

[54] METHOD OF MAKING GRANULATE

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[58] Field of Search 264/8, 9, 13, 5

[56]

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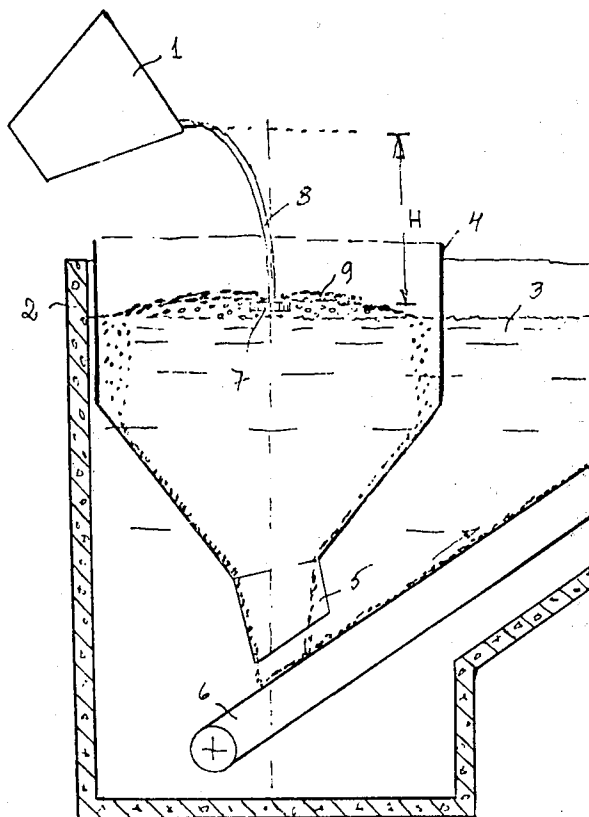
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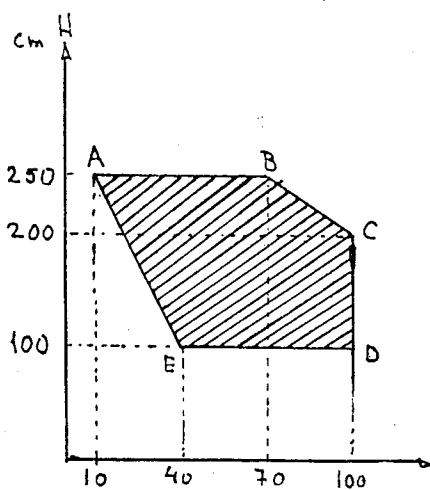
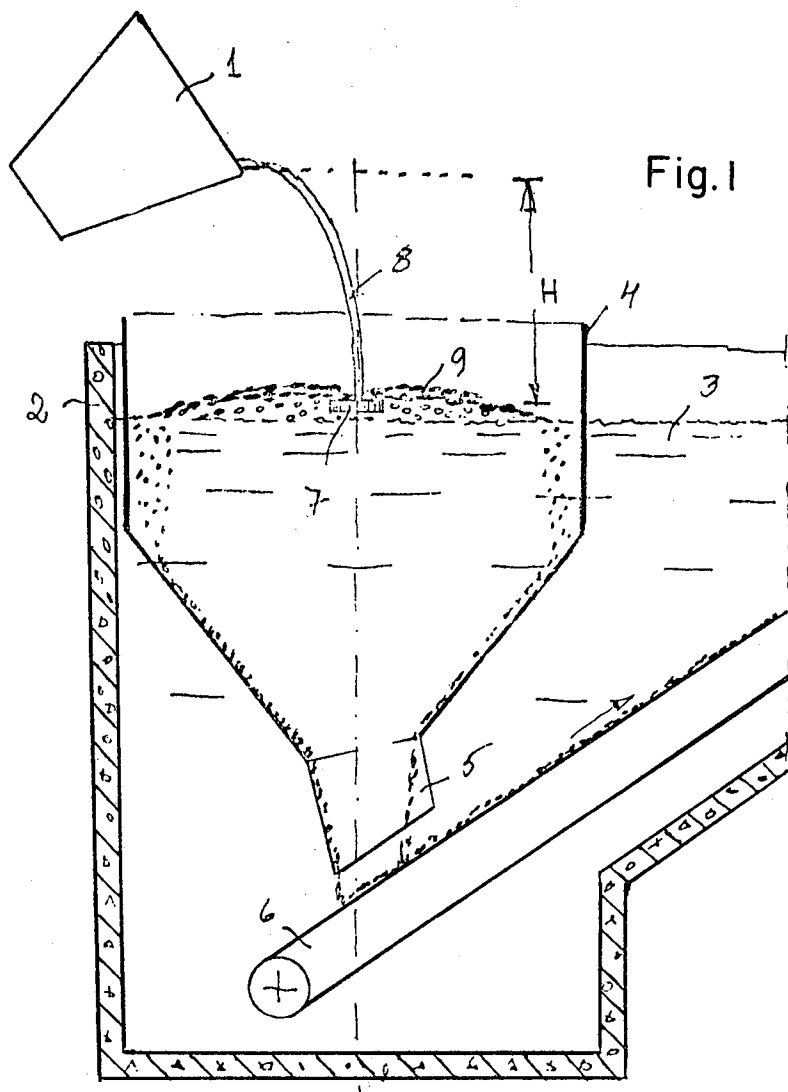
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ABSTRACT

