The gaseous fuel furnaces most frequently used for cementation are divided into two distinct types. To the first belong those heated by illuminating gas; their principal advantages consist in low cost and ease and rapidity with which they can be lighted and started without any special preliminary heating. These characteristics render the illuminating gas furnaces especially adapted to small plants operating intermittently.

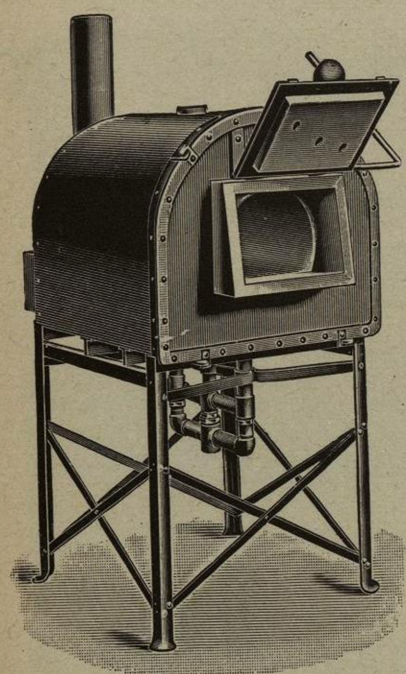

Fig. 96.

Furnaces heated with producer gas, the second type or class, while they present marked advantages, compared with illuminating gas furnaces, especially in economy, regularity and constancy of operation, are more expensive to instal, are more cumbersome, and, on account of their bulk and that of the heat recuperators necessary to obtain sufficiently high temperatures, require a long time and a careful preliminary heating to be lighted and put in operation. They are adapted, therefore, only, to continuous operation.

Among the innumerable varieties of gas furnaces of the two types at present on the market, we will describe only those which are best adapted to cementation practise.

Among the cementation furnaces of small and medium dimensions heated with illuminating gas the muffle furnaces constructed by the firm of Wilhelm Hertsch of Stuttgart are very economical. Fig. 96 represents one of these furnaces. For a muffle 400 mm. wide by 240 high and 600 deep, the complete furnace costs 920 marks ($225). It requires air under a pressure of about 35 cm. of water, consumes about 7 cu. m. (250 cu. ft.) of gas per hour, and reaches a maximum temperature of about 1300° C. in less than thirty minutes.

A furnace similar to that just mentioned, but working without air under pressure, is the muffle furnace of Fletcher, Russell and Co., of Warrington, England, shown in section in Fig. 97 and in perspective in Fig. 98. This furnace is well adapted to the cementation of small pieces. It is, however, not very economical as to consumption of fuel; this follows of necessity from the fact that the gases of combustion remain in contact with the charge or laboratory walls for quite a short space, and issue from the furnace at a high temperature.

