Nov. 16, 1943. F. J. GAVIN 2,334,258

COATING

Filed July 19, 1940 2 Sheets-Sheet 1

Fig. 1.

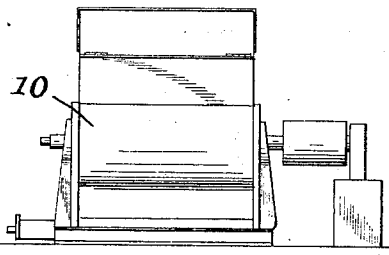


Fig. 2.

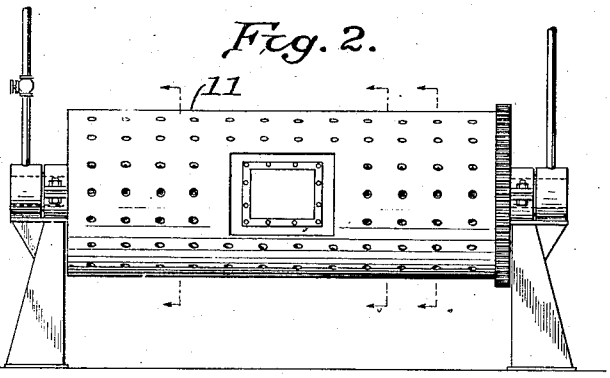


Fig. 3.

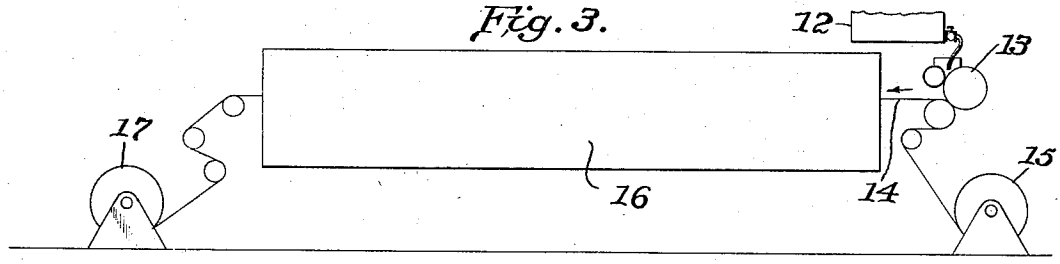


Fig. 4.

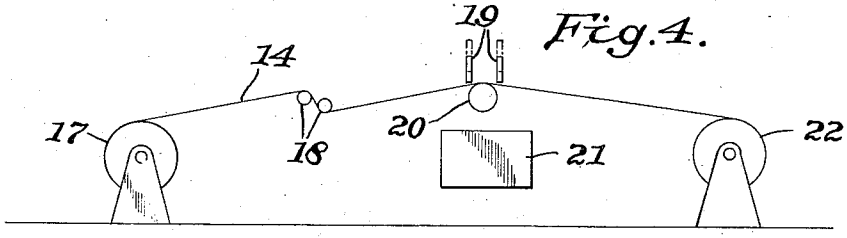


Fig. 5.

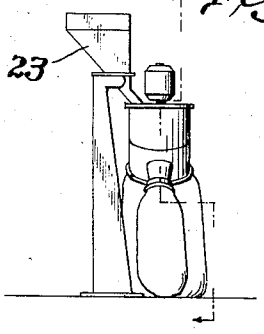
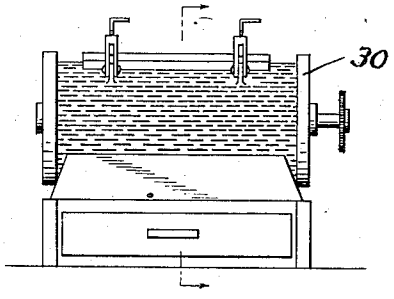


Fig. 6.



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COATING

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Fig. 7.

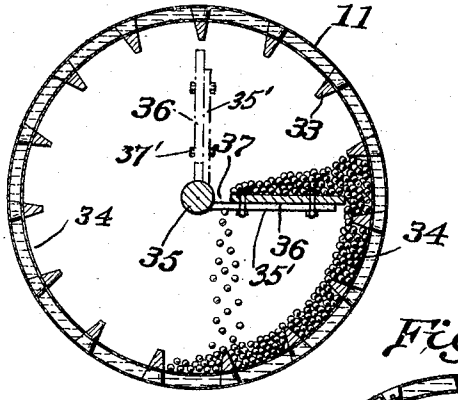


Fig. 8.

