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Further developments on the trailer

Tippers are usually used for transporting loose material. Although such trailers have great universality they also have disadvantages such as centre of gravity displacement at tipping, problems with strongly sticking loads, limits to working height and uncontrolled tipping. Introducing a pushing action front wall solves such problems and there are other advantageous constructional characteristics such as guide rails outside the load bodywork, body cross section with minimum angles, high contact forces at sealing angles through flexible plastic with high elasticity modules and very reliable pushing surface guidance via bearing rollers plus shock absorbency of parallel-run roller packets against distortion of the shoving surface.

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Loose material transport in farming and other sectors is normally realised with three-sided or skip transporters. The known transportation concepts in the form of trailers or articulated attachments are similar and differ only slightly regarding technical equipment. Tipping trailers are used almost year-round.

Despite their great universality these trailers have four, mainly gravity-associated disadvantages:

- the alteration of trailer centre of gravity during tipping leads to a higher risk of the vehicle overbalancing.
- Tipping of material (e.g. clay and loam) with a high degree of stickiness is very difficult or impossible.
- Where there are height limitations (e.g. in barns) tipping is only partially or not possible.
- The tipping of loose material is generally uncontrollable, thus dosing the unloading is not possible.

The pushing front wall principle has been known since 1978 and this solves all the above disadvantages. Described in the associated patent description is a vehicle with box body and unloading equipment by which loose material loaded into the open topside of the box can be pushed to the rear wall of the box which is designed as a hinged flap. The system is realised by designing the front wall of the box as a pushing blade whereby the blade runs in longitudinal channels arranged along the sidewalls of the box container.

For some years now farm trailers with such an unloading principle have been on the market.

The main disadvantages of the known vehicles with the movable front wall are:

- the guiding channels for the movable front wall are situated inside the trailer body
- the resultant problems in the sealing of the gap between the outer edges of the pushing blade and the inner surfaces of the trailer body
- the overflowing of loose material (e.g. wet sand, grain) over the trailer body sidewalls whilst unloading.

Target

The target of further development is avoiding these disadvantages through adapting the movable front wall principle to meet farming requirements.

Required for universal application in the transporting of all the usual loose material in farming, e.g. seed, sand, topsoil, dung or lime is:

- a high degree of sealing efficacy between shoving blade and trailer body to cope with seed
- a reliable and easy guiding of the shoving blade between the side walls without blade angle distortion
- no overflowing of loose material during unloading
- a high shoving power for heavy loose materials (sand, lime)

High sealing efficacy of shoving blade

During shoving of the load, the blade there's a permanent tendency of the blade to angle within the body and so it has to be guided. Contrary to the known technical solutions, fitting the guiding channels immediately under the floor and behind the sidewalls of the body offers a way of keeping this equipment outside the load carrying space and thus minimising necessary angles giving a simple interior contour for easy sealing with just a few sealing elements.

Using plastic with a relatively high elasticity but also deformation resistance gives the desired tight sealing at blade outer edges whilst shoving.

Reliable and easy shoving blade guidance

For easy blade guidance between the sidewalls the blade moves via ball bearing races which are integrated in several roller packets. The roller packets are attached to the blade via parallel links under outward and upward forces which help maintain tolerances between blade and body. The constant contact of the rollers with the guidance surfaces of the trailer body ensures reliable gui-

