the two bodies is such that, in the final arrangement of the system, there is an interpenetration of the crests of one element's corrugated surface into the chambers of the opposite facing element. In this way a product passage gap is created in the space left between these two bodies.

One of the two bodies rotates (rotor), whilst the other is fixed (stator). Both elements contain cavity walls for the passage of the cooling medium and temperature controlled fluids. This cooling/heating fluid system has been designed so as to give two areas of different controlled temperature in the stator, each having 50% of the heat exchange surface. A further independently controlled temperature zone exists in the rotor element, with a further zone positioned in the core of the tempering elements. The key advantages of this machine are:

1 A large surface area in a relatively small space.
2 The formation of a passage/gap for the product, which is of constant dimension and controllable at every point. This applies a homogenous and continuous shearing action, whereas in conventional tempering systems this effect is limited only to the areas of close proximity between the mixers and the heat exchange walls.
3 The possibility of getting into the inside of the machine by simply uncoupling the tempering elements. This is made possible by the fact the machine consists of only two tempering elements within a housing, thus forming a unit which is easy to open.
4 The rotor is driven by a variable speed drive.

The product flows from the centre of the system to the periphery so that, as the cooling area increases with distance from the centre, so too does the volume available to contain the chocolate. This means that the system is not very sensitive to the increase in viscosity of the product during tempering and as a result only very low pressures are present within the machine. In addition, the relative speed between the rotor and stator increases with the distance from the centre. This results in an increasing shear rate and hence a higher shearing stress being applied to the product as its viscosity also increases. This means that the maximum shear stress is applied to the cooled product, where it is able to increase the rate of crystallisation and encourage the formation of stable $\beta_V$ polymorph crystals.

Carle and Montanari produce other temperers including a four-section vertical temperer based on scraped heat exchangers.

*APV Baker:* (No longer produced, but of interest due to its novel features.) In the late 1950s Baker Perkins were licensed to produce their own version of the Sollich built-in tempering techniques. These were designed into enrobers as integral units. Early designs had the problems associated with low residence time systems. Baker Perkins solved these problems in the mid1960s by using a large enrober seed bed with a variable retention time of 15–60 min. This was shown to be enough time, together with efficient agitation, to create the most stable high-temperature coatings. In this machine the principle of seed maturation has been applied to the tempering machine itself, rather than just to

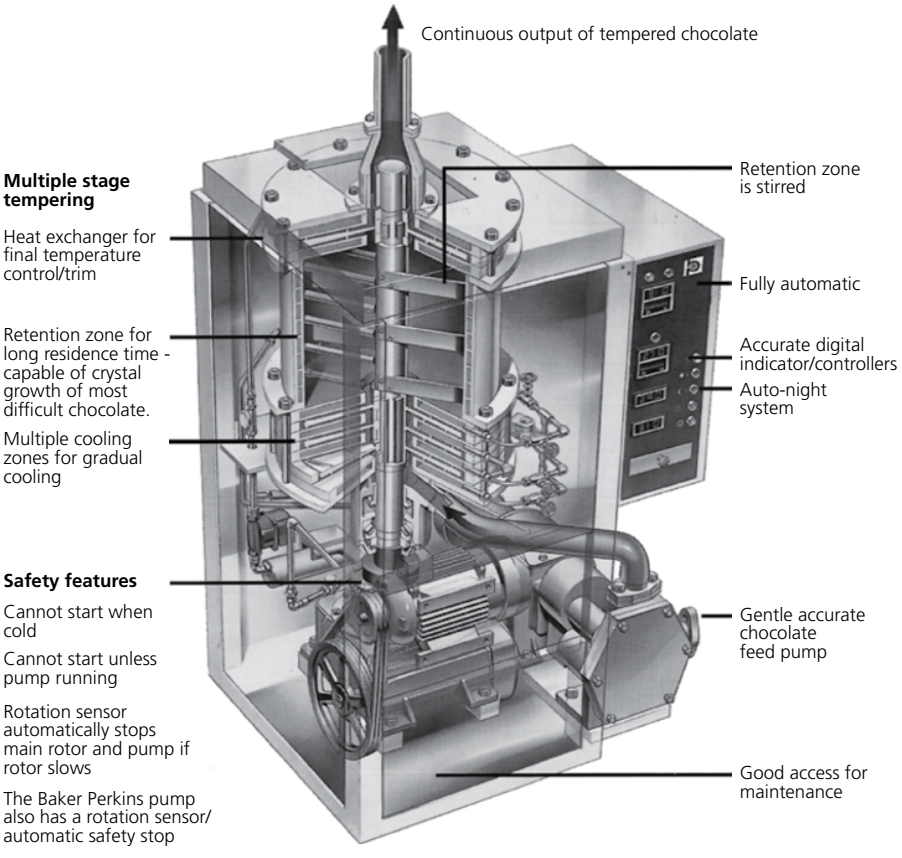


**Figure 13.16** The Baker Perkins 105 TU tempering machine (Baker Perkins BCS Ltd).

a holding tank or the enrober. This led to the development of the Baker Perkins 105 TU ACS tempering machine (Figure 13.16) with a "real" retention zone, located approximately midway through the temperer. Advantageous features of this model were:

1 High-pressure chocolate metering pump.
2 Safety features on start-up.
3 High shear rate Archimedes cooling discs ($8500\,s^{-1}$).
4 Water plates with high velocity turbulent flow.
5 Transition maturation mixing zone giving significant improvement in final crystal hardness (timed residence mixing zone).
6 High shear rate Archimedes control discs controlling temperature to user point.
7 Chocolate zonal temperature control is by autotune electronic instruments operating chilled water-modulating valves, effectively holding temperatures to 0.1 °C.
8 Where the de-seeded chocolate temperature is unreliable, extra preheating plates or cooling plates are available on a modular machine.