

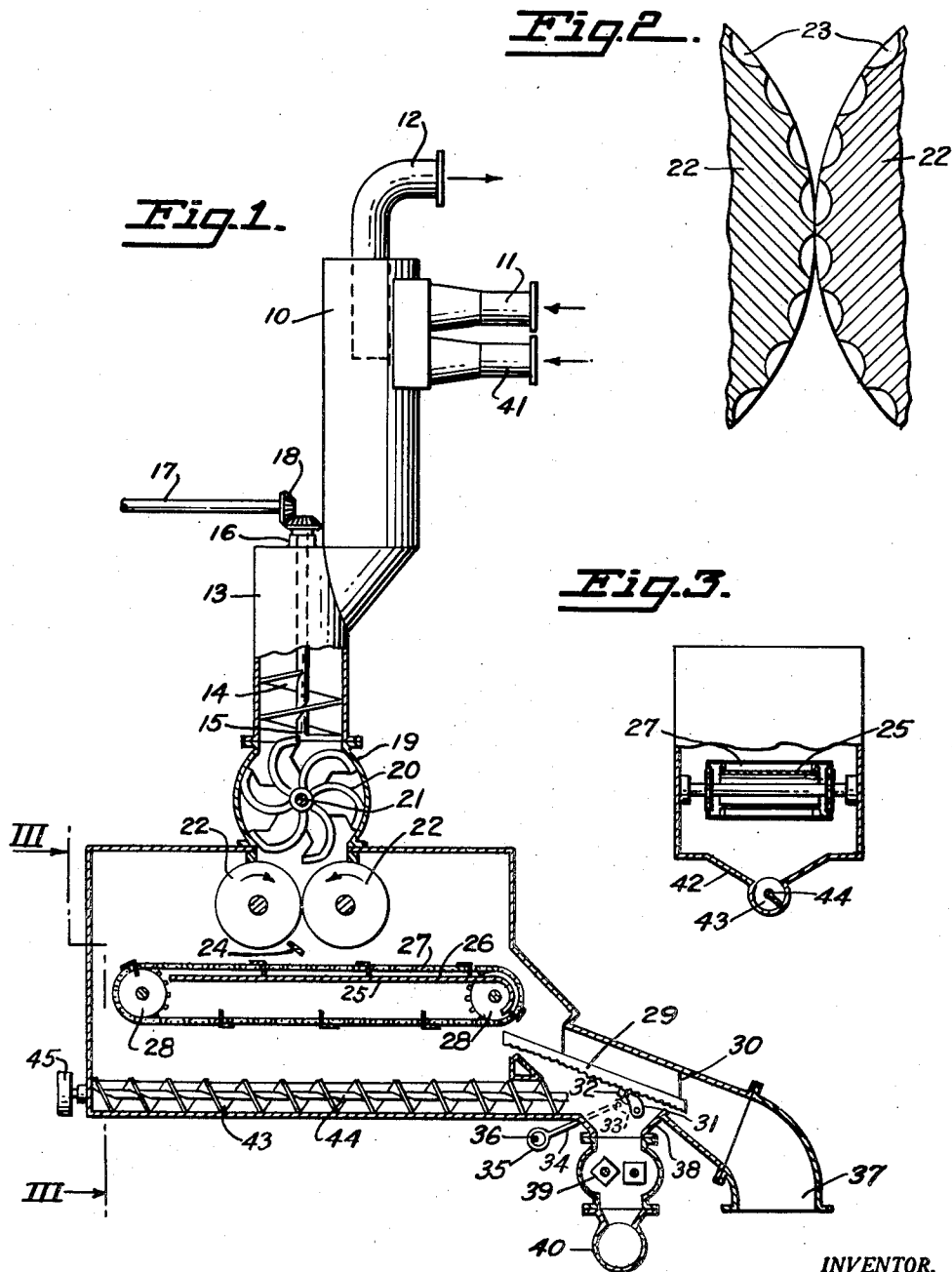
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PELLETING MAGNESIUM DUST

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PELLETING MAGNESIUM DUST

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1 Claim. (Cl. 78-0.5)

1

The present invention relates to the formation of pellets, without the addition of any binding agent, from finely divided solid materials which are characterized by low bulk density and the inclusion of adsorbed gas, and it has particular reference to pelleting impure magnesium dust for the purpose of recovering pure magnesium therefrom by distillation or sublimation. It is division of my copending application Serial Number 571,075, filed January 2, 1945, and now Patent No. 2,485,128, granted October 18, 1949.

