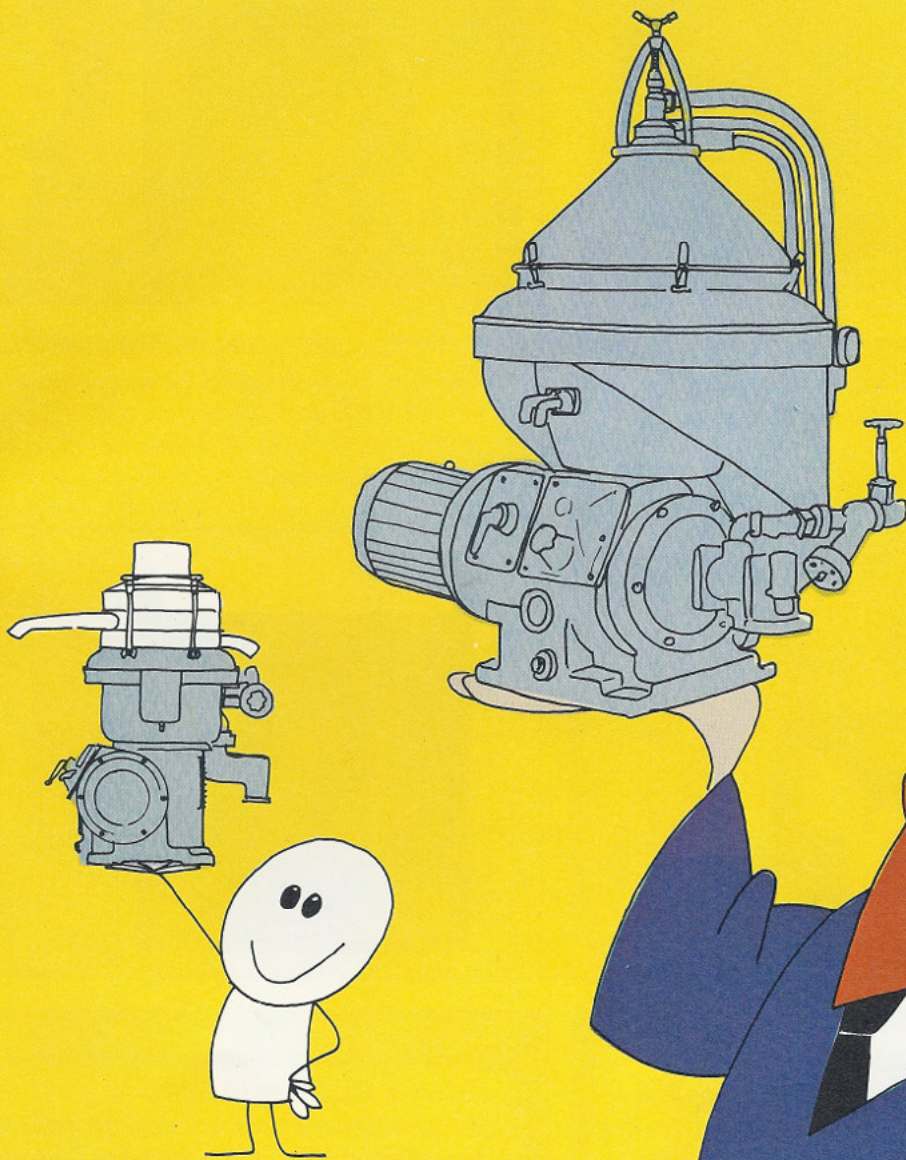


# Thousands of g



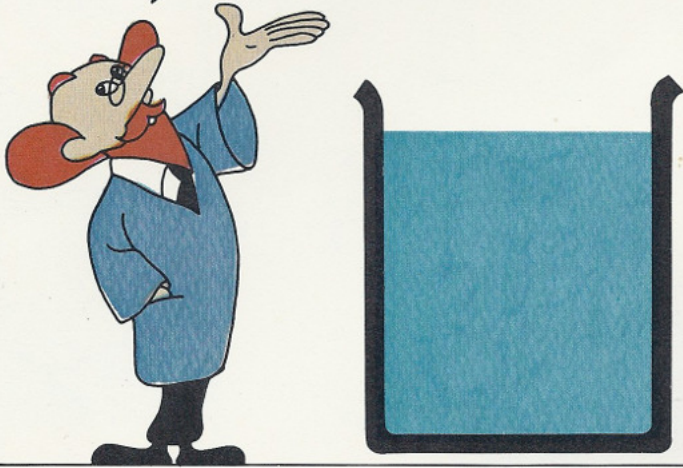
The basic principles of centrifugal separation. An excerpt from the film "Thousands of g".

