Tool Immobilization unit in a membrane cryogenic tank

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GTT is a marine engineering company specialized in the design of cryogenic tanks for LNG storage and transport. GTT has a long experience since the end of the 1960s with more than 300 ships built. Its technologies are characterized by insulating and tight containment systems.

Membrane maintenance operations realized on LNG carriers are generally performed during ship's maintenance survey. For every operation in not accessible areas by walking on the bottom of the tank, tower scaffolding is erected inside the tank.

Concerning LNG FPSO, maintenance operations on membrane will be performed all along the ship's life at open sea. Consequently, tower scaffolding, does not fit for LNG FPSO membrane maintenance, because it is not designed to resist to the movements of a tank at open sea. Thus, GTT has proposed a scaffolding design adapted for LNG FPSO with a pyramidal shape, and develop with Palfinger systems, a new system using a suspended telescopic arm. The principle is to access to the whole membrane of a tank, with a basket fixed at the tip of a telescopic arm, suspended at the centre of the tank.

Because the suspended arm is not infinitely rigid, its tip will deflect during tanks movements (because the telescopic arm is linked to the tank at its base). It will induce basket movements relatively to tank membrane. Consequently, in order to proceed to work such as welding on membrane thanks to this tool, GTT had to find a solution in order to immobilize the basket relatively to the membrane.

Many tools used during membrane erection inside tanks are clamped on membranes.

However, for the suspended telescopic arm, the main difficulty is to find a solution that does not require to precisely position the tool relatively to the membrane for clamping it.

The solution found is exposed here after.