Magnesium is produced in the form of an extraordinarily finely subdivided dust in the course of the electrothermic production of magnesium metal by smelting magnesium oxides or magnesium oxide-containing prime materials with the aid of carbon, which reaction proceeds at temperatures above the boiling point of metallic magnesium so that the metal is set free in the form of vapor. To avoid reversion of the reaction the vapor evolved has then suddenly to be cooled down to a temperature below, preferably considerably below, the solidification point of magnesium. A solid condensate is obtained in this manner in the state of an extremely finely divided dust having highly pyrophoric characteristics that contains on an average about 50% metal, while the balance consists principally of magnesia and carbon with small amounts of other materials present as impurities. From this magnesium dust the metal has then to be extracted, in a second stage of operation, by revolatilization and condensation to be converted into pure compact magnesium. It is the usual practice to make the dust for that purpose into compacted bodies before further treatment to prevent the magnesium vapors disengaged from entraining non-volatile concomitants with them, which otherwise would unavoidably happen owing to the very small size of the said impurities. Furthermore, it has been common practice to wet the magnesium dust with liquid hydrocarbons to reduce the pyrophoric qualities thereof and permit handling in air. This same result can be achieved by the use of liquid hydrocarbon to shock-chill the magnesium vapors evolved at the very point of their escaping from the furnace. However, this procedure is disadvantageous because the wet dust, or paste, must first be dried before the vaporization of the metal can be effected, and after completion of the operation a coked mass remains in the treating vessel which can only be removed by considerable expense and loss of time.

With the view of avoiding these disadvantages, many attempts have been made to enable the

2

magnesium dust in question to be formed into compacted bodies by pressure, in an atmosphere indifferent to magnesium, without the addition of any binding material. However, all these efforts were unsuccessful. Although various types of pelleting machines have been tried, it was hitherto impossible to press the magnesium dust into pellets of appropriate strength with the use of ordinary pelleting methods and machinery that had proved quite satisfactory for making pellets of various other kinds of materials; and this was even the case when precompacting of the dust before subjecting it to final pelleting pressure was resorted to. The bulk density of the light and fluffy dust is so low that it has always heretofore resisted compaction or agglomeration even after separation in bag filters and like equipment. Precompacting of the dust before it is subjected to final pelleting pressure has not solved the problem. It is believed that the inert gaseous medium in which the dust is carried contains so much of the gas entrained or adsorbed by the dust particles that the high pressure of the pellet compressing operation causes the pellet to burst or explode almost immediately after its formation.

It is an object of the present invention to overcome the above mentioned difficulties in the formation of dry pellets of magnesium dust and to provide a method and apparatus for dry pelleting magnesium dust which will result in the formation of strong, uniform pellets capable of withstanding the handling necessary to transfer them through ordinary equipment and charge them to a retort wherein they are to be sublimed and condensed for the recovery of metallic magnesium. A further object of the invention is the provision of a method of making metallic magnesium by the carbothermic process, or otherwise, wherein magnesium dust is pelleted and retorted entirely without the use of a liquid hydrocarbon or other wetting agent. Other objects and advantages of the invention are made apparent in the following detailed description wherein reference is made to the accompanying drawings illustrating a preferred form of apparatus employed in carrying the invention into practice.

In the drawings:

Figure 1 is a schematic view in side elevation of apparatus embodying the present invention with portions of the casing broken away and parts shown in section to illustrate structural details of the interior mechanism,

Figure 2 is an enlarged fragmentary view of a portion of the pellet forming rolls illustrated in Figure 1, and

Figure 3 is an end view partially in section, taken on line III—III of Figure 1.

In practicing the invention the dust to be pelleted is passed between opposed cylindrical rotatable dies on the periphery of which there are provided registering depressions or indentations to form pellets of the desired size and shape. Such dies form the pelleting rolls of standard pelleting equipment employed for forming pellets of other materials, but must be enclosed in a gas tight case for operation with magnesium dust.

