

[54] **DEVICE FOR PRODUCING FINE POWDER OF LIQUID METAL**

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[56]

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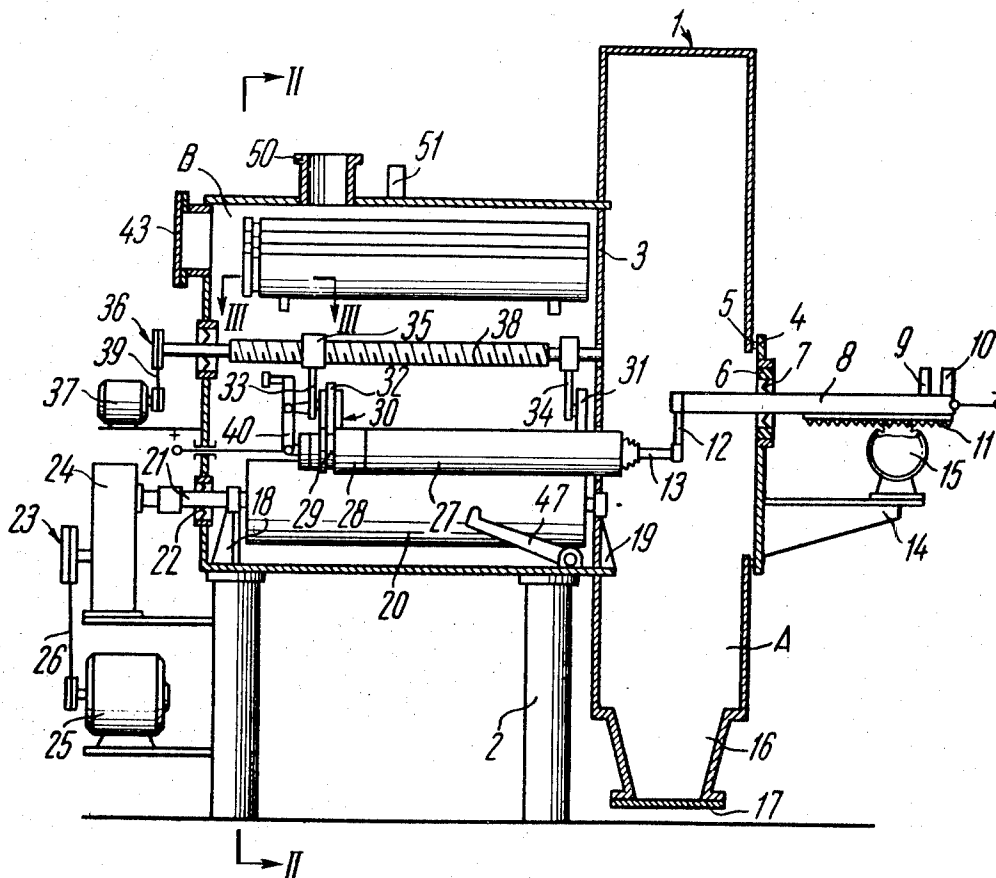
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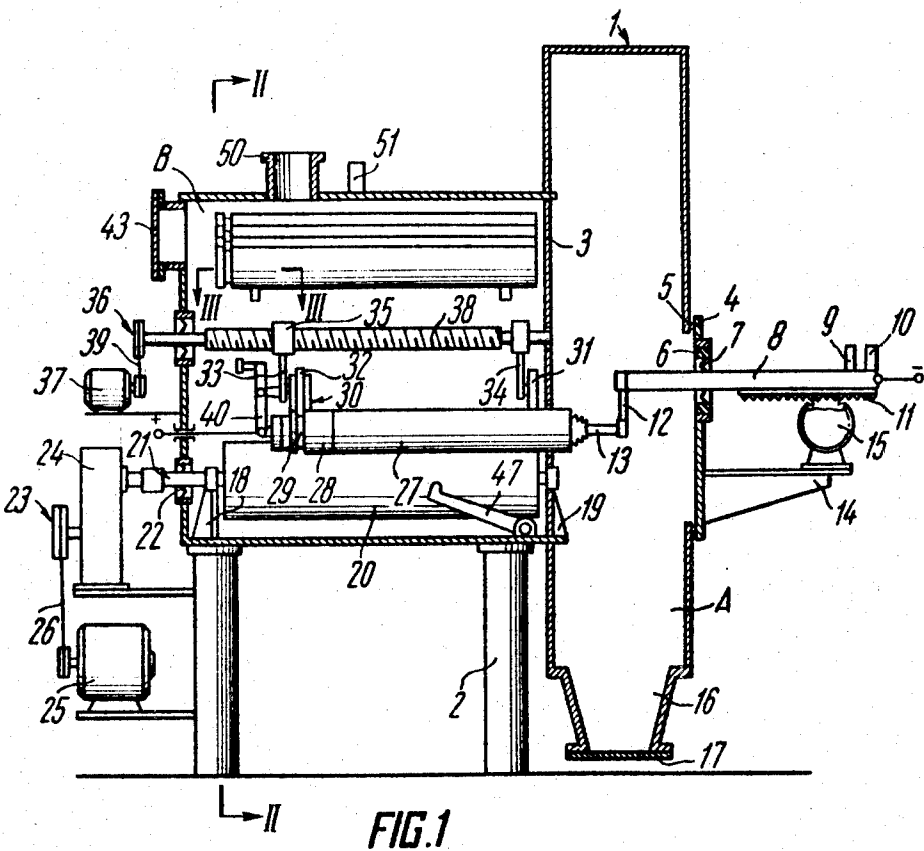
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ABSTRACT