**ALFA-LAVAL**

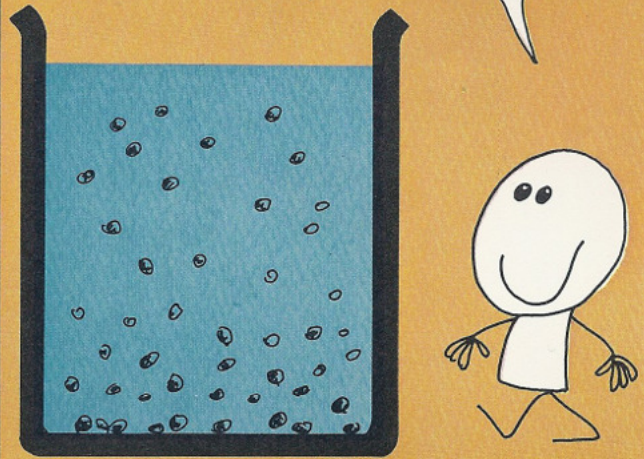


# SEPARATING MIXTURES OF LIQUIDS AND SOLIDS.

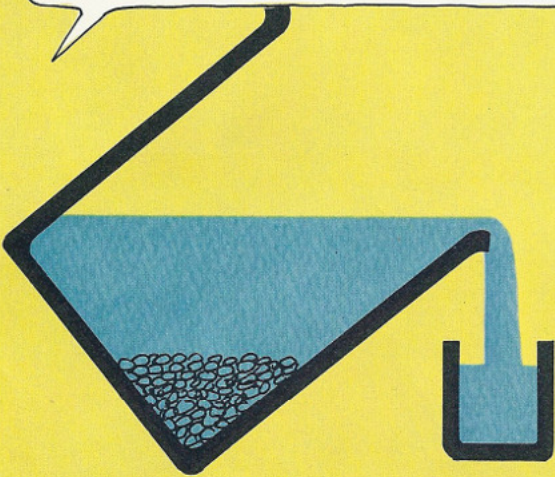
If a cloudy liquid is allowed to stand for a while, it slowly becomes clear – not by magic – but by the effect of gravity – "g".



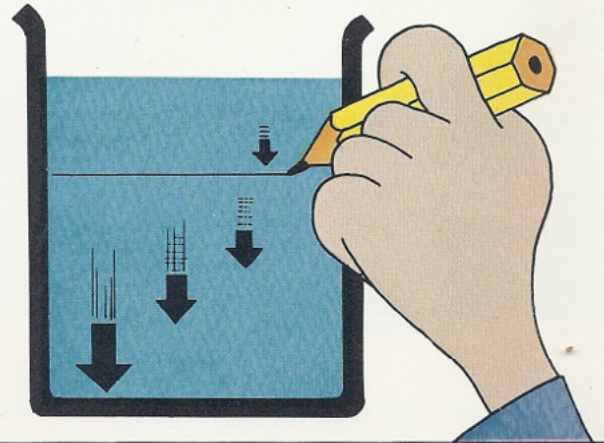
The solid particles simply sink to the bottom.



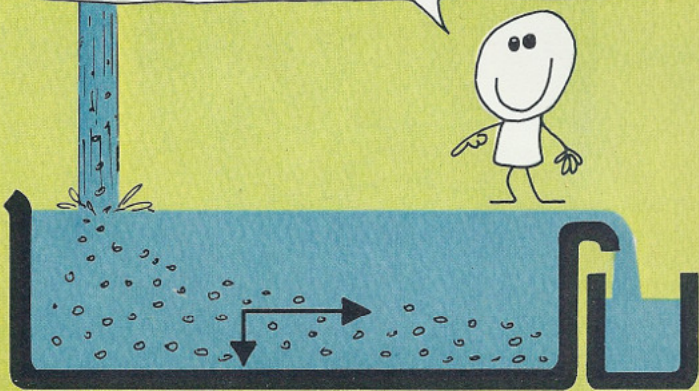
Separation, as this is called, is complete when all the solids lie on the bottom. The water can then be poured off, leaving the solids.



