Aug. 1, 1961 L. R. PAYTON 2,994,102

ALUMINUM CASTING SYSTEM

Original Filed April 15, 1958 3 Sheets-Sheet 1

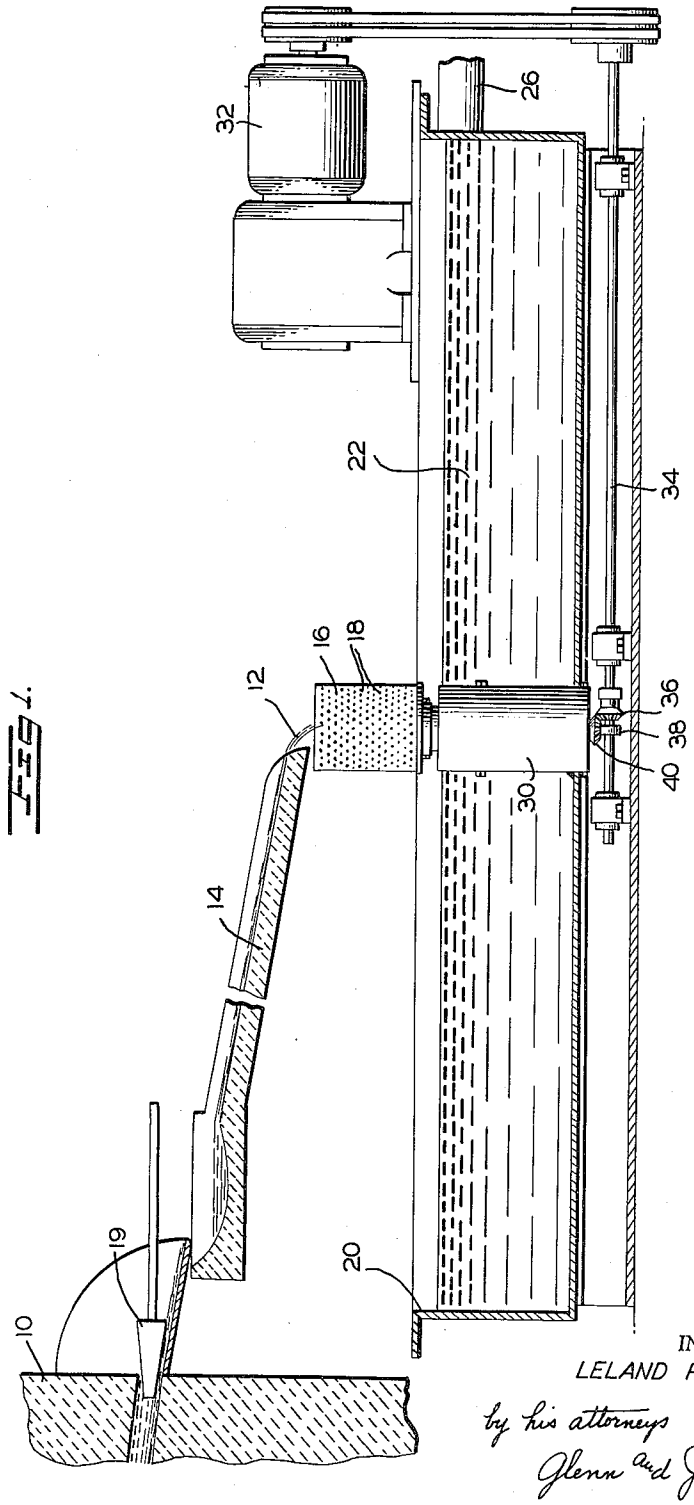


Fig. 1

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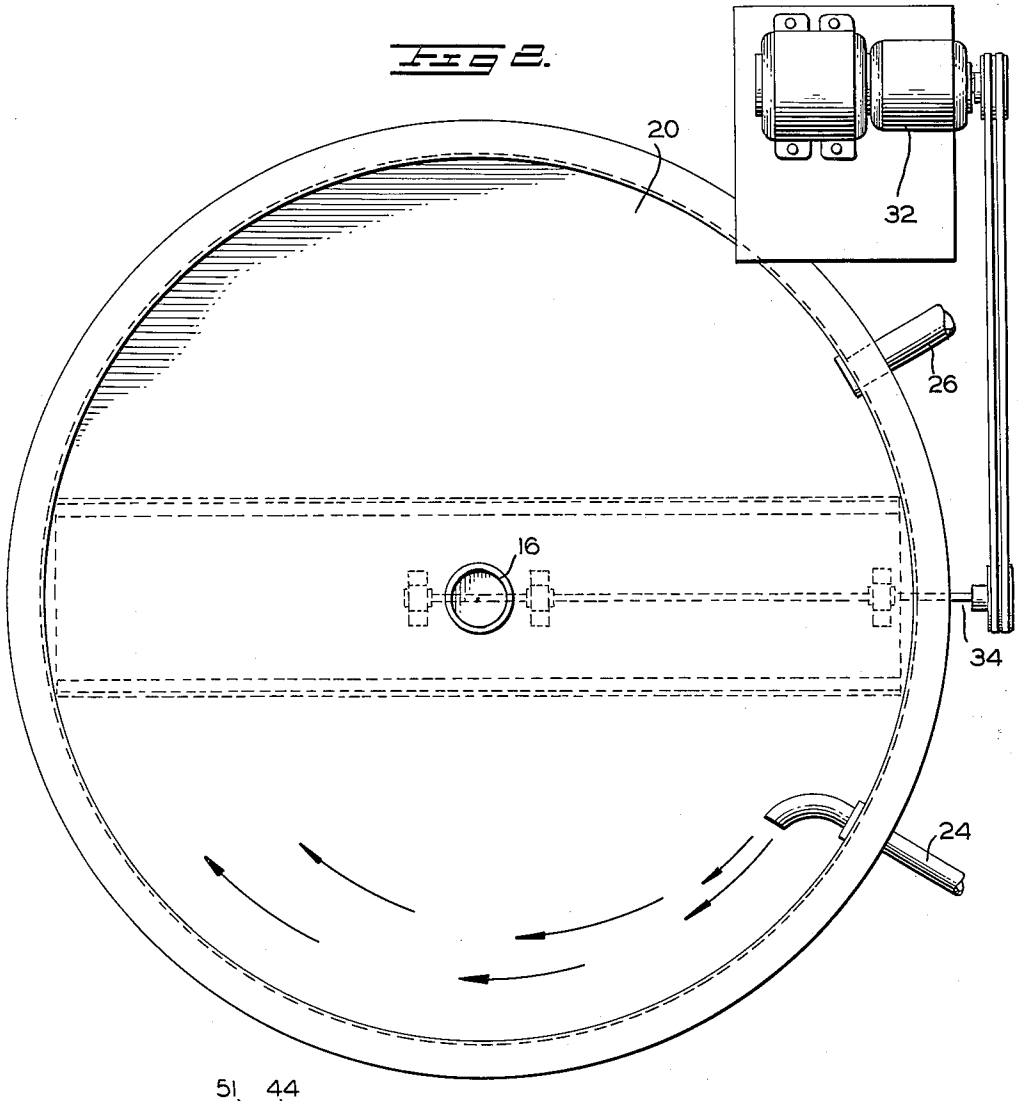
by his attorneys
Glenn and Jackson

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ALUMINUM CASTING SYSTEM

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Fig 2.



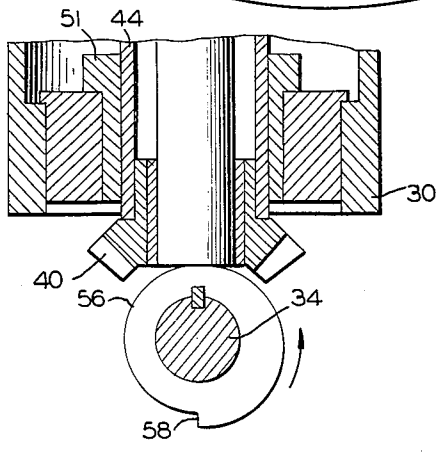


Fig 4.