A device is disclosed for producing fine powder of liquid metal comprising an air-tight chamber which accommodates a nonconsumable and a consumable electrode with the latter being located on two horizontal rolls parallel to each other and connected so as to ensure their synchronous rotation with a rotary gear, the consumable electrode being held tight to the rolls by two rollers one of which is in mesh with the electrode and is connected to a longitudinal feed gear to maintain constant spacing between the consumable and non-consumable electrode.

5 Claims, 3 Drawing Figures





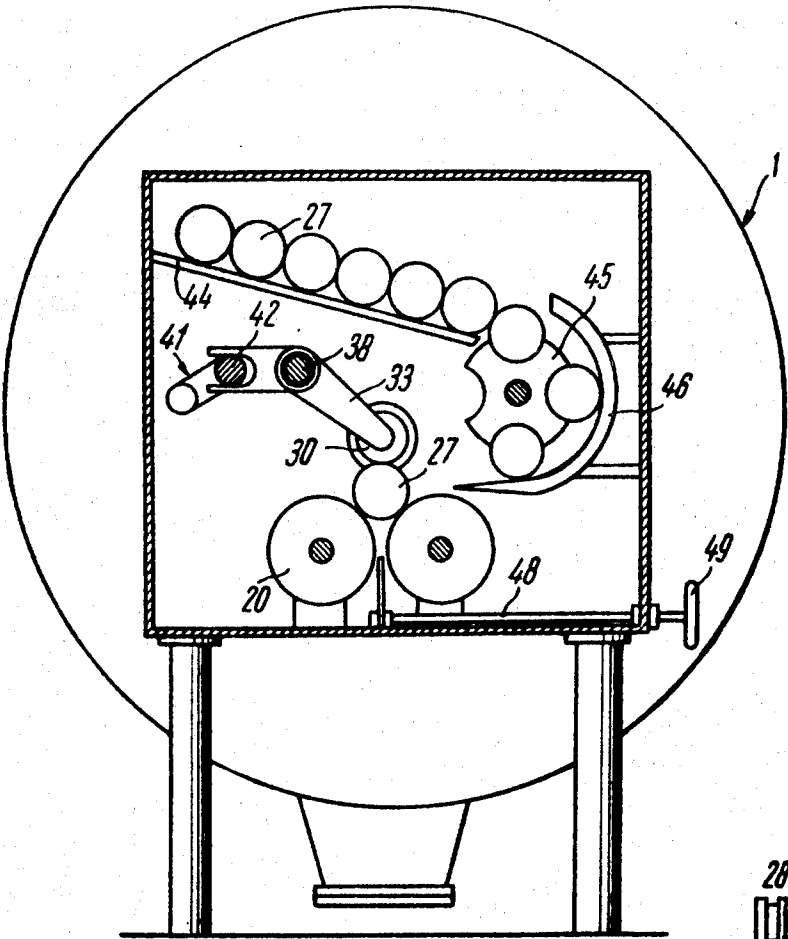


FIG. 2



FIG. 3

DEVICE FOR PRODUCING FINE POWDER OF LIQUID METAL

BACKGROUND OF THE INVENTION

The present invention relates to the field of metallurgy and more particularly to devices for producing fine powder of liquid metal.

Known in the prior art are devices for the production of fine powder of liquid metal comprising an air-tight chamber accommodating a consumable and nonconsumable electrodes. The consumable electrode is connected with a rotary gear for which purpose its overhanging end is rigidly fixed to an output shaft of the rotary gear.

The latter, i.e., the rotary gear together with the consumable electrode secured on it is connected to a longitudinal feed gear to maintain a pre-set distance between the non-consumable and consumable electrodes as the latter is being gradually melted down.

In order to obtain uniform and powdered particles of small volume the consumable electrode is rotated with a requisite speed and the higher the electrode rpm, the larger will be the amount of fine and uniform size particles produced.

In the above device fine and uniform particles can be produced by using consumable electrodes of negligible length (up to 150 mm) and small in weight (up to 120 g). With the electrodes suspended from the shaft end the use of the consumable electrodes of considerable length and weight tends to reduce rigidity of a shaft-electrode system. In addition a further rise in rpm is restricted by wear resistance of packing at the inlet of the rotary gear shaft in the device chamber.

Besides with the above arrangement the length of the consumable electrode is limited due to its cantilever attachment to the gear shaft. That is why an unmelted portion of the electrode (a discarded part or a stub) which is needed for connecting it to the gear shaft is relatively large with respect to the melted portion which is liable to decrease the yield substantially.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a device for producing fine powder of liquid metal which will allow using consumable electrodes of considerable length and weight with a higher speed of rotation.

