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FLUIDIZED IRON ORE REDUCTION PROCESS FOR PRODUCTION OF IRON POWDER

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Fig-1

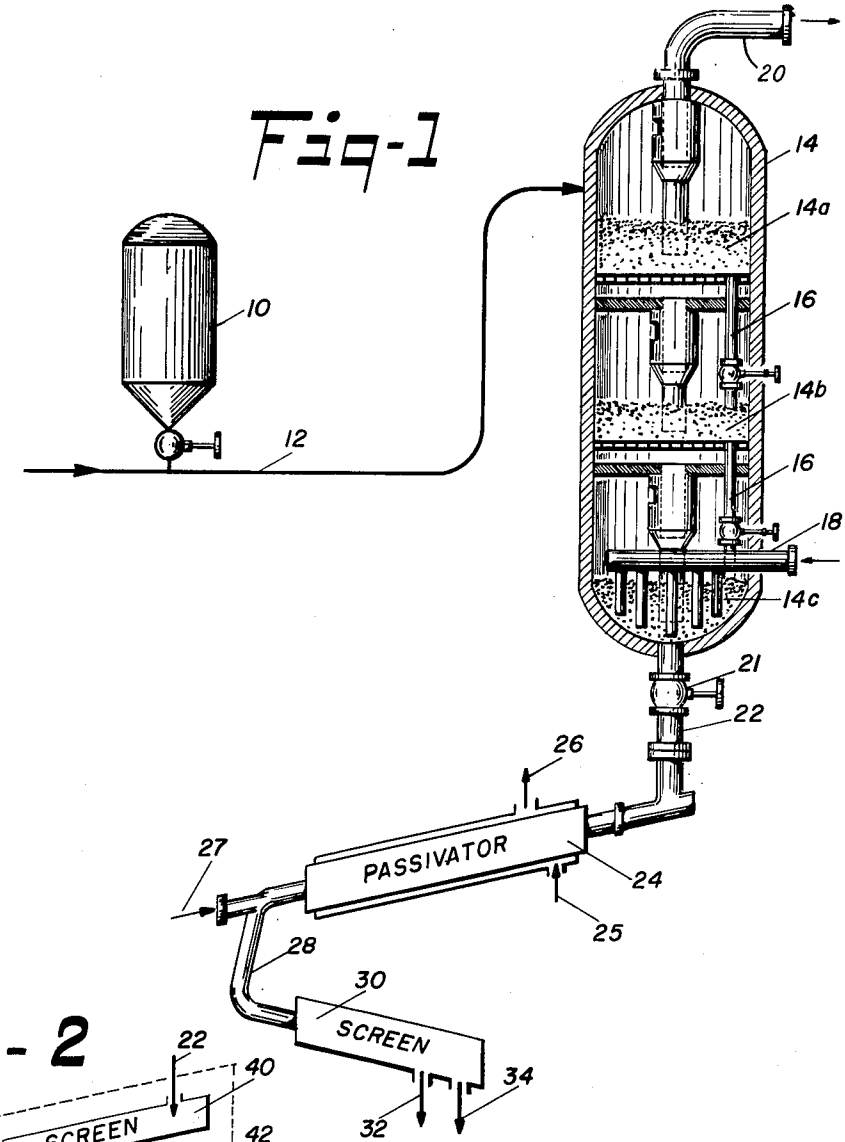
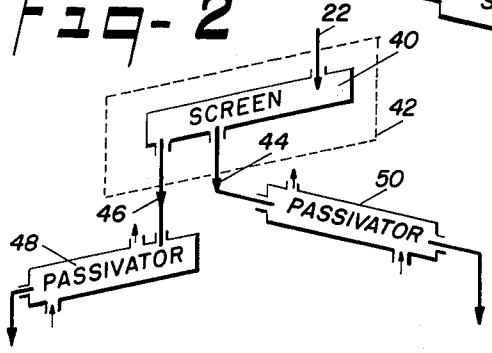


Fig-2



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FLUIDIZED IRON ORE REDUCTION PROCESS FOR PRODUCTION OF IRON POWDER

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3 Claims. (Cl. 75—.5)

This is a continuation-in-part of application Serial No. 112,243, filed May 24, 1961 and now abandoned.

This invention relates to improvements in the production of metal powder for powder metallurgy and is particularly addressed to a combined reduction and screening step by which it is possible to obtain the desired size and density of powder.

It has been established that the grain size of the powder is of decisive importance in the production of articles by powder metallurgy. It has also been established that the powder must be in the order of about 325 mesh and that it must not exceed a volume weight ratio that would interfere with the proper compacting of the powder in the final form.

It has also been established that iron ore can be effectively reduced in the presence of a reducing gas at temperatures below melting to produce a highly pure metal powder. For this reduction, however, it is highly desirable that the iron ore be of such a size that it is fluidizable, and it has been found that when iron ore is ground to a size suitable for powder metallurgy size, this fluidizable condition does not exist. The alternative procedure of grinding the iron powder, after reduction, has been considered undesirable in view of the teachings of the art such as the Brundin Patents 2,857,270 and 2,860,044 which find that a grinding after reduction tends to increase the volume weight above 2.5 and that such powder is thus not acceptable for molding.

We have found that it is not necessary to grind the iron ore to the final particle size necessary for powder metallurgy prior to reduction and, by the particular combination of steps hereinafter described, it is possible to obtain the benefits of a fluidized reduction of the iron oxide such as described in the Keith Patent 2,900,246, and to passivate the reduced iron powder without increasing its density to an objectionable extent so that it will meet the demands for powder metallurgy.

More particularly, our invention relates to a commercial procedure for the production of high quality pure iron powder for powder metallurgy.

