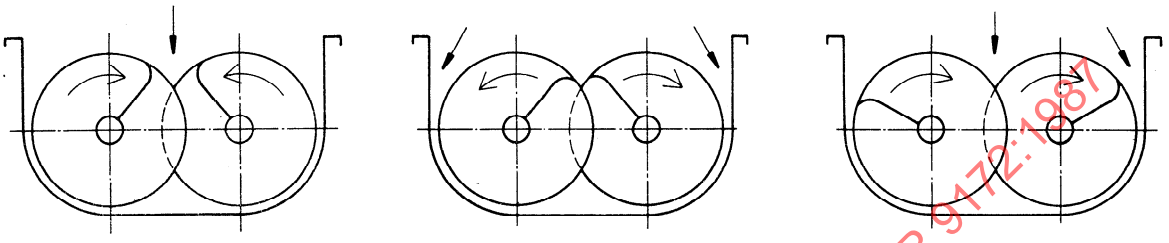


Figure 2

3.1.3 Between multiple screws

Trapping points will occur between adjacent screws [see figures 3a) and 3c)] or on one [see figure 3c)] or both [see figure 3b)] of the trough walls depending on the direction of rotation and the pitch of the screw helix.

The trapping points at the trough sides are the same as in 3.1.1; between the screws, trapping points may occur depending on the distance between the screw blades and the friction generated at the blades.



a) b) c)

Figure 3

3.1.4 Between screw and supporting bars

At the open end of self-charging screws, trapping points may occur between the screw and the bars supporting the outer bearing of the screw shaft (see figure 4); hands are especially at risk if any of these bars are used for moving the conveyor and clearance a is not large enough.

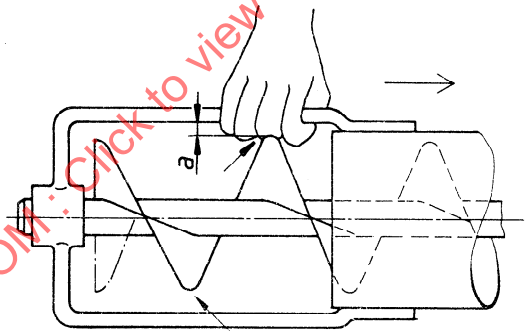


Figure 4

3.1.5 Between screw and ground

On open and running, feeding or distributing screws, trapping points will occur at ground level or between the material to be conveyed and the screw if the screw cannot lift itself because of its own weight or the weight of the machine connected to it.

Usually the feet are pulled in first and the whole body afterwards. Open ends of ribbon-type screws can also catch parts of the clothing, thus unbalancing the whole body or pulling it in.

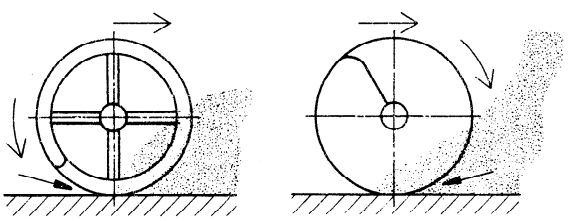


Figure 5

3.2 Shearing points

Shearing points may occur when the screw helix passes edges lying across the conveying direction. Parts of the body which may have become caught are pinched by the screw blade, trapped and then cut off by the scissor action of the screw edge moving close across the edge of the opening.

Shearing points like this occur at the points listed in 3.2.1 to 3.2.5.

3.2.1 At feed and discharge openings

Shearing points occur at feed and discharge openings whatever their position in the housing or the exact configuration of the edge of the opening (see figure 6); hands especially are at risk.

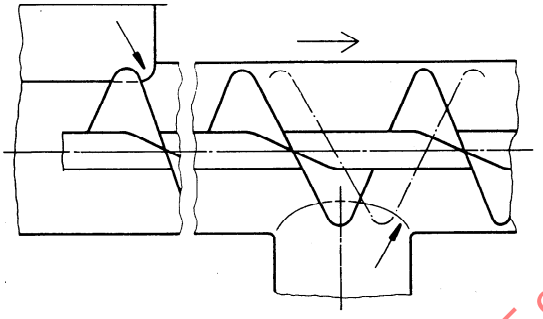


Figure 6

3.2.2 At openings of tubes of self-charging screws

Shearing points occur as the leading edges of the screw helix enter the tube of self-charging screws (see figure 7); depending on the type of operation, hands or feet especially are at risk.