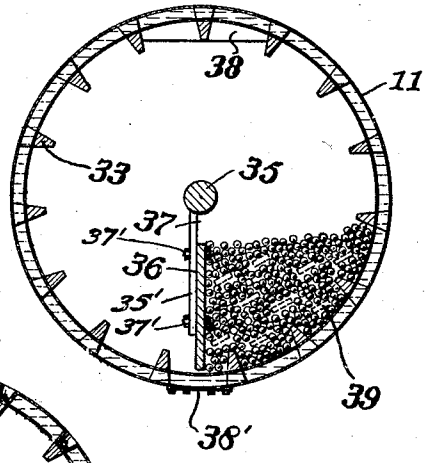


Fig. 9.

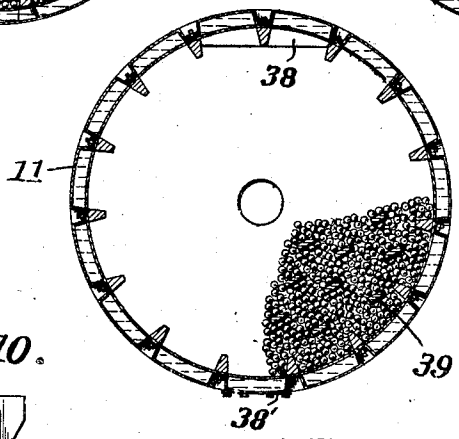
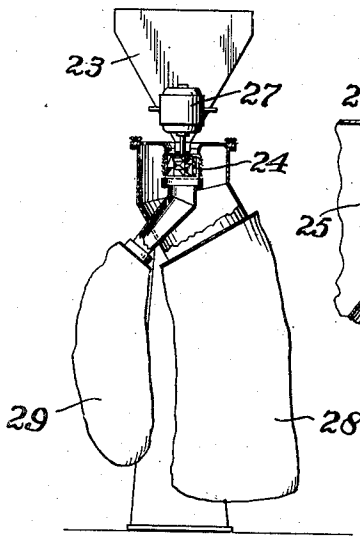


Fig. 10.



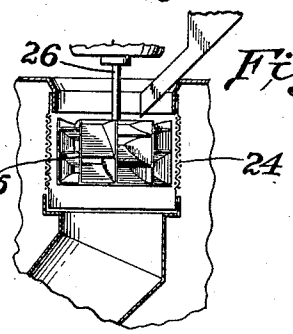
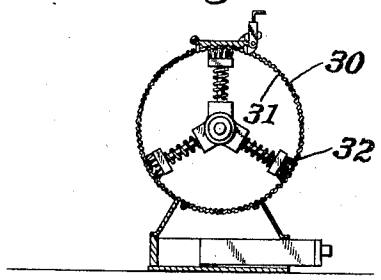


Fig. 11.

Fig. 12.



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2,334,258

UNITED STATES PATENT OFFICE

2,334,258

COATING

Frank J. Gavin, Baltimore, Md., assignor to Crown Cork & Seal Company, Inc., Baltimore, Md., a corporation of New York

Application July 19, 1940, Serial No. 346,452

6 Claims. (Cl. 106—290)

This invention relates to a method of making finely divided metal, for example, aluminum powder useful in the coating arts.

The method comprises the steps of (*a*) grinding the metal in an inert atmosphere and in the presence of a lubricant; (*b*) drying the ground mass to drive off the volatile lubricant; (*c*) agitating the dried agglomerated and particulated mass for a relatively brief period during which time it is subjected to both an impact and shearing action so that the agglomerated bodies are broken down into individualized particles; and (*d*) polishing the individualized particles in a conventional polishing machine in the presence of a leafing agent to brighten the powder and impart to the same the desired leafing quality.

I have discovered that with this sequence of steps a larger quantity of finely divided powder, free of agglomerates and having optimum leafing qualities can be obtained. In addition, the process is much more rapid than customary practice in that whereas present efforts at best require sixteen hours' or more polishing of the powder, the polishing and leafing are accomplished in the present invention in about eight hours; in other words, in about one half the time.