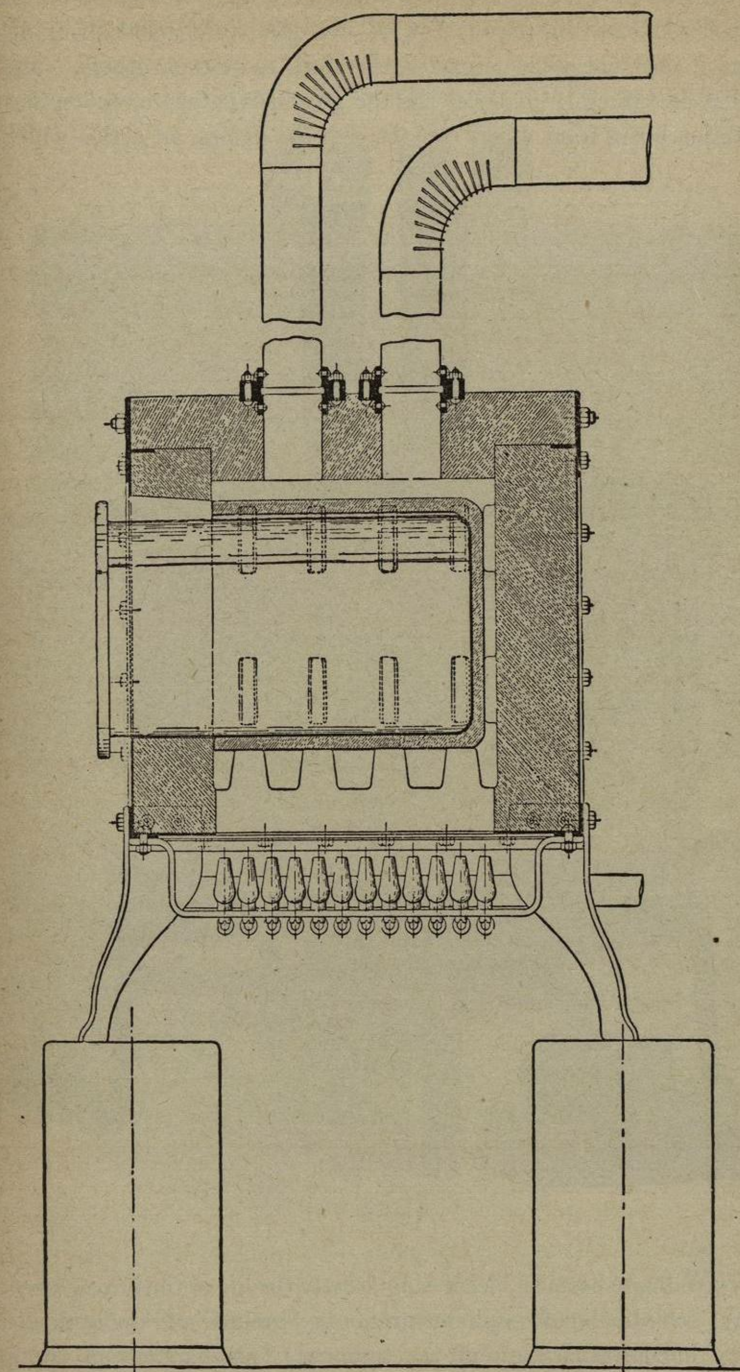

Fig. 97.

The greater part of the muffle cementation furnaces heated by illuminating gas, as they exist on the market, do not differ fundamentally from this one, and it does not seem necessary, therefore, to describe others. The use of muffles of refractory material has the great advantage of protecting the cementation boxes from direct contact with the flames, an action which be-

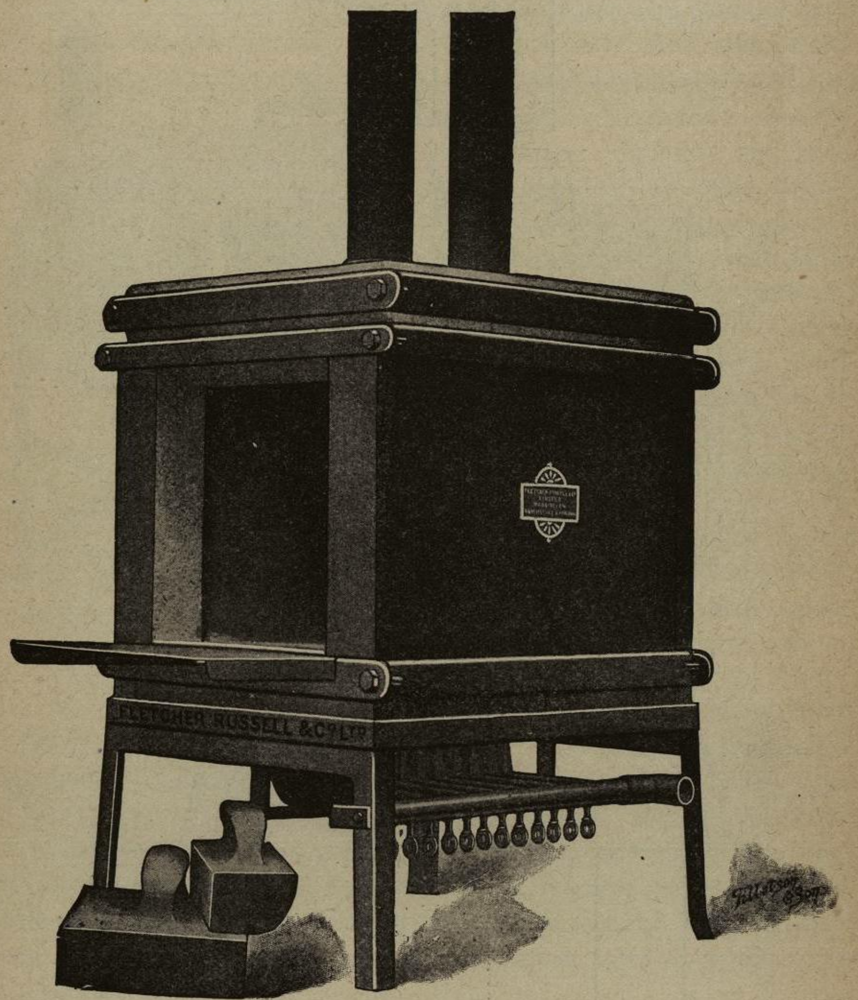

FIG. 98.

comes exceedingly harmful, decreasing greatly the life of the boxes, whenever a neutral or reducing atmosphere can not be obtained and maintained with certainty in the laboratory of the furnace. This happens in the great majority of cases.

On the other hand, however, the muffles of refractory material can be made in practice only of relatively small dimensions and even for such dimen-

sions their fragility makes their life quite short and therefore the cost very high, especially when rather heavy cementation boxes are charged in them.

