

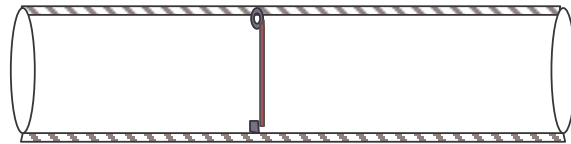
## Design fault in the non-return flap valves of the Duff and Offal chutes on the trawler Gaul

The following sketches show the design principles of a simple non-return valve.

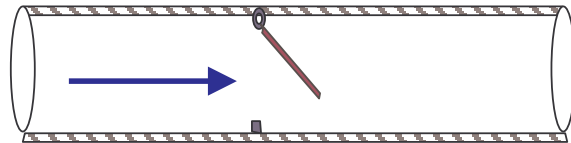
Non-return valves are used extensively in marine, industrial and civil engineering applications, automotive and petrochemical industries, water distribution systems and also in household plumbing systems. The functioning of this type of valve is generally automatic, being triggered by fluid trying to flow in the 'wrong' direction.

Simple non-return flap valve: operating principles:

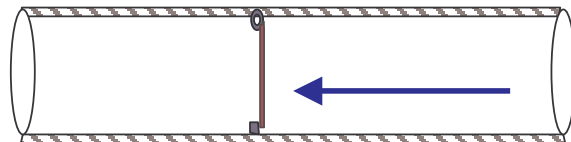
In the pipe sketches below, the non-return flap is hinged at its upper edge and hangs vertically in the pipe due to gravity:



If water starts to flow, the flap opens and water can flow past the valve:



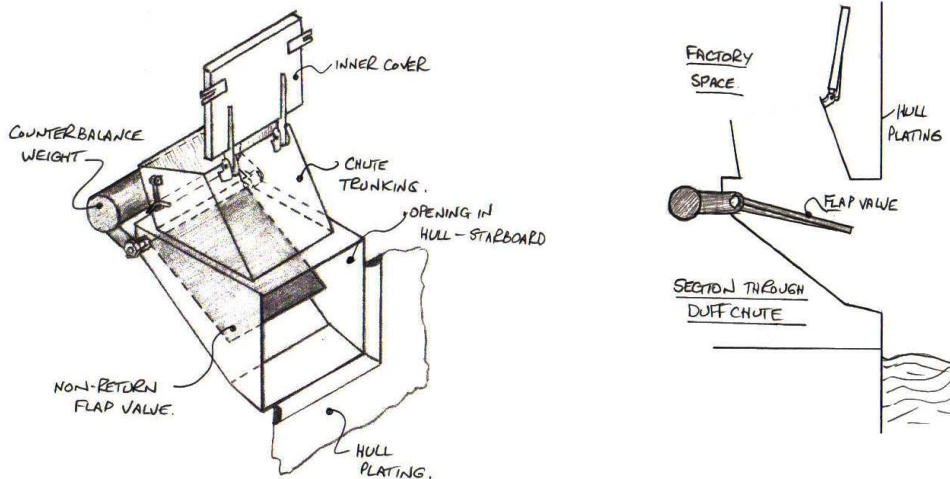
If for any reason, the water flow is reversed the flap closes and the water cannot return:



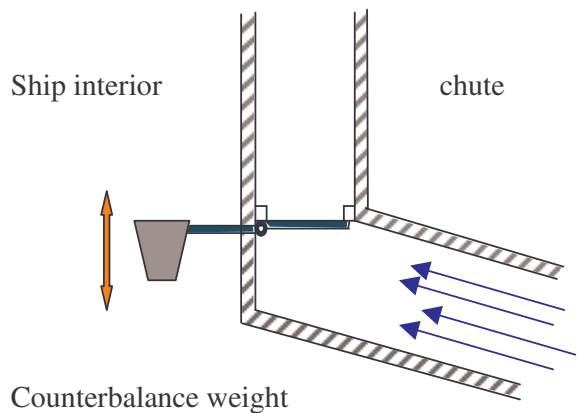
*Note: For pipes that are not installed horizontally, a counter balance weight is often fitted to the non-return flap to keep it in the closed position when there is no water flow.*