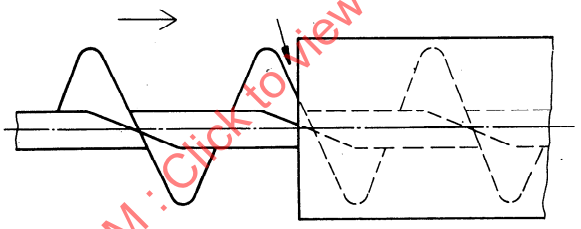


Figure 7

3.2.3 At openings of conveying troughs or tubes (of open feed hoppers or pans)

Shearing points occur as the leading edges of the screw helix enter the conveying trough or tube of an open-feed hopper or pan (see figure 8).

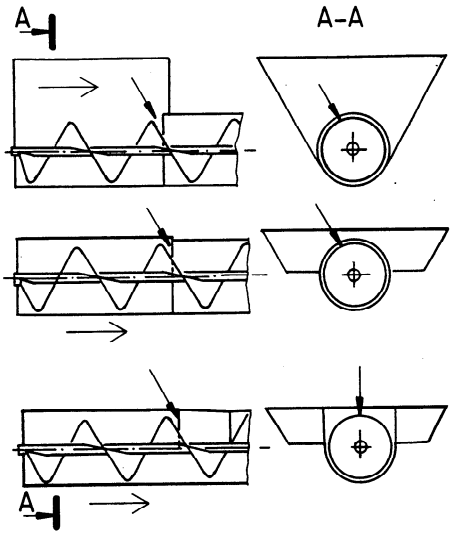


Figure 8

3.2.4 Cross-members

Shearing points occur at points where cross-members are exposed (see figure 9).

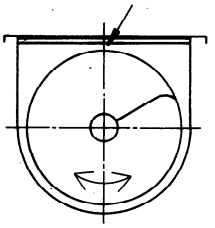
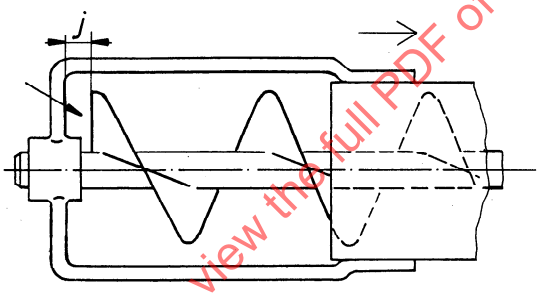


Figure 9

3.2.5 At shaft outer bearings

Shearing points occur at the shaft outer bearings of self-charging screws between the bars supporting the bearing and the lead-in edges of the screw blade (see figure 10).



NOTE — For clearance *j*, see 6.1.

Figure 10

4 Guarding trapping points

Because of the sharp edges of the screw blade and the small clearance between screw and trough, there is always a danger that a trapped part of the body may be sheared. Guards shall therefore be properly constructed to the correct standards.

4.1 Guards for general use

Examples of possible guards for general use are given in 4.1.1 to 4.1.9.

4.1.1 Closed tube

The screw can be placed in a closed tube where all openings for assembly, inspection or maintenance are securely closed (see figure 11). For inspection purposes, permanently fixed glasses or grids may be provided. Any lubrication necessary can be done from the outside.

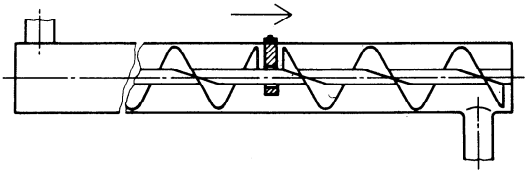


Figure 11

4.1.2 Trough with fixed solid cover

The screw can be placed in a trough with a fixed solid cover (see figure 12). The cover shall

a) be strong enough to withstand the expected loads and at least a load of 100 kg/m^2 if it is possible for the cover to be stepped on;

b) have each removable section fixed by at least two bolts located diagonally.

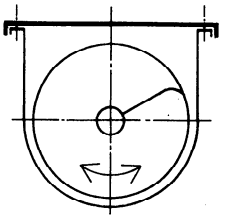


Figure 12

4.1.3 Trough with fixed grid cover

The screw can be placed in a trough with a fixed grid cover [see figures 13a) and 13b)]. The cover shall

a) be designed so that no danger point is accessible through the grid;

b) be strong enough to withstand the expected loads and at least a load of 100 kg/m^2 if it is possible for the cover to be stepped on;

c) have each removable section fixed by at least two bolts located diagonally.

