

# Self-Unloading Vessel Equipped With Bucket Wheel

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## Summary

A novel self-discharging system is helping to ensure rapid turnaround and maximum utilisation of the MV Cambourne for her owners, Civil & Marine Ltd. of Greenhithe, Kent.

The system is based on a bucket wheel designed and manufactured by Strachan & Henshaw, which discharges dredged sand and gravel from the hold on to a ship-mounted conveyor system designed by British Ropeway Engineering Company (BRECO).

The ship and its discharging equipment have been designed as a complete integrated system from the original concept. This has produced a remarkable efficient vessel which can operate with little dependence on quayside installations.

## 1. Introduction

The increasing amounts of sand and gravel to be extracted from the sea bed around the UK led British Ropeway Engineering Company (BRECO) to pioneer the development of self-discharging systems for aggregate dredgers and other vessels used for bringing the material ashore from the dredging grounds. Among the vessels to use this equipment was the MV Cambrae, owned and operated by Civil & Marine Ltd.

Experience with the Cambrae led Civil & Marine to continue the line of development on their latest vessel, MV Cambourne. For this they have combined the resources of BRECO (a member of the Capper Neill Group) with those of Strachan & Henshaw to develop a self-discharging ship which is designed around an excavating bucket wheel coupled to an on-board conveying system. The result is a vessel which can unload her cargo of 2,600 m<sup>3</sup> of material on to a shore-going conveyor system in under three hours (Fig. 1).

## 2. The Bucket Wheel

The bucket wheel, which forms the principal working element of the discharging system, was designed and constructed by Strachan & Henshaw to unload sea-dredged gravel and sand at a rate of 1,000 m<sup>3</sup>/h. With a specific gravity, in drained condition, in the range 1.7—1.82 this matches the capacity of an existing on-shore conveyor system — to be fed by the ship — rated at 1,800 t/h.

These figures, as well as the physical dimensions of the ship's hold, dictated the size of the bucket wheel and determined its rotation and travel speeds. These, in turn, determined the requirements of the on-board belt conveyor system designed by BRECO to complement the bucket wheel.

The bucket wheel has eight buckets each of approximately 800 litres capacity, and is of the cell-less type. It is designed to rotate at 3.75 rpm, which gives 30 bucket discharges per minute; Strachan & Henshaw's experience in bucket wheel design indicated that this is the optimum working speed for this material.

The wheel is mounted transversely to the axis of the ship, on a large diameter shaft supported by a luffing boom. This, with the associated drive motors and control gear, is mounted on a travelling carriage for movement along the length of the hold. The carriage runs on rails which are mounted on the coamings either side of the hold. Fore-and-aft propulsion is effected by chain drive; a static chain supported alongside each rail is picked up and fed in a 'running loop' around a driving sprocket on each side of the carriage to provide positive no-slip drive, whatever the condition of the rails.

Unloading is intended to be completed in 10 passes of the machine, taking a total of about three hours. The bucket wheel is first lifted clear of the material in the hold and runs up to operating speed; then it is lowered into the material to a depth of approximately 0.5 m for the first cut, which is taken travelling aft from its stowed position at the forward end of the hold. The rotating wheel cuts into the material and lifts it in the buckets until gravity causes it to spill through a

