

April 5, 1938.

J. M. OLIN ET AL

2,113,279

PROCESS FOR MANUFACTURE OF SHOT

Filed Aug. 26, 1936

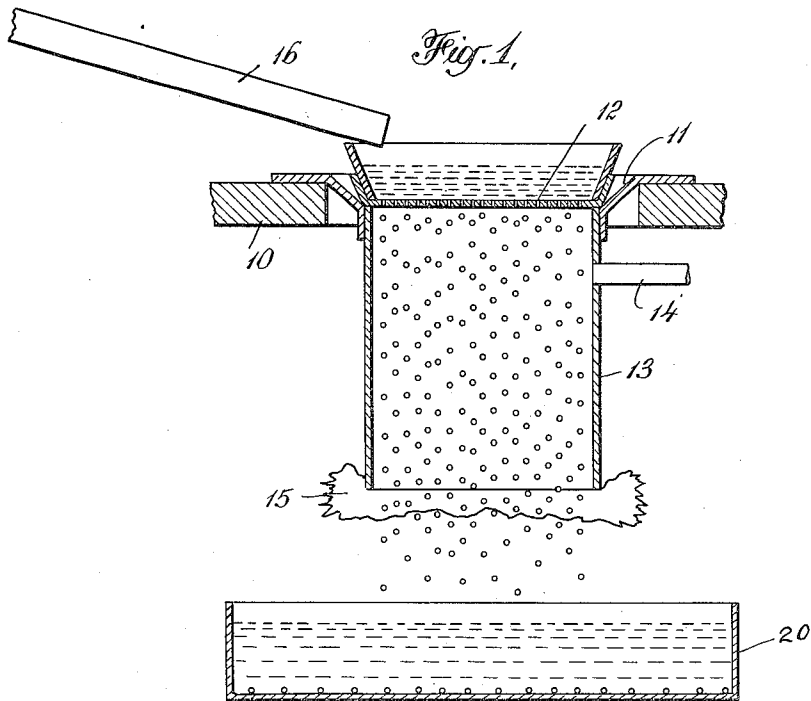


Fig. 2.

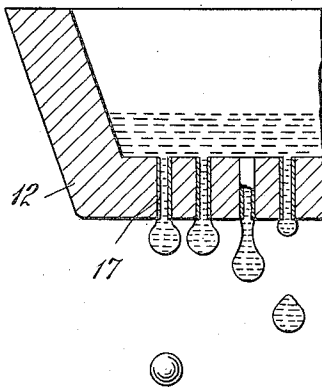


Fig. 3.

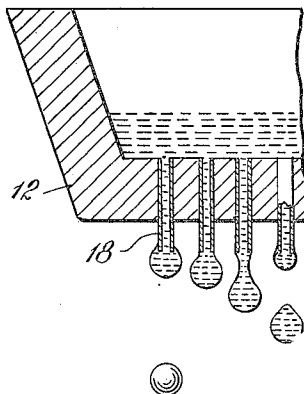
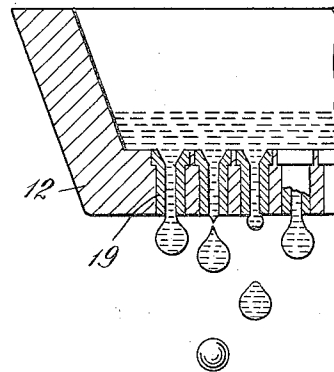


Fig. 4.



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UNITED STATES PATENT OFFICE

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PROCESS FOR MANUFACTURE OF SHOT

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Application August 26, 1936, Serial No. 98,080

25 Claims. (Cl. 83—91)

This invention relates to the manufacture of shot and more particularly to shot formed of lead or lead alloys containing no arsenic, or containing a smaller amount of arsenic than is commonly used in the manufacture of lead shot.

Spherical projectiles for use in fire arms for sportsmen's use are commonly called shot. By manufacturers, shot is commonly designated either as "drop shot" or as "chilled shot". Drop shot is also sometimes called "soft shot".

