Aug. 7, 1945. J. WULFF 2,381,023

APPARATUS FOR PRODUCING IRON ALLOY POWDERS

Filed June 4, 1940

Fig. 1.

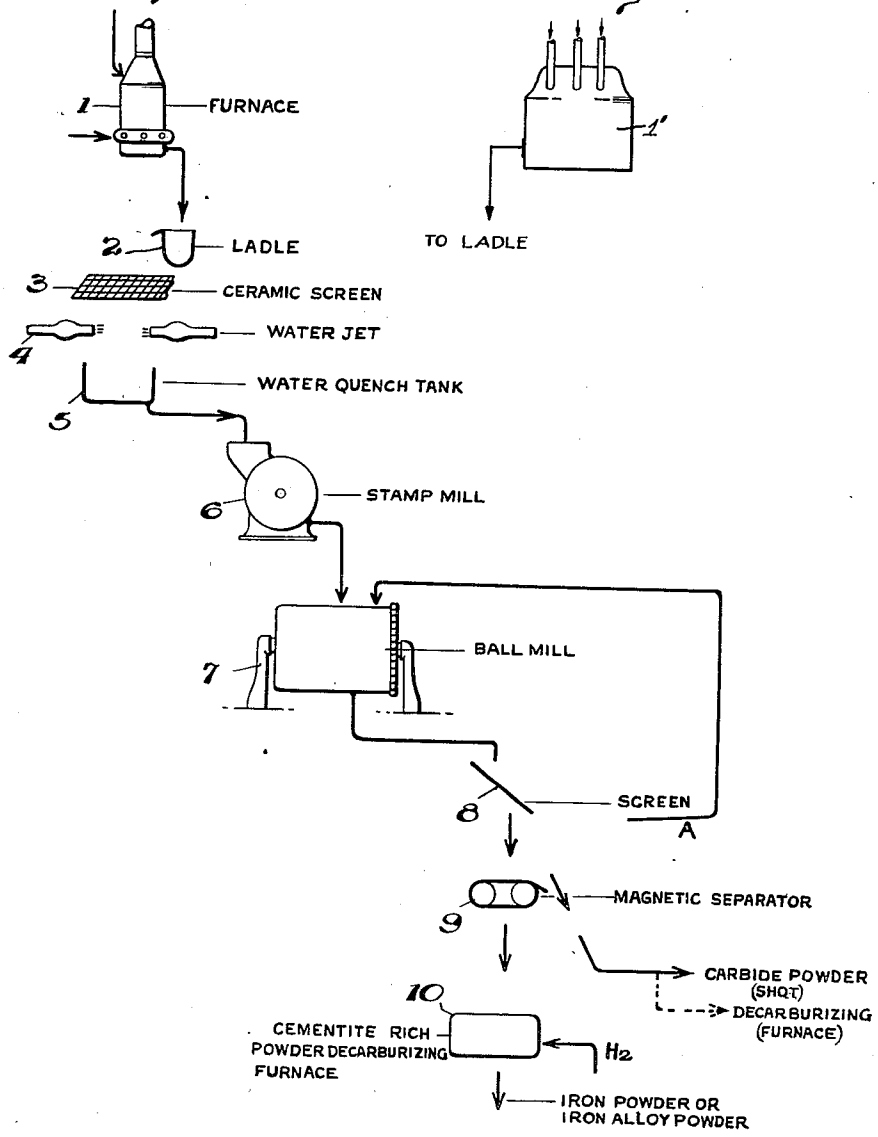


Fig. 2.

Inventor

John Wulff

By Raymond J. Norton

Attorney

Patented Aug. 7, 1945

2,381,023

UNITED STATES PATENT OFFICE

2,381,023

APPARATUS FOR PRODUCING IRON ALLOY POWDER

John Wulff, Cambridge, Mass.

Application June 4, 1940, Serial No. 338,827

10 Claims. (Cl. 266—9)

This invention relates to powder metallurgy, more particularly to an improved apparatus for the production of iron powder and iron alloy powder.

A notable recent advance in metallurgy is the development of the field of powder metallurgy. This deals with the production of metallic reguli from discrete solid metal or powder by compression and heating or sintering the compact.

The potential field of use of metal powders for the production of compacts is very wide, however, the immediate extension is hampered in a number of particulars. As a general proposition, where only strictly mechanical factors are involved in the use of a machine element, a powder metal compact can compete with machined products, produced by fusion metallurgy, only when the machining operations are relatively costly. This is due to the fact that a machine element made up of a powder compact, per unit of weight, is considerably more expensive than when produced by conventional methods from the liquid phase metal. The extension of powder metallurgy is particularly limited in those uses where alloy steels of special specifications are required.

It has been suggested heretofore to produce metal compacts by forming the compact in the desired element shape from iron powder and modifying the physical characteristics of the surface, such for example as increasing the hardness by carburizing or case hardening the surface. It has also been suggested to produce fabricated units of alloy steels, by powder metallurgy methods, by mixing predetermined percentages of iron powder and a powder of the alloying ingredients. These products are expensive due to a high initial cost of the iron powder as well as the alloy addition agents.

