chocolate itself, is being increasingly outsourced by many manufacturers to a few specialist producer companies.

Before further processing, beans must always be cleaned to remove non-cocoa components, for example stones and pieces of metal. Impurities may cause wear and damage to subsequent processing machinery. Cleaning is usually carried out in several stages (see Figure 3.1):

- Removal of coarse and fine impurities by sieving;
- Removal of ferrous matter with magnets;
- Destoning and removal of other high density particles;
- Dust collection during several cleaning steps.

A set of vibrating screens removes both very large and very small particles by sieving. Clustered beans, pieces of wood, strings and other large debris are collected by the coarse screens, whereas cocoa beans pass through. Smaller particles are then allowed to pass through finer screens.

Using counter air flow techniques, low density and dust particles are separated from the beans during the cleaning operation. Removal of dust and sand is

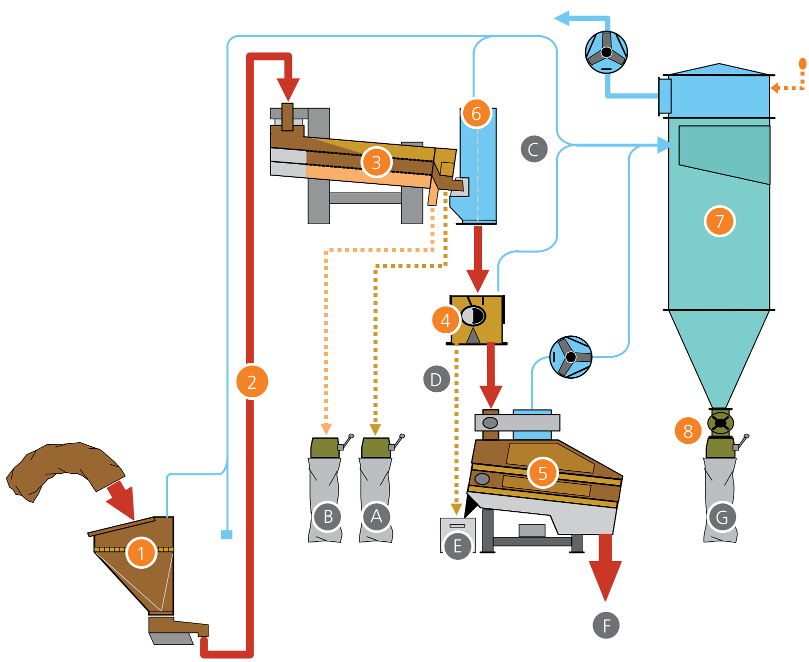

Figure 3.1 Schematic representation of a system for cleaning cocoa beans (Bühler AG). (1) Intake; (2) elevator; (3) separator classifier MTRB; (4) drum magnet DFRT; (5) destoner MTSC; (6) aspiration channel MVSH; (7) aspiration filter MVRT; (8) airlock MPSN; (A) coarse contaminants; (B) fine contaminants; (C) aspiration (dust, shells etc.); (D) metal particles; (E) high density materials (stone, glass etc.); (F) cleaned product (cocoa beans); (G) dust and dirt. Reproduced with permission of Bühler AG, Switzerland.

very important, due to its abrasive nature, which will rapidly wear the balls in ball mills or the surface of refiner rolls.

Ferrous material is removed by magnets, but metal detectors may still be used during further processing. Destoners remove stones and other heavy particles. They operate on the principle of a fluidised bed. The heavy particles (i.e. stones) are vibrated towards the top of the sloping screen with air passing through the screen. The lighter particles remain at the lower end of it.

3.3 Removal of shell

The removal of shell is an important step in the process of making cocoa mass. In the past it was a legal requirement in the European Union (EU), but under the current directive 2000/36/EC, no maximum values are given. However, in the United States maximum values are still set (Codex standard 141-1983, rev. 1-2001). Apart from the legal requirements, proper removal of shell is a prerequisite for a good quality product:

- Shell, by its very nature, is exposed to external factors and will have picked up undesirable contaminants (Knezevic, 1983).
- Shell does not contribute positively to the flavour of the final product and may indeed produce off-flavours.
- Shell is a hard and fibrous material which makes it extremely difficult to grind and leads to abrasion of the grinding equipment.

Moreover, shell separation from the nib influences the yield, and the loss of small nib particles along with the shell is a particularly important financial factor. Ideally the shell should separate cleanly, leaving large pieces of shell and almost intact nib. The shell around some beans cannot be removed easily, however, with certain origins being particularly difficult (e.g. unfermented, small sized and flat cocoa beans).

In practice beans are usually subjected to surface heat treatments to facilitate shell release, such as fluid bed types of dryers, continuous air roasters, infrared dryers or moistening/pre-drying systems. The principle of infrared radiation is based on idea of puffing the shell from the nib (see Figure 3.2). It consists of infrared radiators and a vibrating conveyor belt underneath. The beans rotate on the belt, where they are dried. The moisture in the bean evaporates giving a puffing effect and the heat increases the brittleness of the shell, facilitating easy removal of the shell afterwards. Heat transfer is concentrated on the surface rather than on the inside and unwanted material such as rodent hairs and insect fragments are removed by burning.

An alternative machine is the drum microniser, which has a central infrared radiator within a rotating drum (see Figure 3.3).