Another object of this invention is to ensure a higher yield.

Still another object of the present invention is to increase the production rate of the device.

According to the specified and other objects disclosed herein is a device for the production of fine powder of liquid metal comprising an air-tight chamber which accommodates a nonconsumable and consumable electrodes with their ends spaced apart and with the consumable electrode connected to both a rotary gear and a longitudinal feed gear to keep the distance between the two electrodes constant as the consumable electrode is being gradually melted by which virtue the particles of molten metal coming off the consumable electrode under a centrifugal force and solidifying during their flight collect in the bottom portion of the chamber. Conforming to this invention the consumable electrode is connected with the rotary gear by means of horizontal rolls arranged in the chamber parallel to each other on two supports rotating synchronously in one and the same direction, and mounting the consum-

able electrode held tight to the rolls with the aid of fixtures spaced apart from each other throughout the length of the consumable electrode, with the fixture remote from the electrode end being melted, connected to longitudinal feed drive and geared with the consumable electrode to move in conjunction with the latter.

Where a longitudinal feed gear is employed with a kinematic nut-screw pair and with pressure rollers acting as clamping fixtures, it might be expedient to connect the roller remote from the electrode end being melted to a driven gear link - a nut-by means of a lever fixed rigidly on the nut, with the screw acting as a lever pivotal axis and to couple one lever arm with the roller and another - with a crank gear whose function is to turn the lever in order to force the roller against the consumable electrode and to take it aside when feeding a new consumable electrode onto the rolls.

The above connection of the roller with the longitudinal feed gear is dependable in operation and easy in production.

It might be no less expedient to secure one end of the consumable electrode in a cylindrical holder which is its extension and has an annular groove on its exterior and to provide an external surface of the roller remote from the electrode end being melted with a flange interacting with the side walls of the groove to ensure longitudinal motion of the electrode.

The cylindrical holder in which the consumable electrode is secured holds electrode stubs of minimum size which tends to increase the yield.