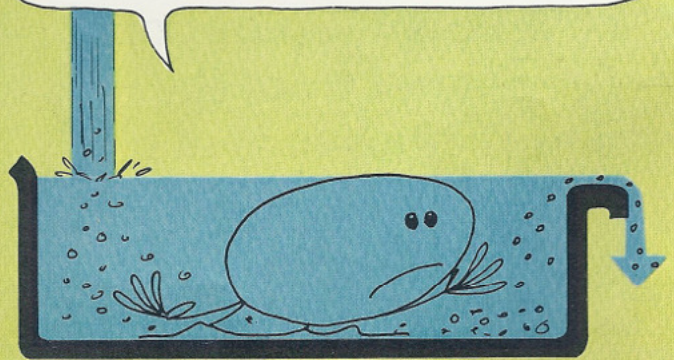
The time that is required for separation to occur depends on the speed of descent and on the distance the particles must travel. A shorter distance results in a quicker separation.



In a tank of this shape, the solids have a shorter distance to travel. The cloudy liquid is fed in at one end and overflows at the other. The solid particles move in two directions – downwards due to gravity and sideways due to the liquid flowing towards the outlet.



If the feed rate is high, some of the particles will not have time to reach the bottom but flow out together with the liquid. An even shorter distance to the bottom is required. But how?

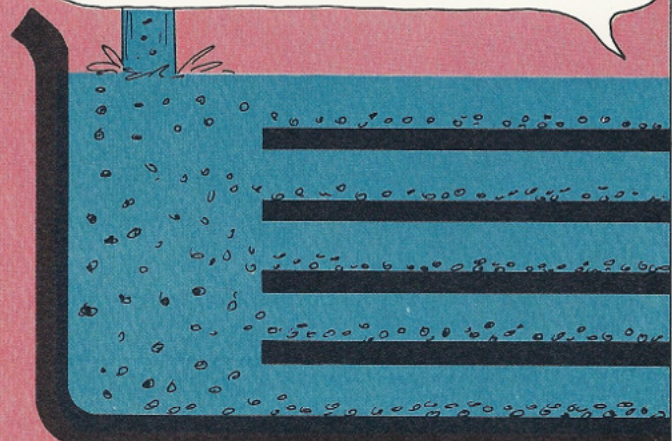




Well – you can fit in plates like this. Then the distance the solid particles have to travel would be very short.

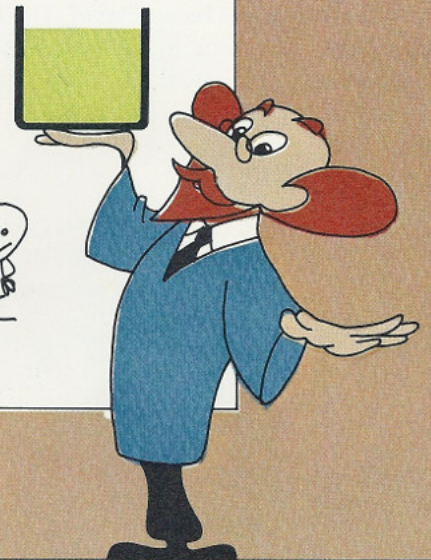
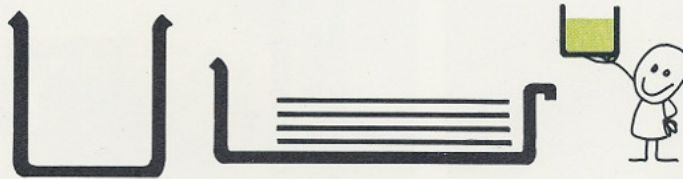


This is an effective way to increase the speed of separation. It's called "thin-strata separation".

