This invention relates to a process of, and apparatus for, extracting zinc from zinc bearing material, the zinc being recovered either in the form of liquid spelter or zinc powder.

The object of the invention is to provide such a process and apparatus which will be economical and efficient in operation.

In carrying out my invention I employ a shaft furnace of the blast furnace type. And I so direct the course of the blast and the gaseous products of combustion with reference to the zinc ore and other materials that are charged into the top of the furnace, and make such provision for the exit of the resulting zinc-bearing gases, that I obtain a high yield of zinc and at the same time overcome the difficulties heretofore experienced in attempting to extract zinc from ores in general.

The principal methods now in commercial use for extracting zinc are (1) electrolytic deposition, (2) electrothermic smelting and (3) retort distillation. Except where cheap electric power is available, the latter process is the one generally used. The disadvantages of this process are that it is a batch process, as distinguished from a continuous one, that it involves the use of small sized units, and that the labor costs are high.

It has heretofore been proposed to overcome these disadvantages by continuously producing gases containing zinc vapor in a furnace of the blast furnace type, into which are charged suitable quantities of zinc bearing materials, fuels and fluxes. But, so far as I am aware, no attempts of this character have been successful because, when cold materials are charged into a furnace of this type, carbon dioxide is formed in the gas stream in sufficient quantity to react upon the zinc vapor and contaminate it with an excess of zinc oxide. The result is that the zinc powder (which is the form in which most of the zinc is removed from the gas stream) is coated with oxide to such an extent that it cannot be properly worked in the furnaces that are now generally used for reducing metallic zinc powder to liquid metal.

By my process and apparatus now to be described, I avoid this difficulty, and produce a zinc powder of a character that can readily be reduced to liquid zinc.

The accompanying drawing, which illustrates more or less diagrammatically, one embodiment of my invention, is a vertical section of a form of blast furnace which I may employ. This furnace 1, has a hearth 2, where heavy reduced metals and the slag resulting from the operations, may collect. The usual tuyères 3 are provided for applying the blast containing oxygen. Either atmospheric air, or some other mixture of gases, may be used for this purpose. The by-pass 5 (of which there may be a number) is adapted to by-pass part or all of the gaseous products of combustion, taking them off at 4 and returning them to the furnace shaft at 6. Valves 12 are provided for regulating the amount of gases by-passed in this way.

At the top of the furnace the gases pass out at 7 through the fume catcher 14 (where any solid matter carried by the gas is collected) and thence through the outlet 15, to be utilized in any desired way.

 Provision is made at 9 for the exit of the zinc bearing gases from which the zinc is removed in the condenser 10.

I shall now describe the manner in which my improved process is carried out in this apparatus. After starting the furnace it is charged through the charging door 8 with a mixture of zinc bearing ore, a proper reducing agent in the form of carbonaceous fuel, and a suitable amount of material capable of forming a liquid slag with the gangue of the ore and the ash of the fuel. A blast is provided at the tuyères 3. The zinc in the ore is present principally in the form of zinc oxide. The oxygen of the blast combines with the carbon of the charge to form carbon monoxide (CO) a short distance above the tuyères, at a temperature of say 1400–1500° C.

At point 4 a large part of these hot gases are by-passed through 5, the remainder passing up through the furnace. The by-passed part of the gases are reintroduced to the charge column at 6. At this point the gases still contain sufficient heat to cause the reduction of substantially all of the easily reducible oxides present in the charge above the point 6. The result is that the charge descending beyond the point 6 contains a mixture of carbon, metallic iron, lead, slag forming material, some zinc and some zinc oxide, all at a temperature of between, say 900° and 1050° C.

This charge now encounters the part of the hot gases not by-passed at 4. These gases contain sufficient heat to complete the
reduction of the zinc oxide, and vaporize the zinc, producing zinc vapor. These gases passing up the shaft from 4 to 6, being reduced in volume and in constant contact with the incandescent carbon in the charge during a comparatively long period, are completely converted to carbon monoxide. Thus, an atmosphere favorable to the existence of metallic vapor is maintained at this zone, and the formation of detrimental quantities of carbon dioxide is avoided. The gases in this zone contain a much larger percentage of zinc vapor than they would if the by-pass 5 were omitted.

At point 9 those gases, or a part of them, are withdrawn to the condenser 10, where the zinc is condensed out in the form of liquid zinc, or zinc powder. Ordinarily it will be condensed into the powder form which is conveyed away by the screw conveyor 13. This powder may then be treated in a well known manner to obtain liquid zinc.

Between point 4 and point 9 at times it may be advantageous to introduce a small quantity of highly heated air or gas containing a higher percentage of oxygen than ordinary air in order to supply through the combustion of part of the carbon in this portion to the charge sufficient heat to completely volatilize the zinc that is in the charge. For this purpose the tuyères 11 are provided.

It is evident that the quantity of gas withdrawn at point 9 may be less than the gas current ascending the shaft at 4, in which case there will still be an ascending current from 9 to 6. Under certain conditions, however, it may be found advantageous to withdraw a larger amount of gas at point 9 than is ascending the shaft at this point, in which case there will be a descending current from point 6 to point 9. These different operating conditions may be conveniently regulated by the amount of gas liberated through 15.

The progress of the charge may be described as follows: (1) Above point 6, drying and preheating of the charge and reduction of iron, lead, etc. (2) From point 6 to point 4, reduction and vaporization of ZnO and withdrawal of gas mixture at point 9. (3) From point 4 to point 3, zone of combustion of all carbon and final fusion of the slag. (4) Below tuyères, collection of slag and non-volatile metals.

The process above described eliminates the disadvantages incident to retort distillation, and overcomes the difficulties heretofore experienced in attempting to extract zinc in furnaces of the blast furnace type. It gives a high yield—eliminating, as it does, substantially all zinc from the residue or slag—and it is economical in operation.

The terms and expressions which I have employed are used as terms of description and not of limitation, and I have no intention in the use of such terms and expressions, of excluding any equivalent of the features shown and described, or portions thereof, but recognize that various modifications are possible within the scope of the invention claimed.

What I claim is:

1. The process of extracting zinc from zinc bearing materials which consists in maintaining in a shaft furnace a suitable charge of zinc bearing material and carbonaceous fuel, applying an air blast near the bottom of such charge, by-passing from a lower zone to an upper zone a part of the gaseous products of combustion formed in the lower zone, thereby preheating the portion of the charge in the upper zone, and withdrawing from a zone in the shaft itself intermediate the ends of the by-pass gases containing zinc vapor.

2. The process of extracting zinc from zinc bearing materials which consists in maintaining in a shaft furnace a suitable charge of zinc bearing material and carbonaceous fuel, applying an air blast near the bottom of such charge, by-passing from a lower zone to an upper zone a part of the gaseous products of combustion formed in the lower zone, withdrawing from a zone in the shaft itself intermediate the ends of the by-pass gases containing zinc vapor, and applying a blast to the lower part of the intermediate zone.