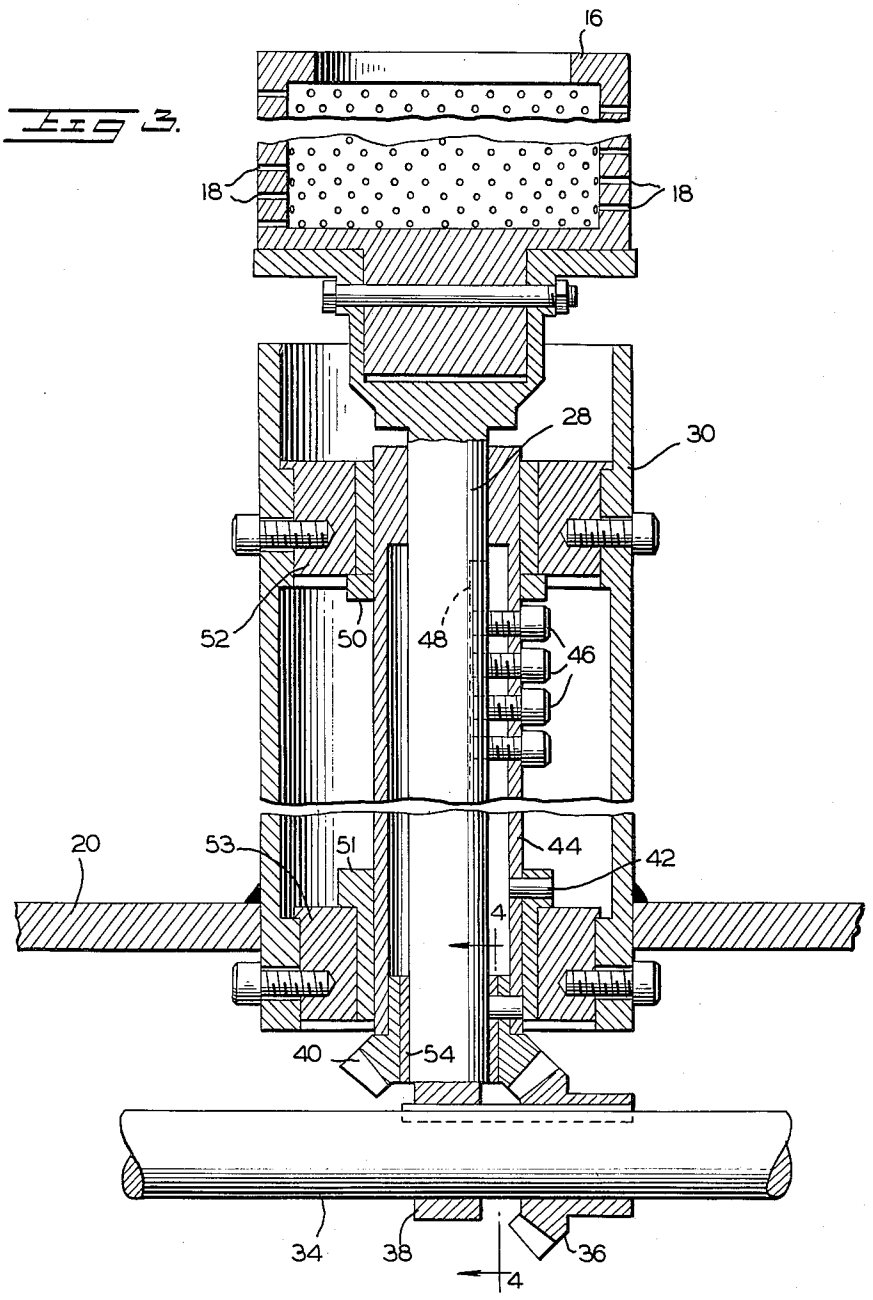
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Fig 3.



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United States Patent Office 2,994,102 Patented Aug. 1, 1961

2,994,102

ALUMINUM CASTING SYSTEM

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Continuation of application Ser. No. 728,584, Apr. 15, 1958. This application May 9, 1960, Ser. No. 27,961
17 Claims. (Cl. 18—2.6)

This invention relates to production of aluminum shot of generally spherical form, and more particularly relates to a means and method of continuously producing such shot by centrifugal action. This application is a continuation of my application S.N. 728,584, filed April 15, 1958.