## The non-return flap valves on the Gaul:

If we now look at the non-return flap valves in the duff and offal chutes on the Gaul, we can see that the chutes were arranged vertically and that the flaps were provided with a counter-balance weight so that they would normally return to the closed position:



Diagrammatically this becomes:



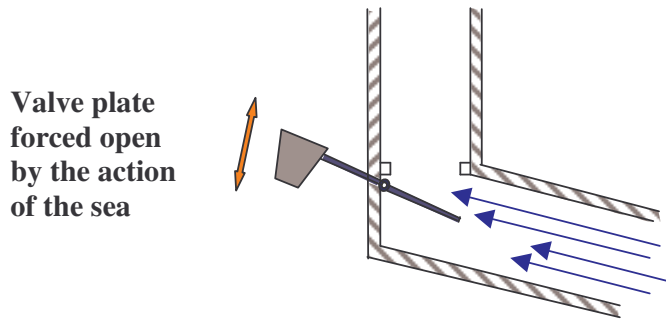
When the flap is fully closed, any inward flow of seawater will tend to keep the valve flap in the closed position.

Sea water

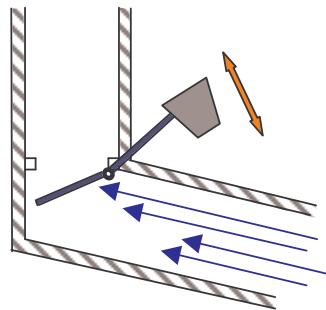
However, if the flap is not fully closed an inward flow of seawater will be able to act on the free edge of the flap and push it open, and this could then allow water to flood into the vessel.

**The design fault:**

In the Gaul the flap has been positioned incorrectly in the chute, in this location it is effectively installed the wrong way round:



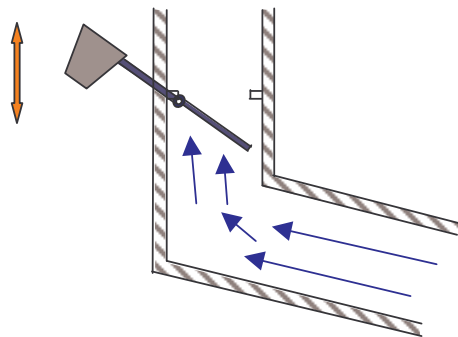
The correct way is illustrated here:

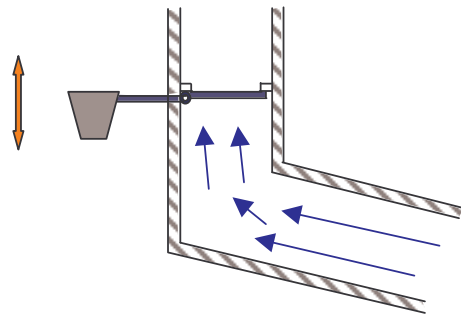


The inward flow of seawater should always push the flap into the closed position, **not into the open position.**

To show that this is a simple oversight in the initial design, a number of additional design arrangements are shown below in which the non-return flap will always ‘fail-safe’ into the closed position:

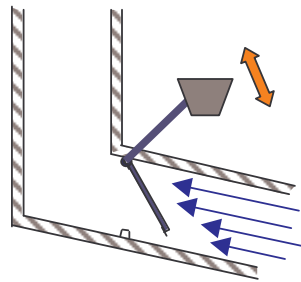
1. If the non-return flap was positioned slightly higher in the chute, the inflow of seawater would always tend to close the flap and this would work satisfactorily no matter which way round the flap was installed.





The seawater acts on the flap and pushes it into the closed position

- Alternatively, the opening direction for the valve flap could be reversed and again this would result in a situation where an inflow of seawater would always force the valve flap into the closed position:



This arrangement is in common usage on trawlers today.



*Image courtesy of Greenpeace*

Of note in this picture is the location of the fish offal - it is below the valve flap. On the Gaul the fish offal would have been on top of the valve flap. With the flap in the position that is indicated in this photo, it may be seen that a wave would undoubtedly push the flap in a downwards direction and, on this vessel, this would **close** the valve, on the Gaul unfortunately, this would **open** the valve