Drop shot is manufactured from what essentially is a relatively pure alloy of lead and arsenic. This alloy in molten condition is allowed to drip through the perforated bottom of a pan at the top of a shot tower, and after falling through a distance of about 150 feet is collected in a water tank. The molten streams of metal delivered through the perforations in the pan or colander at the top of the tower break up into globules of a diameter roughly dependent on the diameter of the holes in the pan and these globules form into substantially spherical shape. The descent through the relatively quiet air within the tower cools and congeals the globules sufficiently to prevent deformation when they strike the water at the bottom of the tower. The main function of the water is to cushion the fall and complete the cooling of the metal. The cooled and substantially round pellets are progressively removed from the water tank by bucket conveyors, or the like. They are then dried and passed to suitable sorting equipment where imperfectly shaped pellets are removed. They are then graded for size and polished and become the so-called shot gun shot of commerce.

For the so-called drop shot or soft shot, arsenic comprises about 0.1% of the finished projectile. The remaining percentage is lead of relatively high commercial purity. If less arsenic is used, the melted pellets do not form into substantially spherical form as they drop from the shot tower pan. Similarly if the lead is contaminated with usual impurities, such as tin, or other metals commonly found in scrap lead, the pellets will not snap into spherical form during the early part of their descent through the air of the shot tower. Nor will the use of arsenic correct the difficulties when scrap lead is used as the raw material if the impurity is a metal or metals higher than lead in the electromotive series, except the alkali and alkaline earth groups.

To make the so-called chilled shot, antimony to the extent from about 1% to 5% is added to the metal fusion. It is well known that pellets of a lead antimony alloy are harder than pure lead,

but it has been the practice in the past to use a higher percentage of arsenic in the manufacture of shot from lead antimony alloys. Commercially pure lead is expensive. Arsenic is expensive.

It is an object of the present invention to provide a method of making shot for use in sporting fire arms whereby the use of arsenic can be greatly reduced, or even eliminated altogether, and whereby impure or scrap lead can form the major constituent of the shot. The process is applicable not only to the art of making drop shot, but also to the art of making so-called chilled shot.

By the expression, impure or scrap lead, we here mean such things as old lead pipe, discarded lead roofing, metal salvaged from worn out storage batteries, etc. No such materials have heretofore been regarded as suitable for shot making. The presence of certain metals in lead alloys, or impurities in lead, prevents the formation of true spheres if the alloy is dropped from a shot tower through air, as is the practice in connection with lead-arsenic alloys in the ordinary method of making shot. We have found that the presence of very small amounts of metals higher than lead in the electromotive series, except the alkali and alkaline earth groups, will prevent the formation of true spheres even though arsenic is present. Thus, the presence of .01% tin, .02% cadmium or .05% zinc prevents the formation of true spheres. As most scrap lead contains tin in amounts greater than .01%, the use of scrap lead in the manufacture of shot for ammunition has heretofore been impossible and this cheaper source of material has not been used.

We have found that if an inert or reducing atmosphere is employed in the shot tower in place of air and particularly throughout that portion of the tower immediately beneath the drip pan where the molten globules are changing over from a tear-shaped globule to substantially spherical form, that the presence of metals higher than lead in the electromotive series as impurities in the lead does not prevent the formation of true spheres. We have further found that either pure lead or lead containing impurities of the character set forth can be employed for the manufacture of shot suitable for use in ammunition manufacture without the addition of arsenic if an inert or reducing atmosphere is employed in the shot tower.

In the accompanying drawing:

Fig. 1 is a somewhat diagrammatic illustration in section of the top of a shot tower;

Fig. 2 is a sectional view on an enlarged scale, of a portion of one form of drip pan used in carrying out the process of our invention;

Fig. 3 is a similar view of another form of drip pan; and

Fig. 4 is a similar view of still another form.

As stated above, the shot may be formed of pellets of lead without arsenic and the lead may also contain other metals as impurities. Metal generally sold as scrap lead containing various impurities and generally containing more than .01% of tin may be employed. Such metal can not be used to form shot by the conventional process. By using scrap lead in place of the commercially pure lead now employed, the cost of the shot can be materially reduced. Also the use of alloys permits variations of the ballistic properties of the finished ammunition to obtain desired results.

