Mobile drive-over hoppers and stackers for filling and emptying grain bunkers

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Abstract

F.A. Miller and Son Pty Ltd (FAMSON) has developed specific machinery for the receival of grain from road transport and transferring the grain to 30 metre wide bunkers. The system is known as a FAMSON D.O.H.S. (Drive Over Hopper and Stacker).

The machinery is portable, can handle wheat at 300 t/hour, is environmentally clean, does not damage the product and loads bunkers from the side so that no trucks drive on the prepared pad The equipment is then shifted inside the bunker and used to outload in conjunction with front-end loaders. Using the hopper as a surge bin and loading trucks on the roadway outside the bunker gives excellent outload rates up to 400 t/hour.

The equipment has proven efficient and cost effective during extensive use over the last three harvests in South Australia, where there were 2 Mt in bunker storage at the end of the 1993–94 harvest. The versatility of the equipment has expanded its use to shed filling and outloading, direct rail wagon loading and grain transfer.

History of Development

F.A. Miller & Son Pty Ltd (FAMSON), has a history in materials handling solutions, particularly grain, and have developed a range of air-supported, 'belt-in-tube' conveyors since 1980.

South Australian Cooperative Bulk Handling (SACBH), the bulk handling authority for South Australia, had until the late 1980s used grain throwers to bunker grain. The inherent problems with this method were extreme dust generation, which caused local governments to ban the use of this equipment near towns, and high double handling costs, as only specialist contractor trucks can be used to load grain into throwers. These trucks had to reverse onto the bunker pad creating a serious safety hazard because the thrower works inside the bunker area. A thrower can handle up to 200 t/hour but, because of truck changeover, this was not averaged over a day's work.

FAMSON was approached by SACBH to design a better system. In 1989 a design for filling 20 m wide bunkers was agreed upon and a machine built. Because of the heavy harvest, the prototype was used at several sites and handled approximately 40000 t of wheat and barley in the first harvest. The equipment performed above expectations. From the experience gained with this prototype, design criteria were set, resulting in the first of the current style equipment being built in 1990 to fill 30 m wide bunkers.

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The final 1990 design had to incorporate many improvements to bring bunker storage to a viable system, not merely a method of unloading the permanent storage system as an emergency method of handling a bumper crop. Specific requirements met by the FAMSON drive over hoppers and stackers (DOHS) system included:

- Environmentally friendly — a minimum of dust and of disruption to the area by noise.
- Complete safety — all reversing of delivery trucks to be eliminated.
- Minimum staff to operate.
- Compatible with permanent existing silo system so growers' trucks, after sampling and weighing, can be directed to permanent or bunker storage.
- Completely self contained and portable, so units can be relocated as harvest requirements of storage become apparent.
- Able to receive from all types of road vehicles — farmers tray-top trucks with side emptying bins through to road trains.
- Cost effective to operate and simple to maintain.
- Capable of filling 30 m wide bunkers with an approximate capacity of 100 t of wheat per metre.
- Able to receive at rates up to 300 t/hour.
- Vehicles to be kept off prepared bunker pad.
- Able to be used in the bunker unloading process.

All these design criteria have been met and are standard features of the FAMSON DOHS system.

Description of drive-over hopper

The drive-over receival hopper is 8 m long, 3.6 m wide and 0.85 m high with 4 ramps to allow trucks to pass over the unit. (Fig. 1). A lid folds back from the centre to form side bulkheads in operation.

The bottom of the hopper is shaped in 4 'V' sections to take 4 ribbon augers which run along the 8 m length and bring the grain to the centre of the hopper. Built into the base of the hopper below the auger level is a transverse box section tunnel with a sliding valve in the top surface. Into this tunnel is fitted a conveyor belt which moves the grain out from under the hopper and delivers it to the stacker.

The unit is powered by a quiet pack diesel over hydraulic power pack operating through a solenoid controlled valve bank. The power pack is bolted to the hopper in operation. The power pack forms part of the total assembly and moves as part of it. The operator has a panel of switches to control the functions of the hopper. The unit has a hydraulic jacking system to raise it and to lower the wheels to move along the bunker.

The entry and exit ramps and sliding gang valve are operated by hydraulic rams. The four ribbon augers in the hopper base and the transfer conveyor are driven by hydraulic motors.

Fig. 1. Mobile drive over hoppers and stackers for filling and emptying grain bunker storage

Description of the stacker

The mobile stacker (Fig. 2) consists of an air-supported 'belt-in-tube' conveyor 25 m long mounted on a mobile frame. The unit has a 16 m cantilever overhang in front of the frame and is raised and lowered using telescopic hydraulic rams.

