However, in view of the immense tonnage of ore smelted annually for the extraction of silver and lead, it is evident that the invention of lime-roasting by Huntington and Heberlein was an improvement of the first order in the metallurgy of lead.

In the case of non-argentiferous galena, containing 65 per cent. of lead (as in southeastern Missouri), comparison may be made with the slag-roasting and blast-furnace smelting of the ore. Here no saving in cost of roasting may be reckoned, and no gain in the speed of the blast-furnaces is to be anticipated. The only savings will be in the increase in the extraction of lead from 92 to 98 per cent., and the elimination of matte-roasting, which may be reckoned as amounting to 50c. per ton of ore. The extent of the advantage over the older method is so clearly apparent that it need not be computed any further. In comparison with the Scotch-hearth bag-house method of smelting, however, the advantage, if any, is not so certain. That method already saves 98 per cent. of the lead, and, on the whole, is probably as cheap in operation as the Huntington-Heberlein could be under the same conditions. The Huntington-Heberlein method has replaced the old roast-reaction method at Tarnowitz, Silesia, but the American Scotch-hearth method, as practiced near St. Louis, is likely to survive.

A more serious competitor, however, will be the Savelsberg process, which appears to do all that the Huntington-Heberlein process does, without the preliminary roasting. Indeed, if the latter be omitted (together with its estimated expense of 63c. per ton of charge, or 79c. per ton of ore), all that has been said in this paper as to the Huntington-Heberlein process may be construed as applying to the Savelsberg. The charge is prepared in the same way, the method of operating the converters is the same, and the results of the reactions in the converters are the same. The litigation which is pending between the two interests, Messrs. Huntington & Heberlein claiming that Savelsberg infringes their patent, will be, however, a deterrent to the extension of the Savelsberg process until that matter be settled.

The Carmichael-Bradford process may be dismissed with a few words. It is similar to the Savelsberg, except that gypsum is used instead of limestone. It is somewhat more expensive, because the gypsum has to be ground and calcined. The process works efficiently at Broken Hill, but it can hardly be of general application, because gypsum is likely to be too expensive, except in a few favored localities. The ability to utilize the converter-gases for the manufacture of sulphuric acid will cut no great figure, save in exceptional cases, as at Broken Hill; and, anyway, the gases of the other processes can be utilized for the same purpose, which is, in fact, being done in connection with the Huntington-Heberlein process in Silesia.

The cost of desulphurizing a ton of galena-concentrate by the Carmichael-Bradford process is estimated by the company controlling the patents as follows, labor being reckoned at $1.80 per 8 hrs., gypsum at $2.40 per 2,240 lbs., and coal at $8.40 per 2,240 lbs.:—

0.25 ton of gypsum	$0.60
Dehydrating and granulating gypsum	0.48
Drying mixture of ore and gypsum	0.12
Converting	0.24
Spalling sintered material	0.12
0.01 ton coal	0.08
Total	$1.64

The value of the lime in the sintered product is credited at 12c., making the net cost $1.52 per 2,240 lbs. of ore.

The low cost allowed for converting may be explained by the more rapid action that seems to be attained with the ores of Broken Hill than with some ores that are treated in North America, but the low figure estimated for spalling the sintered material appears to be highly doubtful.

The theory of the lime-roasting processes is not yet well established. It is recognized that the explanation offered by Huntington and Heberlein in their original patent specification is erroneous. There is no good evidence in the process, or any other, of the formation of the higher oxide of lime, which they suggest.

At the present time there are two views. In one, formulated most explicitly by Professor Borchers, there is formed in this process a calcium plumbate, which is an active oxidizing agent. A formation of this substance was also described by Carmichael in his original patent; but he considered it to be the final product, not the active oxidizing agent.

In the other view, the lime, or limestone, serves merely as a diluent of the charge, enabling the air to obtain access to the particles of galena, without liquefaction of the latter. The oxidation of the lead sulphide is therefore effected chiefly by the air, and the process is analogous to what takes place in the Bessemer converter or in the Germot process of smelting, or perhaps more closely to what might happen in an ordinary roasting-furnace, provided with a porous hearth, through which the air-supply would be introduced. Roasting-furnaces of that design have been proposed, and, in fact, such a construction is now being tested for blende-roasting in Kansas.

Up to the present time, the evidence is surely too incomplete to enable a definite conclusion to be reached. Some facts, however, may be stated.

There is already reaction to a certain extent between lead sulphide and lead sulphate, as in the reverberatory smelting-furnace, because prills of metallic lead are to be observed in the lime-roasted charge.

There is a formation of sulphuric acid in the lime-roasting, upon the oxidizing effect of which