Magnesium dust is first separated from the larger volume of gas in which it is suspended and conveyed by being subjected to a centrifugal or cycloning action. The dust is then directed through packers and feeders, the purpose of which is to compress it and further to expel as much as possible of the gas which is entrained with and adsorbed by the particles of dust. The cycloning, packing and feeding action also effect agglomeration of the particles so that the dust is rendered more nearly solid in form as it approaches the pelleting rolls. After being so compressed, agglomerated, and separated from gas it is fed between the die rolls and emerges in the form of pellets. The pellets are then passed over a screen to effect separation of fine particles resulting from broken and imperfectly formed pellets and the whole pellets which have not broken down during the preceding stages of the operation are directed to storage bins or may be placed immediately into the retorts wherein the steps of sublimation and condensation take place.

The fines from the screening operation may be first broken down to a size sufficiently small to permit their being readily conveyed in a stream of gas or other conveying means and are then returned to the feed end of the pelleting apparatus where they are added to and mixed with the main supply of dust as it is advancing toward the pelleting rolls. The breaking down of the fines is not however essential as the larger particles, and even full size pellets, may be conveyed by a gas stream of sufficient volume and velocity. This recirculation through the pelleting apparatus of the imperfect pellets and other small particles of highly compressed dust is important in that it adds to the extremely finely divided feed a component of highly compacted and agglomerated and substantially gas free magnesium which greatly increases the compactness or bulk density of the total mass. This makes possible the use of ordinary packing and feeding equipment to reduce the total mass to a state which sufficiently approaches a solid state so that when it is finally subjected to the pelleting rolls a relatively large proportion of perfect pellets will be produced.

Referring first to Figure 1 of the drawings an apparatus for carrying out the method of the present invention is shown as comprising a vertically arranged cylindrical cyclone 10 which has an inlet 11 adjacent its upper end, and preferably tangentially arranged, for the admission of the gas conveyed dust to be separated therein. A gas outlet 12 is arranged centrally at the top of the cyclone and the centrifugally separated dust gravitates through the bottom of the cyclone which communicates with a vertical casing 13 containing a dust compacter preferably in the form of a screw or helical plate 14 secured to and rotated by a shaft 15 to advance the dust downwardly and compact it in a manner further to expel the gas therefrom and to induce agglom-

eration. The shaft 15 projects through the upper end of the housing 13 through a gas tight packing gland 16 and is rotated by a drive shaft 17 to which it is connected as by bevel gears indicated at 18. The compacted dust which is fed downwardly by the helical feeder 14 enters a chamber 19 within which a second feeder 20 comprising radially arranged plates rotatable about a shaft 21 act to advance it downwardly toward a pair of pellet forming rolls indicated at 22. The rolls 22 are driven in opposite directions as indicated by arrows and are preferably urged toward each other resiliently by springs or pneumatic means not shown. The surfaces of the rolls 22 are provided with pockets or depressions 23 as shown in Figure 2, which come into registry with each other at the point of tangency of the rolls to form molds or dies which produce pellets of the desired size and shape and discharge them downwardly as the operation of the rolls continues. It is intended that the pellets formed between the rolls be discharged as individual units. They are at times, however, connected together by fin-like portions of the material of which they are made so that they issue in sheets consisting of large groups of connected pellets. A sheet breaker in the form of a stationary, angularly disposed plate 24 positioned directly between the rolls below their point of contact serves to interrupt any sheet like formation of pellets which issues from the rolls and causes it to break up into separate pellets, or at least into small groups of connected pellets which become separated during subsequent operations. The completed pellets are deposited on a conveyor which, as shown in Figures 1 and 3, comprises a flat trough 25, the contents of which are constantly swept or scraped toward the right, as viewed in Figure 1, by scrapers 26, preferably of rubber or other resilient material. The scrapers 26 are carried by endless chains 27 driven by rotating sprockets 28.