An air supported 'belt-in-tube' conveyor (Fig. 3) was chosen for the high capacity at steep angles. The unit operates at 25° when filling a bunker. The conveyor has very high integral strength in the tubular design for minimum weight to allow cantilevering.

The frame mounts on truck wheels on the main axle. These wheels can be fitted to tow the unit in the normal lengthwise manner or at 90o to the tube for movement along the bunker wall. The double rear castors work in either direction. The frame is counter-balanced with concrete ballast blocks.

Power is from a quiet pack diesel engine over hydraulic power pack operating through a solenoid controlled valve bank. The operator has a panel of switches to control the stacker functions. The electrical controls are on a 30 m flex to allow the operator to be located at the hopper for inload and at the delivery point for outload.

The delivery of grain at the discharge is controlled by a multi-directional outlet giving movement across and along the stack. The outlet is operated by hydraulic rams (Fig. 4).

Mobility of system

Once assembled both the hopper and stacker are towed into position with a tractor or front-end loader.

The hopper can be stripped down by removing the transfer conveyor, the four ramps, the wheels and operator walkways to load onto a flat top semi-trailer. The stacker has the belt released and the tube assembly folds 6 m from the discharge end to reduce length for transfer. The main wheels and castor assemblies are removed and the unit fits on to an extendable trailer (Fig. 5). To dismantle and load on to road transport takes

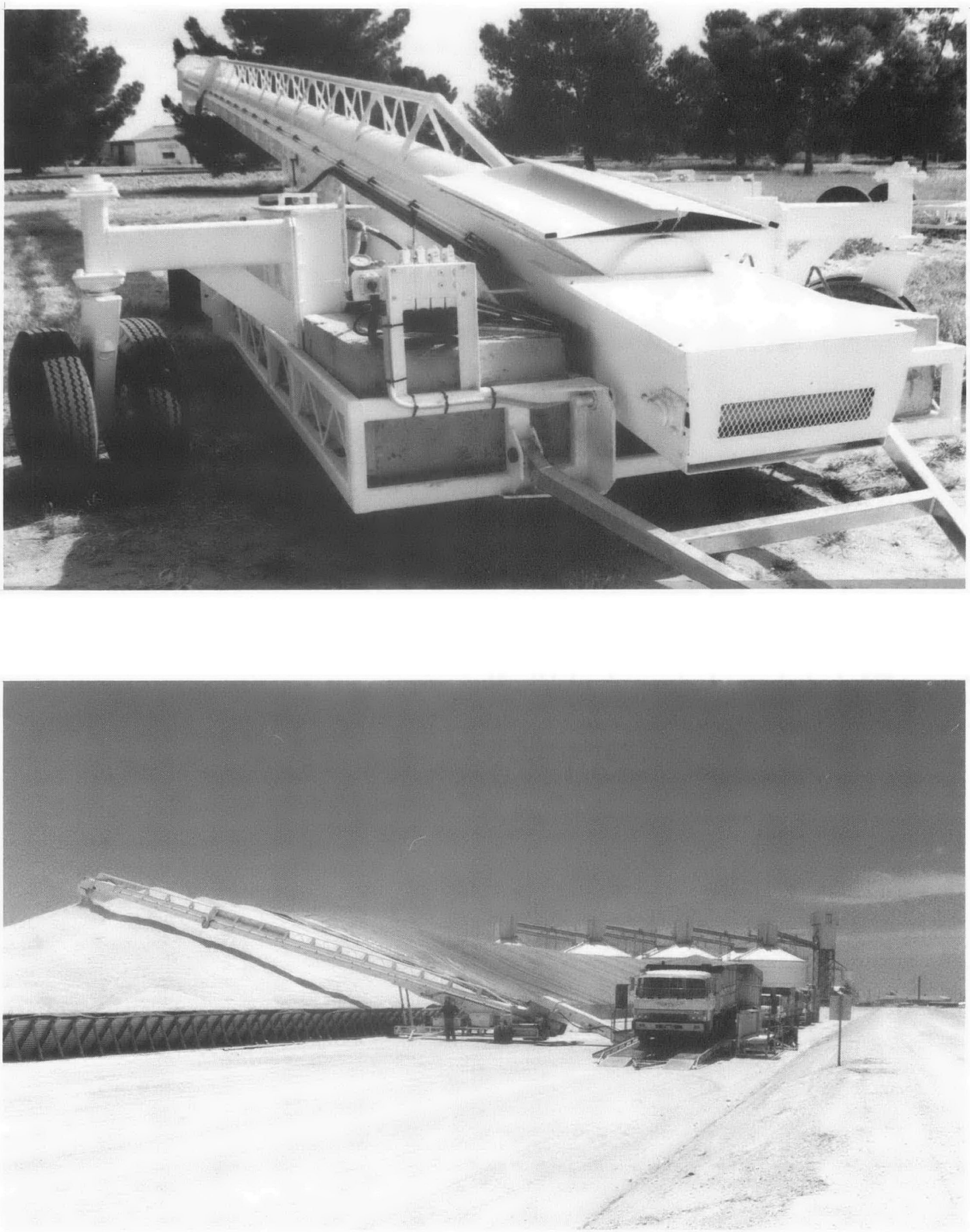

Fig. 2. The mobile stacker

approximately 6 hours with experienced personnel. Reassembly takes about the same time.

