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GRINDING DUST SEPARATION

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GRINDINGS

HANDE SCREENED

CONES SEPARATED

HELD FOR CRUSHING

SCALEPES

SCALPINGS SEPARATED

HELD FOR CRUSHING

KILN

GRADING

SEPARATING ELECTROSTATIC SEPARATOR

STEEL

ABRASIVE

MIDDINGS

CONSUMED

HELD FOR SALE

RE-RUN IN SEPARATOR

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My invention relates to the recovery of stainless steel grindings. An object of my invention is the provision of a simple, efficient and thoroughly practical process for reclaiming stainless steel from stainless steel grindings, which process enables maximum recovery of steel substantially free of abrasive matter and the like.

Another object of my invention is the provision of an economical, continuous process for separating the steel and abrasive components of stainless steel grindings into their two parts, each substantially free of the other, which process in practice requires a minimum of equipment and space, and which is rapid and reliable of performance.

A further object of my invention is the salvage of the abrasive particles from stainless steel grinding dust.

Other objects in part will be obvious and in part will be pointed out hereinafter.

The invention accordingly consists in the several experimental steps, and the relation of each of the same to one or more of the others as described herein, the useful application of which is indicated in the claim following the description of my invention.

In the accompanying drawing there is shown a flow sheet for the separation of stainless steel grindings according to one aspect of my invention.

As conducing to a clearer understanding of certain features of my invention, it may be noted at this point that stainless steel is defined as a low-carbon steel comprising 10% to 35% or more chromium, with or without nickel, and with or without supplemental additions of manganese, silicon, cobalt, copper, molybdenum, tungsten, vanadium, columbium, titanium, sulphur, and the like, for special purposes, and the balance substantially all iron.

It may be further noted that in the production of stainless steel billets, bars, rods, and the like, as well as in the production of numerous other stainless steel products, the metal is subjected to abrasive grinding operations. During the grinding operation considerable amounts of grindings including mixed particles of stainless steel and abrasive material accumulate, particularly where large scale production is involved. These grindings are of various particle sizes and represent a mixture of steel and abrasive as appears more fully hereinafter. Such grindings, heretofore, according to well known practice, have been discarded without any attempt to recover the stain-

less steel and abrasive constituents because of the practical difficulties involved.

A more than negligible recovery value, however, resides in the constituent materials of stainless steel grindings. The included particles of stainless steel are suitable for remelting into scrap and for refinement into finished stainless alloy steel. The abrasive constituent, which for example is of high alumina or carborundum content, represents a marketable product, and thus has considerable reclamation value. The abrasive is, for example, suitable for re-use in the production of abrasive grinding wheels and the like, in providing non-skid surfaces, and for use in especially tough sand-blasting jobs.

Recovery of the stainless steel and abrasive constituents of stainless steel grindings, however, presents a difficult problem. In this connection it is to be noted that the constituent materials are of assorted size and in such condition are difficult to separate. Not only do the grindings include loose, intermingled particles of stainless steel and abrasive dust of differing size, but often various sized cakes or cones of dust such as those formed by hot particles thrown from the abrading wheel during grinding operations. The stainless steel particles of the grindings, moreover, are similar in shape to curled chips from a lathe, and the abrasive particles frequently are held by this curled metallic material in such way as to prevent their easy dislodgment. In short, the mixed sizes and shapes of materials, as well as the materials themselves, make successful salvaging of the metallic and abrasive values quite difficult.

In striving to separate stainless steel grindings so as to recover the included metal values substantially free of abrasive, a series of experiments were made on test samples of such grindings. Experiments involving ordinary magnetic principles did not prove to be at all satisfactory. The curled metallic elements of the grindings bunched together and tangled under magnetic influence and thus entrained a large amount of abrasive material. Similar undesirable results were noted where separation was attempted using known floatation or gravity principles. The resulting separated stainless steel was not at all suitable for remelting because of objectionally high abrasive content.