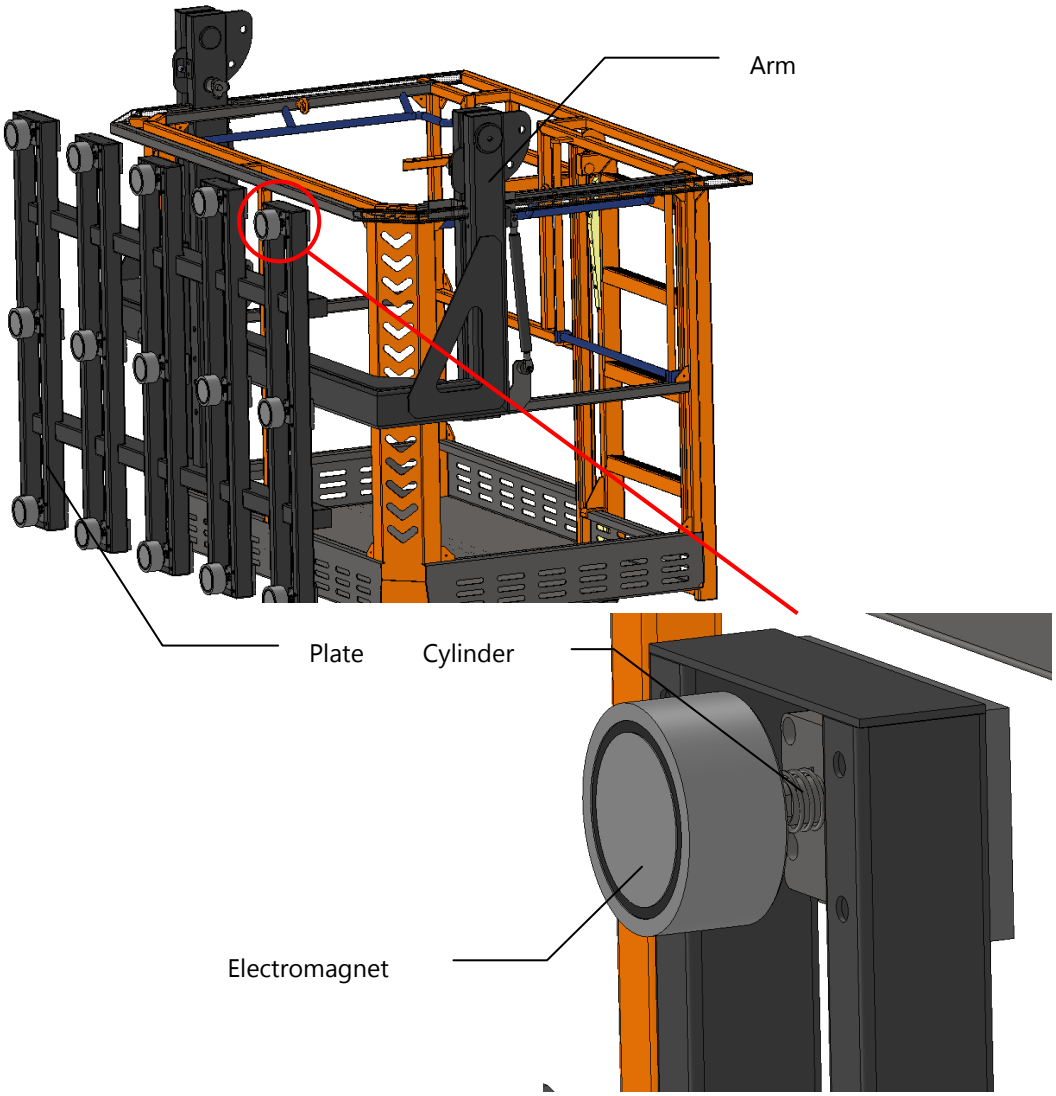
Description

The full immobilization system is made of:

- 1 assembly linked to the basket

  This assembly is made of:

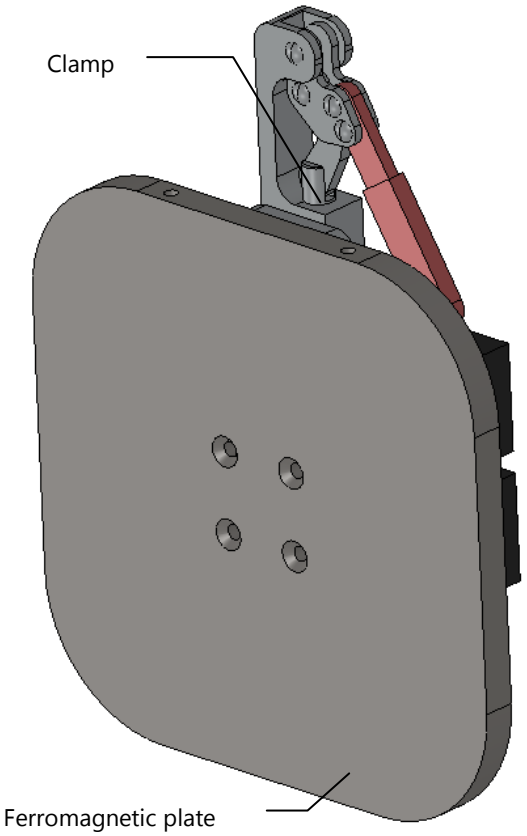
  - 1 arm that can be rotated around the basket horizontal axis with 3 locking positions defined
  - 1 plate that can be rotated up to 5° around every axis of the arm
  - 15 cylinders fixed on the plate, having their sliding axis perpendicular to the plate and evenly spread over 3 rows and 5 columns
  - 15 electromagnets fixed on the 15 cylinders with their magnetic plate parallel to the plate



- 15 independent clamps

  Those clamps are made of:

  - A membrane clamp having two jaws adapted to the membrane geometry (the raised edges for NO96 and the knocks for MKIII)
  - A ferromagnetic plate linked to the clamp and orientated in order to be parallel to the membrane.

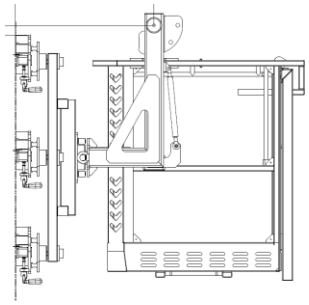
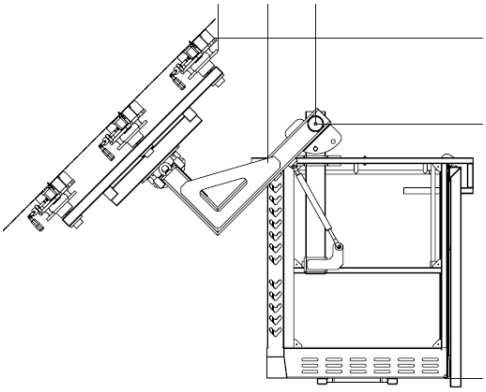
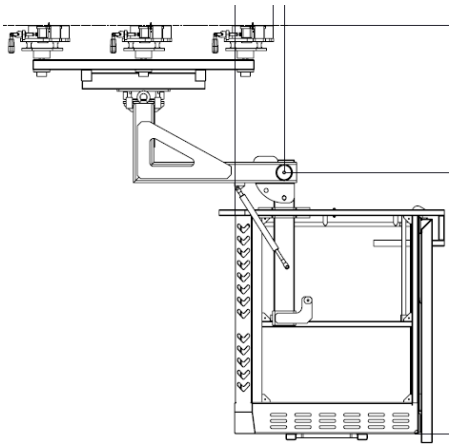


Additionally, the system is equipped with:

- A manual pump which permits to feed the cylinders and block their translation
- A servo valve, which permits to open or close the supply of hydraulic pressure to the cylinders
- A cable cabinet control which permits to control the servo valve and to switch on or off electromagnets.