The steel industry has long used aluminum as a deoxidant and the aluminum for that purpose has been produced by pouring molten aluminum into a container having a series of holes in the bottom, and a pool of water under the holes. The molten aluminum passes through the holes, forms large droplets, and then falls into the water, where it solidifies into generally button-shaped particles having a diameter of about ⅜ inch. The generally flat shape of these particles is satisfactory for purposes of throwing them manually into a ladle or mold of molten steel, in accordance with conventional practice, but the substantially flat shape of these particles prevents them from flowing readily through a pouring device, and thus impeded the development of automatic apparatus for supplying the aluminum to the steel mold or ladle. A generally spherical form of aluminum particles, otherwise known as "shot," is therefore desired for use in deoxidizing steel, as well as for other purposes, but the production of aluminum shot in the desired form has not heretofore been considered practical. Centrifugal casting of various molten materials has long been known as a possibility, but, as pointed out in U.S. Patent No. 2,439,772 issued April 13, 1948, many difficulties are encountered in casting shot centrifugally, and these difficulties have impeded the use of this method, particularly in the case of aluminum. For example, the centrifugally cast particles of metal are apt to form filaments instead of globules; cf. U.S. Patent No. 2,217,235, issued October 8, 1940.

A process of dropping a stream of molten aluminum onto a revolving plate for purposes of dividing it into spherical particles, is disclosed in U.S. Patent No. 2,728,-107 issued December 27, 1955, but that process requires, among other things, a surrounding inert atmosphere, which is more difficult and expensive to provide than an air atmosphere.

In accordance with the present invention, pellets of aluminum shot of useful spheroidal shape are cast simply and economically without the necessity of specially controlling the surrounding atmosphere. Molten aluminum is poured continuously into a revolving pot, and the centrifugal action of the pot forces the aluminum to flow through holes along the side of the pot. Aluminum oxidizes very readily, and forms a tough oxide film. In accordance with the invention, the problems caused by the oxide film are overcome by frequently jarring the pot as it revolves, and the particles thereby produced are found to have the desired spheroidal shape. They also have the important characteristic of being solid, without inclusion of air inside. Such inclusions are undesirable because they not only add to the oxide surface of the shot but also tend to float instead of melting in molten steel and the like.

For a better understanding of the invention and its other details, objects and advantages, reference is now made to the present preferred embodiment of the invention which is shown, for purposes of illustration only, in the accompanying drawings. In the drawings:

FIG. 1 is a vertical section through shot-forming apparatus embodying the invention;

FIG. 2 is a top plan of part of the apparatus of FIG. 1;

FIG. 3 is an enlarged fragmentary section corresponding to part of FIG. 1, but showing more details of the drive means; and

FIG. 4 is a fragmentary section on the line 4—4 in FIG. 3.

The illustrated apparatus has a melting chamber 10 containing molten aluminum 12 heated by conventional means to the required temperature for maintaining the aluminum fluid when it is poured through conduit 14 into the open end of a rotating pot 16 having openings 18 through its sides for release of molten aluminum from the pot. A conventional valve 19 is adjustable to control the rate of flow from the chamber 10 to the pot 16 in order to keep inflow and outflow of the pot in suitable balance.

The pot 16 is mounted in the middle of a circular tank 20, above the level of the body of water 22 in the tank. In order to prevent the water in the tank from becoming excessively hot during operation, water is fed into the tank, preferably constantly, through a lower inlet conduit 24, and is automatically discharged through an open upper outlet conduit 26 when the level of water in the tank rises sufficiently.

The pot 16 is fixed on the upper end of a vertical shaft 28 housed in a surrounding sleeve 30 which extends up through the bottom of tank 20 for purposes of protecting the shaft 28 and its driving mechanism from the water 22 in the tank. A motor 32 is connected to drive a shaft 34 extending beneath the tank, and a bevel gear 36 and cam 38 are fixed on shaft 34 to rotate and vertically reciprocate the shaft 28 and pot 16.

The bevel gear 36 drives a bevel gear 40 which in turn rotates shaft 28 because it is secured by pin 42 to a rotatable inner sleeve 44 which carries bolts 46 projecting into and vertically slidable along an axially extending slot 48 in shaft 28. The rotatable sleeve 44 is secured against vertical movement by a pair of rings 50 and 51 pinned to sleeve 44 and bearing against rings 52 and 53 pinned to outer sleeve 30. The upper end of rotatable sleeve 44 extends slidably around shaft 28 and is journaled in ring 52, while its lower end fits closely around bevel gear 40 which in turn carries a bearing lining 54 fitting slidably around the lower end of shaft 28. Shaft 28 is thus free to move vertically relative to bevel gear 40 and sleeve 44, although it is mounted in them and rotated by them.