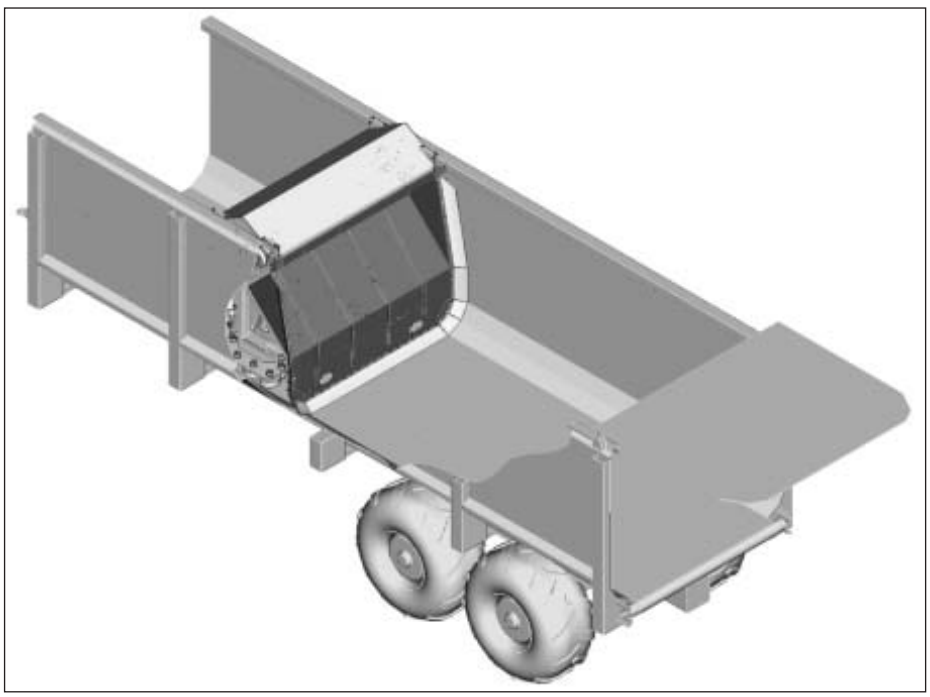

Fig. 1: Transport wagon with moveable push-blade

dance of the shoving blade within the body without angling and this too has a positive effect on sealing efficacy.

Theoretical observations on the overflowing of loose materials

The required craft F_S for shoving loose material is mainly produced from the product of mass force F_m of the loose material heap and friction value μ_R between floor surface and loose material. With the main parameters length of pile l, breadth of pile b, height of pile h and density of pile ρ there results F_s as follows

$$F_S = F_m \bullet \mu_R = V \bullet \rho \bullet g \bullet \mu_R = l \bullet b \bullet h \bullet \rho \bullet g \bullet \mu_R$$

The frictional forces between pile and sidewalls can be ignored in this context. Observing the material pile in model form, one can divide the single pile into a number of similarly sized smaller ones with a partial pile length of l_i. Thus the required forces for pushing such a partial pile necessitate the force F_{Si} which is achieved through

$$F_{Si} = l_i \bullet b \bullet h \bullet \rho \bullet g \bullet \mu_R$$

The contact forces applying within the individual part piles therefore steadily increase right up to the shoving blade from the end of the pile according to the addition of the individual forces F_{Si}.

In order to introduce the moving of the entire pile the required contact forces between the individual part piles must therefore be added and this results in an increasing of pressure within the pile from the end of the pile through to the pushing blade. This increase in pressure is expressed through deformation of the pile in front of the pushing blade from the start of the pushing action which results in the increase in visible pile height in front of the blade. At the same time the density of the pile increases, as does the effective pressure area of the shoving blade up to a balance of forces between pile and shoving blade.

This height increase leads to the overflowing of the load over the shoving blade and the sidewalls in known versions of the system.

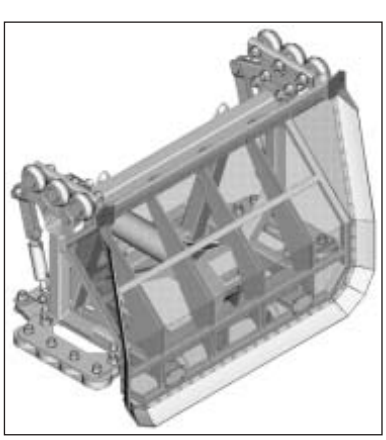

Fig. 2: Moveable push-blade

Avoiding the overflowing of material

The technical realisation of the trial machine planned a connecting belt from the shoving blade and running over the floor of the trailer body. One end of the belt is firmly attached to the shoving blade and stretches rearwards to the unloading point of the body where it runs round a roller. Beneath the transporter body the belt runs to the front and around another roller and is once again attached to the shoving blade.

The described attachment of belt to shoving blade means that the pile to be moved by the shoving blade is directly on top of the belt. The forces for shoving the individual part piles are no longer only carried between one another through the contact to the individual part piles but instead much more through friction between belt surface and every part pile directly in every part pile channelled from underneath. Through this the contact forces between the individual part piles remain constant to a large extent. With this a rising in pile height before the blade is practically avoided.

Through appropriate matching of work material the manufacturer can efficiently influence the friction value μ_R between belt and trailer body surface independently from the load material.

High pushing power for heavy load material

The stable action of the shoving blade inside a trailer with the given positive characteristics in association with a powerful multi-step double acting hydraulic cylinder can demonstrate in this variant the main advantages under practical application.

In the second variant the described combination of the shoving blade with a belt allowed shoving power to be mainly carried by the band. In such a case it would be possible to directly drive the belt and omit the hydraulic cylinder with the shoving blade then serving mainly as a sealing object only which means it need not be so strongly dimensioned.