An important feature of the invention is the step of breaking up the dried ground mass of agglomerates into individualized particles of predetermined mesh size. For this purpose, I have found most useful a "turbo-sifter" generally referred to as the "Abbe-Blutergess." In this apparatus, not only is the dried mass agitated, but the particles and agglomerates are subjected to a combined impact and shearing action by their movement against a screen through which they penetrate. The mesh of the screen is controlled to allow passage of particles of the correct size and the action of the "turbo-sifter" is most efficient in that substantially all of the dry mass is reduced to and recovered as individualized particles of required size. This substantially complete breaking up of the agglomerates is most advantageous in that it reduces materially the extended time period of operation now required for polishing.

Another object of the invention is to provide means for promoting in the ball mill at all times optimum impact of the balls upon the metal as distinguished from present inefficient operations where a substantial amount of attrition and some impact takes place between the balls with no metal between the same. That is to say, instead of having the balls pile up to constantly comprehend a thick peripheral area of the mill cylinder, whereby the form or flow of the mass of balls substantially precludes grinding other than by attrition, I provide a method and construction which prevents such a formation and thereby assures that metal to be ground will not only be positioned in impact relation to the balls as they strike or bombard one another, but the grinding will be substantially entirely by impact. This is important for two reasons, namely, (1) it assures more uniform grinding to a finer mesh size; and (2) more rapid grinding takes place.

A further object of the invention is to provide a ball mill in which the draining of the ground slurry is accomplished without draining off the balls or loose ferrous particles. As will be appreciated, this assists in maintaining the ball mill at its maximum efficiency at all times, and assures that all of the slurry will be drained off and that the slurry will be substantially free of metal particles other than those of the metal which is being ground.

Before describing in detail the present invention, it is to be understood that the invention is not limited in its application to the details of construction and arrangements of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation, and it is not intended to limit the invention claimed herein beyond the requirements of the prior art.

In the accompanying drawings:

Figure 1 is a side elevation of a suitable chopper for reducing metal such as aluminum scrap to a size which can be efficiently treated in a ball mill;

Figure 2 is a side elevation of a ball mill;

Figure 3 is a diagrammatic view of a drier or oven upon which the slurry from the mill is carried by a belt or web and suitably wound into a roll;

Figure 4 is a view of the means for stripping the coating of dried slurry from the web and collecting the same in a box or hopper;

Figure 5 is a side elevation of a "turbo-sifter";

Figure 6 is a side elevation of a conventional polisher;

Figure 7 is a sectional view of a ball mill showing means for assuring that the balls will not pile up at the periphery of the mill but will exert a maximum impact upon the metal to be ground, the disclosure in Figure 7 showing in full lines the means such as a shelf in its normal operative po-

sition and in dotted lines the position which the shelf occupies at the outset while the mill is gaining momentum;

Figure 8 is a similar sectional view showing the shelf in position to act as a barrier for the balls and to allow draining of the slurry without danger of the balls clogging the outlet opening or passing through the same in amount such as would impair the efficiency of the mill and require the addition of further balls as well as the removal of such balls from the slurry; in this view also there is shown as an alternative, means which may or may not be used with the shelf, namely, permanent magnets which cooperate with the shelf so as to retain the balls in position away from the outlet opening and in the general position illustrated;

Figure 9 is a similar sectional view in which the shelf is not used, but in which the magnets are employed to retain the balls away from the outlet opening so that the slurry may be drained without danger of the balls clogging the opening or being removed with the slurry;

Figure 10 is an enlarged elevational view partly broken away of the "turbo-sifter";

Figure 11 is a fragmentary sectional view showing the turbine and screen structure of the "turbo-sifter"; and

Figure 12 is a sectional view on the line 12—12 of Figure 6.

In carrying out the invention, aluminum sheet and foil scrap is chopped to a suitable mesh of about one-eighth of an inch to one-sixteenth of an inch in a rotary chopper indicated by the numeral 10 in Figure 1. This chopper is of conventional form.

The chopped material is rendered oil and grease-free by washing it with any suitable solvent and is then annealed at about 750° F. approximately one and one-half hours to soften the metal for more rapid breakdown in the ball mill.