Granulated iron is prepared by pouring molten iron onto the upper surface of a fixed plate, from which surface discrete drops rebound and fall into a cooling bath.

1 Claim, 2 Drawing Figures





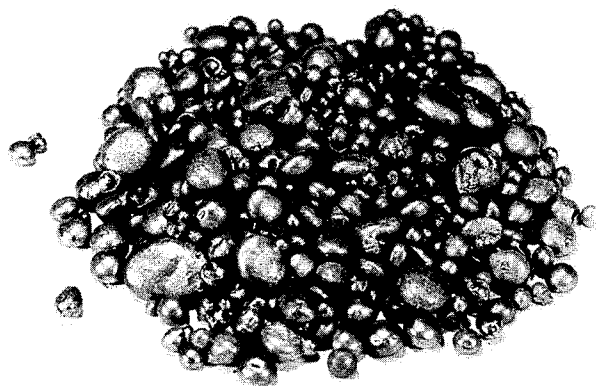


FIG. 3

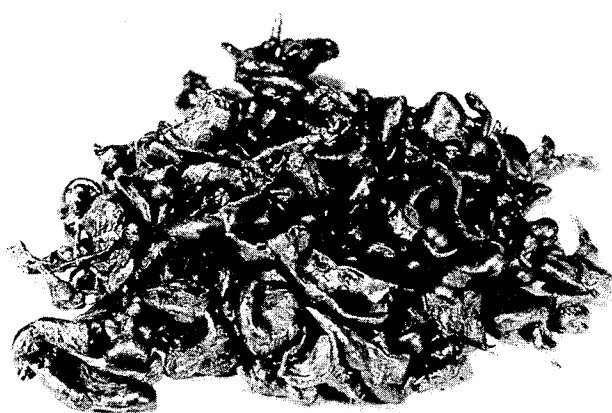


FIG. 4

METHOD OF MAKING GRANULATE

This application contains subject matter common to my U.S. patent application Ser. No. 788,293 filed Dec. 31, 1968, now abandoned, and is a continuation-in-part of said patent application.

The present invention relates to a method of making a granulate from normally solid but meltable materials having relatively high melting points and selected from the group consisting of crude iron, steel and ferro-alloys, from a melt of said material. Particularly the invention relates to and has been developed for crude iron granulation and it is deemed to have its greatest importance in this field.

In manufacturing steel one starts from scrap iron and/or crude iron. The crude iron usually has the shape of "pigs" which are rather heavy (about 40 kg) and troublesome to handle. Usually, the pigs are handled by means of lifting magnets which have a rather small capacity as to quantity of goods handled per hour. Moulds for pigs, lime for the moulds, and wages for casting the iron into pigs all involve considerable expense.

It heretofore had been known that these drawbacks might be overcome by giving the crude iron the shape of granules instead of pigs. Granules are namely much easier to handle. They can, for example, be stored in silos and be transported as other kinds of bulk goods. The invention, therefore, in its first respect aims at presenting a method of granulating crude iron and other metals and alloys selected from the group consisting of crude iron, steel, and ferro-alloys.

In order to achieve these advantages, methods for the granulation of iron and the like previously have been developed. A characteristic feature of these processes is that they are complicated, or that they involve complicated apparatus which require careful attention and service if they at all are possible to utilize for the granulation of iron and similar materials which in their various state very easily adhere to and agglomerate on the surfaces of solid objects.