Cam 38 preferably has a spiral cam track 56 which rides against the lower end of shaft 44 until the step 58 at the end of the cam is reached, at which point gravity abruptly drops the end of shaft 44 onto the inner end of the spiral track 56, with a resultant jarring action. Others forms of cams and the like can be used to accomplish this purpose, but it is necessary to repeat this action frequently.

Example 1

A typical pot 16 is made of cast iron and has an outer cylindrical radius of 3 inches, a cylindrical wall thickness of 7/16 inch, and an inside height of 7¼ inches measured from the bottom of the inside of the pot to the interior horizontal surface of the inturned flange around the top of the pot.

The radius of the opening at the top of the pot, which is not critical, is 2 inches. The holes are of 0.052 inch diameter drilled radially through the cylindrical wall of the pot, and are arranged in 27 equally spaced rows each containing 37 holes spaced evenly around the row in

staggered relation to the holes in the adjacent rows. The 0.052 inch holes are preferred, because they have been found to give shot having the narrowest range of size distribution and hence the most uniform product.

The pot is preheated to approximately 1350° F. and is then revolved at approximately 400 revolutions per minute as molten aluminum is poured into the pot at said temperature and at a rate of about 3,000 pounds per hour. During most of each revolution the pot is spirally cammed up a distance of approximately 3/16 inch, and then it abruptly drops back down on the foot of the spiral under the influence of its weight at the end of the revolution. That action jars the pot vertically once during each revolution. The detached particles of aluminum assume a solid, spheroidal shape as they are thrown by the centrifugal action of the pot in a free falling trajectory over the pool of water in the tank 22, with a drop of preferably about 12 to 19 inches, and a horizontal radius movement of about 2 or 3 feet. The particles are substantially solidified in the air, at least around their outer portion, before they hit the water, and consequently are not substantially flattened or distorted by impact against the water. An 84-inch inside diameter of the tank is sufficient to cause all of the particles to fall into the water. The operation can be continued as long as desired, and during the operation the water is preferably cooled by adding fresh water to replace the heated water, and the shot is constantly shoveled out, or otherwise removed. In order to facilitate removal, the bottom wall of the tank can be sloped downwardly toward its outer periphery and outlet ports can be provided around the lower portion of the tank for washing out the shot with some of the heated water released from the tank, or other expedients can be adopted to make removal of the shot more convenient. During the operation, the heat of the incoming molten aluminum fed to the pot keeps the pot at a high temperature of approximately 1320° F., which is apparent because the pot glows red during the operation, when a cast iron pot is used.

In spite of the fact the particles are discharged through air to the water in the tank, they are found to have a bright surface, indicating a minimum of oxide formation. The particles are solid and have good uniformity of spheroidal shape, with a minimum of strings and tails, and after drying and screening it is found that about 95% will pass through a 5 mesh screen and be retained on a 10 mesh screen.

Example 2

When the above Example 1 is repeated, except that the pot is revolved at 600 r.p.m., the rate of production rises to about 4,000 pounds per hour, and about 95% of the particles are −5 to +10 mesh (i.e., pass 5 mash and are retained on 10 mesh), among which are a noticeably increased proportion of particles having strings and tails, so that they are not spheroidal.

Example 3

When Example 1 is repeated, except that the pot is revolved at about 200 r.p.m., the production rate drops to about 2,000 pounds per hour, but the particles produced remain bright and fairly uniform in size, about 95% −5 to +10 mesh. The particles are substantially free of any tails or strings, but the proportion of out-of-round particles increases considerably. The latter effect increases so much as to make the product generally unacceptable when the pot of Example 1 is revolved at 100 r.p.m., when the production drops to 1750 pounds per hour (95%−4+8 mesh).

Example 4

When the above Example 1 is repeated, except that the hole size is changed to 0.040 inch, the production is as follows: 100 r.p.m., no usable product; 200 r.p.m., 1500 pounds per hour (about 95%−5+10 mesh); 400 r.p.m., 2500 pounds per hour (about 95%−6+10 mesh); 600 r.p.m., 3500 pounds per hour (about 95%−8+12 mesh). In all cases, the particles are generally smaller than with the 0.052 inch holes, and at low speeds (e.g., 200 r.p.m.) the proportion of out-of-round particles increases, while at high speeds (e.g., 600 r.p.m.) the proportion of particles with strings and tails increases.