It would be also sound practice to provide in the top portion of the chamber an inclined platform for spare consumable electrodes, with a distributing or control gear and guide rods for feeding consumable electrodes arranged at a lower edge of the platform.

With the above arrangement, i.e., by mounting the inclined platform for spare electrodes and the distributing gear a semi-automatic supply of the electrodes onto the rolls is provided which steps up the output of the proposed device as it does not necessitate the unsealing of the chamber in placing a new electrode on the rolls.

It would be also sound practice to mount a crank within the chamber arranging it under the rolls so that on swinging the end of its arm will pass between the rolls and due to its interaction with the end plane of the consumable electrode will push out the unmelted part of the electrode to the bottom portion of the chamber.

By fitting the proposed device with the aforesaid crank a discarded part or a stub of each electrode can be removed without unsealing the chamber and this promotes higher production rates.

Through the use of consumable electrodes of considerable—up to 500 mm. — length and 50 mm in diameter rotating with a higher rate with respect to the speed of rotation of a gear shaft, which is attained due to different diameters of the rolls and consumable electrode as well as due to the semi-automatic supply of consumable electrodes and stub discharge, the device for producing fine powder of liquid metal manufactured in conformance with the invention will enable about a 10-12-fold increase in the device output; it will also allow a higher percent of fine uniform spherical particles to be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

For the purpose of giving those skilled in the art a better understanding of the invention the following il-

lustrative example is given to be taken with reference to the appended drawings, in which:

FIG. 1 is a longitudinal sectional view of a device for producing fine powder of liquid metal conforming to this invention;

FIG. 2 - section II—II of FIG. 1;

FIG. 3 - section III—III of FIG. 1 on an enlarged scale.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

A device for producing fine powder of liquid metal comprises air-tight chamber 1 (FIGS. 1 and 2) mounted on columns 2. Chamber 1 is made up of two compartments A and B in communication with each other and separated by partition 3.

Compartment A of chamber 1 has a port closed with door 4 sealed in with lining 5. Door 5 incorporates built-insulator 6 with packing ring 7. Introduced through packing ring 7 into compartment A of chamber 1 is the end of tubular rod 8 insulated electrically from chamber 1 and fitted with conduits 9 and 10 intended accordingly for feeding and discharging cooling fluid. The end of rod 8 located outside chamber 1 carries rack 11 which is attached to it and connected to a power supply source (not shown in the drawing). Secured on the other end of rod 8 enclosed in compartment A of chamber 1 is stand 12 carrying nonconsumable electrode 13. Electric current flowing through rod 8 and stand 12 passes to electrode 13.

Set up on the lower part of door 4 is arm 14 mounting pinion gear 15 meshing with rack 11 which is designed for lengthwise displacement of nonconsumable electrode 13.

In the bottom part of compartment A of chamber 1 there is a hopper 16 closed with a cover 17.

The bottom part of compartment B of chamber 1 accommodates rolls 20 mounted on supports 18 and 19. Each of the rolls is connected with the aid of appropriate shaft 21, running through packing 22 into chamber 1, to rotary gear 23 equipped with reducer 24 and electric motor 25 interconnected by chain gear 26.

Consumable electrode 27 is laid on rolls 20 with one electrode end being secured in cylindrical holder 28 which acts as its extension. Owing to this attachment of consumable electrode 27 a stub (an unmelted portion of the electrode) may have minimum size. The external cylindrical surface of holder 28 is provided with annular groove 29 (FIG. 3).

Rolls 20 are much larger in diameter than consumable electrode 27. This will allow a high speed of rotation of consumable electrode 27 to be attained with rolls 20 revolving at a relatively low rate.

To hold electrode 27 tight to rolls 20 use is made of fixtures. These are rollers 30 and 31 spaced apart along the length of consumable electrode 27. The exterior of roller 30 remote from the end of electrode 27 which is being melted, is fitted with flange 32 which is introduced into groove 29 in holder 28. Rollers 30 and 31 are attached to cranks or crank arms 33 and 34 respectively.

