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Application Aspects of Continuous Unloaders

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Anwendungsaspekte kontinuierlich arbeitender Schiffsentlader
Aspects de l'application des déchargeurs continus
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連続アンローダーの応用面
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Anwendungsaspekte kontinuierlich arbeitender Schiffsentlader

Ein kontinuierlich arbeitender Schiffsentlader wird vorgestellt, der auf dem Prinzip der Eimerketten-Förderung beruht. Er kann die meisten Schüttgüter entladen, hat einen niedrigen Energieverbrauch und Austragsvorrichtungen, die nur zu geringer Staubentwicklung führen.

Aspects de l'application des déchargeurs continus

Présentation d'un déchargeur de navire continu, qui est en fait un élévateur à godets. Il peut servir au déchargement de la plupart des matériaux en vrac, nécessite une faible consommation d'électricité et décharge sans causer de poussière.

Aspectos de la aplicación de descargadores continuos

Se presenta un diseño de descargador continuo de buques que es básicamente un elevador de cuchara excavadora. El puede descargar la mayoría de los materiales a granel, consume poca energía y descarga el material con baja emisión de polvo.

Summary

There is currently a very rapid growth in volume of dry bulk shipments, requiring higher unloading rates, ship sizes, and different technical solutions and unloading equipment.

Many consider that the upper practical limit of the size of grab unloaders has been reached. Environmental constraints are forcing equipment manufacturers to search for other solutions. Several types of machines are being developed as a result.

Paceco after years of research work, has developed an unloader which is of a continuous dragline type. It can discharge most bulk materials, has low power consumption, can unload with little dust emissions, and is easy to operate. It can be adapted to many installations by varying the support structure and the size of the buckets.

The first commercial machine is proving itself in Gulfport, Mississippi, USA, unloading ilmenite mineral sand. Because of the pressure for more efficient higher capacity unloaders, it is believed that there will be a gradual increase in the application of various types of continuous discharging machines.

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1. Introduction

The movement of bulk solids in and out of ships has come some considerable way since the period of sacks and strong backs. The ingenuity of man has produced the clam shell or grab unloader for discharging, and the boom type conveyor and chute for the loading of bulk materials. In order to reduce the cost of transportation, ship sizes have dramatically increased in recent years, resulting in the requirement for higher and higher discharge rates to reduce turnaround time.

Equipment manufacturers have responded with larger capacity grab unloaders, resulting in extremely expensive and ponderous machines. Many feel that the limit in size has been reached and that some other type of unloader must be developed to satisfy the requirements for higher capacity, lower power consumption and less weight.

The following sections attempt to summarize future ship unloading requirements and the response by Paceco, Inc. to meet these requirements.

2. Dry Bulk Material — Characteristics and Tonnage

In recent years there has been a dramatic increase in dry bulk tonnage and significant changes in materials being transported. For example, more iron ore is beneficiated prior to shipment, more bauxite is processed into alumina prior to shipment, and iron ore distribution patterns are changing with the establishment of direct reduction steel mills in smaller countries.

The European Community Commission (EEC) on Energy predicts that coal imports will increase from the current annual level of $66 \cdot 10^6$ t to $280 \cdot 10^6$ t by the year 2000. US coal exports are expected to increase by 37% to $89 \cdot 10^6$ t/year by 1990. Imported coal is projected to reach 10^7 t/year by the end of the decade, compared with $2 \cdot 10^6$ t in 1979.

The export of US agricultural commodities continue to rise. In 1980, $137.5 \cdot 10^6$ t are expected to be exported, an increase of 15% over 1979.

3. Shipping Fleet Characteristics

During the last 30 years there has been a complete change in bulk carriers, from multi-deck ships, to the open hold type. This has made possible the use of larger grab unloaders and now, the continuous unloader.

Ship size has dramatically increased, placing additional importance on increasing unloading rates. In addition to oil-bulk carriers, we are now seeing combination bulk-container ships.

The self-unloading fleet has been slowly increasing for the short trip market. In the USA the river barge fleet has shown and will continue to show rapid growth sparked by the increase in coal and agricultural product shipments.

In reviewing the range of modern bulk carriers, both the width and depth of these vessels vary greatly, with each combination placing different demands on the unloading system.