Moreover, the utilization of the heat generated by the fuel is made con-

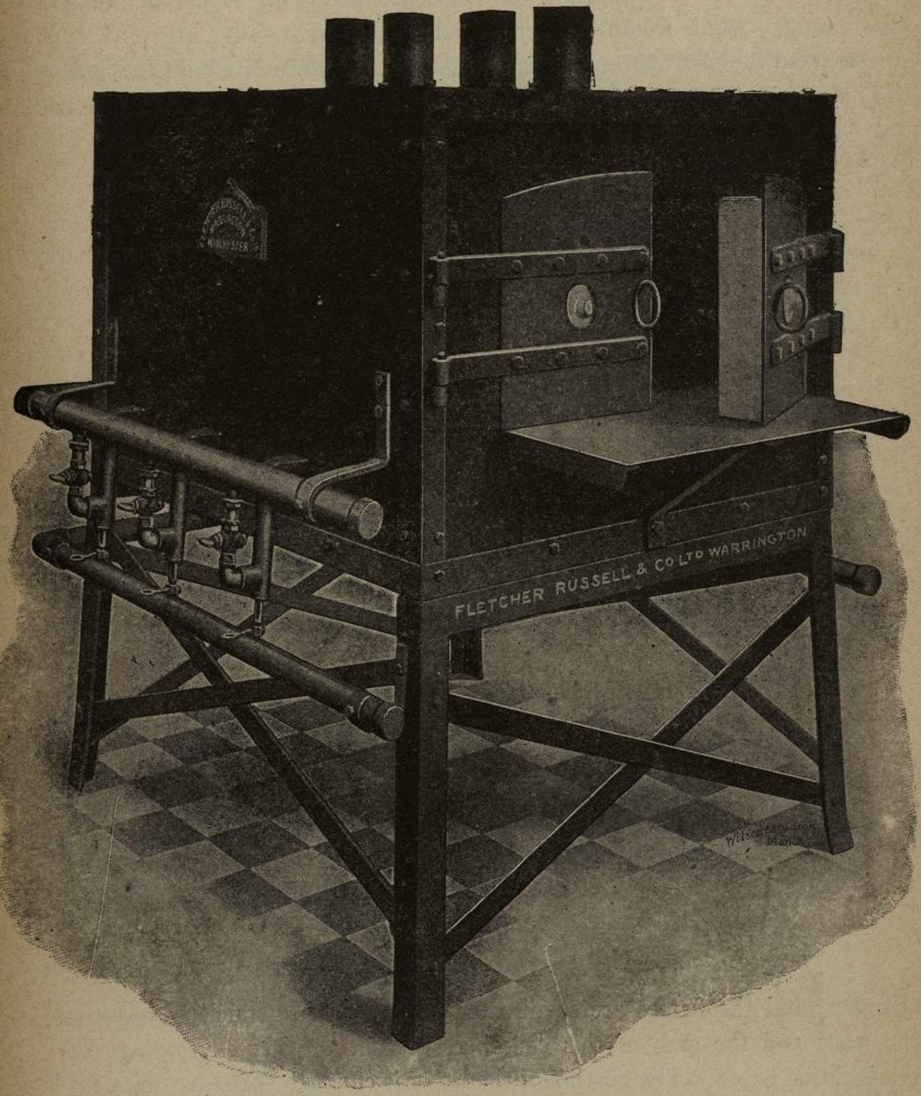

FIG. 99.

siderably less perfect by the interposition of the refractory wall of the muffle, which is not only a cause of greater consumption of fuel but aggravates all the disadvantages which are due to slowness of heating of the boxes. The disadvantages just cited diminish when the muffles of refractory material are replaced by muffles of cast iron or cast steel, which are stronger and better conductors of heat than those of refractory clay. However, such can be used only at relatively low temperatures (about 900°), for at higher temperatures they "swell" and may easily melt locally on the least overheating. Those of cast steel also cost too much; both are easily oxidized when they come in direct contact with the flames, so that their use merely lays upon the muffle disadvantages which would be averted from the boxes.