Crank 33 is rigidly fixed to nut 35 which is a driven member of longitudinal feed gear 36. The latter comprises electric motor 37 and screw 38 which constitutes a driving member connected to electric motor 37 by chain gear 39.

Crank 34 is mounted on a cylindrical portion of screw 38 which acts simultaneously as a pivotal axis of cranks 33 and 34.

Crank 33 carries current collector 40 coupled to a power supply source (not shown in the drawing).

Opposite arms of cranks 33 and 34 are coupled to crank gear 41 which is intended for forcing rollers 30 and 31 against and taking them aside from electrode 27.

For connecting cranks 33 and 34 to crank gear 41 each crank is provided with a slot wherein shaft 42 of crank gear 41 is introduced.

Arranged in the top portion of compartment B of chamber 1 is a hatch closed with cover 43 and designed for introducing spare consumable electrodes 27 into compartment B of chamber 1.

Spare consumable electrodes 27 are placed on inclined platform 44 secured in compartment B. At the lower edge of the platform is disposed distributing gear 45 made in the form of a Maltese cross and allowed to swing. The above distributing gear has curvilinear guides 46 intended for holding consumable electrodes 27 in place in distributing gear 45 when the latter swings.

In the bottom part of compartment B of chamber 1 is set up lever 47 secured on shaft 48 which rotates with the aid of flywheel 49 located outside chamber 1. Lever 49 is mounted so that as shaft 48 turns the end of its arm passes between rolls 20 and on interacting with the end plane of electrode 27 ejects holder 28 together with the stub into compartment A.

Chamber 1 is fitted with branch pipe 50 which serves for connecting it to a vacuum pump (not shown in the drawing) and with sleeve 51 intended to connect the chamber to an inert gas source (not shown in the drawing).

A device for producing powder of liquid metal functions in the following manner.

Introduced alternately into an open charging hatch is a requisite number of consumable electrodes 27 connected beforehand to holders 28. Electrodes 27 roll down over an inclined platform 44 to distributing gear 45. As the latter swings electrodes 27 enter alternately the recesses in distributing gear 45 to be conveyed to rolls 20 and followed by curvilinear guides 46.

Before the first consumable electrode has rolled down onto rolls 20 pressure rollers 30 and 31 are raised a little by appropriate cranks 33 and 34 and kept in that position by crank gear 41 with roller 30 maintained in the extreme left-hand position (FIG. 1). In the meantime current collector 40 is automatically shifted to the extreme left-hand position.

By swinging distributing gear 45 through 90° the first electrode 27 is pushed onto rolls 20.

Crank gear 41 on rotating causes cranks 33 and 34 to turn about screw 38 clamping consumable electrode 27 by rollers 30 and 31 with flange 32 of roller 30 entering annular groove 29 in holder 28.

With door 4 of compartment A being uncovered nonconsumable electrode 13 is secured in stand 12. Then both door 4 and cover 43 of the charging hatch are closed and chamber 1 is evacuated by a vacuum pump through branch pipe 50.

As soon as requisite rarefaction is obtained in chamber 1 the vacuum pump is detached from chamber 1 and its volume is filled with inert gas fed via sleeve 51 to build-up a requisite pressure.

Next electric motor 25 of rotary gear 23 is actuated imparting a rotary motion through chain gear 26, reducer 24 and rolls 20 to consumable electrode 27.

Following that electric motor 37 of longitudinal feed gear 36 is brought into operation thereby imparting a longitudinal motion through chain gear 39 and screw 38 to nut 35 and crank 33 secured on the nut together with roller 30. Since flange 32 of roller 30 is engaged with and introduced into, groove 29 of holder 28, consumable electrode 27 moves together with roller 30 along rolls 20. Simultaneously current collector 40 is shifted clockwise until it touches the face of holder 28.

The end of consumable electrode 27 is introduced into compartment A through a hole in partition 3 of chamber 1.

With the aid of pinion gear 15 and rack 11 rod 8 with nonconsumable electrode 13 mounted on stand 12 is rapidly shifted counterclockwise until it contacts consumable 27 and nonconsumable 13 electrodes whereupon the latter is quickly moved at a requisite distance ensuring stable arcing.