4. Design Criteria for Ship Unloaders

The basic design requirements are as follows:

— Simplicity of design
— Ability to handle various sizes of ships
— Ability to handle large tide variations
— Ability to control dust
— Ease of operation
— Ability to handle various materials
— Minimum of specialty parts

There are many variables to be considered in providing an unloading system. For example, the large ships require very high capacities to achieve rapid turnaround. With some barge transport projects, when the yearly tonnage is modest, a low unloading rate is desired to keep the capital expenditures down.

Material characteristics, such as dustiness, lump size, stickiness, abrasiveness, density and propensity to explode and corrode, can have a marked effect on the type of unloader. Yet, in a number of facilities, it is necessary to handle a wide variety of materials. This places unusual demands on the type of unloader and the dust collection equipment that may be required to meet environmental standards.

In some applications, a large tide variation must be accommodated, in others in order to save capital costs, a fixed machine is required with the vessel being moved under it.

Equipment manufacturers have long been aware of these problems and the market potential for improved unloading equipment. As a result, they have responded with a variety of designs, some of which have performed well on certain types of products. The main thrust of the designs varies, depending on the particular application in mind. Some are best suited for dusty products, some for light-weight materials, and others for high volume non-dusty ores.

Such machines fall into the following categories:

— Pneumatic
— Screw elevators
— Bucket-wheel belt
— Bucket elevators
— Digging bucket elevators
— Belt elevators

No one type is suitable for all materials or installations. For example, several US companies have supplied large chain and link bucket elevators for the unloading of coal from river barges. These machines perform extremely well in this application but do not adapt themselves successfully to the unloading of coal from large bulk ships. Pneumatic machines have been used extensively to unload finished cement and alumina, although they are not suitable for heavy or lumpy material.

Straight bucket elevators work well on free-flowing materials and the screw type elevator has proven to be very satisfactory on certain products at low to moderate unloading rates. However, to date, the screw elevator has not demonstrated the ability to handle heavy abrasive ores at high tonnage rates. Some of the designs able to handle ores at high tonnage rates are not economically competitive for light-weight products at low to medium tonnage rates.

To more specifically illustrate some of the trade-off factors that the user must study in employing a continuous unloader, the following is a review of the Paceco Catenary Continuous Unloader and its limitations and advantages in the unloading of bulk materials.

5. Paceco Research and Development Programs

Paceco has designed and manufactured medium sized grab unloaders (1000 t/h) for many years. Fig. 1 shows a typical

Fig. 1: A 1000 t/h grab bucket unloader. The machine features a semi-automatic operation mode and an integrated dust collection system, and is used exclusively to unload alumina

grab unloader complete with dust collection system, for handling alumina. The Paceco Continuous Unloader is the result of an intensive design effort to provide a machine which could overcome many of the inherent problems of grab unloaders, and to provide a machine better able to meet future requirements.

Development efforts started in 1960, and after carefully examining all of the modern concepts for continuous bulk unloaders, it was decided to focus on improving the state-of-the-art.

Early observations showed that bucket wheel or bucket ladder type continuous unloaders, which operate at the end of a long vertical arm, must crowd their digging buckets into the material. This creates tremendous forces which are subsequently transmitted to the supporting structure. As a result, an extremely strong and heavy machine is required for

the support, which necessitates a more expensive dock. To reduce or eliminate these problems, Paceco decided to experiment with a line of drag buckets to achieve the digging and elevating function. A working model was built and operated (Fig. 2), followed by a full size prototype (Fig. 3). Performance was as predicted, however, line speed was limited and the unit could not recover material under the deck.