According to known methods of disintegrating molten metals, usually principles are utilized which are based on centrifugal throwing, spraying or the like. According to one suggested process a stream of molten metal is disintegrated by means of a cross-shaped device rotating at great speed, the arms of the cross throwing metal drops to the sides. Also several other, previously proposed, methods are based on the "rotation-throwing-means" principle. Such means may be disc-shaped and suitably provided with vanes or the like, similarly to blades in a water turbine. According to another embodiment, the throwing means is given the shape of a rotating cone, the peak of which is directed upwards: the molten metal pours over the brim of a basin and down upon the surface of the cone which is arranged beneath the basin. The method utilizes the continuous spreading out of the melt in combination with a centrifugal force.

For manufacturing shot, for example, the industry has also used lattices which disintegrate the melt into drops, the sizes of which depend on the sizes of the meshes in the lattice. This method can only be used for metals having moderate melting temperatures, e.g., lead, and which do not adhere to and agglomerate on the surfaces of solid object, and therefore can hardly be used for the granulation of iron, steel or ferro-alloys.

It is therefore also an object of the present invention to provide a granulation method which does not require any complicated apparatus calling for careful attention and service, and which — owing to the fact that the melts in question very easily adhere to the surfaces of most solid objects — would cause severe disturbances in the production of granules.

The method according to the present invention involves the step of causing a stream of the molten metal freely to fall onto the upper horizontal surface of a flat, fixed plate (hereafter to be described) with such a speed that it is disintegrated by its kinetic energy into separate drops, which drops rebound from the plate and fall down into a cooling bath beneath the plate. Upon their contact with the surface of the bath the drops may to a certain extent be further disintegrated. The plate material must to a sufficient degree be refractory but it must not be wetted by the molten metal so that the metal would adhere to, and build up agglomerates of solidified metal on, the plate surface. Of course the plate material also must have a sufficient strength to resist the impact by the metal stream. It is therefore a third object of the invention to provide a plate material which possesses these features. Experiments have shown that suitable plate materials can be selected from the group of materials consisting of refractory ceramics, graphite, refractory metal compounds, and combinations of said materials. For instance, refractory ceramics are found to be useful as a plate material for the granulation of crude iron, while graphite combined with refractory metal compounds are more suitable for the granulation of ferro-nickel.

There are, however, in the "disintegration by impact against a plate" method some severe problems which have required considerable consideration in the development of the present invention. Thus, in some cases the granules got the shape of flakes which like leaves whirled down through the cooling water, so that they often came into contact with the walls of the cooling basin and adhered to the latter. In other cases the granules were so large that they were not sufficiently cooled when they reached the bottom of the basin or came into contact with means arranged in the basin, and for that reason adhered to the basin or said means. Such granules also often sintered together into big agglomerates, causing disturbances in the granulation process. On the other hand, in other cases the granules became smaller than was desired for a later metallurgical process.

It is, therefore, another object of the present invention to provide a method which gives granules having the most suitable sizes and shapes for the granulation process and, as well, for a later metallurgical process for which the granules are intended. Thus the invention aims at producing smooth granules, at least the major portion of which has shapes varying from substantially round or oval discs to drops and spheres, and having sizes varying from 2 mm up to 25 mm measured over the longest extension of the granule. By the expression "major portion" herein is meant 90 weight-percent of the granulate.

Experiments carried out during the development of the method of the present invention have shown that the desired smooth shapes and sizes of the granules can be achieved only if the molten metal stream falls substantially vertically (not more than 10° deviation from the vertical direction) against the horizontal plate sur-

face and, at the same time, the length of the fall and the temperature of the metal stream are kept within certain critical limits. These criteria are discussed hereinbelow.

The invention will now be described in greater detail and with reference to the accompanying drawing, in which

FIG. 1 schematically illustrates the carrying out of the invention;

FIG. 2 is a diagram in which the shadowed area A-B-C-D-E corresponds to those critical values of the functional relation between the falling length and the temperature of the metal stream for which the desired shapes and sizes of the granules can be obtained;

FIG. 3 shows granules produced by granulating at a point according to the invention within the shadowed area of the diagram of FIG. 2; and

FIG. 4 shows deformed granules produced by granulating at a point outside the area in the diagram.