The present invention deals with the concept of extending the field of use of ferrous powder metallurgy by providing a simple and efficient apparatus in which cheaper forms of ferrous materials may be processed to produce efficient iron and iron alloy powders.

The present invention relates to the subject matter disclosed in my applications Serial Nos. 338,825 and 338,826, filed June 4, 1940.

As explained in the earlier applications, the novel apparatus described herein is developed for the purpose of utilizing a very cheap source of iron such as relatively high carbon pig iron or alloy steel scrap, melting this down in efficient furnace equipment and subsequently processing this melt to produce iron powder or iron alloy powders of predetermined carbon analysis. As described in the cross referenced applications, in the new method a high carbon iron or iron alloy melt is rapidly quenched so as to produce in effect a white cast iron, i. e., a very brittle structure low in austenite and high in brittle constituents, such as cementite, pearlite and martensite. The apparatus described herein is designed so as positively to achieve a desirable brittleness. After production of the solid phase brittle cast iron, means are provided to disintegrate the material and subsequently to separate the material into fractions relatively rich and relatively poor in carbon. Depending upon the particular specifications, especially with respect to carbon, which are required, the low carbon fraction is further processed to reduce the carbon content and addition-alloy to advantageously modify the physical characteristics so as to render the ultimate powder more amenable to compacting and sintering.

In order to more fully explain the invention a preferred apparatus is shown in diagrammatic form in the accompanying drawing, in which Fig. 1 is a flow sheet of the apparatus and Fig. 2 is a diagrammatic illustration of an electric furnace which may be employed in the apparatus.

In carrying out the process cheap raw material, such as a cheap pig iron low in phosphorous, sulphur and silicon, is charged to a suitable furnace 1. This furnace may be of any suitable type, such as an electric furnace as shown in Fig. 2 or an efficient type of cupola furnace as shown in Fig. 1. When high iron alloys, such as the high chromium alloy powders, are to be produced any suitable type of electric furnace may be employed. When producing iron alloy powders, and depending upon the particular ultimate iron alloy powder desired, alloy addition agents, such as chromium, vanadium, molybdenum, manganese, tungsten and the like may be added to the melt either in the form of pure metals, ferro alloys or alloy scrap. When utilizing alloy steel scrap as the sole charge, such scrap may be melted down in an electric furnace under a carbon blanket so as to insure a high carbon content in the melt and a consequent brittleness in the quenched material.

The charge in cupola furnace 1 or electric furnace 1' may be heated to a desired elevated temperature of the order of from approximately 2600° F. to 2750° F. or more. The cast iron or alloy cast iron thus made is poured into ladle 2 and the ladle is discharged on to a refractory screen 3 constructed of graphite or a suitable

ceramic. The screen serves to divide the mass of molten metal into a series of streamlets and these are immediately quenched and shotted by means of water or other suitable quenching medium forced through the appropriately positioned jets 4. This quenching and shotting serves to divide the cast metal into shot of the order of about 1/8 to 1/4 of an inch or finer. The shotted material is discharged into a water container 5.

The material thus produced is essentially a white cast iron or alloy cast iron and because of its high percentage of cementite is characterized by an extreme brittleness. If the silicon and other graphitizing agents are kept low in the melt there will be a minimum of free graphite or temper carbon and the shot material will be extremely hard. This brittleness is advisedly sought and employed for the purpose of disintegrating the shot in standard equipment and subdividing the material into a carbon rich fraction and an iron or iron alloy rich fraction relatively low in carbon. For this purpose the shotted material may be taken either from storage or directly from the container 5 and passed to any suitable type of stamp mill 6. If desired the material discharged from the stamp mill may be classified and the larger particles returned for further disintegration. After reduction in the stamp mill to an intermediate degree the product is charged to a ball mill 7 and there further reduced in size. The brittle cementite will crush very readily and also assist in crushing the more metallic pearlite, martensite, troosite or undecomposed austenite which may be present. The disintegrated product is discharged from the ball mill to the screen 8 and a fine powder of from 100 to 200 mesh or more average size is conveyed to the magnetic separator 9. The larger particles discharged from screen 8 may be returned to the ball mill for further reduction. The material discharged from the ball mill which is finer than 100 mesh will be comprised of substantially 75% cementite.

The brittle powder, separated out magnetically in the separator 9 may be charged to any suitable decarburizing furnace 10. This powder may be decarburized, as is known, at a temperature of from 400° to 800° C. in an atmosphere of a reducing gas such as hydrogen, hydrogen-steam or other decarburizing agent so as to reduce the carbon content to the desired degree. With such a treatment the pearlitic powder may be reduced from a carbon content of the order of 1.7% to 0.8% or lower. This decarburization treatment at elevated temperatures also beneficially modifies the powder for ultimate use in powder compacts so that it is sufficiently plastic under pressure to make dense compacts. During this decarburization treatment, as those skilled in the art will appreciate, the pearlitic surfaces of the particles are decomposed to form the softer more plastic ferrite. By controlling the temperature and time of this treatment the depth of this ferritic case may be controlled. The product produced is new in the field of powder metallurgy and is particularly useful for compacting, comprising as it does a tough core having an integral more plastic surface or case.

