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PROCESS FOR MAKING METAL PARTICLES

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Fig. 1.

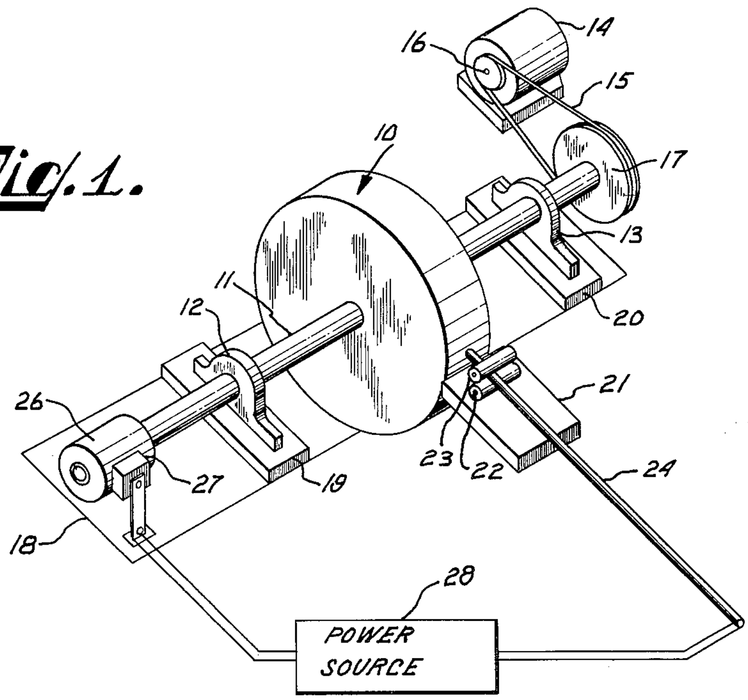


Fig. 3.

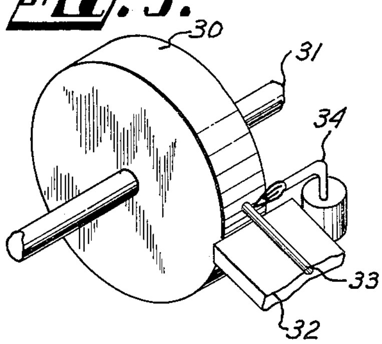


Fig. 4.

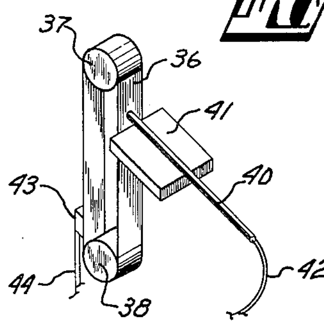
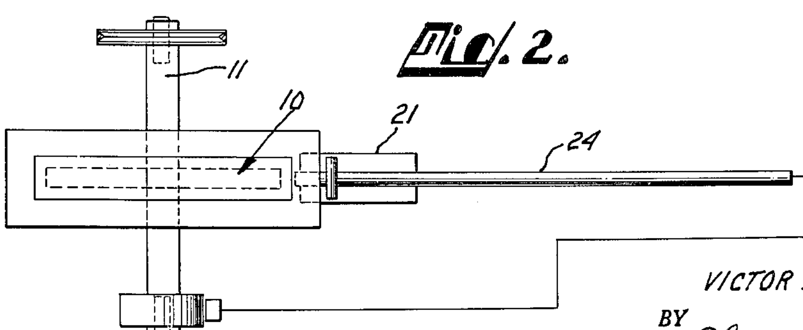


Fig. 2.



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PROCESS FOR MAKING METAL PARTICLES

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This invention relates to a process for producing finely divided metal particles of a relatively high degree of uniformity and of generally smooth globular configuration from solid relatively large pieces of metal. Although the invention is described relative to disintegration of metal in particulate form because of the relative importance of this aspect, it will be observed that the process and apparatus of the invention is usable with any fusible material having a surface tension such as to cause free-falling molten particles thereof to assume generally ovoid or globular form.

Fine metal particles referred to as "shot" or "grit," depending upon size range, are used extensively in industry as abrasives for glass cleaning and for surface conditioning in a process which involves projecting such shot or grit at high velocity against a surface to be treated. The invention is not concerned with this cleaning or treating process as such, and accordingly this process is not described in detail. The invention, however, is directed to method and apparatus for forming shot and grit for this and any other uses and is characterized by the formation of such material at considerably lower costs than is achieved in present practice. The low cost of the product is due in part to the inherent nature of the method of its manufacture, and in part to the adaptability of the process to scrap materials of widely varying composition and configuration. Present techniques of shot-forming involve the ejection of molten cupola metal into a high velocity stream of superheated steam with rapid quenching in a liquid bath. Another process referred to as the cut-wire process involves shearing steel wire with a rotary cutter at very high speed.

