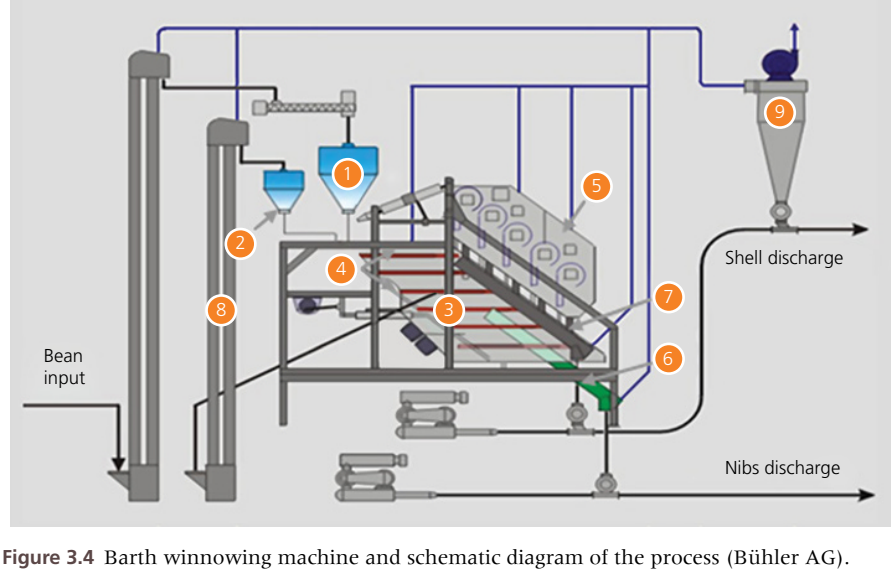

Figure 3.4 Barth winnowing machine and schematic diagram of the process (Bühler AG). (1) First impact crusher; (2) second impact crusher; (3) screening system with sieve decks; (4) oscillating sifters; (5) aspiration system; (6) collecting chute for nibs; (7) collecting chute for shell; (8) return flow elevator; (9) cyclone. Reproduced with permission of Bühler AG, Switzerland.

Ziegleder and Oberparleiter (1996) have proposed a moisture treatment prior to roasting. In this, steam is condensed on the nib, resulting in a water addition of about 15%. This moisture aids the formation of more flavour precursors during the 10–15 min processing time at 40–60 °C (104–140 °F). After drying to 3% moisture at 98–110 °C (208–230 °F) and roasting, this gives a product with a more intense flavour compared with normally roasted beans.

Mohr *et al.* (1978) have demonstrated that a slow reduction in moisture content to about 3% followed by a rapid heating to the final roast temperature is the optimal way of roasting. The highest roasting temperature depends upon the required roast intensity and the equipment used. All types of roaster can be operated over a wide range of roasting conditions.

Whole bean roasting was the original method and often used to produce cocoa masses with delicate flavours, due to the preservation of the volatile cocoa flavour notes within the shell during roasting. Also the removal of the shell after this type of roasting is relatively easy, as the shell becomes loose during the roasting. Currently nib roasting is also widely used, in part due to distinct improvements in cocoa powder obtained with alkalisation of the nib before roasting.

Many different roasting systems are in the market place often using conduction and/or convection as the heat transfer mechanism.

Batch drum roasters are frequently used in the cocoa industry for nib roasting (see Figure 3.5). The principle of these roasters is generally the same. Nib is fed into the drum and depending on taste requirements water can be added and a specific roasting profile will be applied. Roasting occurs by heat from the drum wall and the product tumbles in the drum, thus avoiding burning and localised overheating.

Effective debacterisation can be carried out by adding water and assuring the presence of steam in the drum. Roasting temperatures, holding times and amount of water added vary according to the equipment being used and the desired flavour profile of the product. Generally the final roasting temperature is 110–140 °C (230–284 °F). Microbiological tests must be carried out for each specific roasting profile to ensure that it kills all pathogens (e.g. *Salmonella*) and reduces the total bacterial content (Brenner, 1991; Cerny, 1991; see Chapter 25).

After roasting, the product is cooled down in an external cooler. Using these types of drum roasters it is extremely important to maintain a strict separation between the raw and roasted nibs, because the loading and discharge may occur through the same door and cross-contamination of microbiological material can easily take place.

Alternatively, continuous vertical air roasters can be used for cocoa beans or nibs (see Figure 3.6). This type of shaft roaster is divided into a number of sections; the top sections are used to roast, the lower ones for cooling.

The roaster will be filled from the top and the product cascades down the roaster through a series of shelves. Each shelf tilts to discharge its load onto the one below, after a preset retention time. Hot air passes through special ventilation