When desirable, and prior to treatment in the decarburizing furnace 10, the magnetic concentrate obtained from the magnetic separator 9 may again be milled so as to establish an optimum size distribution and may then be passed through the magnetic separator to separate a relatively magnetic concentrate from a relatively non-magnetic tailing. In this way a cementite rich powder may be produced.

It will be appreciated that in this type of apparatus a plurality of useful products may be produced. The fine iron or iron alloy powder of low carbon content, obtained from the decarburizing furnace 10, may be diluted and homogeneously admixed with the carbon rich fines, obtained in separator 9 to produce a compact of the desired carbon analysis. The carbide powder separated out in magnetic separator 9 may be used either directly or after any predetermined treatment as an abrasive or metal cleaning compound. Similarly, this carbon rich powder may, if desired, be admixed with pure iron powder for making powder compacts of a specified carbon content or it may be mixed with tungsten and iron, tungsten and cobalt, tungsten and vanadium and the like to produce improved metal carbide containing tools which closely approximate the composition of the high speed tools.

As explained in copending application Serial No. 338,825, in producing compacts from the improved iron powders or iron alloy and/or carbide powders, established powder metallurgy methods may be employed. In the event that the flow factor of the powder which is employed is below that which is desired this may be improved by coating the powder with stearic acid or similar dry lubricant.

It will be appreciated that the present invention provides an especially economical apparatus for producing iron powder and iron alloy powder of any specified composition. These new products may be obtained by utilizing standard, readily available equipment which is adapted to process the cheapest forms of raw material.

While a preferred apparatus has been described, it is to be understood that this is given to exemplify the underlying principles and not as limiting the useful scope of the invention to the particular units described.

I claim:

1. An apparatus for producing iron powder and iron alloy powder for powder metallurgy comprising a furnace, a quenching means associated with the furnace to quench and shot a furnace heat, means to disintegrate the shotted material and a magnetic separator adapted to separate the disintegrated material into a carbon-poor powder concentrate and a carbon-rich powder tailing.

2. An apparatus for producing iron powder and iron alloy powder for powder metallurgy comprising a furnace, a quenching means associated with the furnace and adapted to quench and shot a furnace heat, means to disintegrate the shotted material, means to classify the disintegrated product and means to separate the product into a relatively magnetic and a relatively non-magnetic fraction of different carbon analysis.

3. An apparatus for producing iron powder and iron alloy powder for powder metallurgy which comprises a furnace, a quenching means associated with the furnace and adapted to quench a furnace heat, mechanical means to disintegrate the quenched material, means to separate the material into a carbon-rich and a carbon-poor fraction and means to decarburize the carbon-poor fraction.

4. An apparatus for producing iron powder and iron alloy powder which comprises a furnace, a quenching means associated with the furnace and adapted to quench a furnace heat, means to disintegrate the quenched material to a predeter-

mined fineness, magnetic means to separate the material into a carbon-rich and a carbon-poor fraction and means separately to decarburize the fractions.

5. An apparatus for producing iron powder and iron alloy powders for powder metallurgy which comprises a furnace, means associated with the furnace to quench and shot a furnace heat, a stamp mill adapted to disintegrate the shotted material a magnetic separator associated with the stamp mill and adapted to separate the disintegrated material into a relatively magnetic concentrate and a relatively non-magnetic tailing.

6. An apparatus for producing iron powder and iron alloy powder for powder metallurgy which comprises a furnace, means associated with the furnace to quench and shot a furnace heat, a stamp mill, means to feed the shotted material to the the mill, a ball mill adapted to receive and further disintegrate the product from the stamp mill, means to screen the product from the ball mill and means to separate the screened product into carbon-rich and carbon-poor fractions.

7. An apparatus for producing iron alloy powder for powder metallurgy which comprises an electric furnace, a quenching means associated with the furnace and adapted to quench and shot an alloy heat, mechanical means to disintegrate the shotted material and means to separate the disintegrated product in carbon-rich and carbon-poor fractions.

8. An apparatus for producing iron alloy powder for powder metallurgy which comprises an electric furnace, a quenching means associated with the furnace and adapted to quench and shot an alloy heat, mechanical means to disintegrate the shotted material, means to separate the disintegrated product in carbon-rich and carbon-poor fractions and means to decarburize the carbon-poor fractions.

9. An apparatus for producing iron powder for powder metallurgy comprising a cupola furnace, a quenching means associated with the furnace and adapted to quench and shot a high carbon iron heat, mechanical means to disintegrate the shotted material and magnetic means to separate the disintegrated product into carbon-rich and carbon-poor fractions.

10. An apparatus for producing iron powder for powder metallurgy comprising a cupola furnace, a quenching means associated with the furnace and adapted to quench and shot a high carbon iron heat, means to disintegrate the shotted material, magnetic means to separate the disintegrated material into carbon-rich and carbon poor fractions and means to decarburize the carbon-rich fractions and means to decarburize the carbon-poor fractions.

JOHN WULFF.