The clean and annealed chopped scrap is transferred to a steel ball mill of conventional construction, indicated at 11 in Figure 2. The ball mill contains various diameter steel balls, and the proportion of scrap load to steel balls is generally maintained at about 1:15 to 1:20 by weight. I have found that modification of the ball mill in a novel manner contributes substantially to the efficiency of its operation and will subsequently describe the improvements represented by Figures 7, 8 and 9. The mill is charged through an opening which is shown as closed by a removable cover 38.

A grinding liquid or lubricant such as "Varnolene" or "Solvesso" is added to the scrap in a proportion of about two pounds of liquid to one pound of scrap. Preferably, stearic acid, palm oil or other suitable lubricant which may ultimately act as a leafing agent also is added to a total amount of one per cent of aluminum weight. For present purposes, it will be assumed that one hundred pounds of the chopped annealed scrap is introduced into the ball mill.

The mill is now tightly closed, subjected to a partial vacuum, and flushed with an inert gas, e. g., nitrogen, to rid the chamber of oxygen, thereby rendering the atmosphere explosion-proof. Milling is carried on over a period of from seven to nine hours, depending upon the particle size desired.

When the particle size is of suitable fineness, the slurry of lubricant and finely divided aluminum particles is drained into a suitable container 12, as shown at the right of Figure 3. In this slurry, much of the finely divided aluminum is in agglomerated form, and the aluminum is devoid of any leafing tendency. The slurry is now continuously discharged from the tank 12 to the bight between a pair of rolls indicated at 13, from which it is continuously passed to the upper side of the continuously moving web 14. This web 14 is unwound from a roll 15 and, carrying this charge of slurry, is continuously passed through a drying chamber 16 where the volatile lubricant is driven off and the slurry dried as a film upon the web. The web coated with the dried slurry is wound into a roll 17. Thereupon, the roll 17 is reversed, as shown in Figure 4, and the web carrying the dried film on its underside is continuously drawn between cracking or breaking rollers 18 and a pair of reciprocating members 19 which strike the upper side of the web on either side of a supporting roll 20 disposed below the web. Since the dried coating of slurry is on the under-surface of the web, the cracking action of the rolls 18 allows it to be knocked off as thin plates by the reciprocating members 19 and thrown downward into the hopper 21. The web, freed of the coating, is rewound into a roll, as shown at 22, and is ready for operation again in connection with the drying chamber, as shown in Figure 3. The aluminum collected in the chamber 21 is in the form of particles and agglomerated masses or plates, free of volatile grinding lubricant, but having a coating of the stearic acid.

The agglomerated and particulated mass collected in the chamber 21 is then placed in a turbo-type of sifter and agitator, as shown in Figures 5, 10 and 11, preferably one of the "Abbe-Blutergess" type. That is, the dried mass is introduced to the hopper 23, from which it passes into the screen cylinder 24, shown in Figures 10 and 11, and is subjected to a shearing and impact action by rotation of the blades 25 mounted on the vertical shaft 26 which, in turn, is connected to a suitable motor such as an electric motor 27. The "turbo-sifter" whirls the aluminum mass at a high speed, for example, 3,500 to 5,425 R. P. M., against the circular screen 24 having a suitable mesh, e. g., about 100 mesh which surrounds the turbo head 25. This tangential impact and shearing action reduces the agglomerated particles and plates to individualized particles. Due to the high speed impact and shearing factor in the "turbo-sifter," an entire charge of one hundred pounds of agglomerate can be completely reduced to a mass of individual aluminum flakes of required fineness within thirty minutes without interfering with the leafing quality to be subsequently imparted. The particles and plates sheared against the screen 24 pass therethrough and are collected in the bag 28. The larger particles which because of their size cannot be broken down to a sufficient fineness in a given time and at a given speed of the turbine are collected in the smaller bag 29 and it is interesting to observe that with an average charge, substantially all of the aluminum agglomerate fed to the "turbo-sifter" is recovered as individualized particles. The small quantity which collects in the bag 29 may be returned to the sifter for further action, if desired.

This operation in the "turbo-sifter" reduces by one-half the time required to polish the powder in the ordinary brush polisher. This is true because the entire action of the polisher is im-

mediately employed for polishing and imparting the leafing quality to the powder, rather than initially breaking up agglomerates before the individual particles could be reached. In other words, with the present invention, the polisher acts to polish the particles and impart the leafing quality to them, since the particles fed to the polisher are already in individualized condition and have a coating of the leafing agent such as stearic acid thereon.