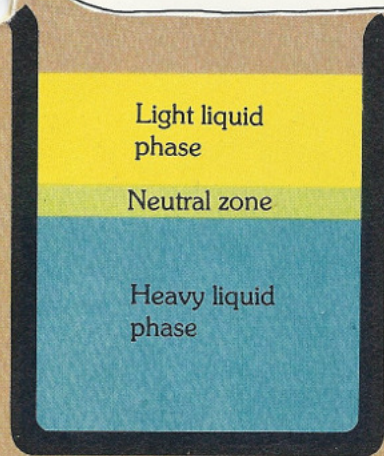


### SEPARATION OF TWO LIQUIDS.

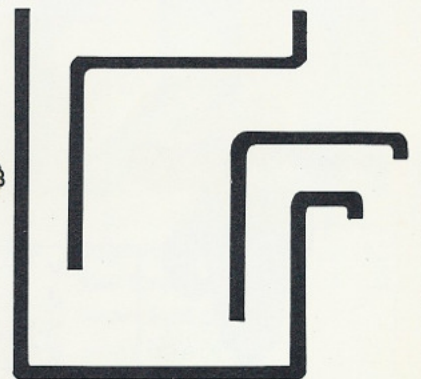
Gravity can also be used to separate two liquids from each other if they do not dissolve into each other. Liquids like oil and water, for example.



When separation commences, three layers are formed. The neutral zone in the middle gradually becomes less and eventually forms a thin dividing layer.

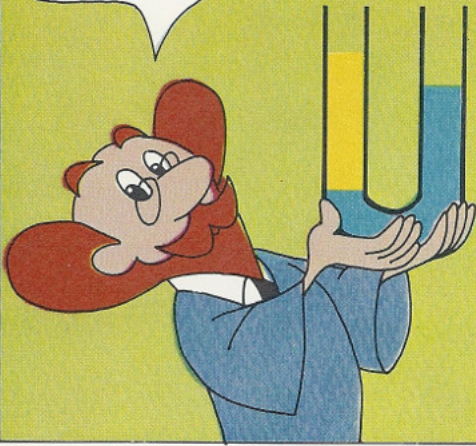


In the same way as with the solid particles, this separation process can also be made continuous. The feed comes in at one end, but now, of course, two outlets are necessary – one for each phase.

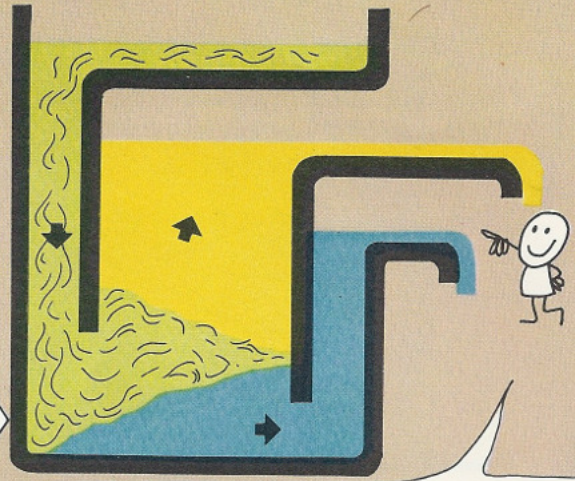




Let's take a look at the principle of communicating vessels – or the U-tube. The lighter liquid is pushed upwards by the heavier.

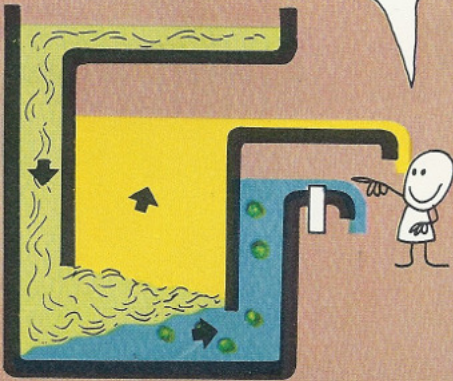


Compare

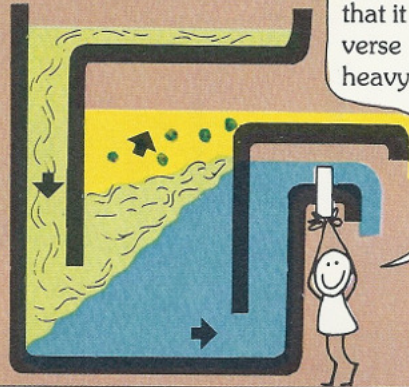


Our liquid mixture flows in through the inlet and finds its way under the baffle plate where it creates a neutral zone.