To avoid the disadvantages of muffles, hearth furnaces are built in which the cementation boxes, carefully closed, are placed directly in the combustion

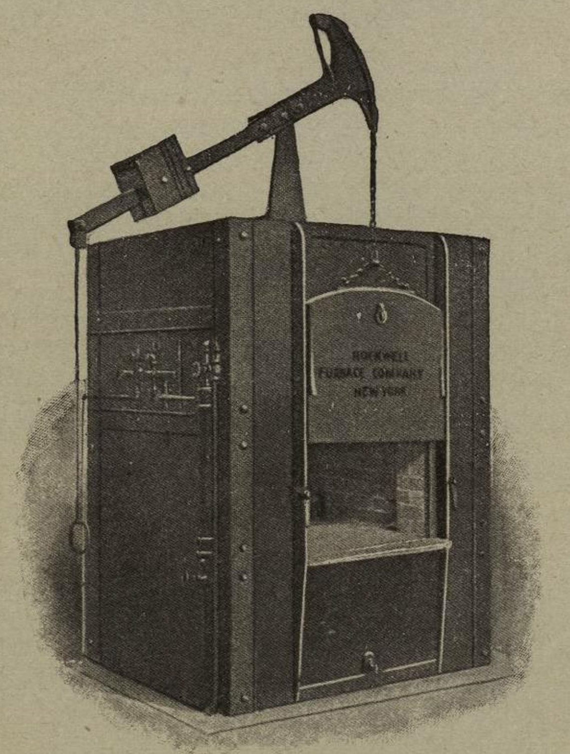

Fig. 100.

chamber, and the flames are so directed as to bathe as much as possible the walls and the arch of this chamber, without directly enveloping the cementation boxes. The heating of the latter is effected, therefore, more by the heat radiated from the walls and arch of the laboratory than by the heat communicated directly to the boxes by the flames. Furnaces of the type just referred to, heated by coal gas, are made in an exceedingly great variety of forms and sizes by many firms.

Fig. 99 represents one of these furnaces, made by the house of Fletcher, Russell and Co., of Warrington. The available space in the chamber is

60 cm. wide by 30 cm. high and 90 cm. deep. As is seen from the illustration, the flames enter the heating chamber near the hearth.

Analogous to these but heated *from above* are the furnaces constructed by the "Rockwell Furnace Company" of New York. Fig. 100 is the exterior view of one of these furnaces, especially adapted to cementation in boxes. Figs. 101, 102, and 103 show how the heating is effected from above. The same furnace can be used for burning heavy oils "vaporized" by means of one of the well-known vaporizers. The heating from above, obtained in

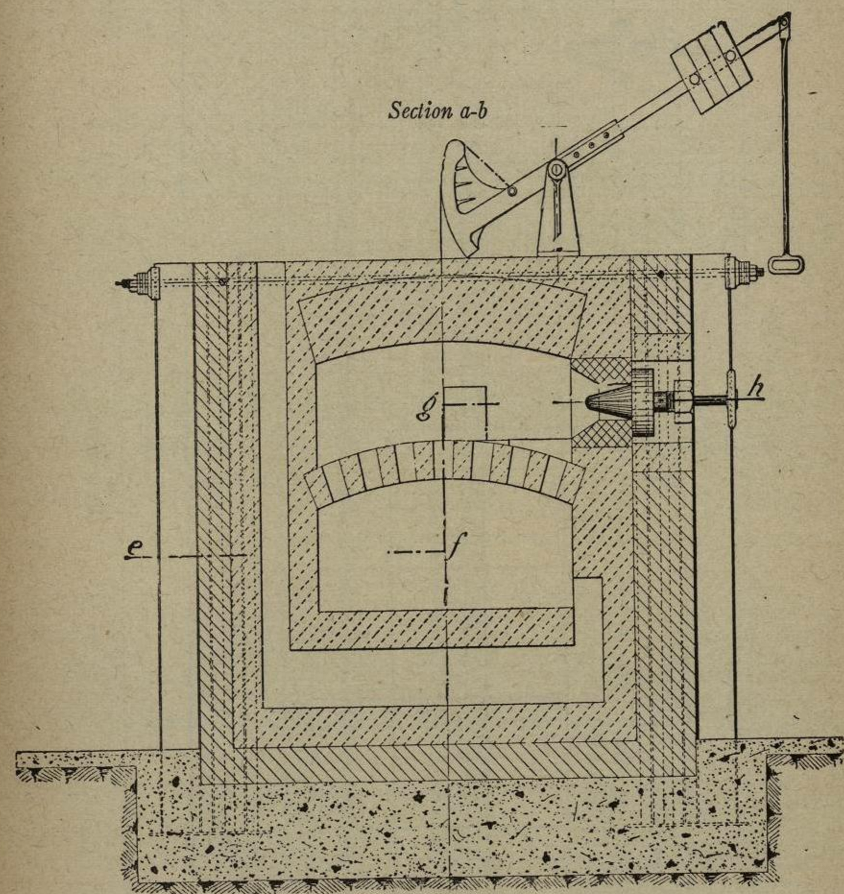

Fig. 101.

the way indicated in the accompanying figures, seems in fact to assure the obtaining of a gradual, more uniform and more constant heating of the objects placed in the chamber than can be obtained by heating from below.

Furnaces heated from above, such as the type just described, present the disadvantages of higher cost of equipment and greater difficulty and cost of repairs of the refractory parts; disadvantages not wholly compensated by a somewhat lower consumption of fuel than in furnaces heated from below.

