



Loading arms and their control panels

in hazardous areas

by Sandra Wassink



Kanon Loading Equipment b.v. and Electromach b.v., a member of R.STAHL AG, have enjoyed a long and successful technological partnership which has solidified over time. Kanon is the world's most innovative manufacturer of marine loading arms. After their establishment in 1979, they set out to create an international network of carefully selected and intensively trained agents and associated partner companies.

Marine loading arms

The loading arm is an assembly of articulated piping developed to transfer liquids and gasses between a storage facility and a tanker vessel. These units are used in a wide range of applications from cryogenic to high temperature products, and they can transfer the most hazardous or corrosive fluids. Loading arms are used in all areas of the processing industry including chemical, petrochemical, storage terminals, pharmaceutical, healthcare, and food and beverage.

Ten years ago, the now widely-known, fully rigid and symmetric design was introduced into the market. Due to its obvious success, and its exceptional reliability, the design has also been made recently available for LNG (Liquefied Natural Gas) applications.

The symmetric design divides the mechanical force equally within the loading arm structure, which makes the unit especially suited for extraordinary applications in explosion hazardous and safe environments, such as oversized dimensions and installation on moveable carts or floating jetties.

The basic design

The basic design of a loading arm is shown in Figure 1.

The stand post is a fixed part and the outboard arm and inboard arm are movable parts. All these parts are very heavy as the piping is made of steel. The movable parts are balanced by counterweight to increase their safety. Moreover, only the piping and construction steel need to be brought into motion. This can be done manually (for small size loading arms) or hydraulically.

Instead of two separate counterweights, a marine loading arm can have a single rotating counterweight in order to achieve the same effect. In this case the counterweight rotates with the outboard arm for a more efficient design. The counterweight is directly connected to the outboard arm and the angular position of the counterweight is parallel to the position of the outboard, like a pantograph. The connection between the counterweight and the outboard arm can be made by a cable and wheel assembly (Figure 2) or a rigid connection with a steel bar as shown in Figure 1.

Although both methods are widely applied, from a maintenance point of view there is an important difference.

The counterweight with cable and wheel requires regular greasing of the cables and regular inspection and tension adjustment. In the case of the rigid connection the balancing only has to be adjusted once at the factory and then never again.

The choice of one rotating counterweight and a rigid connection to the outboard arm provides the most reliable and effective solution, and most loading arms manufactured by Kanon are designed according to this principle.

The construction of the product piping

There are different ways to construct the product piping. The two main constructions are: Piping attached to a support frame or self supporting piping.

The original design is product piping supported by a support frame, which offers some flexibility by means of bearings. The frame bears all the weight of the steel piping of the product line including forces due to wind, variations in ambient temperature, and earthquake. The product piping only has to withstand the combination of product temperature and pressure.

Nowadays there are two cases that require a support frame: cryogenic applications like LNG and aggressive liquids that will heavily corrode the piping.

The more innovative design is self supporting product piping. Due to several improvements over the years, the need for a separate support frame was eliminated. This means an improvement in efficiency in terms of steel for the support construction, and natural resources needed for production of redundant steel, bearings, greasing etc.

If the swivel joints are strong enough to withstand relevant forces (depending on the product and structure), the product piping can be constructed to be self supporting. Any reinforcements will be welded to the product piping to prevent bending and to achieve the required stiffness. →

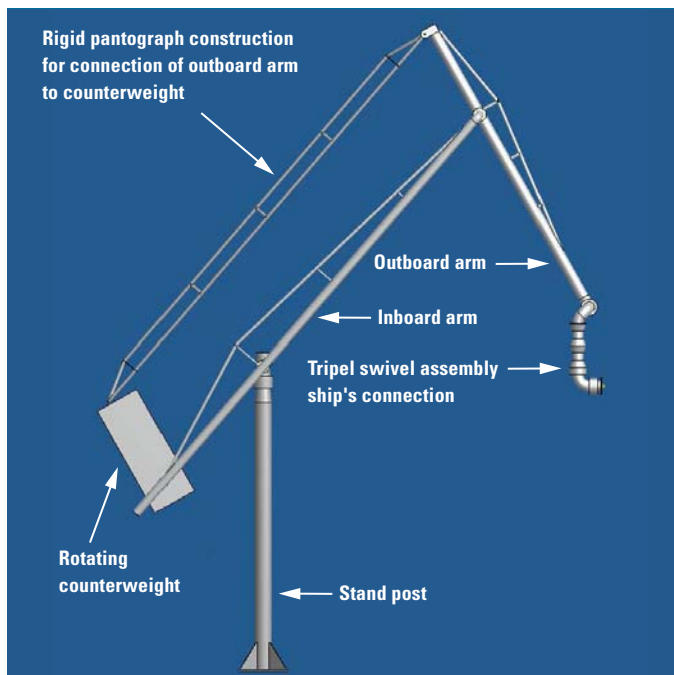


Figure 1: Basic design of a loading arm



Figure 2: Loading arm with rotating counterweight



Figure 3: Symmetric design of the loading arm

Symmetric design

Marine loading arms with symmetric design are the next step in product development. The symmetric design has two inboard arms (Figure 3). This design offers several important advantages:

- > symmetric load on the swivel joints
- > symmetric division of forces within the structure
- > lower weight due to slim design
- > no permanent moments on the jetty, only incidental bending moments due to wind loads and earthquake
- > large dimensions possible with extended reach, and without huge construction

Until recently, the symmetric design was only available for self bearing product piping, and not for a configuration using separate support construction, as is needed in cryogenic applications such as LNG. This achievement provides the benefits of symmetric design to every possible application.