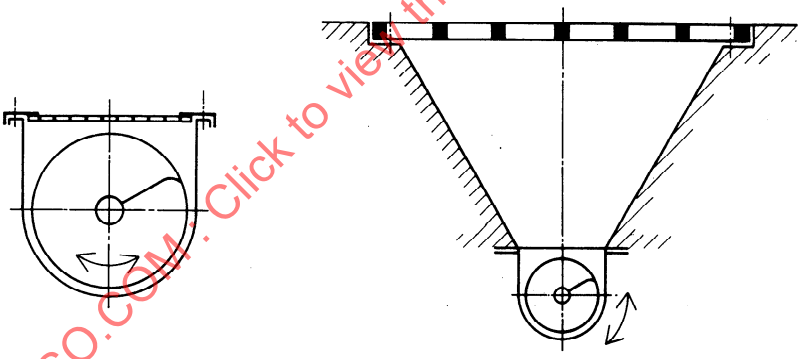


Figure 13

4.1.4 Trough with opening cover

The screw can be placed in a trough with an opening cover (see figure 14). The cover shall be

a) electrically or mechanically interlocked with the drive of the screw conveyor;

b) designed so that it can be stepped on without it being possible to reach any danger point, as specified in 4.1.2 and 4.1.3.

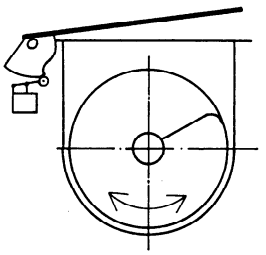


Figure 14

4.1.5 Trough with fixed cover and feeding slot

The screw can be placed in a trough with a fixed cover and feeding slot (see figure 15) in which

a) the nip point at the trough wall is covered;

b) the distance d to the screw edge is at least 50 mm; and

c) the free edge B of the cover is bent towards the screw shaft to afford better protection.

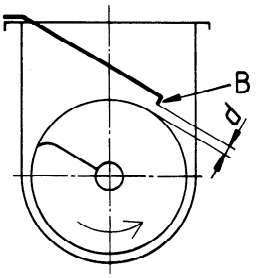


Figure 15

4.1.6 Open trough in enclosed areas for loose bulk material

The screw can be placed in an open trough in enclosed areas for loose bulk materials, e.g. bunkers, silos, etc. (see figure 16); these areas shall be designed so that

a) they cannot be entered, or

b) they are guarded against entry during operation of the screw conveyor;

c) no trapping point is accessible through unguarded openings.

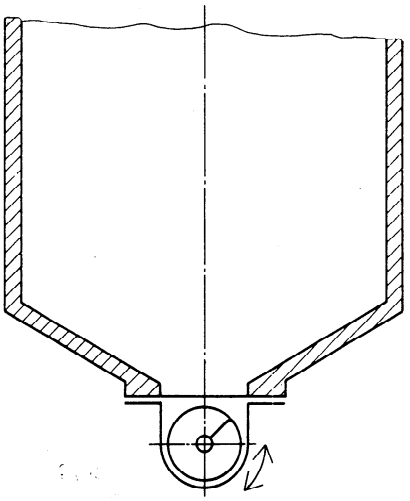


Figure 16

4.1.7 Open trough with temporary grid covers

The screw can be placed in an open trough with temporary grid covers in enclosed areas which may be entered temporarily for cleaning and complete emptying purposes with the aid of the screw conveyor; the cover shall be designed so that no trapping point is accessible through the grid (see figure 17).

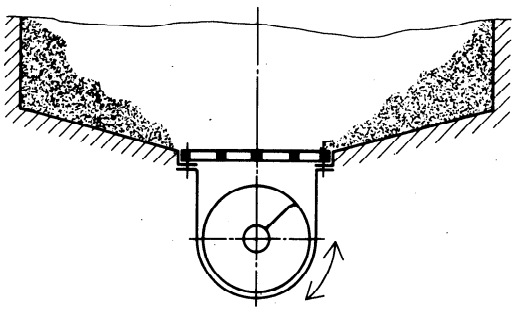


Figure 17

4.1.8 Tube or trough with openings

The screw can be placed in a tube or trough with openings if the openings are guarded as specified in 5.1.1 to 5.1.4 or 5.1.6; if such guards are used, nip and pinch points will also be protected.