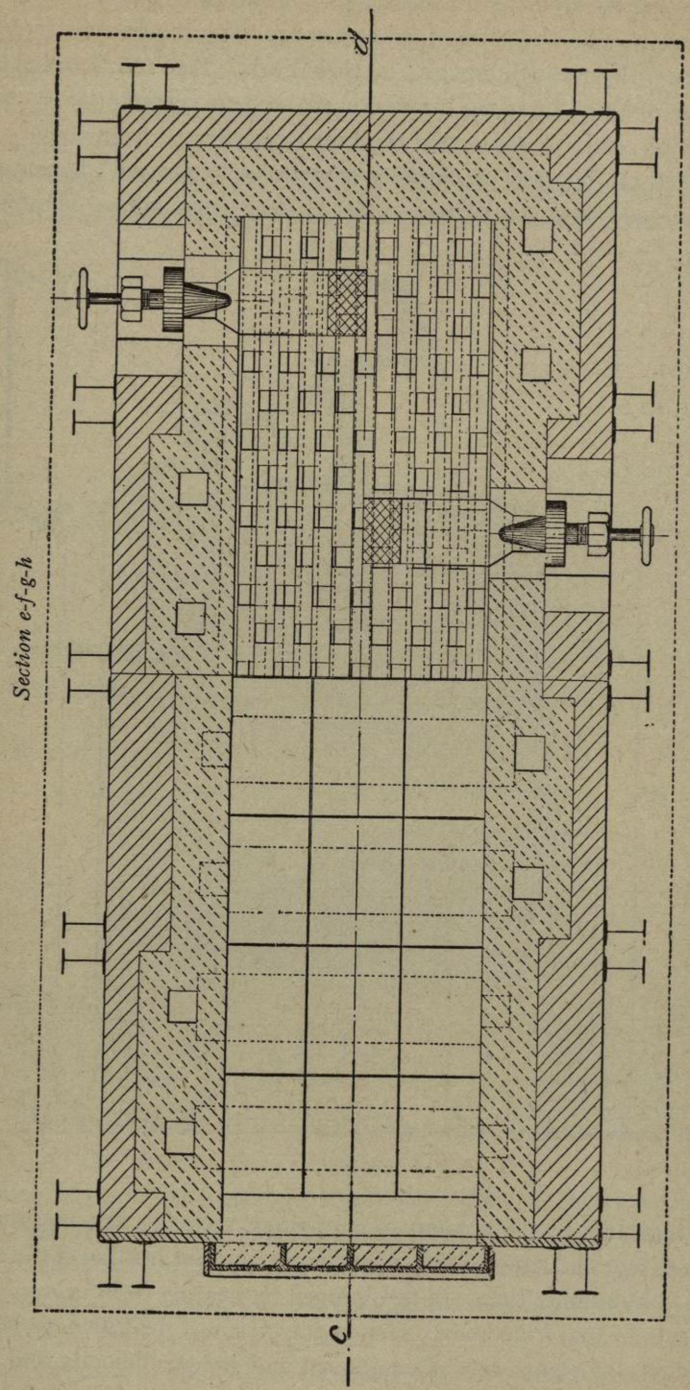

FIG. 102.