Figure 4: Hydraulic quick coupler

Further development in marine loading arm technology to make ship-to-shore connections easier

For transferring fluids from a storage facility to a tanker vessel, flexible parts in the ship-to-shore connection (STS-Connection) are necessary in order to follow a ship's movement. However, these parts have to incorporate wear and tear, limited lifetime, and relatively inconvenient operation.

There are 3 ways to make a flange-to-flange connection: Bolted flange connection, manual quick couplers and hydraulic quick couplers.

Bolted flange connecting requires the operator to turn a loading arm swivel joint to match the hole patterns of both flanges, and the large number of bolts take a considerable amount of time and effort to fasten, especially in case of high wind speed (speeds up to 22.5 m/s during operation are relatively common).

Manual quick couplers increase the speed and convenience of connecting; however, it cannot be done at a remote distance. Both flanges need to be moved manually before fastening.

Hydraulic quick couplers offer the possibility of connecting the marine loading arm to the ship's manifold by pushing a single push button from a remote distance. Unfortunately, conventional hydraulic couplers that have been marketed throughout the years are very expensive and complex, and often require service by the original equipment manufacture.

Therefore Kanon has developed a hydraulic quick coupler with multi-size capability (patent pending) (Figure 4).

This design is the result of the extensive experience Kanon has been able to accumulate over the years working closely with the users. The quick coupler provides an efficient solution for the demanding marine loading environment.



Figure 5: Explosion protected control panel for loading arms, Electromach BV



Figure 6: Local operator terminal, Electromach BV

Marine Loading Arms in hazardous areas

Marine loading arms are in contact with the widest range of liquids and gases. This also includes challenging products such as, explosive gases and flammable liquids. Due to this exposure, most of the loading arms are implemented in hazardous areas. Therefore, the associated control panel of the loading arm has to meet a broad range of standards dealt with in explosion protection.

In order to meet the market demand, three different types of control panels are required.

The most popular system is a panel, made up of an assembly of two enclosures type of protection increased safety »e« and two enclosures type of protection flameproof enclosures »d« (Figure 5).

This control panel is approved according to the ATEX directive 94/9/EC, the IECEx Scheme, and the new and old versions of US Standard with the classification:

IEC and EN Standard: Zone 1 and Zone 2, Explosion Group IIB+H₂

NEC 500: Class I, Div 2, Group C+D

NEC 505: Class I, Zone 1 + 2

The second version is specifically made for IIC applications. This includes an assembly with a flameproof enclosure, where the direct entries are created by means of conduit fittings and hubs.

Where the operator is confronted with the monitoring of a number of loading arms, distributed over a large area in the field, the combination with a flameproof panel with a terminal box in increased safety combined with several local operator terminals type of protection increased safety with integrated components Ex d in the field provides an efficient solution (Figure 6).

Local control

Control of the loading arm can be done directly on the local control panel by means of pushbuttons, selector switches and indicators.

Explosion protected pendant control

Three different solutions are applicable:

- › A pendant can be connected to the local control panel with a 50 meter extension cable. A reliable method, however, the operator has to move a lot during the operation carrying the cable.
- › A pendant will be mounted on every swivel joint by means of a short cable. This is the most efficient solution as only a short piece of cable is used and there's no need to carry a heavy cable around. However in the situation of controlling multiple arms, multiple pendants are also necessary, requiring an increase in instrumentation, a larger PLC, and resulting in a bigger enclosure.
- › A pluggable pendant: In this case all loading arms will have an explosion protected connector mounted on the swivel joint. A pluggable pendant can easily be connected directly into the connector. Comparing to the other solutions, this method is subject to mechanical wear and tear. →



Radio control

In case of radio control a receiver will be built inside the flameproof CUBEx enclosure that is mounted within the Hydraulic Power Pack (HPP). With radio control no cables are required, and the loading arm selection can be made on the radio transmitter. Radio control is the most efficient system of controlling, particularly in cases of controlling multiple loading arms.

HMI position monitoring system

Optionally a Human Machine Interface (HMI) position monitoring system can be chosen. The loading arm position monitoring system is based on a stand alone PC complete with runtime HMI software package and application software for loading arm monitoring.

The position of a loading arm is measured with three analogue values. These variables will be evaluated together with fixed arm values like height and length of the arm, the operating envelope values, the distance of the loading arm to the shore and other details. Using all these values the real position is then calculated. Movements like between ship and shore, as well as left-right and up-down are visible in real-time on the PC screen

On each arm an explosion protected enclosure with an integrated remote I/O system is installed. The data collected per arm will be transmitted to the PC via a CAN-bus network and connected to the PC CAN-bus network card.

Each arm can be monitored separately or monitored in combination. Up to four arms (as selected by the operator) can be monitored at the same time, and on one screen.

Thanks to this technological partnership, Electromach has been able to provide Kanon with technological solutions that implement the demands of the modern operator and reflect the ever increasing challenges of the marine loading arm market.

Source:

Robin Boot, Sales & Marketing Manager, Kanon Loading Equipment b.v.
LNG industry (www.lngindustry.com) Tank Storage (march 2007)