Method of operation

Once in place at the side of a bunker, the system is operated by one main operator and an assistant.

Trucks drive onto the hopper and discharge as directed. The sliding gang valve is opened to control the gravity flow on to the transfer conveyor which feeds the main stacker. As the level in the hopper drops, the ribbon augers are engaged to maintain the feed rate onto the transfer conveyor. During this period the next truck moves on to the hopper and begins discharge to maintain the maximum output rate.

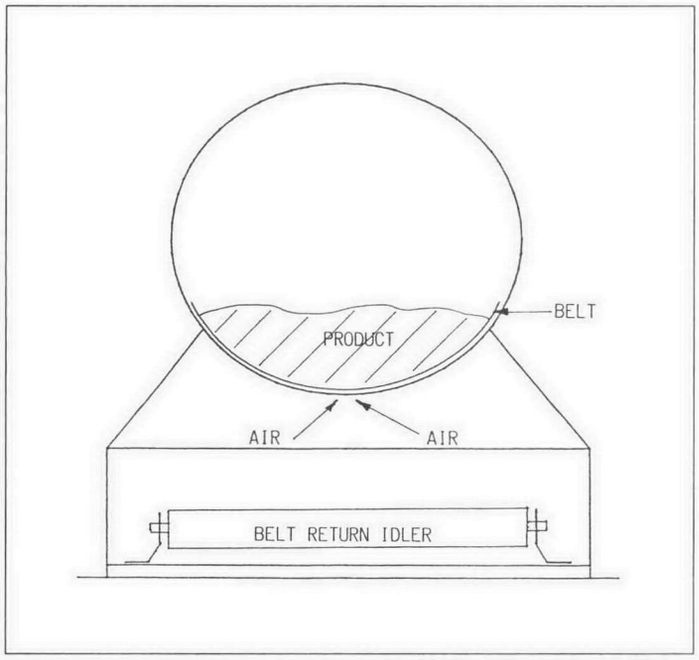

Fig. 3. Cross-section of a typical 'air supported' belt conveyor.

Once the stack is built to the required height using the stacker outlet to fill along the bunker as far as possible, the stacker and hopper are towed forward until the stacker outlet feeds backwards to give the best heap without extra moves. The movement along the stack takes approximately 10 minutes.

At the end of the day, or in bad weather, the lid folds down to cover the hopper.

Method of operation — unloading a bunker

Unloading a bunker is accomplished by setting up the hopper and stacker inside the bunker walls so that the stacker discharge is over the bulkheads above the side road in line with the area occupied by the hopper when loading the bunker. In this way trucks drive on the prepared highway alongside the bunker to be filled. No reversing is needed.

The hopper is modified by removing the four ramps and fitting bulkheads across the ends to form a deeper unit. The hopper is then set up to feed to the stacker. Front end loaders are used to fill the hopper and can build up a reserve while trucks are moving or returning from delivery.

The operator stands on a tower near the delivery end of the stacker where he can direct the truck driver and see the grain in the truck. The electrical controls for the hopper and stacker are located in the operator's tower so that he can control the hopper gang valve and stacker outlet directions to load the trucks.

As the bunker is unloaded, so the system is moved along to stay close to the grain stack for the front-end loaders.

Conclusion

The DOHS system, as developed, has proven to be a very efficient and cost-effective system for the rapid handling of grain in to and out of bunker systems. Sixteen units are currently in operation. More are being considered.

The versatility of the equipment lends it to many other uses. Units are now being used to load and unload long storage sheds, and for direct transfer of grain from road transport to rail wagons for bulk rail direct shipping.

Fig. 4. Multi-directional outlet.

Fig. 5. Extendable trailer carrying tube assembly.

At a bunker site in Cummins, South Australia a system for receiving from bulk rail to store in bunkers has been developed. The rail line runs over a pit in which two hoppers are placed to receive from the bottom discharge rail wagons. The grain is transferred to road trucks which, in turn, deliver to the bunkers under construction. Trains up to 1200 t capacity are unloaded in under 4 hours, allowing three trains per 12-hour day.