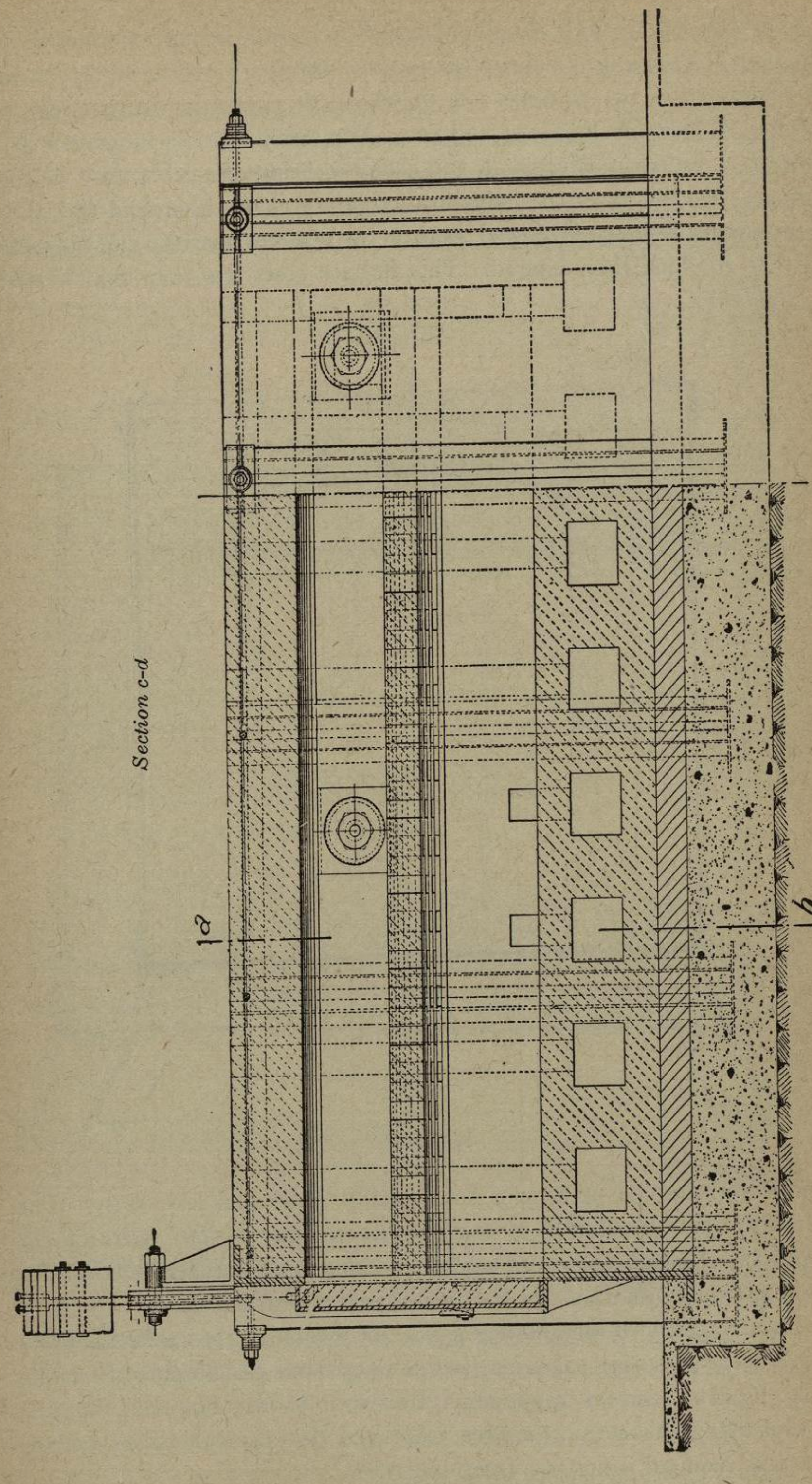

FIG. 103.

To partially eliminate the disadvantages of each of the two types of furnaces, the same Rockwell firm makes a special type of furnace which can be heated by illuminating gas or heavy oil, in which the circulation of the gases is effected as shown in Figs. 104 and 105. The combustion of the gas or hydrocarbon vapors is effected in the chamber below the laboratory of the furnace; the hot gases circulate in appropriate channels around the laboratory, enter it from above and issue at the bottom, near the end opposite to that at which they entered. This furnace costs less than that heated

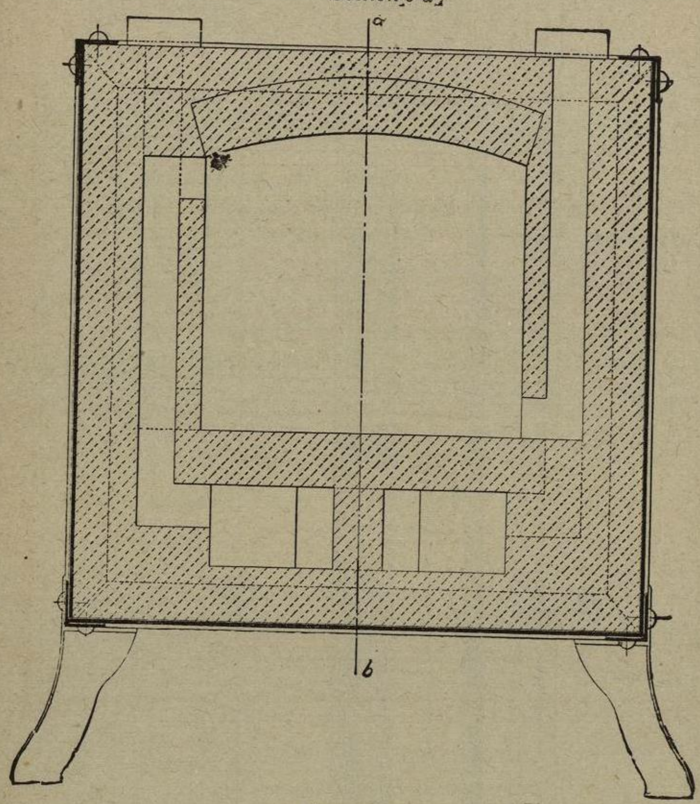

FIG. 104.

from above, and its up-keep is considerably easier and less costly. The uniformity and constancy of temperature in the various parts of the laboratory, although not equal to those obtained with furnaces heated from above, are amply sufficient for the greater part of practical cases.