This conveyor deposits the pellets on an inclined screen 29, preferably supported as by flexible links 30 to permit it to be agitated. Agitation of the screen may be effected by a lever 31 arranged to strike a lug 32 on the screen, the lever 31 being carried on the same shaft which carries a lever 33 connected by a link or connecting rod 34 with an eccentric cam 35 on a rotating shaft 36. Unbroken pellets and large pieces which pass over the screen may be conveyed through an outlet 37 to a storage bin or directly to the retort that is to be charged with them. The fines which pass through the screen 29 are received by a hopper-like portion 38 of the casing which surrounds the screen and may be passed through a breaker or crushing apparatus indicated at 39 by means of which they are reduced to sufficiently small particles to facilitate their being transported by a stream of gas flowing through a conduit 40 which directs them back to the upper end of the apparatus where they are admitted to the cyclone through an inlet shown at 41 which is similar in construction and arrangement to the dust inlet 11. While the breaking up of the fines before they are conducted back to the feed end of the apparatus is not essential their mixture with the dust constitutes an important step in the process. These fines, even when reduced in size by mechanical breaking constitute relatively solid, substantially gas free and highly agglomerated particles which, when added to the very finely divided feed, serve to increase the average density of the entire mass and produce a body of mate-

5

rial which may be formed into satisfactory pellets by the action of the compactor 14, the feeder 19 and the pelleting rolls. The process tends automatically to maintain a properly balanced feed of new and recirculated material as a high percentage of broken or imperfect pellets issuing from the pelleting rolls produces a heavy recirculated feed. This increases the average density of the material passing to the rolls and therefore produces more perfect pellets.

As the entire mechanism is enclosed in a gas tight housing, as shown, so that the process may be carried on in a controlled atmosphere, a considerable amount of metallic dust as well as larger particles of compacted dust will accumulate in the bottom of the housing which incloses the pelleting rolls and the conveyor. To prevent this accumulation from building up to the point where it might interfere with the operation of the apparatus the bottom of the housing may be shaped to form a trough 42 communicating with a screw conveyor 43 as shown in Figures 1 and 3. The shaft 44 which supports the helical vane of the screw conveyor is journaled at one end in a gas tight bearing and projects to the exterior of the housing where it may be fitted with a pulley 45 for connection to a suitable source of power. The shaft may be rotated at intervals and need only be operated at slow speed so that its opposite end may be supported only by contact of the helical vane with the bottom of the trough in which it rotates. The conveyor terminates in the hopper 38 so that the accumulation in the bottom of the housing may be discharged as often as necessary into the hopper where it will become mixed with the fines which make up the recirculated feed.

While the action of the pellet forming rolls in the production of pellets from magnesium dust is apparently similar to their action in forming pellets of other materials, it has been found that this type of apparatus is particularly adapted to the production of magnesium pellets because of the extremely high pressures obtainable, and because of the fact that as the registering pockets on opposed rolls approach the point of contact of the rolls, they produce a die which closes with a sort of hinge like action coming together last at its top edges. Consequently as the pressure on the contents of the die increases there is a point of escape for the gas which is squeezed out of the magnesium dust until the instant of final closing of the die when the pressure is greatest. This action tends to eliminate as much gas as possible and thus to produce a more compact pellet.

6

Spent residues from preceding sublimation or distillation runs, e. g. in an amount of 10 to 30% of the total weight, may additionally be introduced in the feed for the purpose of further improving the strength of the molded pellets.

What is claimed is:

Apparatus for forming pellets from finely divided solids entrained within a gaseous stream, including in combination a vertically arranged cylindrical cyclone separator having a tangentially arranged feeder mechanism through which the solids and gas are introduced into the cyclone and an outlet pipe located at the top of the cyclone through which separated gas is removed as the solids are subjected to the action of the cyclone during the passage of solids therethrough, a vertically arranged compacting means which receives solids discharged from the separator comprising a rotatable helical screw plate arranged within a cylinder for compressing the solids as they progress therethrough, a vane feeder connected to the compacting means, a pair of cooperating pressure rolls in communication with said vane feeder and arranged to compress the substantially gas free solids into hard dry pellets capable of standing in air without combustion, a gas tight housing for said cyclone feeder, said compacting means, said vane feeder, and said pressure rolls to thereby permit conduct of the operation under an inert atmosphere and to prevent explosion of any pyrophoric material therein.

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