4.1.9 Tube or trough with open discharge end

The screw can be placed in a tube or trough with open discharge end if the angle of the final edge β is less than or equal to the flank angle α at the outer edge of the screw blade (see figure 18).

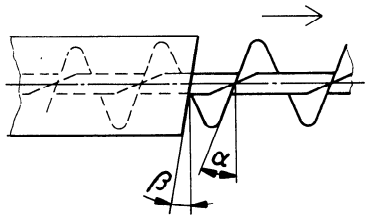


Figure 18

4.2 Guards on open troughs

Open troughs are only permissible if the nature of the work precludes the use of covers and if the side walls are high enough to prevent trapping points being accessible.

Examples of possible guards on open troughs are given in 4.2.1 and 4.2.2.

4.2.1 High side walls of the trough

High side walls prevent anyone from reaching over and touching a danger point (see figure 19). If possible, the design should preclude the possibility of anyone falling into the trough; otherwise guard-rails should be fitted (see figure 20).

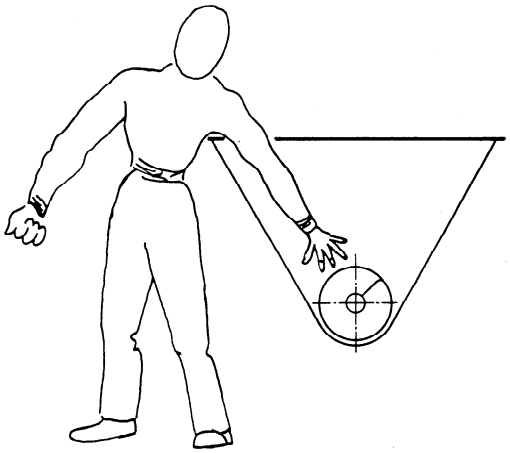


Figure 19

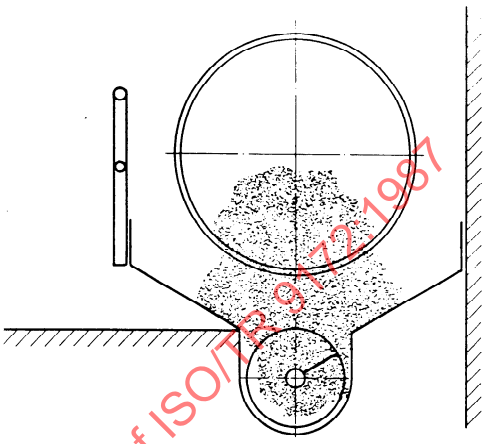


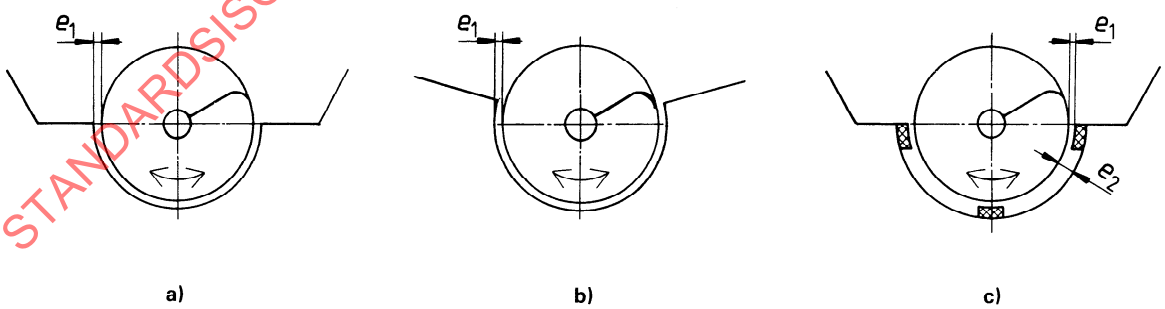
Figure 20

4.2.2 Clearances at edges of surfaces radial to the screw blades

Trapping points can be avoided between the edges of surfaces radial to the screw blades and the blades

a) if the clearance e_1 [see figures 21a), b) and c)] is less than 5 mm, or

b) if the clearance e_1 is reduced to less than 5 mm by fitting a stringer to the edge of the surface and if, beyond this stringer, the clearance e_2 is not greater than 15 mm [see figure 21c)].



a) b) c)

Figure 21

4.3 Guards on feeding and distributing screws

Screws used for reclaiming, stacking or levelling open stacks cannot generally be guarded as described previously because the operational process may be unacceptably hindered. Where access to these areas is necessary, these machines have to be provided with appropriate guards as described in 4.3.1 to 4.3.4.