When a supply of illuminating gas is not available, the gas furnaces described in the preceding pages may be run by gasoline gas, obtained from one of the usual air-current vaporizers. It is well known, however, that the gas thus obtained is very expensive; moreover, the operation of the various apparatus required is not free from danger

Besides the normal types of illuminating gas furnaces referred to in the preceding pages and intended to heat ordinary rectangular cementation boxes, there are on the market gas furnaces of various forms designed for the cementation of pieces of special forms which can not be placed in the usual boxes. As an example of these there is a vertical cylindrical furnace intended for the cementation of very long pieces (as, for example, the axles of railway cars), constructed by the "Società Italiana per la Cementazione e

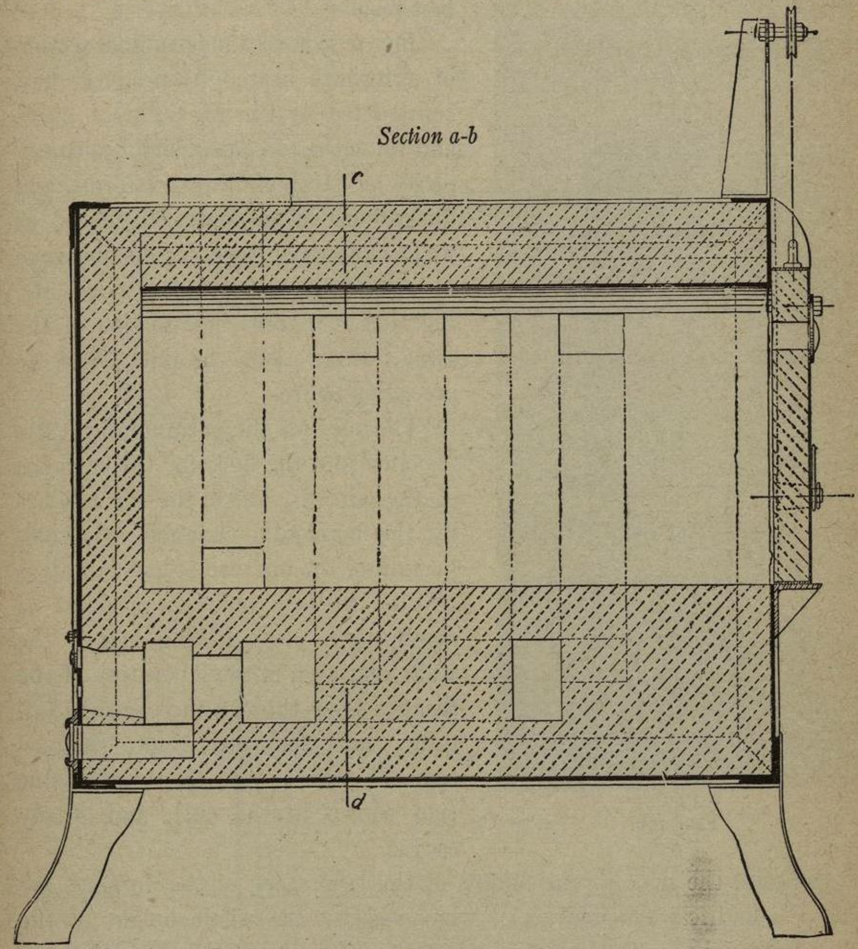

FIG. 105.

gli Acciai Speciali" of Turin, shown in Fig. 106. This furnace is heated throughout its whole height by a series of independently regulated burners, fed with illuminating gas and with air under pressure (about 70 cm. of water).

The stopcocks which furnish gas to each of the two series of burners are first regulated so as to obtain approximately the same temperature in the two parts of the furnace. By regulating then, with care, the width of the two exits for the products of combustion, at the upper and the lower part of the furnace, it is easy to obtain complete uniformity in temperature throughout the whole length of the laboratory of the furnace. A tube of wrought steel forms the cementation box. The axle to be cemented is placed in this tube and surrounded by the solid or mixed cement. The tube is then placed upright inside the furnace.

We will now show some examples of producer-gas furnaces chosen from those which I find to have given the best results.

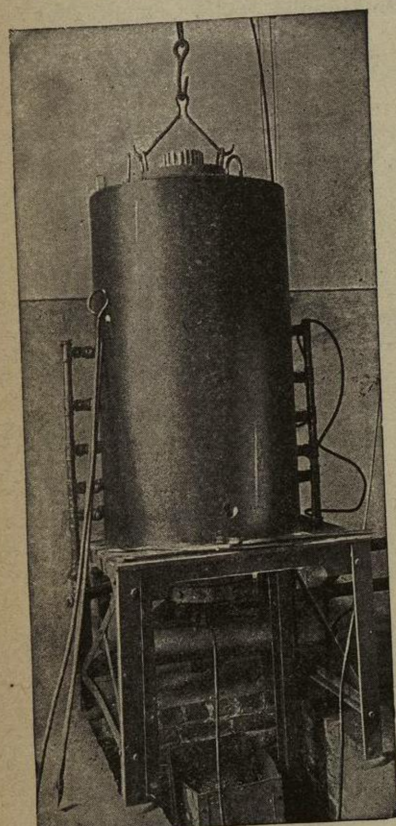

Fig. 106.

