this clay in enormous quantities. The approximate composition is 50 per cent. silica, 15 per cent. alumina, 10 per cent. lime, 7 per cent. iron, 5 per cent. carbonaceous matter, together with water and traces of magnesia, potash and soda.

PLASTIC OR STRONG CLAYS are composed chiefly of silica and alumina in combination, and chalk of a creamy consistency must be added to prevent distortion and excessive shrinkage in drying and burning. *London clay*, from which the well-known London stock bricks are made (see p. 11), is of this class.

CLAY SHALES, quarried in Durham, Lancashire and Yorkshire particularly, produce excellent bricks. Shale is a hard, laminated rock which is reduced to a plastic mass suitable for brick-making by weathering and the addition of water (see next column). It is found, often in the same quarry, with a varying content of oxides of iron, etc., and the careful blending of these shales produces bricks, used for faced work, of different shades. A typical shale may contain roughly 60 per cent. silica, 25 per cent. alumina, 0·6 per cent. chalk, 7 per cent. oxides of iron, 2 per cent. magnesia and traces of alkalis (potash and soda), organic matter and water.

FIRECLAY is quarried in Lancashire, Durham, Northumberland, Yorkshire, Staffordshire and other parts of the country. It contains a large proportion of silica (varying from 50 to 70 per cent.) and little, if any, lime and iron. Bricks made from such clay are highly resistant to high temperature and are therefore suitable for the lining of furnaces and fireplaces.

MANUFACTURE OF BRICKS

The various methods of production are determined very largely by the nature of the clay or shale, and may be divided into the (*a*) semi-dry or semi-plastic process, (*b*) stiff-plastic process and the (*c*) plastic process.

(a) *Semi-dry or Semi-plastic Process.*—The clay or shale is comparatively dry. It is ground to a fine powder by heavy rollers, passed through a screen, mixed to a uniform consistency, pressed and re-pressed in moulds by very powerful machinery (see p. 3) and burnt. Sometimes the screened material is damped by sprayed water. Because of the dryness of the material the bricks are taken direct from the moulding machine to the kiln, the usual intermediate drying stage being omitted. The process is relatively cheap. This process is adopted for the production of Flettons, owing to the suitability of the Knotts clay.

(b) *Stiff-plastic Process.*—This process, which is being adopted to an increasing extent, is similar to the above, except that the water content of the material is increased and therefore less powerful machinery is required to mould the bricks (see p. 3). A separate drying plant is not always necessary. The process is usually applied to hard, dry clays, such as marls, and certain shales; it may also be applied to wetter clays, provided they have been partially dried before being crushed.

(c) *Plastic Process.*—The clay suitable for this process contains a large proportion of moisture, and is used for making wire-cut and hand-made bricks (see pp. 3 and 4). The bricks must be carefully dried before being burnt.

The various processes of (1) preparation of the clay or shale, (2) moulding, (3) drying and (4) burning are briefly described in Vol. I.

1. PREPARATION.—The top soil, or *overburden* or *callow*, is first removed. Clay is dug either by hand or by mechanical excavators such as a *steam-navvy*, which consists of a jib having a bucket with steel claws attached. The bucket is pressed against the base of the quarry face, and as it ascends the claws remove the clay which passes into the bucket; the jib is swung round until the bucket is over a wagon which receives the clay discharged from it. Shale is usually loosened by blasting and then filled into wagons either by hand or by means of the steam navvy.

Weathering.—In the absence of crushing machinery, certain clays are subjected in winter to exposure to the weather. This is usual in small works where moulding and subsequent operations are only carried out during the spring and summer months and the clay is dug in the autumn. The excavated clay is spread over the ground for a slight depth (not more than 2-ft.) to allow the action of the frost to break down the clay into minute particles. Stones, roots, etc., are removed, whilst at least once during the winter the clay is turned over to increase the exposure and improve its workability.

There are several methods of conveying the clay or shale from the quarry or pit. One form consists of an "endless wire rope" to which the bogies or wagons are attached; the moving rope drags the full wagons (which run on rails) up the incline to the mill as the empty wagons descend and return to the pit. Alternatively a motor tractor may be used to haul the wagons.

Cleaning.—Some clays require to be "cleaned." Stones, coarse vegetable matter, etc., may be removed either by hand picking, or the clay may be passed through a wash mill.

Blending.—Clay or shale used for making common bricks is usually taken as quarried direct to the crushing machinery. That for the more expensive bricks, especially multi-coloured facings (see p. 13), often requires the material from different strata to be mixed together as required. This important operation, known as blending, includes the removal of any undesirable material. The selection of the various clays or shales is made at the quarry-face and the blending is performed by one or more mechanical mixers, in conjunction with the grinding or crushing machine.

Reduction.—The machinery for reducing the clay or shale to a fine condition depends a good deal upon the character of the material. Thus, an *edge-running mill* is suitable for hard, dry clays which have been previously crushed by a *stone breaker*, whereas *crushing rolls* are effectively employed for plastic clays.

One form of stone breaker or disintegrator consists of a rapidly rotating shaft from which hammers are hung to break up the material to a coarse powder.

There are three types of *edge-runners* or *grinding mills*, *i.e.* (1) *dry* or *revolving pans*, (2) *wet pans* and (3) *pan mills*. A dry pan consists of two heavy metal rollers which rotate in a revolving pan having a perforated base; the latter may be 10-ft. in diameter and the size of the perforations varies from $\frac{1}{16}$ to $\frac{1}{2}$-in.; water is added to the clay or shale as required during the grinding operation, and the crushed material passes through the base to a pit or is conveyed by a belt to the moulding machine. A wet pan or *chaser mill* has two rotating rollers or runners which revolve in a fixed pan, the base of which is in the form of a grating having $\frac{1}{4}$ to $\frac{3}{4}$-in. slots through which the crushed material is forced; the material is softened by water which is sprayed over it. A pan mill or *tempering mill* consists of a pair of runners and a solid revolving pan which receives a measured charge of clay and a definite amount of water; grinding proceeds for about twenty minutes before the material is removed. A *pug mill* may be used in lieu of a pan mill, and consists of a vertical metal cylinder in which curved