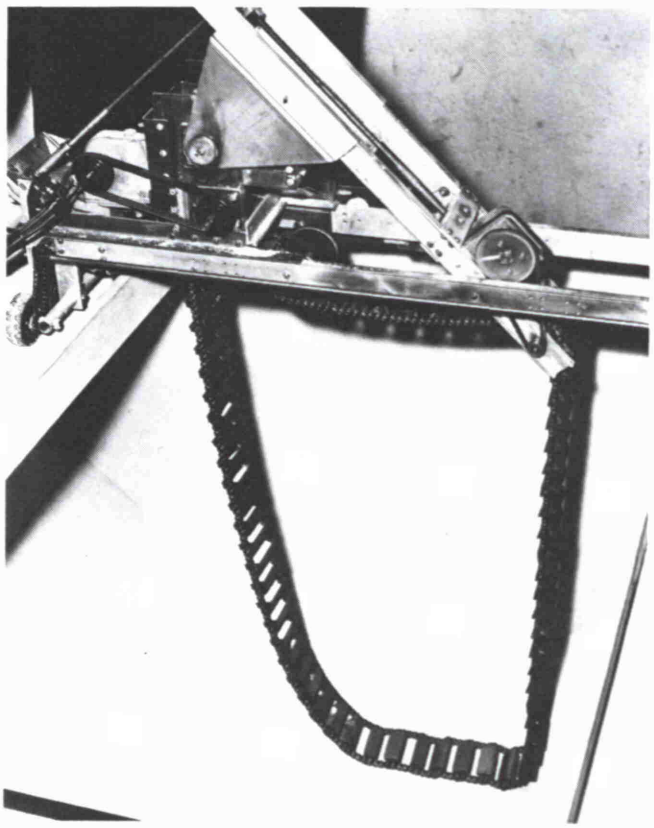

Fig. 2: Prototype continuous unloader model featuring square buckets and chain-link construction

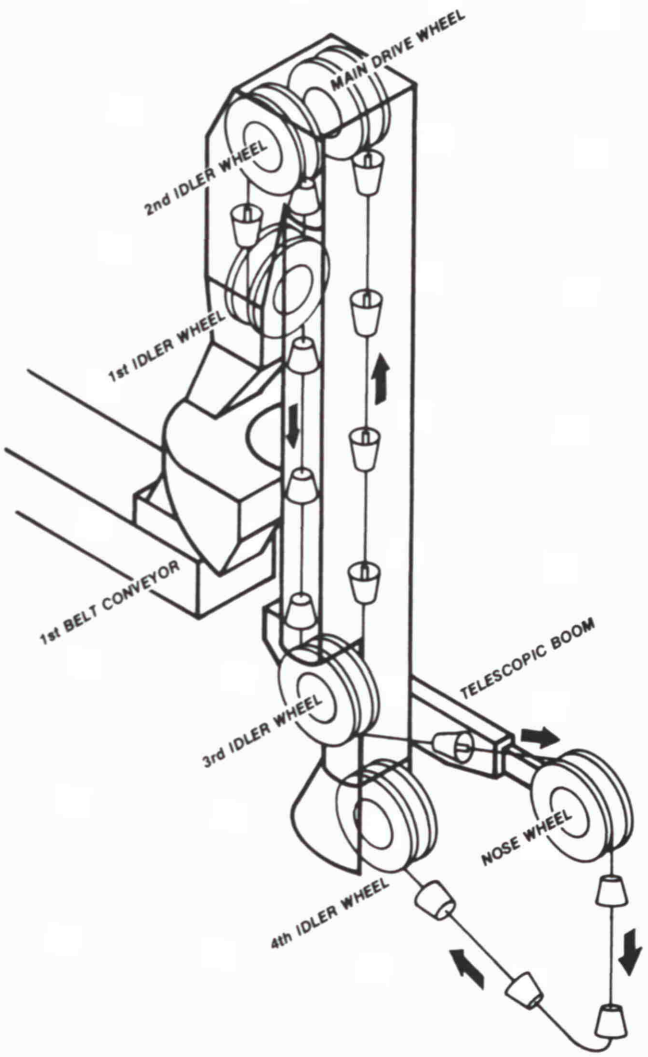

Fig. 3: Schematic drawing of the round bucket-cable configuration showing the bucket travel from fill to discharge to return

To overcome these limitations, the design was revised to use round buckets on a cable driven by a special sprocket wheel, with an arm to reach under the wing of a ship. The arrangement of drive and idler wheels along with the bucket travel from filling, to dumping, and return is shown in Fig. 3. After experimentation with a scale model, a full size prototype (254 mm buckets) was built. Fig. 4 shows the prototype discharging sugar. The unit was also tested on unloading copra and wet sand. Fig. 5 shows the bucket line passing over the nose wheel on its way to product recovery.