In making shot from scrap lead or other metal, the apparatus of Fig. 1 may be used. In this figure, the floor 10 at the top of the shot tower is provided with an opening into which loosely fits a skeleton frame 11 serviceable as a support for the drip pan or colander 12. Frame 11 also can be used as a support for the upper end of cylinder 13. The latter is provided with an inlet pipe 14 through which an inert or reducing gas can be supplied to fill cylinder 13 and maintain the desired non-oxidizing atmosphere at the perforations in the drip pan. The diameter of cylinder 13 can be the same as the diameter of the drip pan. Its length is ordinarily dependent on the average size of the pellets desired in that particular run of the shot tower. When steam is used as the inert atmosphere, it can be permitted to escape freely at the bottom of cylinder 13. If illuminating gas, or other combustible gas, is supplied to cylinder 13, it is good practice to ignite it at the lower or open end of cylinder 13, as indicated at 15, to avoid developing an explosive mixture in the shot tower. Steam may be supplied to the tower through pipe 14, or illuminating gas to be burned at the bottom of the cylinder 13 may be supplied through this pipe. The shot are collected in a water bath 20 in the usual manner.

As stated above, the invention may be employed in the manufacture of shot from impure or scrap lead, either with or without the addition of arsenic, and preferably without such addition. In carrying out the process the molten metal is syphoned from a large fusion kettle through a feed pipe 16 into the drip pan or colander 12, all in accordance with the usual practice. The tower 13 is filled with an inert gas and in the practice of the process we find that the use of dry steam is advantageous. We have found that the presence of the steam or other inert gas in the tower requires the provision of means for preventing the molten metal from clinging to the drip pan and we accordingly modify the ordinary construction of drip pan as shown in Figs. 2 to 4. In the form shown in Fig. 2, the pan 12 is formed of aluminum and the openings in the pan are lined with steel tubes 17, the inner and outer surfaces of which are tinned. In using the word "tinned" we do not limit ourselves to the specific metal tin, but use the term common in the art meaning coating the surface, by the aid of a flux, with easily fusible molten metal such as tin, solder, lead-antimony alloys and the like. The globules of molten impure lead or lead alloy drop from the underside of the pan and form spheres as illustrated. The tinned sur-

faces of the tubes 17 reduce the resistance to the flow of molten metal, similar to the effect of a wetted surface. The molten metal thus flows freely through the tubes and spreads until the metal at the bottom of the tube covers the end of the tube. Further spreading is prevented by the aluminum surface of the pan. The hanging drop of metal remains in this position until its weight is sufficient to detach it. It then falls through the tower and forms a substantially uniform sphere. From the above, it will be seen that the outside diameter of the tube determines the size of the shot.

In the form of the invention shown in Fig. 3 of the drawing, the pan 12 may be formed of steel. The openings are lined with tinned tubes similar to those heretofore described but the tubes extend beyond the bottom of the pan as indicated at 18. This likewise prevents the metal from spreading over the bottom of the pan and results in the formation of spheres of substantially uniform size.

In the form of the invention shown in Fig. 4 of the drawing, the pan may be made of steel and is first provided with openings of larger diameter than the intended diameter of the perforations through which the molten metal passes. These openings are lined with aluminum bushings 19 having openings of the desired diameter. The openings in the bushings are formed by drilling holes slightly smaller than the required diameter and then drawing a hard steel wire through them until the proper size is obtained. The lower end of the opening is polished and the burr is removed from the edge. It will be seen that in this form of the invention the walls of the openings and the bottom surfaces adjacent thereto are formed of aluminum to which molten lead will not cling or over which it will not spread. This prevents the molten metal from clinging to the walls of the opening, and results in the formation of uniform spheres. Various other expedients may be resorted to to prevent clinging of the molten metal to the bottom of the pan. A solid aluminum pan, for instance, may be employed or the walls of the orifices and the adjacent portion of the bottom of the pan may be chromium plated or plated with other metal to which lead or lead alloys do not have a tendency to cling. The metal drips through the perforations in the bottom of the colander and immediately comes in contact with an atmosphere of dry steam.

Under the above conditions the little streams of molten metal break up into globules and each globule takes on a spherical form. This desired action is practically instantaneous with pellets of the more usual sizes. For instance, in making #10 shot it is sufficient if cylinder 13 is 8 inches long. For shot commonly designated as #2 there are advantages in having a cylinder 10 feet long.

A sound scientific explanation of why the desired result is attained when steam is used as the non-oxidizing atmosphere is not easy to formulate. There is the obvious explanation that incipient oxidation does not take place, and that the perforated bottom of the pan is kept hot, not only by the molten metal above, but by the hot steam beneath. But according to our present ideas, the true explanation is more complex, and centers around certain obscure principles of the laws of surface tension as applied to a molten metal body falling freely. But whatever may be the true explanation of the complex principles

involved, there is the net commercial result that lead containing other metals as impurities, generally known as scrap lead and very impure in character and very cheap in price, can be used as raw material for making high grade shot for shot gun cartridges of ordinary calibre, such, for instance, as the 10, 12 and 16 gauge shot gun shells commonly used by sportsmen in hunting birds and other small game or for use in trap shooting.