The process of the present invention in contrast involves feeding a relatively large piece of metal or other fusible material toward a moving heat-resistant surface and heating the metal piece at the point of proximity to the moving surface to approximately its melting point or higher. The moving surface may constitute the periphery or side face of a rotating wheel or the linearly moving surface of an endless steel belt, or the like. The effect of the interaction between the locally heated metallic feed member and the moving surface is to discharge a stream of metal into the ambient atmosphere for consequent formation either at the point of discharge or shortly thereafter of very small particles of relatively high degree of uniformity in size and in generally spherical shape. Depending upon the grade of product desired by the ultimate user, the material produced as described may be screened or otherwise sorted into various size ranges of any desired size differential.

The invention will be more clearly understood by reference to the accompanying drawing, in which:

Fig. 1 is a schematic illustration of one form of apparatus for accomplishing disintegration as described;

Fig. 2 is a partial plan view of the apparatus of Fig. 1;

Fig. 3 is a partial schematic view of an alternative apparatus; and

Fig. 4 is a partial schematic of still another alternative form of apparatus.

Referring to Figs. 1 and 2 of the drawing, the apparatus there shown comprises a wheel **10** mounted for rotation on an axle **11**. The axle is supported between two pillow blocks **12**, **13** and is connected to a motor **14** by a belt **15** traveling over a motor pulley **16** and an axle pulley **17**. The structure may be supported on a bed **18** and, in the embodiment shown, insulated therefrom by the insulating mounting blocks **19**, **20**.

A feed platen **21** supporting feed rollers **22**, **23**, which may be driven by any conventional means, not shown, is supported adjacent the periphery of the wheel **10** and provides means for advancing a feed stock **24** toward the periphery of the wheel **10**.

As previously noted, the process depends upon the application of moderately high heat to the localized point of the feed stock **24** in proximity to the wheel surface. In the embodiment shown in Figs. 1 and 2 this is accomplished by applying electrical power between the feed stock and the wheel so as to produce a localized arc between the wheel surface and the proximate end of the feed. This may be accomplished by fixing an armature **26** to the axle **11** and connecting this armature through a brush **27** to one side of a power source **28** and connecting the feed stock **24** to the other side of the power source **28**. I have found that the power source may be either D.C. or A.C. and among other parameters the rate of disintegration of the metal bar **24** is a function of the magnitude of the power applied to the arc.

For high speed operation in which considerable heat is developed it may be desirable to artificially cool the wheel **10**. This may be accomplished by making the wheel hollow, as shown in the top sectional view of Fig. 2, permitting the flow of the cooling medium, as for example through the axle **11** which can also be made hollow, into the interior of the wheel **10**. Other conventional cooling techniques can be employed.

Fig. 3 shows schematically a portion of apparatus similar to that of Fig. 1 including a wheel **30** mounted for rotation on an axle **31**, a feed platen **32** and a feed stock **33** adapted to be moved toward the surface of the wheel **30**. In this instance the electrical heat source of the Fig. 1 embodiment is replaced by an external source comprising a torch **34** directed on the end of the feed stock **33** proximate to the wheel periphery. The torch **34** is representative of any form of external heat application which may be accomplished through an induction coil or through a radiant heating coil disposed around the feed stock **33** in the region of approach to the wheel. The object in any case is to apply to this localized portion of the stock sufficient heat to produce fusion in conjunction with the discharge thereof from the parent metal.

The process is dependent upon the interaction of the locally heated metal feed stock with the moving heat resistant surface, which can be also accomplished in the manner shown in Fig. 4 in which the wheel of the previous embodiments has been replaced by a moving belt **36** traveling over rollers **37**, **38** which may be driven by conventional means. A metal feed member **40** fed across a platen **41** is introduced against the surface of the belt **36** in the same manner as against the periphery of the wheel **10** in Fig. 1. In this embodiment heat may be applied electrically, as indicated schematically by leads **42**, by brush **43** and leads **44**, or by any of the other means discussed above.

By way of a specific example, the process has been successfully carried out using as the feed a ⅜ inch chromium nickel alloy rod, a large quantity of such rods being available virtually as scrap as used sucker rods from the oil industry. A mild steel wheel 12 inches in diameter and approximately 2½ inches wide was rotated at approximately 1200 r.p.m. by a 5 horsepower motor. An electric current of between 75 and 100 amps. was applied between the rod and the wheel with a rod consumption of approximately one inch per minute.

The process is exceedingly flexible relative to operating variables and applicable materials. With respect to operating variables, production rate increases significantly with power increase, with an increase in the linear speed of the moving surface and with the application of preheat to the feed material. In this latter respect it may be desirable to pre-heat the feed material prior to the application of higher intensity localized heat at the point of approach to the moving surface. This pre-heat reduces the power requirements or the localized heating requirements for a given production rate.

With respect to the moving surface, bronze or stainless forgings are preferred to minimize surface burning, although any relatively heat-resistant material appears to be suitable. Where arc heating is used, this material of course must be conductive or at least must be provided with a conductive surface. Configuration of the moving surface is susceptible to many modifications, variations therein having effect on the particle size of the product. A smooth surface will produce a smaller product in general than will a roughened surface, and it is even possible to employ a serrated surface so as to achieve a roughly pulsed operation producing even larger particles.