By utilizing this particular combination of round buckets and wire rope, the line speed was increased to 183 m/min.

Fig. 6 shows the next machine in the development being tested as a reclaimer on iron oxide pellets. The machine demonstrated its capability to dig in many products, from wood chips to iron ore, although its basic limitation is in handling material that is either very sticky or has a large particle size distribution. However, with hardened bucket lips and a reinforced collection chute, heavy abrasive materials are easily unloaded.

6. Paceco Continuous Unloader

Figs. 7 and 8 show the most recent unit installed at the Port of Gulfport, Mississippi, USA. The system is completely enclosed after the buckets leave the digging surface. This naturally protects the material from moisture and eliminates spillage of the product. For dusty materials, a dust collection system is added with air suction at each material transfer point.

The requirements for the port of Gulfport were for an unloader that could handle containers, break bulk shipments, heavy lift operations, and unload both barges and ships. The prime product to be unloaded is ilmenite, with additionally commodities such as fish meal, fertilizers, and bauxite being handled. The unloader was designed with a heavy duty hydraulic drive to allow ores to be handled.

A key factor in unloading costs is the time required for performing the clean-up. With a grab unloader, depending on product characteristics and ship configuration, approximately 20% of the product must be moved by dozers to a position that will allow the grab to make recovery, this is a time-con-

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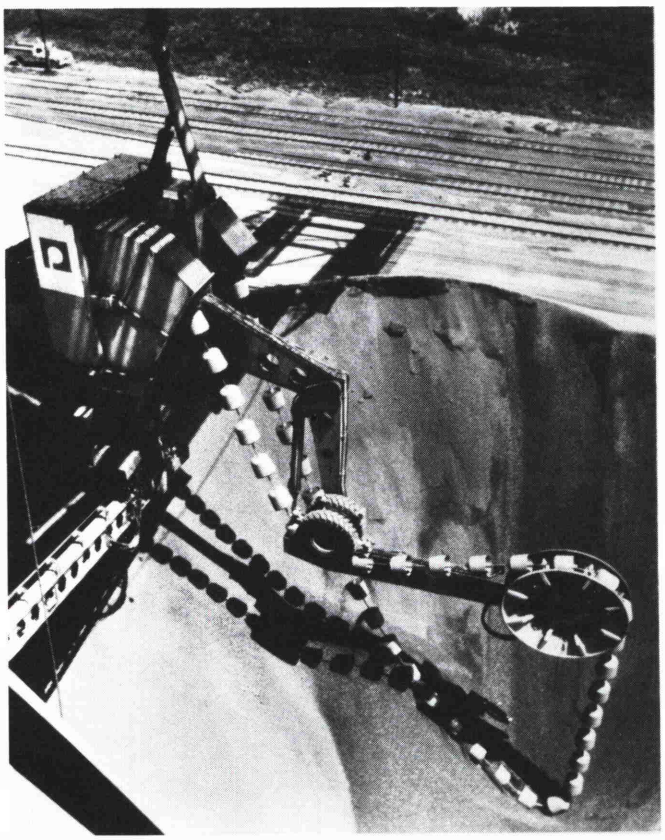

Fig. 4: Full size prototype unloader with 254 mm buckets shown discharging raw sugar