In place of steam, there can be used as the substantially neutral atmosphere such inert gaseous material as nitrogen, carbon dioxide, or their equivalents. In general, we select an environment compatible with the needs of the metals and alloys being shot. For impure lead, or for alloys commonly sold as scrap lead, steam, nitrogen, or carbon dioxide will serve the purpose adequately. For zinc, or other metal having a strong avidity for oxygen, whether the metal be pure or impure, our process contemplates the use of a distinctly reducing atmosphere, as hereinafter explained.

According to another embodiment of our process of making shot out of unusual raw materials, the atmosphere maintained around the pellets throughout the initial part of their flight is distinctly reducing in character. For instance, we may use illuminating gas, water gas, producer gas, butane, hydrogen, or their equivalents, of course, taking the necessary precaution not to develop an explosive mixture throughout the shot tower. The expedient most commonly used by us has been the maintenance of a flame at the bottom of cylinder 13, and a complete combustion there of the gas after it is passed through the cylinder from the source of supply 14. For instance, the metal fusion in the drip pan may consist of zinc of the purity ordinarily found in commercial zinc of high quality, and the protecting atmosphere can consist of illuminating gas. The resultant finished shot is spherical in shape according to usual shot making practice and the percentage of pellets discarded because of irregular shape is not substantially higher than the percentage discarded in the present lead arsenic practice. Similarly, through use of the process here described, scrap zinc is made available for shot making and at costs for raw material far lower than those now prevailing in ordinary shot making.

Whether the initial metal fusion consists essentially of lead, either pure or impure, and whether with or without an intentional addition of arsenic, and whether it consists essentially of zinc, either pure or impure, the practice of using antimony to give the pellet greater hardness is entirely compatible with the broad principles of our improved process of shot making. If the fusion consists essentially of lead, pure or impure, the percentage of antimony added for hardening purposes can equal or greatly exceed the percentage now commonly used. It is possible to make the antimony hardened pellets without adding any arsenic. Similarly, if scrap lead be used as the raw material, antimony can be added in the percentage now commonly used, and even far in excess of those percentages without commercially impairing either the quality or the yield of the finished product. Arsenic additions to chilled shot of the antimony type play essentially the same function as arsenic additions to pure lead shot, that is to say, the arsenic has a controlling influence on the spherical shape and consequently on the percentage of yield from the tower. But according to our invention the use

of arsenic as a controlling factor has been superseded by the provision of a suitable atmosphere in that part of the shot tower where the dripping streams are breaking up into globules and where those globules are shaping themselves into substantially their final form. This fundamental change in shot making throws open to the use of the shot manufacturer as raw materials a great variety of metals and alloys not heretofore useful in this art and some of them at very much less cost than the raw materials heretofore commonly used.

In a copending application we have described more in detail the use of our process in the manufacture of zinc shot and we have pointed out therein as the salient features of that invention ammunition and elements thereof wherein zinc, or alloys of zinc, with or without the addition of pellets of other metals or alloys constitute the novel features.

While we have referred to the presence of .01% tin, .02% cadmium and .05% zinc as being a sufficient amount of an impurity to prevent the formation of true spheres by the conventional process, said impurities may be present in much greater amounts when the shot is dropped through an atmosphere of the type disclosed in this application. Each of these metals is higher than lead in the electro-motive series. On the other hand, the presence of impurities consisting of metals lower than lead in the electro-motive series does not have any deleterious effect in preventing the formation of spherical globules by the conventional process. Thus, the presence of .10% copper or .10% bismuth in an arsenic-lead alloy produced shot suitable for use in the manufacture of ammunition by the conventional process.

Some of the metals, higher than lead in the electro-motive series, either do not alloy with lead or, if an alloy is prepared, will not remain in that state at shot dropping temperature. Therefore, in the claims when we have used the expression "alloy of lead and a metal higher than lead in the electro-motive series, except the alkali and alkaline earth groups", we mean to exclude those metals which will not alloy with lead and remain in that state at shot dropping temperatures.