Many materials can be disintegrated by this process including mild steel, alloys, non-metallic fusible materials such as various refractories and ceramic compositions, providing the surface tension of these materials in molten or semi-molten state is such as to result in formation of discrete particles during a free travel in the ambient atmosphere. One of the major advantages of the process is the adaptability to a wide range of feed stocks, permitting the use of low cost and even semi-scrap materials. In some instances it may be desirable to carry out the process in an inert atmosphere so as to prevent carbonization of certain feed materials such as high carbon steel.

It is apparent that the process of the invention has a wide flexibility as to the materials to which it is applicable and with respect to the parameters of operation in the production of a product of widely differing properties. Many modifications will occur from the description herein given.

I claim:

1. Apparatus for producing particulate metal from a solid metal piece which comprises a wheel having a heat-resistant surface, means rotating the wheel, means for feeding the solid metal piece toward the wheel surface and generally normal thereto, and means for heating substantially the entire portion of the piece approaching proximity to the wheel surface to a temperature at least approximating the melting point of the piece.

2. Apparatus for producing particulate metal from a solid metal piece which comprises a continuous belt having a heat-resistant surface, means for causing movement of the belt, means for feeding the solid metal piece toward the moving belt, and means for heating substantially the entire portion of the piece approaching proximity to the belt to a temperature at least approximating the melting point of the piece.

3. Apparatus for producing particulate metal from a solid metal piece which comprises a heat-resistant member, means for feeding the solid metal piece toward the heat-resistant member, means for moving the heat-resistant member so that a surface thereof adjacent the metal piece is displaced substantially normal relative to the motion of the metal piece, and means for striking an electric arc between the member and the piece to heat substantially the entire portion of the piece approaching proximity to the moving surface to a temperature at least approximating the melting point of the piece.

4. A process for producing finely divided metal particles from a relatively large metal piece which comprises progressively advancing the piece against a moving heat-resistant surface, and heating substantially the entire end of the piece in the proximity of the moving surface to at least approximately its melting point.

5. A process for producing finely divided metal particles from an elongate metal bar which comprises progressively advancing the bar lengthwise and linearly against a heat-resistant surface, and heating substantially the entire end of the bar in the proximity of the surface to at least approximately its melting point, and moving the surface relative to the bar to place successive areas of the surface in the proximity of said end of the bar being heated.

6. A process for producing finely divided metal particles from an elongate metal bar which comprises progressively advancing the bar lengthwise against and approximately normal to a heat-resistant surface and heating substantially the entire end of the bar in the proximity of the surface to at least approximately its melting point, and moving the surface approximately normal to the direction of movement of the bar to place successive areas of the surface adjacent said end of the bar being heated.

7. A process for producing finely divided metal particles from a relatively large metal piece which comprises progressively advancing the piece against the surface of a rotating wheel and heating substantially the entire end of the piece in the proximity of the surface to at least approximately its melting point.

8. A process for producing finely divided metal particles from a relatively large metal piece which comprises progressively advancing the piece against a surface of a moving heat-resistant belt, and heating substantially the entire end of the piece in the proximity of the belt to at least approximately its melting point.

9. A process for producing finely divided metal particles from a relatively large metal piece which comprises progressively advancing the piece against a heat-resistant surface, heating substantially the entire end of the piece in the proximity of the surface to at least approximately its melting point by striking an electric arc between the moving surface and the piece and moving the surface relative to the piece to place successive areas of the surface in the proximity of said end of the piece being heated.

10. A process for producing finely divided metal particles from a relatively large metal piece which comprises progressively advancing the piece against a heat-resistant surface, heating substantially the entire end of the piece in the proximity of the surface by external means to at least approximately its melting point and moving the surface relative to the piece to place successive areas of the surface adjacent said end of the piece being heated.

11. Apparatus for producing particulate metal from a solid metal piece which comprises a heat-resistant member, means for feeding the solid metal piece toward a surface of the heat-resistant member, means for moving said surface approximately normal to the direction of movement of the solid metal piece, and means for heating substantially the entire portion of the piece approaching proximity to the moving surface to a temperature at least approximating the melting point of the piece.

12. A process for producing finely divided metal parts from a relatively large piece of metal which comprises progressively advancing the piece against a heat-resistant surface having an area at least as great as the area of the piece parallel to the surface, heating the piece to at least approximately its melting point at the point of proximity to the surface and moving the surface relative to the piece so that successive areas of the surface are placed in the proximity of the heated portion of the piece.

13. Apparatus for producing particulate metal from a solid metal piece which comprises a heat-resistant mem-

ber, means for feeding one end of the metal piece toward a surface of the member, means for moving said surface relative to said end of the metal piece to continually place successive areas of the surface in the proximity of said one end, the heat-resistant member being arranged so that the surface area thereof in the proximity of said one end of the metal piece is always greater than the surface area of said one end of the metal piece exposed to the heat-resistant member and means for heating said end of the metal piece to a temperature at least approximating the melting point of the metal piece.

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