An outstanding object of my invention, accordingly, is the provision of a practical and reliable process for effecting separation of the steel and abrasive constituents of stainless steel grindings, which process involves grading the grind-
ings so as to remove cones and scalpings from the dust material, in which the dust material itself is graded into several classes each of uniform particle size, which includes an electrostatic separating step wherein the several classes of graded dust are individually separated into steel dust and abrasive dust, and which enables economical reclamation of steel and abrasive material of high quality, using simple and compact equipment.

Referring now more particularly to the practice of my invention, in achieving cleanly separated stainless steel and abrasive particles from stainless steel grindings, I subject the grindings, sequentially to grading and electrostatic separating steps. The grindings which I separate, for example include in substantial amount, particles of stainless steel comprising at least 10% chromium, and abrasive particles comprising a substantial amount of alumina, carborundum, or the like.

Where the grindings to be separated include mixed cakes or cones and loose particles of stainless steel and abrasive, I first eliminate the more coarse material (see Figure 1). In this connection, as a preliminary step I prefer to screen the stainless steel grindings on a heavy mesh screen, such as a suitable hand screen. The cones or cakes remain on the screen and are held aside, as indicated at 11, for further treatment as described more fully hereinafter.

A very considerable portion of the grindings passes in the form of dust through the hand screen and, for example, is deposited onto a suitable conveyor or elevator. Where this material still includes somewhat large particles or formations, it is preferably conveyed to a scalping unit, as shown at 14, and is scalped such as by screening on an Overstrom scalping screen. The relatively coarse material retained on the scalping screen, like that recovered on the hand screen, is held for further treatment as at 12s. The more fine particles of the grindings sift through the scalping screen and are recovered in a hopper or the like.

After elimination of the relatively large formations such as the cakes or cones and scalpings included in the grindings, the dust recovered is dried at 13, because of further handling. In this connection it may be noted that stainless steel grindings frequently are quite moist since the grinding shop is sprayed with water to quiet the dust that is raised in the grinding operation. Moreover, the grindings ordinarily are stored outdoors where they are subject to various weather conditions. The particles of material thus tend to stick and cake and are difficult to handle in fine screening operations. Thus, in preparing the recovered grinding dust for further and more refined screening, I find it helpful to feed the dust, as by conveyor, into a rotary kiln, or the like, fired to a temperature sufficiently high to effect removal of substantially all moisture from the dust material and impart free-flowing characteristics thereto. After being dried in the kiln, the material is fed, as through a chute, to a refined grader.

I grade the dried grinding dust, as at 14, into several grades or groups of dust differing respectively, in the average diameter of their particles. This is important because the abrasive particles stick or are entrapped within the curd of the metal chips and it is extremely difficult to separate them even at best. I find that grading before separating permits a more complete separation of metal and abrasive. Thus, for example, I run the dried dust into a nest of fine mesh screens, ranging in sizes from 20 to 64 mesh; preferably into screens of 20, 34, 54, and 64 mesh sizes, respectively. The particles retained on each screen are of substantially uniform particle size and are in excellent condition for subsequent electrostatic separation.

In grading the various groups of graded stainless steel grindings, I subject each grade, in turn, to electrostatic separation, as generally indicated at 15 in the drawing. Such electrostatic separation is begun, for example, by conveying one group or grade of the dust into a suitable hopper, and feeding regulated amounts of the dust downward by gravity past a charging electrode of the tined-rod type and onto the surface of an electrically grounded rotating separator or precipitator drum made of metal. The particles of mixed stainless steel and abrasive material are electrically charged by the charging electrode to a potential differing from that of the grounded separator drum. As the charged particles fall onto the surface of the separator, they give up their charges quickly or slowly, depending on their materials and sizes. Accordingly, the particles may be considered to adhere to the metal drum, depending upon their electrical conductivity properties.

In order to recover separated particles of stainless steel, middlings, and abrasives, three receptacles, for example are disposed in a nest beneath the metal drum in the direction of rotation thereof. The stainless steel particles of the graded material, being somewhat better conductors of electricity than the abrasive particles, soon assume charges equal to that of the grounded separator drum and, accordingly, fall into the first of the three receptacles, denoted 15a. Entangled or adhering particles of stainless steel and abrasive, which I term middlings, fall into the intermediate receptacle, 15b, because of more retarded dissipation of charge. The abrasive particles, because of still more retarded dissipation of charge either fall, or are removed by means of a brush so as to fall, into the third or last receptacle, 15c.