Under the influence of the electric arc consumable electrode 27 starts melting (fusing) and under centrifugal forces the particles or droplets of liquid metal run off the melting surface of the consumable electrode in a radial direction and upon reaching the electrode edge scatter in compartment A. During their flight the particles form spherical granules which on encountering the resistance of inert gas cool down, solidify and slide off into hopper 16.

As consumable electrode 27 is being melted, longitudinal feed gear 36 imparts a predetermined translatory motion to consumable electrode 27 which ensures a constant spacing or gap between consumable electrode 27 and nonconsumable electrode 13.

Melting continues until all the consumable electrode 27 is melted down except for a small fraction (stub) at the connection of consumable electrode 27 with holder 28.

To complete the melting process either nonconsumable electrode 13 is quickly swung clockwise to extinguish the electric arc or the power supply source is cut off. At the instant the melting operation ceases longitudinal feed gear 36 is disengaged. Simultaneously rotary gear 23 of electrode 27 is also cut off. Next rollers 30 and 31 are carried off the stub of consumable electrode 27 which is effected by means of crank gear 41. By turning lever 47 the stub with holder 28 is discarded from rolls 20 into compartment A. Following this longitudinal travel gear 36 is operated and roller 30 is returned in its initial left-hand position.

Distributing gear 45 directs the next consumable electrode 27 onto rolls 20 and the cycle is repeated.

After all the consumable electrodes have been melted chamber 1 is unsealed by opening cover 43 of the charging hatch. Hopper 16 is uncovered and the powder produced taken out. On being emptied hopper 16 is closed again.

Then a new lot of consumable electrodes is charged. What is claimed is:

1. A device for producing fine powder from liquid

metal comprising: an air-tight chamber; two horizontal rolls mounted in parallel with each other on two supports in said chamber; means for rotating said rolls in one and the same direction; a consumable electrode disposed on said rolls and in rotation therewith; a nonconsumable electrode disposed in said chamber so that one of its ends is spaced apart from one end of said consumable electrode and arcing means for producing an electric arc between these ends of said nonconsumable electrode and said consumable electrode; first fixture means and second fixture means for holding said consumable electrode tightly to said rolls and located along the length of said consumable electrode so that said first fixture means is in close proximity to said electric arc, said second fixture means being remote from said electric arc and in mesh with the consumable electrode to rotate in conjunction with said consumable electrode; means for longitudinally feeding said consumable electrode coupled with said second fixture means for maintaining constant distance between said consumable and nonconsumable electrodes so that during gradual melting of said consumable electrode under the action of said arcing means particles of said liquid metal of uniform shape come off said one end of said consumable electrode under centrifugal force provided by the rotation of said consumable electrode and thereby solidify to form said fine powder; and means for collecting said fine powder produced.

2. A device as claimed in claim 1 in which said longitudinally feeding means comprises a kinematically interacting nut and screw member, wherein a roller is rigidly connected to said nut by a first lever means, said nut also being connected through a second lever means to a crank gear so that said screwed member acts as a pivotal axis when said crank gear turns the second lever means to either force the roller against the consumable electrode or withdraw said roller from a consumed electrode when a further consumable electrode is introduced onto said rolls.

3. A device as claimed in claim 2 in which that end opposite to said one end of said consumable electrode is secured in a cylindrical holder the exterior of which has an annular groove having side walls, said roller being provided with a flange on its external surface, said flange engaging said groove, thereby interacting with the side walls of the groove.

4. A device as claimed in claim 1 wherein the top portion of said air-tight chamber is provided with an inclined platform for accommodating spare consumable electrodes, and wherein distributing gear means and guide means are provided at the lower edge of said inclined platform for delivering further ones of said spare consumable electrodes from said inclined platform onto the rolls.

5. A device as claimed in claim 3 in which said air-tight chamber is provided with ejector means for ejecting said cylindrical holder containing an unmelted portion of said consumable electrode, into said bottom portion of said air-tight chamber.

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