The metal, magnesium, is sometimes included in the alkaline earth group and sometimes excluded. In the practice of the present process, it behaves like members of the alkaline earth group and is intended to be included in the group.

The term "lead", as used in the claims, is intended to mean commercially pure lead which does contain small amounts of other metals. Missouri soft lead, for instance, may contain as high as .06% copper but the presence of copper and other metals lower than lead in the electro-motive series does not have any deleterious effect in preventing the formation of spherical globules by the conventional process. Commercially pure lead, however, does not contain metals higher than lead in the electromotive series in amounts greater than .01%. The term "lead" as herein used, therefore, includes these other metals both higher and lower than lead in the electromotive series in the amounts in which they are commonly present.

This application is a continuation in part of our copending application Serial No. 672,394, filed May 23, 1933.

We claim:

1. The process which comprises separating an alloy of molten lead and a metal higher than

lead in the electromotive series capable of alloying with molten lead, except the alkali and alkaline earth groups, in amounts sufficient to prevent the formation of spheres in an atmosphere of air, into globules at the top of a shot tower, and maintaining a non-oxidizing atmosphere in the portion of the tower through which the fused alloy starts its flight.

2. The process which comprises separating an alloy of molten lead and a metal higher than lead in the electromotive series capable of alloying with molten lead, except the alkali and alkaline earth groups, in amounts sufficient to prevent the formation of spheres in an atmosphere of air, into globules at the top of a shot tower, and maintaining an atmosphere of inert gas in the portion of the tower through which the fused impure lead starts its flight.

3. The process which comprises introducing molten lead containing as an impurity a metal higher than lead in the electromotive series and capable of alloying with molten lead, except the alkali and alkaline earth groups, in amounts sufficient to prevent the formation of spheres in an atmosphere of air, into a perforated drip pan arranged at the top of a shot tower, permitting the metal to pass through perforations in the bottom of the drip pan, and protecting it from contact with oxygen during at least the initial part of its flight down said shot tower.

4. The process which comprises introducing molten lead containing as an impurity a metal higher than lead in the electromotive series and capable of alloying with molten lead, except the alkali and alkaline earth groups, in amounts sufficient to prevent the formation of spheres in an atmosphere of air, into a perforated drip pan arranged at the top of a shot tower, preventing the metal from spreading on the bottom of the pan, and protecting it from contact with oxygen during at least the initial part of its flight down said shot tower.

5. The process which comprises separating an alloy of molten lead and a metal higher than lead in the electromotive series capable of alloying with molten lead, except the alkali and alkaline earth groups, in amounts sufficient to prevent the formation of spheres in an atmosphere of air, into globules at the top of a shot tower, and maintaining an atmosphere of dry steam in the portion of the tower through which the fused impure lead starts its flight.

6. The process which comprises introducing molten lead containing as an impurity a metal higher than lead in the electromotive series and capable of alloying with molten lead, except the alkali and alkaline earth groups, in amounts sufficient to prevent the formation of spheres in an atmosphere of air, into a perforated drip pan arranged at the top of a shot tower, permitting the metal to pass through perforations in the bottom of the drip pan, and maintaining an atmosphere of dry steam in the portion of the tower through which the fused impure lead starts its flight.

7. In the process of making shot from molten lead containing as an impurity a metal higher than lead in the electromotive series and capable of alloying with molten lead, other than the alkali and alkaline earth groups, in amounts sufficient to prevent the formation of spheres in an atmosphere of air, the step which comprises protecting the globules by a non-oxidizing atmosphere during at least the initial portion of their flight down the shot tower.

8. The process of making substantially spherical shot suitable for use in the manufacture of shot gun cartridges which comprises separating molten lead containing as an impurity a metal higher than lead in the electromotive series and capable of alloying with molten lead, other than the alkali and alkaline earth groups, in amounts sufficient to prevent the formation of spheres in an atmosphere of air, into globules at the top of a shot tower, and protecting said globules by a non-oxidizing atmosphere during at least the initial part of their flight down said shot tower, whereby said globules are caused to assume a substantially spherical shape during the initial part of their flight.

9. The process of making substantially spherical shot suitable for use in the manufacture of shot gun cartridges which comprises separating molten lead containing as an impurity a metal higher than lead in the electromotive series and capable of alloying with molten lead, other than the alkali and alkaline earth groups, in amounts sufficient to prevent the formation of spheres in an atmosphere of air, into a perforated drip pan arranged at the top of a shot tower, permitting the metal to flow through the perforations into the top of the shot tower to form globules, and protecting said globules by a non-oxidizing atmosphere during the initial part of their flight down said shot tower, whereby said globules are caused to assume a substantially spherical shape during the initial part of their flight.