Once separation is achieved by one of the grades or groups of grinding dust, another grade is subjected to separation and so on until separation of all grades has been completed.

The more coarse formations of stainless steel and abrasive particles including cakes, cones and scalpings recovered during the initial screening steps also are well worth processing. These formations, therefore, are converted into grinding dust as by crushing in a suitable crushing mill or the like. The crushed material then is dried, graded into several groups of uniform particle size, and is subjected grade after grade to electrostatic separation as described hereinbefore with respect to the original grinding dust recovered from the grindings.

Likewise, the middlings collected during the electrostatic precipitation operations both with respect to the original grinding dust and to the crushed lump material, are re-dried and re-graded into several groups of different average particle size. The re-graded middlings then are separated grade after grade by electrostatic separation. I find that such procedure enables an additional recovery of separated stainless steel and abrasive particles and at the same time considerably lowers the volume of middlings accruing from the process.

In separating the graded stainless steel grind-
ing dust by electrostatic separation, I achieve a highly refined recovery of separate metallic and abrasive values, thus making available for actual practical use separated products from a material which has, heretofore, represented a total waste. The dried mixed particles of grinding dust are easily and accurately graded and in graded condition do not stick together. By drying and grading the mixed grinding dust I find that a much improved character of separation is obtained as compared with where the drying and grading is omitted. The particles, because of their dryness and uniformity of size, do not tangle mechanically to any appreciable degree as they are fed to the electrostatic separator or during the period of actual separation. The stainless steel particles recovered as a result of separation are of such character as to be ready for immediate remelting as in the production of stainless steel. On the other hand, the abrasive recovered represents a readily marketable product and this contributes materially to the economic aspects of my process.

It must also be noted that my process is rendered continuous by proper coordination of the equipment employed in carrying out the several steps, and that with such coordination, separation of a large tonnage of grindings is successfully achieved in a short period of time. The process may be performed using simple, compact equipment and the income enjoyed over a period of several months more than equals the initial cost of the equipment.

Thus, it will be seen that there is provided in this invention a process of separating stainless steel grindings in which the various objects heretofore noted together with many thoroughly practical advantages are successfully achieved. It will be seen that the process gives, in a simple and economical manner, high grade separated products which are satisfactory for re-use without further separation treatment, and that the process is applicable to the wide range of stainless steel grinding compositions encountered in the stainless steel industries. It will be seen further that the process is successfully performed using equipment which occupies a minimum of space and which can be operated continuously so as to handle a maximum volume of available stainless steel grindings.

While as pointed out heretofore, the initial hand-screening and scalping operations of my process are employed for the removal of large formations such as cones, cakes, scalpings and the like from the grindings, it will be understood that a single screening step, or other form of initial separation, may be used where conditions permit. At times, I find considerable advantage in crushing the formations while they are still mixed with the finer material and, too, where large formations are substantially absent from the grindings the initial screening may be entirely omitted.

It will also be understood that while I prefer to employ an electrostatic separator of the grounded rotary drum type, it is within the scope of my invention to employ other types of such separators.

As many possible embodiments may be made of my invention, and as many changes may be made in the embodiment heretofore set forth, it is to be understood that all matters described and illustrated herein is to be interpreted as illustrative and not in a limiting sense.

I claim:

In the recovery, from stainless steel grindings, the steel containing 10% to 35% chromium, with or without nickel and other alloy additions, such grindings comprising caked and loose particles, the steel to be recovered being in such pure form as to be suitable for remelting, the art which includes screening the loose dust particles from the caked dust particles; drying the screened loose particles; grading the dried particles on screens of approximately 20, 34, 54 and 64 mesh sizes into at least four groups of individual average particle size; separating the graded particles of each group on an electrostatic separator; crushing the caked particles of grinding dust and drying, grading and individually electrostatically separating the crushed material; and combining the several groups of separated stainless steel particles.

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