as in the production of aluminium or sodium, the direct current can alone be used.

(7) **Cables, measuring instruments, and regulating devices:** the latter being required for advancing the electrodes as they are consumed in the furnace, and for regulating by this means—or in some other way—the amount of current flowing through the furnace.

Classification.

The usual classification of electric furnaces depends primarily upon the nature of the resistor used to develop the heat. Thus there are arc furnaces, in which the heat is developed in the electric arc; and resistance furnaces, in which the heat is developed by the passage of the current through a solid or liquid resistor. The classification may depend, also upon the manner in which the heat is transmitted to the charge; thus in arc furnaces the heating may be **direct,** as in Siemens' vertical arc furnace, in which the metal to be melted forms one pole of the arc; or **indirect,** as in his horizontal arc furnace, where independent electrodes are employed, and in which the heat is transmitted from the arc to the charge by radiation and conduction.

In resistance furnaces the charge to be heated may itself constitute the resistor, or else an independent resistor may be employed. The latter nearly always consists of a solid core, usually of carbon, and it may be surrounded by the charge that is to be heated, or imbedded in the walls of the furnace. A charge that is to be heated directly by the passage of the current, may be either liquid, or solid, and in the case of a liquid charge, the electric current may produce heat merely, or may also exert electrolytic action.

The following classification is based on these considerations, and includes examples of each class.

Arc Furnaces.

The heat is produced by one or more electric arcs.

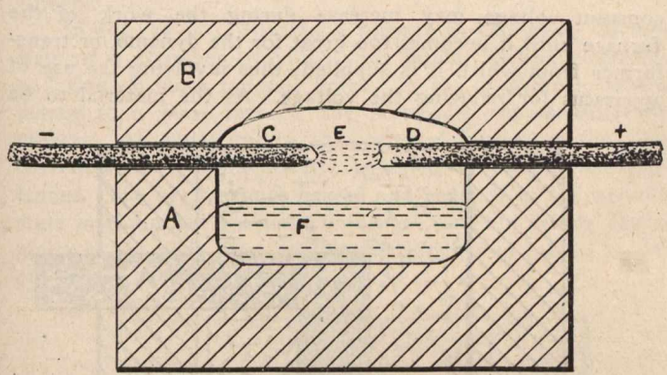

Fig. 10.—Independent Arc Furnace.

(1) **Independent arc furnaces.**—The arc is independent of the charge to be heated; being formed between two or more movable electrodes. The charge is heated by radiation from the arc, which is usually horizontal.

Fig. 10 shows such a furnace, consisting of a refractory chamber, A.B., in which an arc, E, is formed between the movable carbon electrodes C and D; the material to be heated being shown melted at F.

Examples:—Moissan furnace, Fig. 6 (p. 172)
Siemens' horizontal arc furnaces, Fig. 3 (p. 171).

The Stassano steel-making furnace.—The last named consists of a chamber lined with magnesia bricks, and provided with three carbon electrodes, between which a three phase arc plays. The ore or other material is placed in the chamber below the level of the arc, and is heated by radiation.

(2) **Direct heating arc furnaces.**—The charge in the furnace forms one pole of the arc and is thus heated directly as well as by radiation. The arc is usually vertical.

Fig. 11 represents an arc furnace in which the material D to be heated, forms one pole of the arc. A is a chamber lined with refractory material, and B and C are the two electrodes: the upper one, B, is movable; the lower, C, is fixed —forming part of the bottom of the furnace, and making electrical contact with the charge D.

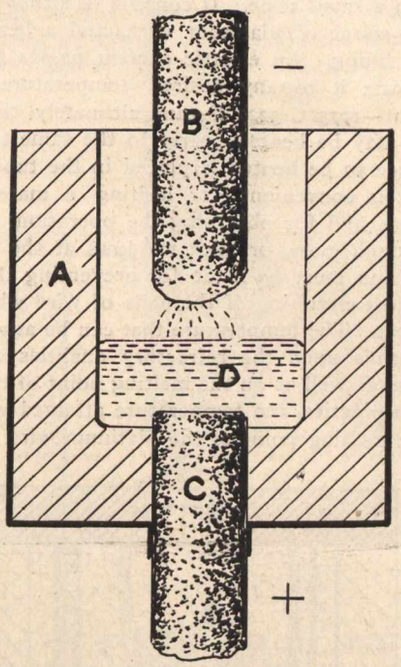

Fig. 11.—Direct Heating Arc Furnace.

Examples:—Siemens' vertical arc furnace, Fig. 2 (p. 170).
Willson's carbide fornace, Fig. 7 (p. 172).

Heroult steel furnace.—The latter consists of a chamber for containing the molten steel, and of two vertical carbon rods dipping through holes in the roof. An arc is formed between each carbon rod and the fused charge; the current entering through one rod, passing through the melted steel and slag, and returning through the other rod. Furnaces of this class are rather less convenient for scientific investigations than the independent arc furnace; because it is less easy to regulate the temperature of the furnace; the arc is more difficult to control when the charge consists of cold metal, and the carbon of the electrodes is apt to affect the chemical composition of the charge. On the other hand, the heat is transmitted more directly, thus obtaining a greater economy and only one movable carbon electrode is needed for each arc.

Resistance Furnaces.

In these, the heat is produced by the passage of the electrical current through some solid or liquid resistor. They may be divided into two main classes, in one of which a special resistor is provided, and in the other the charge itself

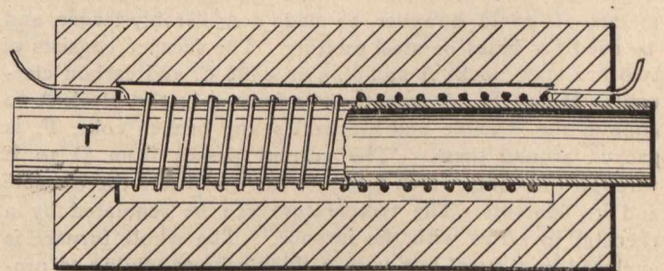

Fig. 12.—Electrical Tube Furnace.

constitutes the resistor. The second class may be subdivided into two classes, conditional upon whether the current is used merely to heat the charge, or in addition, to produce electrolysis of the fused contents of the furnace.

Resistance Furnaces With Special Resistor.

The resistor is a solid, and is imbedded in the walls of the furnace, or in the charge itself.

(1) With the resistor in furnace walls.