By fitting a threshold in the lower outlet, the level of the neutral zone can be regulated. The height of the threshold is important. If it is too low, some of the lighter liquid will follow the heavy liquid out.

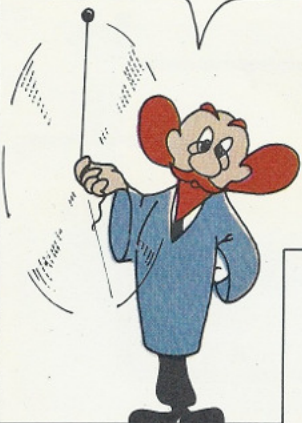


Adjust the threshold so that it is high and the reverse happens – some heavy liquid will flow over with the light liquid.



Even if we have made the process continuous it still works very slowly as long as we only use gravity.

But can we increase the speed of separation? Yes! By increasing the force of gravity – "g". This force can be increased 1000s of times over by replacing gravity with centrifugal force generated mechanically.

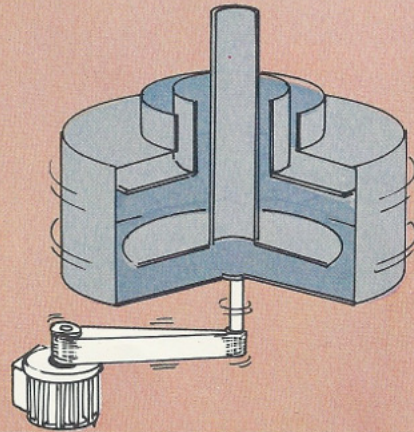


STOKES LAW

$$v = \frac{d^2(S-S')}{18\mu} \cdot g$$

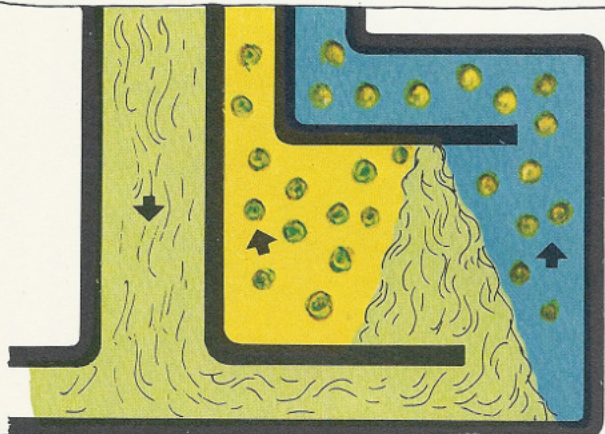
- v = settling velocity
- d = particle diameter
- S-S' = density difference
- μ = viscosity
- g = gravitational acceleration

Let's take the tank in our example and make it spherical so that it can rotate. We turn it faster and faster – centrifugal force becomes greater and greater!

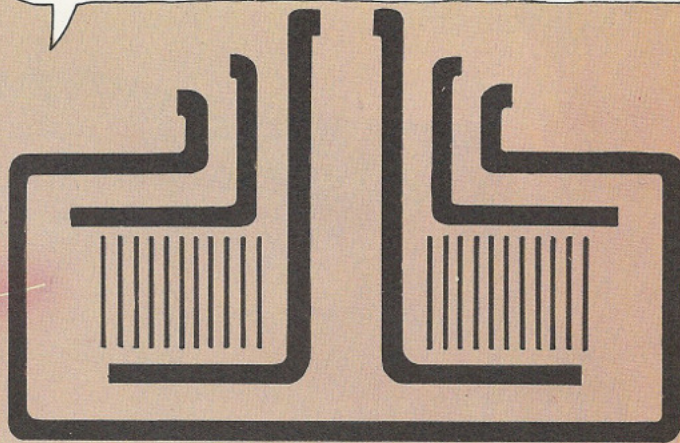




What happens in the revolving tank, or bowl as we call it, as it spins? Separation takes place – but not very efficiently due to the distance the heavy phase must travel to reach the wall.