Further objects and advantages of our invention will appear from the following description of preferred forms of embodiment of our invention as more particularly shown on the attached drawing in which:

FIGURE 1 is a schematic view of a powder metallurgy reduction process.

FIGURE 2 is a partial schematic view of modified steps in the process.

The reduction of iron ore by the H-iron process as more clearly defined in the patent to Keith, 2,900,246, and as described in the "Journal of Metals," issue of April 1957, page 586, includes the conveyance of the iron ore from a hopper 10 by dense phase gas transport through line 12 to a multiple stage reactor generally indicated at 14. Preferably, this reactor is provided with several separate beds of iron ore indicated as 14*a*, 14*b*, and 14*c* which may be transferred from top to bottom through valved downcomers 16.

To such reactor 14 a reducing gas such as hydrogen is fed by distributor 18 to the bottom reduction zone 14*c*. The gases then pass up through beds 14*b* and 14*a* with the removal of hydrogen and water vapor overhead at

20. Such reaction is normally accomplished at a temperature of about 700° to 1100° F., preferably 800° to 950° F., and under a pressure of 150 to 650 p.s.i.g., preferably 350 to 450 p.s.i.g. By suitable valve 21, the reduced ore is removed at 22 as desired. For the purposes of this invention, such reduction of the ore is at least 90% complete, and preferably in the range of 92–98% with a 95% reduced iron being generally the most satisfactory. Such reduced iron contains less than ½ of 1% of gangue.

For the purposes of fluidized treatment, the iron ore is normally of a size all of which will pass through a 20 mesh screen, and at least about 25% passes through a 325 mesh screen. Such a material, however, is too coarse for the usual powder metallurgy and as hereinafter described this is finally screened to the desired size without, however, the difficulties of exceeding the volume weight condition which normally results as described in the Brundin Patent 2,860,044.

However, the iron powder as it discharges from the reactor 14 through the line 22 is generally pyrophoric and it is necessary to passivate it before storage or use. This may be accomplished by passing the reduced iron powder through a suitable passivation chamber generally indicated at 24, and frequently consisting of some form of kiln which may be heated to change the surface of the powder to avoid reoxidation. The heating gas is indicated as entering at 25 and discharging at 26. An inert gas 27 may be used in the passivation chamber 24.

The passivated reduced iron in line 28 is next passed through a screen 30 which separates the powdered iron into two fractions comprising fine particles which may be removed at 32 and coarse particles which may be removed at 34. The screen 30 may be a typical vibrating type.

The fine fraction of reduced iron at 32 is arranged to meet molding powder specification with all of it passing through a 100 mesh screen and from 50–80% passing through a 325 mesh screen. It is found that this material is entirely satisfactory for powder metallurgy processes.

The coarse fraction of reduced iron at 34 is usually of a size that 100% passes through a 20 mesh screen and from 0–30% will pass through a 325 mesh screen. This may be diverted to other purposes as for example welding rod coating preparation.

A typical fluidizable composition is as follows—

Mesh (Tyler):	Percent
+20	1.5
20—28	2.5
28—35	5.9
35—48	8.2
48—65	11.9
65—100	13.4
100—150	12.7
150—200	11.7
200—270	6.3
270—325	5.2
—325	20.7

While it is not entirely clear as to why the fine fraction after passivation has the volume weight of less than 2½ and effectively meets all specification for powder metallurgy, it is our belief that this is due to the fact that the powder is reduced by the herein described fluidized process in the presence of hydrogen at temperatures which are normally not in excess of about 1000° F. This is apparently less destructive to the porous quality of the iron powder than the previous and customary reduction which took place at temperatures in the order of 1800° F. which is far beyond any that is found necessary in the fluidized process.

Furthermore, although the passivation is accomplished

under temperatures from 1200–1600° F. This does not appear to destroy the porosity which would jeopardize the volume weight characteristics of the iron powder.

While the sequence of reduction followed by passivation is considered preferable an alternative operation is shown in FIGURE 2. In this arrangement the substantially completely reduced iron powder removed in line 22 is first screened at 40 with the screen carried in an inert atmosphere generally indicated by the container 42. Relatively large and coarse particles of reduced iron are removed at 44, and the fine particles are removed at 46. Each of these fractions are then separately passivated in the passivator 48 and passivator 50 at temperatures up to about 1600° F. The fine particles are then suitable for powdered metallurgy purposes.

While we have shown and described a preferred form of embodiment of our invention primarily drawn to the reduction of iron oxide for the production of powdered iron to be used in powder metallurgy, it will be apparent that the invention is also applicable to the reduction of other metals including tungsten, molybdenum, manganese, etc.

We claim:

1. A method for the production of iron powder for powder metallurgy which powder will have a volume-weight ratio less than 2.5 and of a size all passing through a 100 mesh screen and from 50–80% passing through a 325 mesh screen, which comprises feeding an iron oxide normally of a size all of which will pass through a 20 mesh screen and at least about 25% of which passes through a 325 mesh screen, passing a hydrogen gas through the reaction zone at a velocity to fluidize the ore, maintaining a temperature in the reaction zone in the order of 700–1100° F., maintaining a superatmospheric pressure in the reaction zone in the range of 150 to 650 p.s.i.g., removing the reduced iron when the reduction is at least 90% complete and the iron is pyrophoric, and screening a fine fraction of a size all of which will pass a 100 mesh screen and from 50 to 80% of which will pass a 325 mesh screen from the remaining material having a size all of which passes a 20 mesh screen and from 0–30% passing through a 100 mesh screen.

2. A method for the production of iron powder as claimed in claim 1 wherein pyrophoric iron is passivated before screening.

3. A method for the production of iron powder as claimed in claim 1 wherein the pyrophoric iron is passivated after screening.

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