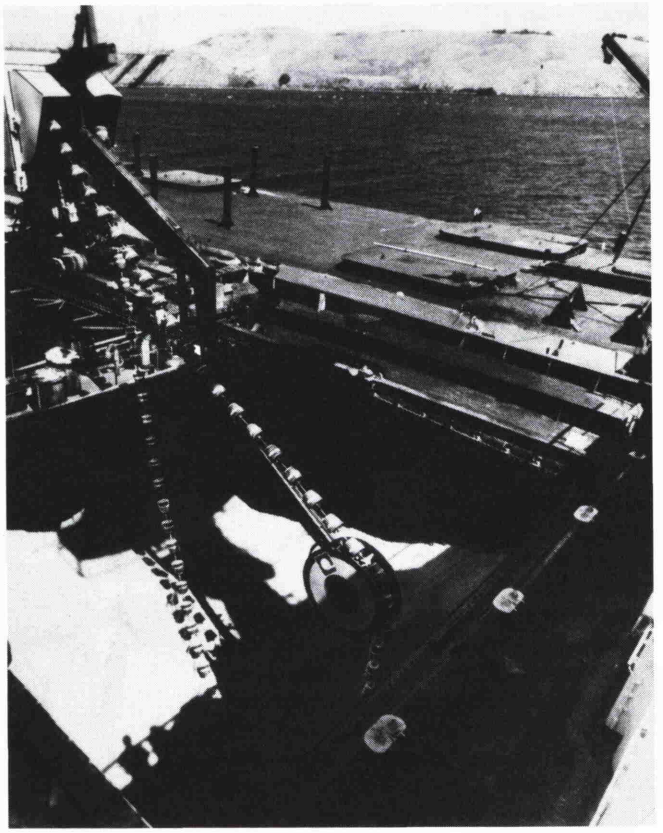

Fig. 6: Development model with 457 mm buckets and featuring telescoping arm shown recovering iron oxide pellets

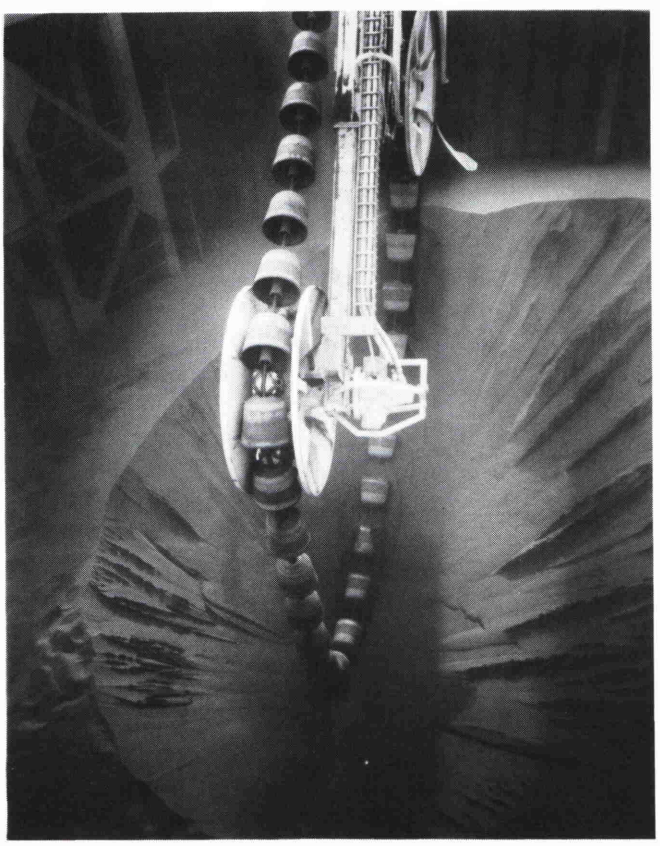

Fig. 5: Close up view of bucket action and sprocket type nose wheel support. Bucket size 381 mm product ilmenite

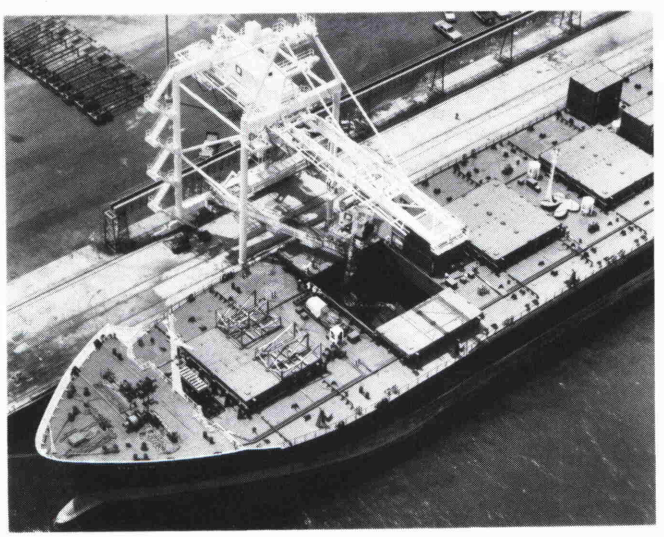

Fig. 7: Multi-purpose container-bulk unloader with 381 mm buckets installed at Gulfport, Mississippi, USA, shown discharging ilmenite mineral sand

suming and expensive process. The Catenary Unloader, with the telescoping arm and nose wheel, can place the bucket line in the corner of the hold and make a recovery without assistance. Depending on the hold configuration, the machine will remove from 95—98% of the product without any assistance.