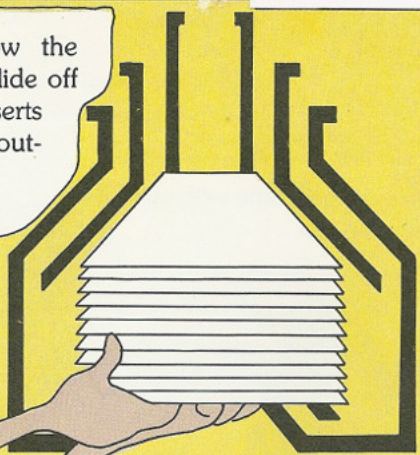


Remember the plates we fitted into the stationary tank? Well, here we fit cylindrical inserts. . .



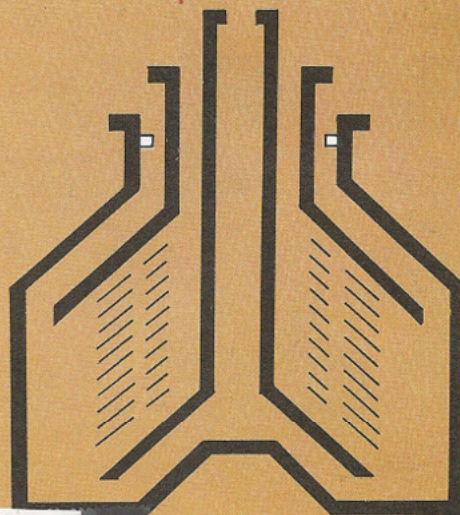
DISC STACK.

... but to allow the heavy phase to slide off the cylindrical inserts and move outwards. . .



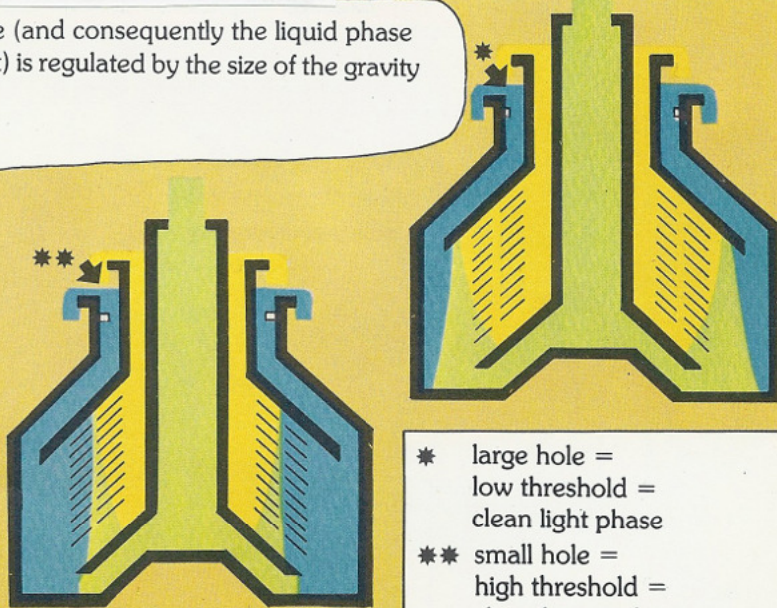
... we made them conical and changed the bowl shape to suit them!

Another improvement was to make holes in the disks. These are located in the region of the neutral zone.