10. The process which comprises separating molten lead containing less arsenic than is necessary to form spherical globules when lead is dropped through an atmosphere of air, into globules at the top of a shot tower, and maintaining a non-oxidizing atmosphere in the portion of the tower through which the globules start their flight.

11. The process which comprises separating molten lead containing less arsenic than is necessary to form spherical globules when lead is dropped through an atmosphere of air, into globules at the top of a shot tower, and maintaining an atmosphere of dry steam in the portion of the tower through which the globules start their flight.

12. In the process of making shot from molten lead containing less arsenic than is necessary to form spherical globules when lead is dropped through an atmosphere of air, the step which comprises protecting the lead globules by a non-oxidizing atmosphere during at least the initial portion of their flight down a shot tower.

13. The process of making substantially spherical shot suitable for use in the manufacture of shot gun cartridges which comprises separating molten lead containing less arsenic than is necessary to form spherical globules when lead is dropped through an atmosphere of air, into globules at the top of a shot tower and protecting said globules by a non-oxidizing atmosphere during at least the initial portion of their flight down said shot tower whereby said globules are caused to assume a substantially spherical shape during the initial part of their flight.

14. The process which comprises separating molten lead containing more than .01 percent of tin into globules at the top of a shot tower, passing the globules down a shot tower, and maintaining a non-oxidizing atmosphere in the portion of the tower through which the globules start their flight.

15. The process which comprises separating

molten lead containing more than .02 percent of cadmium into globules at the top of a shot tower, passing the globules down a shot tower, and maintaining a non-oxidizing atmosphere in the portion of the tower through which the globules start their flight.

16. The process which comprises separating molten lead containing more than .05 percent of zinc into globules at the top of a shot tower, passing the globules down a shot tower, and maintaining a non-oxidizing atmosphere in the portion of the tower through which the globules start their flight.

17. The process which comprises separating molten lead containing more than .01 percent tin into globules at the top of a shot tower, passing said globules down the shot tower and maintaining an atmosphere of dry steam in the portion of the tower through which the globules start their flight.

18. The process which comprises separating molten lead containing more than .02 percent cadmium into globules at the top of a shot tower, passing said globules down the shot tower and maintaining an atmosphere of dry steam in the portion of the tower through which the globules start their flight.

19. The process which comprises separating molten lead containing more than .05 percent zinc into globules at the top of a shot tower, passing said globules down the shot tower and maintaining an atmosphere of dry steam in the portion of the tower through which the globules start their flight.

20. In the process of making shot from molten lead containing more than .01 percent tin, the step which comprises protecting the globules by a non-oxidizing atmosphere during at least the initial portion of their flight down a shot tower.

21. In the process of making shot from molten lead containing more than .02 percent cadmium, the step which comprises protecting the globules

by a non-oxidizing atmosphere during at least the initial portion of their flight down a shot tower.

22. In the process of making shot from molten lead containing more than .05 percent zinc, the step which comprises protecting the globules by a non-oxidizing atmosphere during at least the initial portion of their flight down a shot tower.

23. The process of making substantially spherical shot suitable for use in the manufacture of shot gun cartridges which comprises separating molten lead containing more than .01 percent tin into globules at the top of a shot tower and protecting said globules by a non-oxidizing atmosphere during at least the initial part of their flight down said shot tower whereby said globules are caused to assume a substantially spherical shape during the initial part of their flight.

24. The process of making substantially spherical shot suitable for use in the manufacture of shot gun cartridges which comprises separating molten lead containing more than .02 percent cadmium into globules at the top of a shot tower and protecting said globules by a non-oxidizing atmosphere during at least the initial part of their flight down said shot tower whereby said globules are caused to assume a substantially spherical shape during the initial part of their flight.

25. The process of making substantially spherical shot suitable for use in the manufacture of shot gun cartridges which comprises separating molten lead containing more than .05 percent zinc into globules at the top of a shot tower and protecting said globules by a non-oxidizing atmosphere during at least the initial part of their flight down said shot tower whereby said globules are caused to assume a substantially spherical shape during the initial part of their flight.

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