4.3.1 Cover and guard-rail

Covers and guard-rails can be used on feeder screws of loaders and reclaimers which travel along the ground and where the trapping points are on the ground, provided that

a) the top cover guards at least the upper third of the screw (see figure 22);

b) the end of the ribbon-type screw is shaped as described in 4.3.3 and the top cover guard extends beyond the end of the screw blade surface by a clearance f of at least 120 mm, if the screw ends in a spiral, or by a clearance f of at least 50 mm, if the screw ends in a ring;

c) a guard-rail is positioned in the direction of travel at a distance in front of the screw g of 500 mm and at a height h of 500 mm.

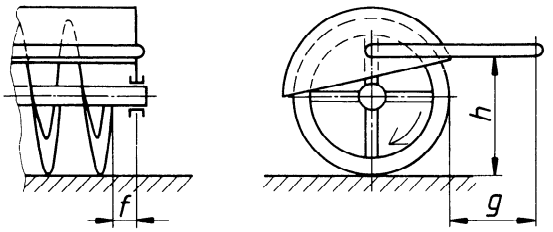


Figure 22

4.3.2 Guards

A guard alone can be used on feeder screws of loaders operating at ground level and where the trapping point is in the upper guard, provided that

a) the guard is designed so that no danger point is accessible through it (see figure 23);

b) the clearance i between the guard and screw is greater than 80 mm;

c) the clearance off the ground k of the guard is greater than 80 mm;

d) the end of the ribbon-type screw is shaped as described in 4.3.3 and the top cover guard extends beyond the end of the screw blade surface by a clearance f of at least 120 mm, if the screw ends in a spiral, or by a clearance f of at least 50 mm, if the screw ends in a ring.

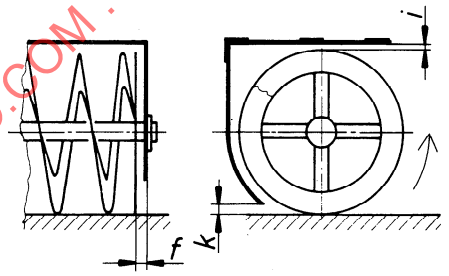
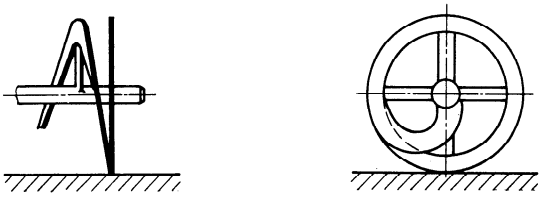


Figure 23

4.3.3 End ring or spiral

The end of a feeding ribbon-type screw, as referred to in 4.3.1 and 4.3.2, can either be shaped as a ring [see figure 24a)] or a spiral [see figure 24b)] to prevent clothing or parts of the body getting caught.



a) b)

Figure 24

4.3.4 Machine structure or guard-rails

Machine structure or guard-rails can be used as protection on distributing screws on asphalt road-finishers where

a) the machine structure guards the screw from above, front and rear, or

b) the upper guard is replaced either by a grid (see figure 25) or a hand-rail (see figure 26) at the side of the platform and with a height *l* of 0,8 m [1].

If removable screw extensions are used, these shall also be protected on the open sides either by guards or guard rails.