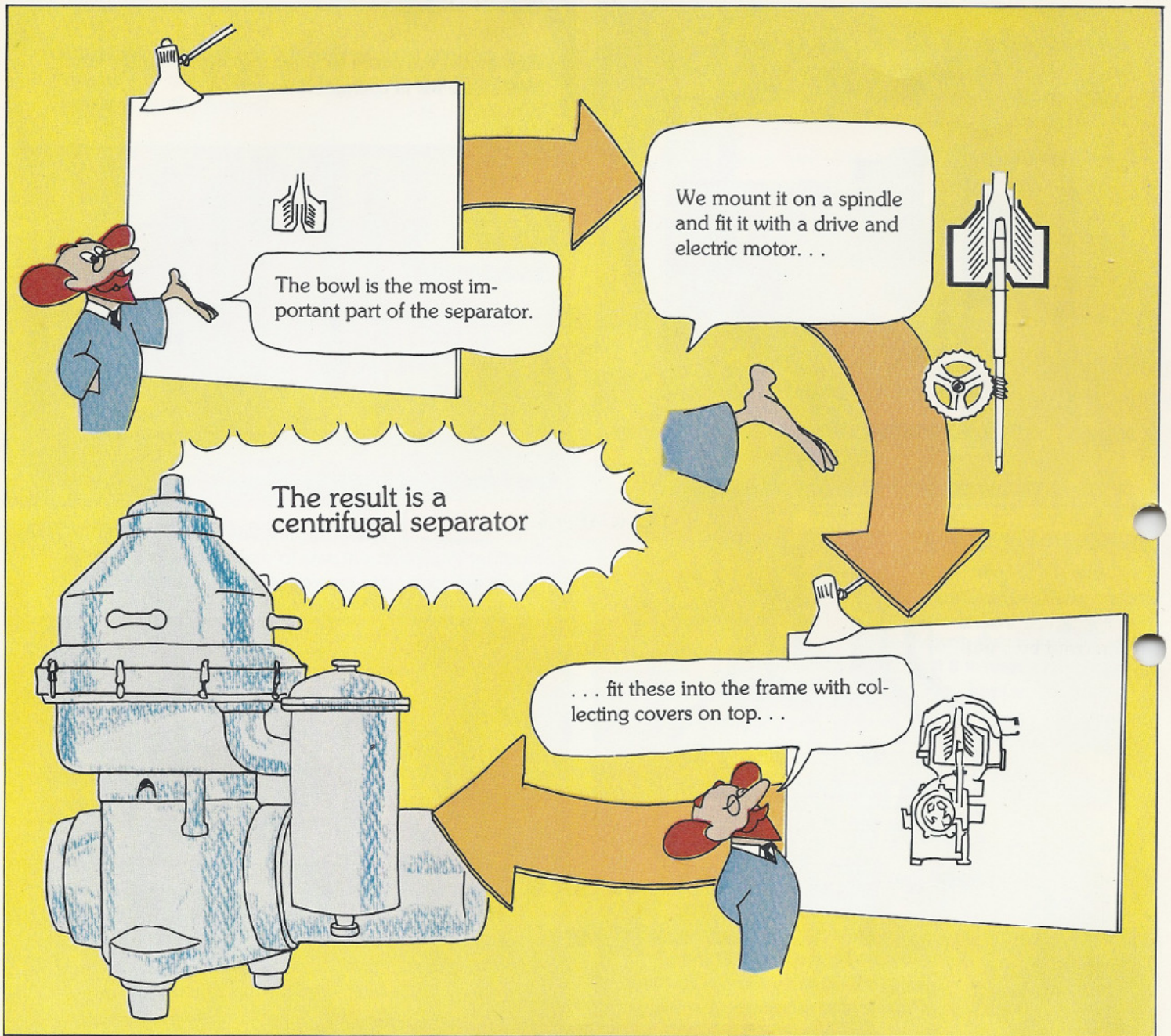
GRAVITY DISCS.

The neutral zone (and consequently the liquid phase we want cleanest) is regulated by the size of the gravity disk.

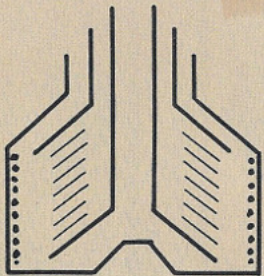


- \* large hole = low threshold = clean light phase
- \*\* small hole = high threshold = clean heavy phase

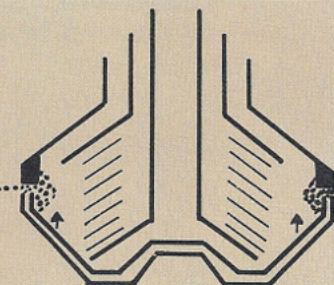




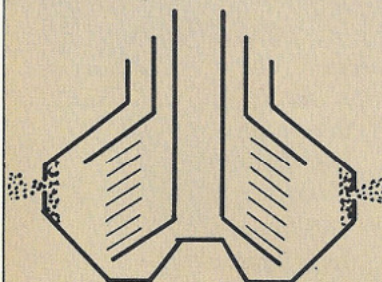
BASIC TYPES OF CENTRIFUGE BOWLS.