The particles collected in the bag **28** are of the required size, since they have passed through the predetermined mesh of the screen **24**, and are now introduced to the polisher shown in Figures 6 and 12. This is of conventional type **30** having a roughened or corrugated inner wall **31** and a suitable number of radially disposed rotary resiliently mounted pressure brushes **32** and imparts the leafing property and full reflectivity to the individualized particles in an atmosphere of oxygen. Whereas heretofore the polishing action required from sixteen to eighteen hours, it is now accomplished in accordance with the present invention in about an eight hours' brushing cycle. If necessary, additional leafing agent such as stearic acid is added to the polisher.

Referring to Figures 7, 8 and 9, I have illustrated an improved method of ball mill grinding and an improved ball mill. In Figure 7, the ball mill **11** has the usual longitudinally extending internal ribs **33** which form pockets **34** in which the balls are disposed and carried during a certain period of the rotation of the mill. Located centrally within the mill is a longitudinally extending shaft or bar **35** which may be turned to any one of a number of positions and held fixed. This bar has arms **35'** which carry a longitudinally extending plate or shelf **36** projecting radially a distance sufficient to provide a slight clearance between it and the inner ends of the projections **33**. The radial extension of the plate **36** can be adjusted on the arms by means of the slotted bolt connections **36'** to vary the clearance in accordance with the speed of the mill, the lubricant employed and the temperature of the mass. This plate or shelf **36**, which is carried by the axially extending adjustable shaft **35**, at its inner end adjacent the shaft, forms a plurality of slots **37** therewith defined by the supporting arms **35'**.

In starting the mill, the shaft **35** and shelf **36** are turned to position the shelf in the dotted line vertical position shown in Figure 7 until a sufficient momentum is overcome whereupon the shaft and shelf are turned to bring the shelf to the horizontal position shown in Figure 7. Thereafter, as the mill rotates, the balls held in the pockets **34** comprehend a thin layer because as the pockets traverse the point coincident with the shelf **36** where they would normally tend to roll downwardly and pile up in a thick layer, such balls are directed by the radially extended shelf inwardly upon the same and then drop downwardly through the slots **37** in the shelf. As a result, attrition grinding is reduced to a minimum and impact grinding of a constant or controlled character is positively established to a maximum. In other words, there are very few impacts or bombardments of balls between which there is little or no metal because the metal coats the balls very readily and the impact grinding action of the balls is predominant. There is no building up of a thick peripheral pile of the balls which would create predominant attrition grinding.

The present mill therefore provides (1) positive assurance that most of the grinding will be done by impact and (2) that a maximum amount of metal will be constantly acted upon by the bombardment or impact of the balls. As a result, more rapid and constant grinding takes place and the aluminum is reduced to a substantially uniform finer powder size.

In Figures 8 and 9, I have shown the mill in draining position. It will be noted that the axial shaft **35** is turned to bring the shelf **36** to a downward vertical position as in Figure 8 and the shelf adjusted downwardly so as to support the balls away from and to one side of a drain opening which is shown as closed by a removable cover **38'**. In this manner, the drain opening is shielded from the entrance of the balls and a larger recovery of the ground slurry is made possible. In order to more positively preclude the entrance of balls into the drain opening and prevent the contamination of the slurry with ferrous particles chipped off from the balls or the mill, I prefer to position in the mill in that area where the balls will be built up by the vertically disposed shielding plate **36** or barrier as shown in Figure 8, a plurality of permanent magnets **39**, which attract the balls and any ferrous particles and retain the same as shown in Figure 8 or as shown in Figure 9. In the latter view, the axial shaft **35** and shelf **36** are not employed, and it is, of course, to be understood that the use of the permanent magnets **39**, while preferred, is not necessary in connection with the structure shown in Figures 7 and 8.

The provision of a mill having the axially extending rod **35** and the adjustable radially extending shelf **36**, as will be observed, allows the balls to be carried upwardly in the pockets **34** in the direction of rotation of the mill and as they reach a point adjacent the horizontal position of the shelf **36**, they are directed inwardly and fall by gravity into impact relation with other balls arranged in the pockets **34** below the shelf. In other words, instead of the balls rolling downwardly upon one another and building up in a pile to grind by attrition, they drop through the slots **37** and are freely suspended in their travel from the shelf to the balls beneath which they engage to accomplish reduction of particle size by impact.