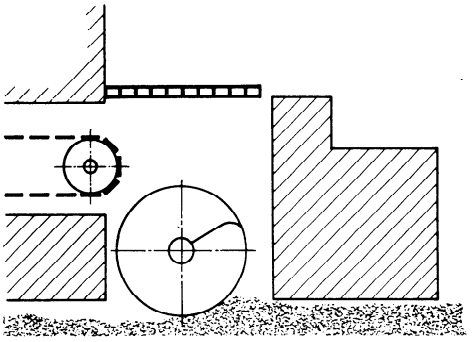


Figure 25

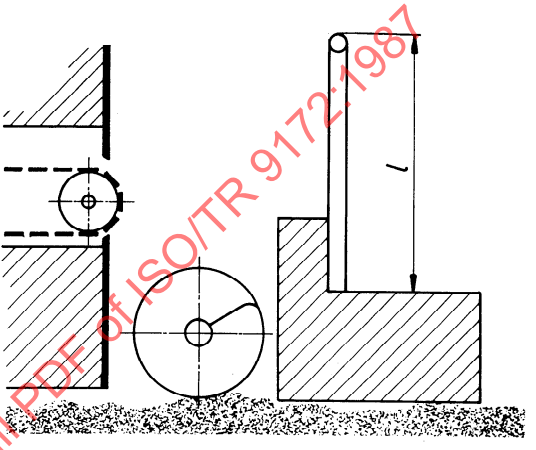


Figure 26

5 Guarding shearing points

5.1 Guards in housings

Since shearing points are a result of the operating principle of screw conveyors, a check is necessary at every opening in the trough or tube and, where necessary, a guard shall be fitted or the design altered in such a way that the danger of part of the body, usually fingers or hands, being sheared or crushed is averted.

Guarding is possible by safety devices as described in 5.1.1 to 5.1.6.

5.1.1 Feed and discharge pipes

Feed and discharge pipes can be directly connected to the body of the conveyor (see figure 27) thus rendering the screw inaccessible.

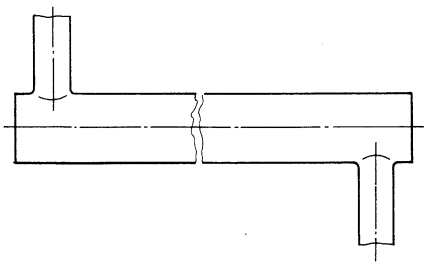


Figure 27

1) National standards may require that the height *l* have a different value.

5.1.2 Inlets and outlets through which it is impossible to reach

Inlets and outlets can be designed so that if the relationship between dimensions m and n (see figure 28) is in accordance with table 1, no danger point is accessible.

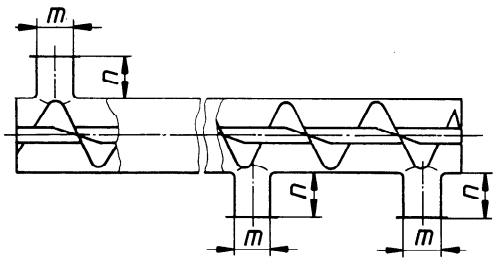


Figure 28

Table 1 — Relationship between dimensions m and n

Dimensions in millimetres

m	$m \leqslant 50$	$50 < m \leqslant 56$	$56 < m \leqslant 60$	$m > 60$
n	$n \geqslant 100$	$n \geqslant 110$	$n \geqslant 150$	$n \geqslant 850$

5.1.3 Grids in the inlets and outlets

Grids can be fitted to inlets and outlets so that if the relationship between the slit width w and safety distance x (see figure 29) is in accordance with table 2, no danger point is accessible.

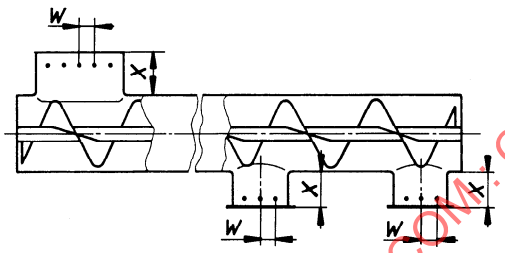


Figure 29

Table 2 — Relationship between slit width and safety distance

Dimensions in millimetres

Slit width, w	$8 < w \leqslant 20$	$20 < w \leqslant 30$	$30 < w \leqslant 135$
Safety distance, x	$x \geqslant 120$	$x \geqslant 200$	$x \geqslant 850$

5.1.4 Internal plate guards in the inlets and outlets

Radially mounted internal plate guards can be fitted to inlets and outlets so that if the relationship between dimensions m and n (see figure 30) is in accordance with table 1, no danger point is accessible.

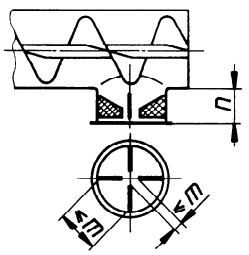


Figure 30