Fig. 107 shows a longitudinal section of a furnace heated by producer gas, constructed by Ch. M. Stein of Paris, and intended to cement simultaneously pieces of steel of ordinary forms and dimensions in cementation boxes, as well as pieces of large dimensions, such as connecting rods, shafts, axles, etc. Fig. 108 is a transverse section of the same furnace along the line *AB* of the preceding figure.

The flues for the entrance of the gas (6) open into the flues for the entrance of the air (8), which the air reaches by the horizontal channels (7); combustion of the mixture of gas and air is effected in (5), and the products of combustion, after having heated the walls and arch of the laboratory of the furnace, issue through the channels (9), from which they return into the passage (10), thence into the principal flue (not shown in the cut), and finally escape.

Opposite the door in the middle of the laboratory of the furnace are placed cylindrical crucibles (11), which occupy the whole height of the laboratory and pass through the arch of the furnace. The front half of the laboratory is intended for the heating of the ordinary cementation boxes (13) lying on balls placed on special tracks (14) set in the hearth. A series of dampers placed along the channels (6), (7) and)10), regulate the gas and air which reach the furnace and the draft of the chimney.

The boxes (13) are put into the furnace through the openings (15), which are then closed by means of doors (16); these details are represented in Figs. 109 and 110. The door is suspended by a chain to a beam (22) with counterpoise (23), and is formed of a steel frame in which, held by the wedge

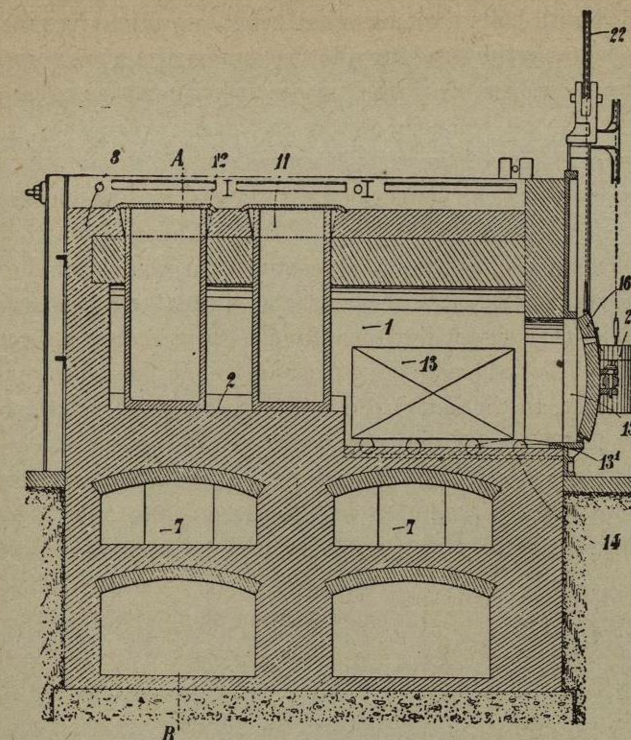

Fig. 107.

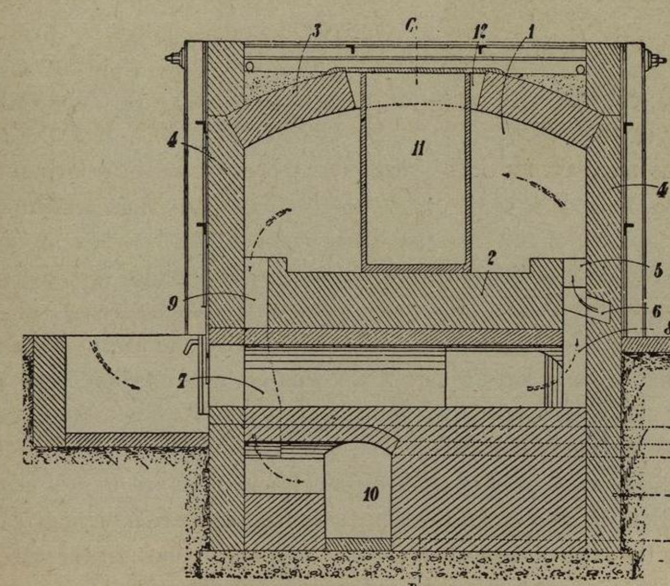

Fig. 108.