Use

1. Depending on the membrane orientation where the worker want to immobilize the basket (wall, upper chamfer or ceiling), the arm of the immobilization system has to be rotated and clamped at 0°, 45° or 90°.

		
Immobilization system in wall inspection configuration	Immobilization system in upper chamfer inspection configuration	Immobilization system in ceiling inspection configuration

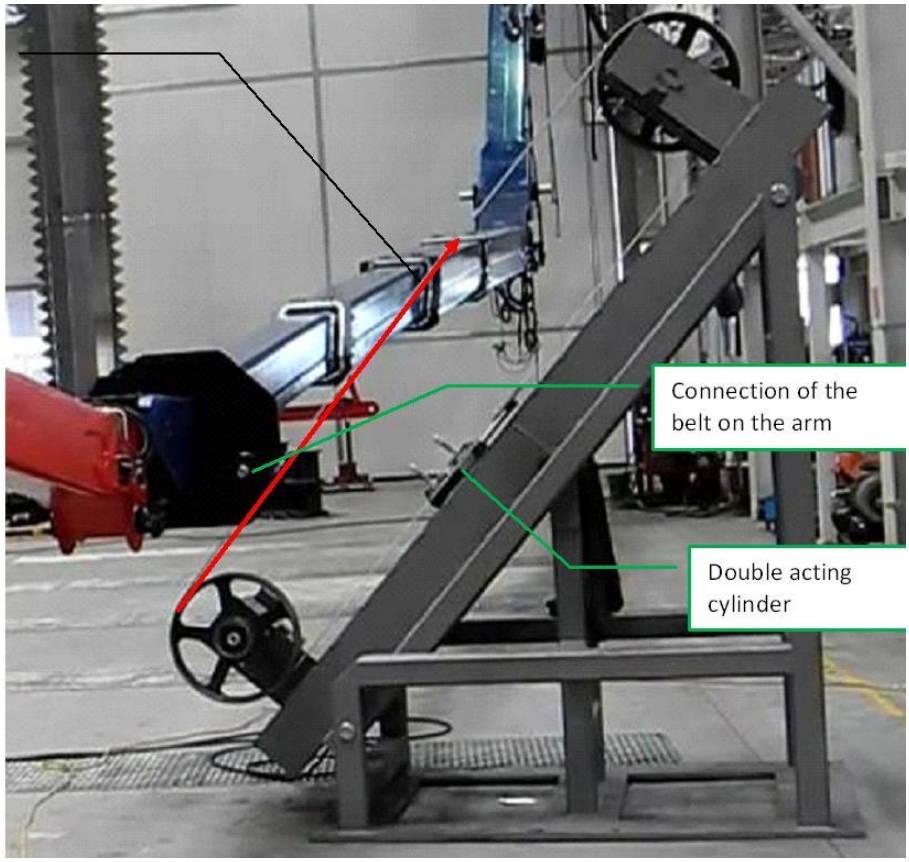
2. The basket has to be brought in front of the area where the basket has to be immobilized and the 15 clamps have to be installed on the membrane.
3. The magnets switch button has to be turned “on”
4. The basket has to be moved in order to plate the electromagnets on the clamps plates.
5. The cylinders have to be blocked by pumping the manual pump

Tests

GTT have tested the solution found on a 1:1 bench test.

- The system has been manufactured and installed on the basket of the Palfinger system telescopic arm.

- A system has been realized, in order to apply an alternative load on the telescopic arm. This load generates a deflection of the arm's tip, equivalent to the maximum movements of the arm's tip, relatively to the membrane, inside a membrane LNG FPSO tank.



A mock up tank has been realized in order to simulate the wall, the ceiling and the upper chamfer of a tank

The immobilization system has been tested by clamping the basket on the mock up tank membrane wall, then upper chamfer, then ceiling in spite of its movements (before clamping). After clamping, every movements between basket and membrane was suppressed, despite of alternative load applied on telescopic arm simulating the tank's movement on which telescopic arm base is fixed.

Conclusion

Thanks to the immobilization unit, even if the basket of the developed tool is moving relatively to the membrane because of the tank movements; it can be easily immobilized on the tank membrane and the developed tool will allow to proceed to work such as welding on membrane.