In FIG. 1, numeral 1 designates a ladle containing molten crude iron. A basin 2 is filled with a body of water 3 up to a certain level. A plate construction 4 having the shape of a cylinder with a diameter of 3-4 meters is immersed in the body of water. The lower, tapered portion of the cylinder 4 converges into a pipe 5 the mouth of which is located over a conveyor 6 which also is immersed in the body of water. At a height between 0.2 and 1 meter above the upper surface of the bath there is a fixed plate 7 having a flat upper surface. For the granulation of crude iron a refractory ceramic material (firebrick) has proved to be a suitable material for the plate 7. Firebrick, however, is not possible to use when granulating for instance ferro-nickel owing to wetting reasons: in such case materials containing graphite as a dominating constituent are suitable as constructional material for the plate. The plate 7 is fastened on a pole running down in the bath, the pole not being shown in the Figure.

In the diagram of FIG. 2 the abscissa T stands for the number of centigrade degrees by which the temperature of the molten metal stream exceeds the solidus temperature of the metal in question. The ordinate H stands for the height of the free fall of the metal stream. The shadowed area A-B-C-D-E in the diagram defines the values of H and T which must be combined to give the desired shape and size of the granules.

The process of granulation simply is carried out, using this apparatus, by pouring molten iron in a stream 8 upon the plate 7. The deviation of the stream 8 from the absolutely vertical direction as it strikes the plate must not be greater than 10°. If the free vertical drop is sufficient (at least 100-250 cm.- see the line D-E-A in the diagram in FIG. 2) and if the temperature of the metal is at least 10°-40°C. above the solidus temperature of the metal in question, (see the line E-A of FIG. 2), the stream disintegrates by the impact against the plate 7, spreading out like an umbrella 9 of droplets from from the plate, and it may further disintegrate to a certain extent upon impact against the water surface. The shape of the "umbrella 9" is apparent from FIG. 1. In the water the droplets solidify into granules of the general shape apparent from FIG. 3.

The crude iron granules of FIG. 3 were produced by granulating with a free drop H of the stream of 2.2 me-

ters and at a temperature of the iron 50° centigrade the value of T exceeding its solidus temperature.

The deformed iron pieces shown in FIG. 4 were produced with the metal at the same temperature as in the just described experiment, but with a falling distance of only 0.5 meter. If, on the other hand, the drop is too great and/or the temperature too high, the result is undesirably small granules (above and to the right of the line A-B-C-D in the diagram). The solidified granules sinking through the body of water are guided by the cylinder 4 and the pipe 5 towards the conveyor 6, which conveyor transports the granules up from the water basin. They dry very quickly, due to their residual heat, so that they are quite dry when they reach a silo (not shown) where they can be stored without rusting.

The invention can of course be modified to some extent within its spirit and scope defined by the claims. Thus, in the claims it is declared that the plate 7, which is essential for the invention, shall be fixed. It is the intention of this way of expression to indicate that the invention is not based on the principle of throwing according to which rotating members are being utilized. It is also possible to arrange a funnel over the plate 7 in order to ensure that the stream of molten metal not fail to strike the plate, or to ensure that it strikes substantially vertically; such use of a funnel (or equivalent) presupposes that the funnel does not reduce the speed of the stream to such an extent that the stream is not disintegrated in the desired manner against the plate. The latter, however, can easily be regulated by arranging the funnel at a distance above the plate giving the same speed to the stream as in un-funnelled free fall.

I claim:

1. In a method of making a granulate from normally solid but meltable material having relatively high melting point and selected from the group consisting of crude iron, steel and ferro-alloys from a melt of said material, which melt is cooled and caused to solidify in a liquid bath, the improved technique according to which a continuous stream of the material in molten state is caused freely to fall onto the upper horizontal surface of a fixed plate made from a material which is non-wettable by said melt and selected from the group consisting of refractory ceramics, graphite, refractory metal compounds and combinations of said compounds; any deviation of the stream from the vertical direction at contact with the plate not being greater than 10°; and wherein the height of the free fall of the molten metal stream and the number of centigrade degrees by which the temperature of the metal melt exceeds the solidus temperature of the metal are defined by the area A-B-C-D-E of FIG. 2 of the accompanying drawing, whereby the molten metal stream by its own kinetic energy is disintegrated against the plate into separate drops which drops spread out from the plate like an umbrella and fall down into the cooling bath where they solidify to smooth granules, at least 90 weight-percent of which granules have sizes varying from 2 mm to 25 mm and have shapes varying from round or oval discs to drops and spheres.

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