Example 5

When the above Example 1 is repeated except for use of 0.086 inch holes in the pot, the particles are larger and generally similar to but less well formed than the particles produced from 0.052 inch holes at corresponding speeds. The production rates and sizes at 100 r.p.m. are 2250 pounds per hour (about 95% −4 +8 mesh), at 200 r.p.m. are 2500 pounds per hour(about 95% −4 +10 mesh), at 400 r.p.m. are 350 pounds per hour (about 95% −5 +10 mesh), and at 600 r.p.m. are 4500 pounds per hour (about 95% −5 +10 mesh). In general, only about 50% of the screened particles are acceptably spheroidal.

The above-mentioned mesh sizes are U.S. Standard Sieve.

In all cases, the particles are free of internal voids and suitable for deoxidizing steel. The spheroidal particles have the further advantage of being readily poured through a tubular passage or other channel, and consequently are readily charged, in controlled quantities, into a body of molten steel, or into any other place where such particles may be required for deoxidizing, alloying or other purposes.

As indicated in the examples, a pot having an outer radius of 3 inches has an operating range of about 200 to 600 r.p.m. with peripheral holes of about 0.040 to about 0.086 inch, the preferred speed being about 400 r.p.m., and hole diameter being about 0.052 inch. As the outer radius is increased, the speed must be decreased in order to maintain the same centrifugal force, if substantially the same product is to be obtained. The reverse applies, within reasonable practical limits, if the outside diameter of the pot is decreased. The fact that centrifugal force is proportional to the square of the angular velocity multiplied by the radius determines the corresponding speeds for different outside pot radii.

While present preferred examples of the invention, and methods of practicing the same, have been described and illustrated, the invention is not limited thereto, but may be otherwise embodied and practiced within the scope of the following claims.

I claim:

1. The method of continuously forming aluminum shot, comprising the steps of continuously pouring molten aluminum into a container having peripheral openings therethrough while continually revolving the container to centrifugally force the molten aluminum through said openings, repeatedly jarring the container, detaching successive small portions of the molten aluminum from the outer ends of the openings, and cooling the detached portions of the aluminum into solid spherical particles of aluminum shot.

2. The method of claim 1, in which the container is revolved about a vertical axis.

3. The method of claim 1, in which the detached particles of aluminum are passed through air into water.

4. The method of claim 3, in which the particles are solidified around their outer portions before reaching the water.

5. The method of claim 1, in which the container is reciprocated in a direction parallel to its axis of rotation.

6. The method of claim 1, in which the molten aluminum is fed into a container at a temperature in the range of about 1280° F. to about 1350° F.

7. The method of claim 1, in which the effective diameter of the openings is in the range of about 0.040 inch to about 0.086 inch.

8. The method of claim 1, in which the effective diameter of the openings is about 0.052 inch.

9. The method of claim 1, in which the centrifugal force at the outer ends of the openings is equal to that when the outer ends of the openings are spaced about 3 inches from the axis of rotation, and are rotated at a speed in the range of about 200 r.p.m. to about 600 r.p.m.

10. The method of claim 9, in which the effective diameter of the openings is in the range of about 0.040 to about 0.086 inch.

11. The method of claim 9, in which the rotational speed is about 400 r.p.m. and the effective diameter of the openings is about 0.052 inch.

12. The method of claim 1, in which the container revolves about a vertical axis, and the detached particles of aluminum pass through air into a pool of water having its upper surface spaced below the lowermost perforations by a vertical distance in the range of about 12 inches to about 20 inches.

13. Apparatus for producing metal shot, comprising the combination of cylindrical pot having radially extending openings through its cylindrical side, means mounting the pot to rotate about a vertical axis, means to rotate the pot, means to jar the pot as it revolves, and a conduit for conveying molten metal to the interior of said container.

14. Apparatus according to claim 13, in which the means to vibrate the container comprises a cam follower connected to the container, a cam rotatable against the follower to vibrate the container, and drive means for the cam connected to the rotational drive means whereby the container is jarred at least once during each revolution.

15. Apparatus according to claim 13, including a tank for holding a body of water around the container with the upper surface of the water below the container in position to catch the particles of shot thrown from the container.

16. Apparatus according to claim 13, in which the openings have an effective diameter in the range of about 0.040 to about 0.086 inch.

17. Apparatus according to claim 13, in which the openings have an effective diameter of about 0.052 inch.

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