Wethey, improved	65- 70
McDougall, Evans-Kleptko, Anaconda, Mont.	84 86
Edwards	140-152
Herreshoff-McDougall	30- 35

It is evident, therefore, that we may safely claim for furnaces of this class an efficiency varying from 33 to 75 pounds per square foot per day for ordinary conditions, and as high as 150 pounds per square foot per day when but little sulphur elimination is required. This latter figure may properly be used in making comparisons with the blast-roasting processes.

Revolving Cylinder Roasters.—As exemplified by the Brückner cylinders, this type of roaster was very popular at one time both in lead and copper work, but is now almost entirely abandoned. The high proportion of flue-dust made by the Brückners was one of the principal causes of the gradual abandonment of this method of roasting. It is to be regarded essentially as a revolving reverberatory furnace in which the inner lining of the cylinder becomes successively the hearth and the reverberatory arch of the furnace, and the exposure of fresh surfaces of ore is accomplished by the changing talus of the material as the cylinder slowly revolves. The area of the hearth may be taken for practical purposes as equivalent to the horizontal projection of the cylinder.

At the Germania plant, in Utah, the Brückner practice attained its highest perfection. Here the cylinders were 22 feet long by 8½ feet diameter, and treated 12 tons per day. Equivalent area of hearth was 187 square feet, making the efficiency factor 128 pounds per square foot per day.

To summarize the characteristics of the automatic roasters of the reverberatory type, we may say that they show a distinct gain in efficiency over the hand-stirred type, though the gain is not so marked as one would expect. The truth is that a practical limit is soon reached as to the amount of sulphur that can be burned on a square foot of hearth area in a given time without causing the sulphides to melt and interfere with the further progress of the reaction, or clog the stirring mechanism. This practical limit probably corresponds closely to the efficiency factor of 75 pounds per square foot per day, though in certain special cases where the ore contains less sulphur, or from its nature will bear a higher temperature without fusing, or where there are special provisions for moderating the resulting temperatures, (as in some of the improved types of MacDougall furnace, notably the Wedge furnace), the efficiency factors may be carried as high as 175 pounds per square foot per day.

III.—Blast Roasting in Pots.

The last paragraph called attention to the great stumbling-block in the way of increasing the efficiency of the mechanically stirred reverberatory, arising from the too rapid generation of heat by the mass-action, whereby the sulphide is caused to melt or "matte." The next important advance in the art of roasting resulted from the discovering how to control and check this mass-action. It was accomplished by mixing the grains of sulphide to be roasted with grains of an inert or refractory material in such proportion that the particles of sulphide are held apart from one another by refractory grains. If a mass of material so constituted be ignited at one surface and a blast of air forced through it, the sulphide particles will successively shrivel up in the fierce oxidizing blast, and the reaction will propagate itself through the mass in the direction of the air current. An additional advantage may be secured if the isolating grains are of such composition that, while they remain inert during the roasting period, they will, at the temperature developed by the cumulative mass-action, combine with the newly formed metallic oxides to form a reasonably fusible slag or sinter. This is the action as we now understand it, but at first the reason for the extraordinary rapidity of the roasting was not so evident. Instead of recognizing it as a purely mechanical effect, Messrs. Huntington and Heberlein, who first developed this process, were misled into the belief that some powerful chemical reagent was at work, and that the burnt lime they employed as an isolating ingredient of the charge was the vehicle for nascent oxygen in the form of CaO_2. So sure were they of this fact that they based their patents in all the important countries of the world upon this reaction, and the theory was generally accepted as true until research demonstrated that it was untenable. Even then it was generally held that the lime had some important though mysterious chemical effect, and the process was still called "Lime Roasting." It has now been demonstrated that many other substances will answer as well, if not better than lime, and "Blast Roasting" is now generally accepted as the more logical and precise designation.

Although Messrs. Huntington and Heberlein did not realize at first the true cause of their success, they are none the less entitled to great credit for working out a successful process which constituted a great step in advance, and removed some of the most perplexing difficulties of the lead metallurgist. They made it possible to roast fusible galena ores cheaply, efficiently and with diminished metal losses, yielding a product of remarkably favourable physical character, which greatly promoted the efficiency of the subsequent smelting. Although the form of apparatus they employed (blast-pots) was crude and primitive, the efficiency factor was far higher than had ever been previously attained by what Dr. Peters has referred to as the "wealth of science and modern mechanical skill," as applied to the roasting problem.

The procedure originally proposed by Huntington and Heberlein required a pre-roasting of the charge before treatment in the pots, but as experience was gained in manipulation it was found possible, under some conditions, to dispense with the pre-roast and subject the charge to direct converting. The variations in the process devised by Carmichael and Bradford in Australia, and by Savelsberg in Germany, dispensed with pre-roasting. The first named investigators noticed that sulphate of lime was quickly formed in the converter, and reasoned that it might as well be introduced at the start in place of the burnt lime. Savelsberg carried this reasoning still further, and substituted crushed limestone. Patents were granted to all of these investigators, and their processes have found extensive utilization. But the efficacy of the lime was unquestionably overestimated, and its true function misunderstood.

The original Huntington-Heberlein pot was small and deep. As the roasting and sintering action propagates itself progressively upwards, the time needed to complete a charge depends more upon the distance which this silowly moving zone has to travel than upon the actual weight of material treated. The present writer has shown in a previous article that, on account of this progressive sintering, most of the space in a converter is utilized for storing rather than for treating its con-