The provision of the permanent magnets **39**, it will be noted, have the function of positively retaining the balls clear of the drain opening in the mill and to one side thereof so that the balls will not collect and interfere with draining on the one hand nor be carried off with the slurry on the other. In addition, these magnets prevent contamination of the slurry with ferrous particles.

In connection with the carrying out of the invention, the slurry may be continuously delivered from the mill **11** to the chamber **12** and then continuously delivered therefrom to the belt **14**. Instead of reversing the belt **14** as a roll, and as shown in Figure 4, the belt may be twisted and continuously traveled past the breaking and knocking-off instrumentalities **18** and **19**. In such continuous operation, the dried mass is delivered continuously to the hopper **21** and from the same is continuously fed to the hopper **23** of the "turbosifter." In the latter, instead of the individualized particles being collected in the bag **28**, they are delivered continuously or intermittently to the polisher **30** and from the same.

As stated heretofore, the grinding or reduction of the aluminum to a powder of desired fineness is accomplished by grinding in the ball mill in the presence of a suitable lubricant which may consist of a volatile material such as "Varnolene" or "Solvesso," and preferably also includes a lubricant such as stearic acid which also acts as a leafing agent. The reduction of the aluminum in the ball mill in an inert atmosphere, i. e., in the absence of oxygen precludes any appreciable leafing quality being imparted to the particles by the stearic acid during grinding. However, the reduced particles retain a coating of the stearic acid thereon which is not substantially interfered with by the subsequent treatments, and, in many cases, this coating is sufficient to impart the required leafing characteristic when the finely divided metal is finally acted upon in the polisher. In some cases, an additional amount of leafing agent may be added to the polisher if necessary, and, of course, the full amount of leafing agent required will be added to the polisher when it has not been incorporated during grinding or the other subsequent operations. As explained, the polisher in accordance with the method described has two functions, namely, (1) to brighten the particles, and (2) impart the leafing quality thereto in the presence of oxygen which is maintained in the polishing chamber.

The magnets 39 are inserted into the chamber just prior to draining. The magnets are removed from the chamber prior to the reducing operation of the ball mill.

Features not herein claimed are covered in my continuation-in-part application Serial No. 497,370, filed August 4, 1943.

I claim:

1. The method of treating metal to form metal powder, which comprises grinding the metal in the presence of a lubricant, drying the ground slurry, breaking up agglomerates in the dried mass into individualized particles, and as a separate step polishing the mass of individualized particles in the presence of a leafing agent to brighten the particles and impart thereto a leafing characteristic.

2. The method of treating metal to form metal powder which comprises grinding the metal in the presence of a lubricant, drying the ground slurry, subjecting the dried mass to a shearing and impact action for breaking up agglomerates into individualized particles, and as a separate step polishing the mass of individualized particles in the presence of a leafing agent to brighten the particles and impart thereto a leafing characteristic.

3. The method of treating aluminum to form metal powder which comprises grinding the metal in an inert atmosphere in the presence of a lubricant, drying the ground slurry, breaking up agglomerates in the dried mass into individualized particles, and as a separate step polishing the mass of individualized particles in the presence of a leafing agent to brighten the particles and impart thereto a leafing characteristic.

4. The method of treating aluminum to form metal powder which comprises grinding the metal in an inert atmosphere in the presence of a lubricant, drying the ground slurry, subjecting the dried mass to a shearing and impact action for breaking up agglomerates into individualized particles, and as a separate step polishing the mass of individualized particles in the presence of a leafing agent to brighten the particles and impart thereto a leafing characteristic.

5. The method of treating aluminum to form metal powder which comprises grinding the metal in an inert atmosphere in the presence of a lubricant and a leafing agent, drying the ground slurry, subjecting the dried mass to a shearing and impact action and breaking up agglomerates into individualized particles, separating and recovering the individualized particles, and as a separate step polishing the mass of individualized particles in the presence of a leafing agent to brighten the particles and impart thereto a leafing characteristic.

6. The method of treating metal to form metal powder which comprises grinding the metal in the presence of a lubricant, continuously drying the ground slurry as a film upon a moving web, removing the dried film from said web, breaking up agglomerates in the dried mass into individualized particles and as a separate step polishing the mass of individualized particles in the presence of a leafing agent to brighten the particles and impart thereto a leafing characteristic.

FRANK J. GAVIN.