A well known problem with grab unloaders is operator fatigue. Most companies have supplied semi-automatic controls on such machines to help overcome this problem. Close operator attention is still required to return and position the bucket inside the ship's hold to prevent equipment and ship damage. The situation with continuous unloaders is entirely different, as the unloading mechanism is placed on the pile and the operating poceeds with little or very slow movements only.

The reduction of energy costs has become a very important issue in evaluating terminal operations. Mechanical continuous unloaders offer dramatic reductions in power consumption. For example, Paceco has recently proposed both a grab unloader and a continuous unloader for a coal unloading terminal. The average unloading rate for the grab was approximately 890 t/h and the continuous unloader was approximately 1030 t/h. Motor name-plate ratings for the hold, close and trolley motors for the grab unloader totalled 900 HP. For the continuous unloader, name-plate ratings for bucket line and conveyor operation totalled 550 HP. Actual electrical cost savings will depend on local conditions and rate structure for the particular installation.

For installations where only ship discharging is required, a revolving tower crane, as shown in Fig. 9, would be offered. With the control station mounted on the lower leg near the bucket line, optimum visibility and peak operator efficiency is realized.

7. Conclusion

No one continuous unloader can efficiently and effectively handle any discharging job, because of the many variables inherent in such operations. However, the Paceco continuous unloader does satisfy the design and operation criteria in many applications and offers the following capabilities:

1. Lower costs for original equipment, operation, maintenance and power consumption.
2. The machine reaches into normally inaccessible wing areas in the holds of ships and barges.
3. It cleans up in corners usually without mechanical assistance.
4. It provides constant rated production capacity at all unloading depths except during clean-up.
5. Minimisation of operating procedures and maintenance with simplicity of design.
6. Elimination of ship damage during the unloading operation.
7. Reduction of dust and loss of product.
8. The minimum of operator training needed.

Fig. 8: Side view of Gulfport installation showing the bucket line, digging arm and dockside take-away conveyor

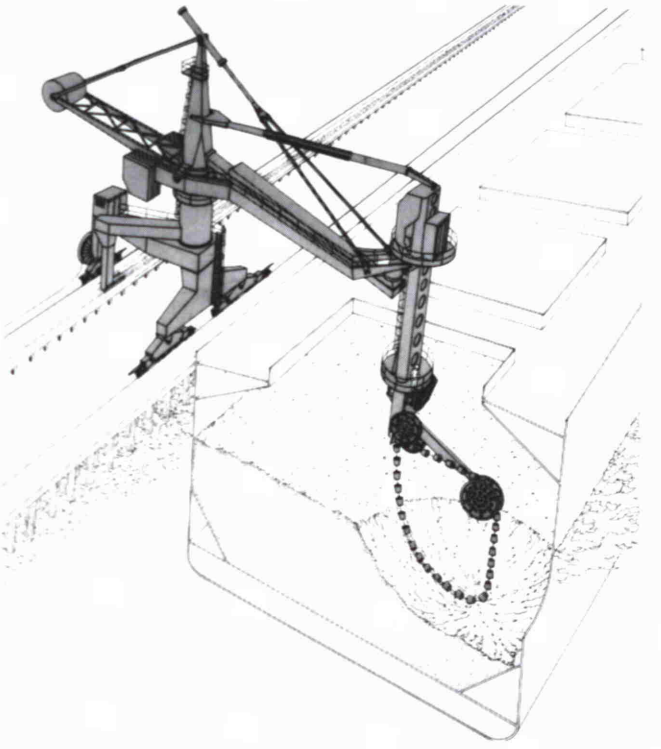

Fig. 9: Continuous unloader with 762 mm buckets supported by a revolving crane. Enclosed elevating, dumping and take-away design with integrated dust collecting system