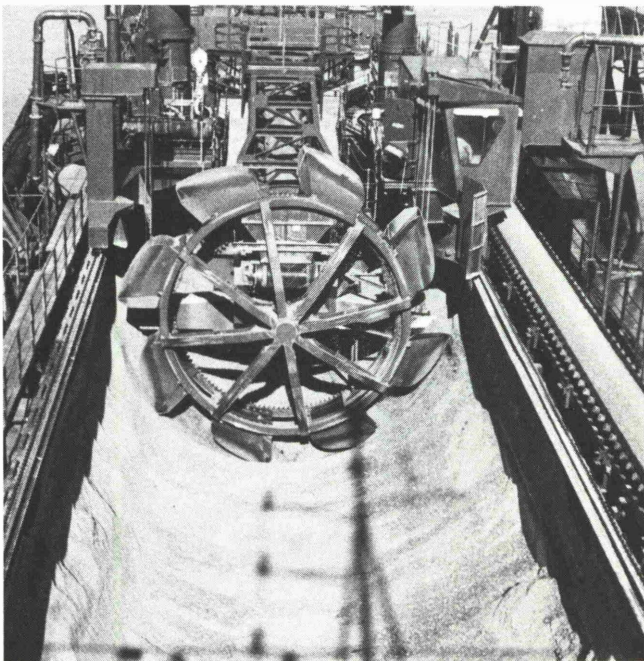


Fig. 1: Bucket wheel excavating aggregate from ship's hold

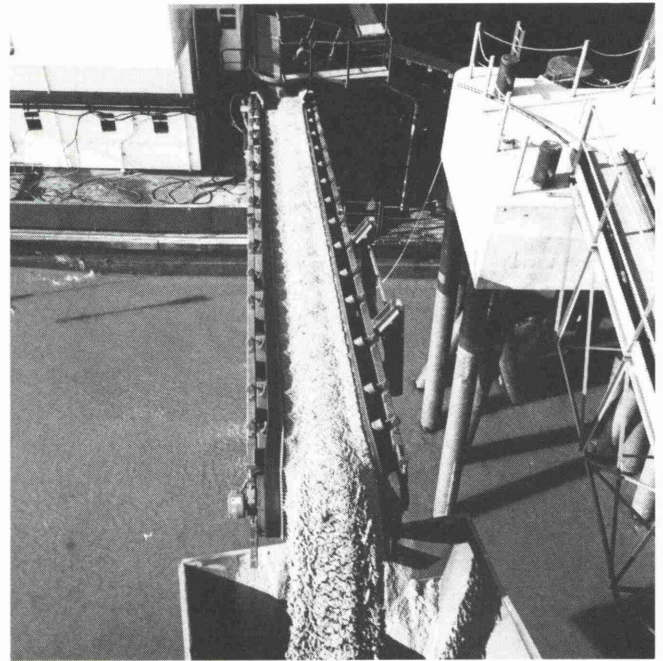


Fig. 2: MV Cambourne's boom conveyor discharges aggregate into a hopper feeding the shore-going conveyor system

chute which guides it on to a belt conveyor running the length of the machine boom. This feeds a cross conveyor, which in turn deposits the discharged material on to the main fore-and-aft conveyor mounted on the starboard side of the hold.

The bucket wheel operator works from a cabin situated on the after end of the travelling carriage, beside the bucket wheel and ideally placed to monitor the whole discharging process. The cabin also houses all the electrical and hydraulic control equipment for the wheel, which is designed with full protection from salt spray, sand, gravel, or any of the potentially damaging elements in its working environment.

### 3. Deck Conveyor System

The deck conveyor system designed by BRECO also takes into account the arduous climatic and corrosive conditions experienced by this type of vessel, and its need for maximum availability. The system consists of three troughed conveyors, each driven by its own 65 HP motor, and is used to transfer material from the bucket wheel to the shore facility. The material, which can be deposited at any point along the bucket wheel's 44 m working travel, is carried aft along the starboard side and discharged on to an inclined conveyor which elevates the material to the height required to discharge into the hopper of a ship-to-shore boom conveyor.

### 4. Boom Conveyor

The boom conveyor is mounted on a slewing tower about 2m above the deck and is able to be luffed from the horizontal up to an angle of 25 degrees. When not in use it is stowed horizontally on a crutch inset on the starboard side of the bridge structure. Bringing the conveyor into operation

or stowing it away on completion is carried out at slow speed through a local pendant control, the operation taking less than five minutes to complete.

During the unloading operation the position of the boom conveyor is adjusted from a control house on the front of the bridge superstructure, any adjustments to cater for tide, wind or other conditions being easily made as the hydraulic control is precise. The ship's boom conveyor discharges directly on to the shore-going conveyor system leading to the raw material stockpiles (Fig. 2).

### 5. Marine Operation

Recognising the realities of marine operation, the whole system has been engineered to permit discharging to be carried out in winds up to 80 km/h in any direction, with the ship listing up to 6 degrees to port or starboard, or when trimmed by the stern, to produce a gradient at the rails of up to 1 in 40. While at sea, the machine is firmly secured at the forward limit of its travel to withstand pitch and heave motions of up to 0.93 g up or down, and a sea load on forward facing exposed surfaces of up to 0.78 t/m<sup>2</sup>. Roll to port or starboard of up to 28 degrees, with a complete roll cycle period of 13.4 seconds, has also been catered for.

### 6. Conclusion

Early experience with the MV Cambourne has shown that this self-discharging system is a highly practical means of achieving maximum utilisation of the vessel for bringing sand and gravel ashore from the North Sea dredging areas. The MV Cambourne was built by Ailsea Shipbuilding Co. Ltd. (part of British Shipbuilders) of Troon, Ayrshire and Rendel Palmer & Tritton was the Naval Architect.