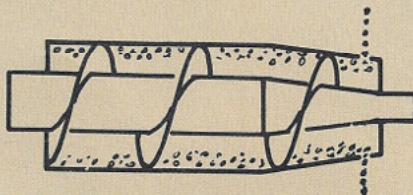
Solids-retaining separator



Solids-ejecting separator



Nozzle separator

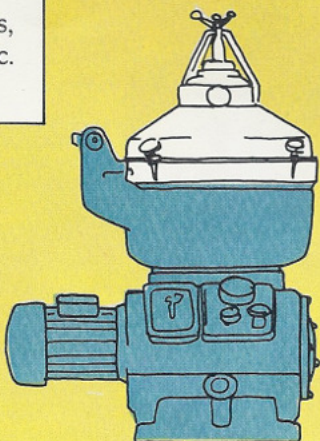


Decanter centrifuge

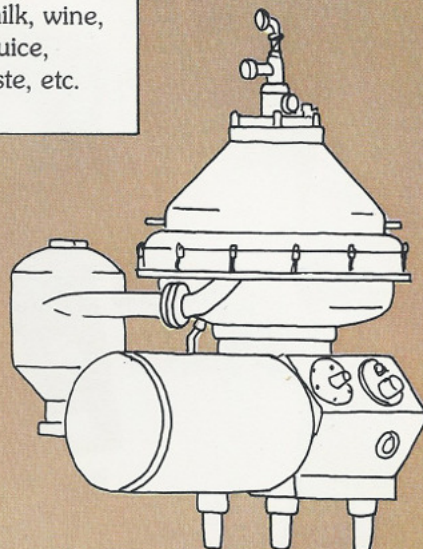


# CENTRIFUGE APPLICATION.

Explosives, edible oils, soap, rubber latex, etc.



Fuel oils, milk, wine, beer, fruit-juice, nuclear waste, etc.



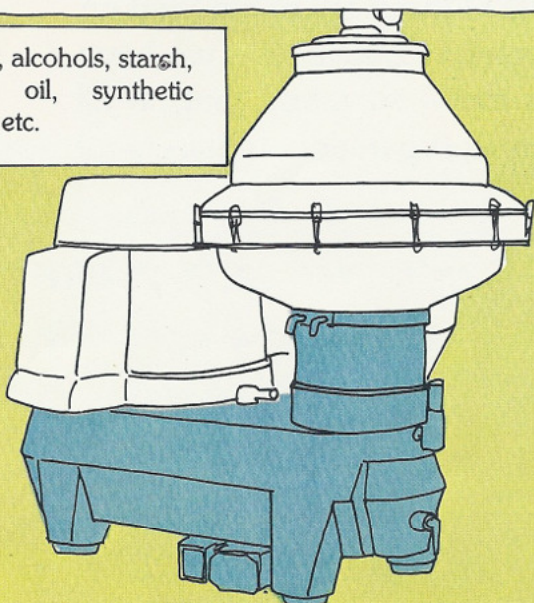
This is a **solids-retaining separator**. It's used for separating liquid mixtures that have only a low amount of solids in them – no more than 1%. This is because the machine must be stopped, the bowl dismantled and the solids removed by hand.



For liquids with a higher solids content (up to 10%) or when it's undesirable to stop the machine for emptying, a **solids-ejecting separator** is the one to use. The solids that collect in the bowl are shot-out by periodically uncovering slots in the periphery of the bowl for a fraction of a second.

If a process liquid contains over 10% solids – a **nozzle separator** should be used. Here, the solids leave the bowl in a continuous stream.

Yeast, alcohols, starch, palm oil, synthetic fuels, etc.



For dewatering sludge containing up to 60% solids, a **decanter centrifuge** is used. This machine has a horizontal drum or rotor in which separation takes place in the same way as in the vertical separator. The decanter has no disk stack, however, the solids being removed continuously from the drum by a screw conveyor.

Fish processing, meat by-products, sewage dewatering, plastics, etc.

