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MANUFACTURE OF SHOT

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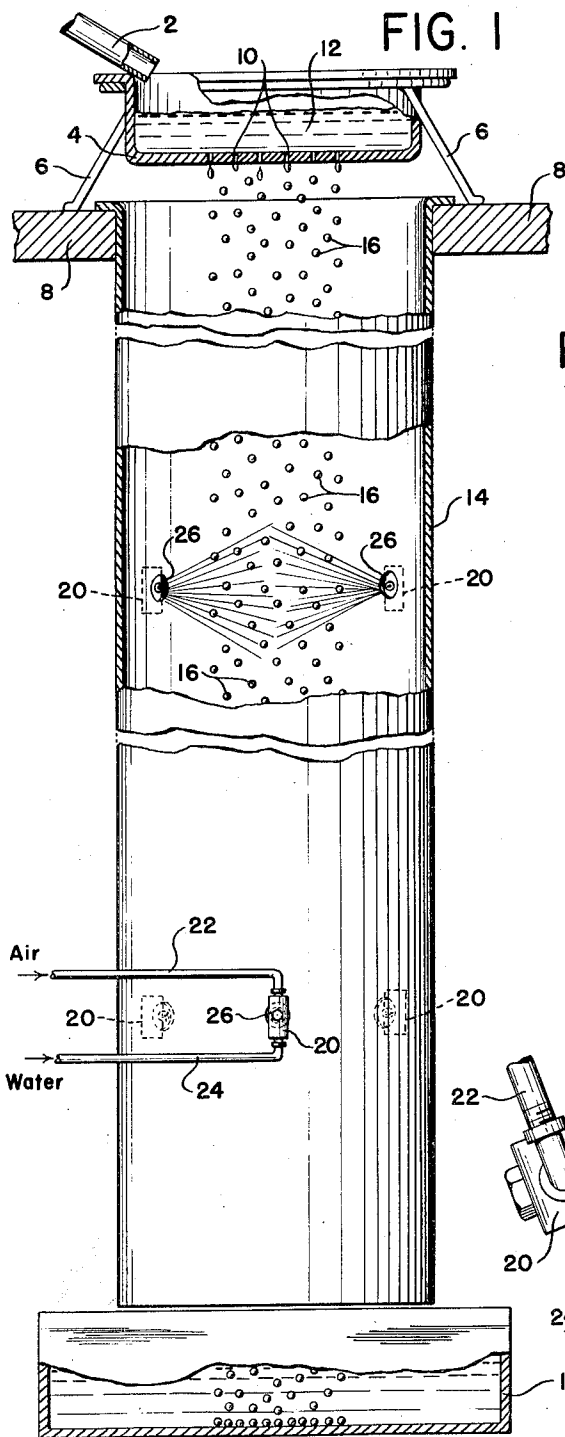


FIG. 2

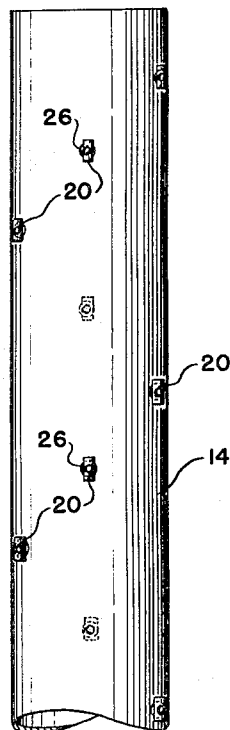


FIG. 3

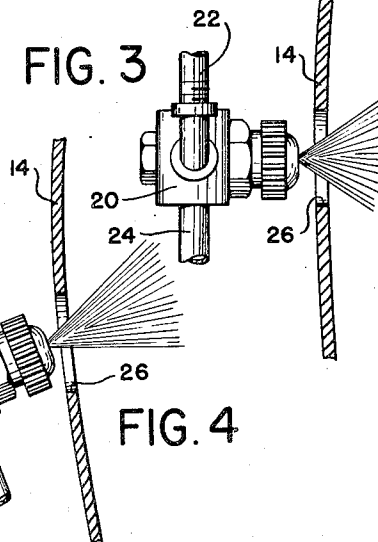


FIG. 4

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MANUFACTURE OF SHOT

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7 Claims. (Cl. 18—47.2)

This invention relates to the manufacture of shot, and more particularly to improved means for cooling molten metal pellets as they fall through a shot tower.

Shot used in manufacture of shot shells for sportsmen's use, and for other purposes, is formed by delivering molten lead or other metal to a pan having a perforated bottom arranged at the top of a shot tower. A water tank is placed at the bottom of the tower into which the shot falls. The perforations in the bottom of the pan determine the size of the shot, although the relation of the diameter of the openings to the size of the shot is not a direct one. Thus in producing #7 shot pellets (diameter .100") the diameter of the openings in the pan is about .030" and for "T" shot (diameter .200") it is about .240". To solidify the shot as the pellets fall through the tower, it is necessary to remove a certain amount of heat. If the shot are not sufficiently solidified before they strike the water, they will be flattened to some extent and will be unsatisfactory.

While the height of the shot tower may be varied, it is more or less standard practice in the industry to employ a tower about 180 feet high, and drop the pellets through an atmosphere of air. However, with the larger sizes of shot, the cooling efficiency of the tower is much reduced due to a reduction of heat transfer rate between the shot pellets and the atmosphere of the tower. The reduction of heat-transfer rate is due to two effects; first, the volume or mass of the individual pellet increases faster than the surface exposed to the cooling air in the tower; and second, the heat must be conducted a greater distance from the interior to the exterior of the pellet. Moreover, a more complete solidification of the larger pellets must be effected in order to avoid distortion when the pellets strike the water. It has, therefore, been found impossible, from a practical point of view, to produce the larger sizes of shot, such as "T" shot, in the towers generally used except in the cold winter months when the heat transfer is more rapid.

I have found that the cooling of the falling lead pellets can be improved by dropping them through an atmosphere of "cold fog." Such fog, as distinguished from spray or mist, comprises a suspension of minute water particles of a diameter of about .0004" in air. Such particles, because of their extremely small size, do not fall but remain suspended in the air, the tower being thus substantially filled with cold fog. The lead pellets falling into this atmosphere lose heat in supplying the latent heat of vaporization of the fog particles. As a result of the more efficient cooling thus obtained I have been able to produce larger sizes of shot in summer months at a greater rate of production than has heretofore been possible in the colder winter months.

I am aware of prior proposals to employ an atmosphere in a shot tower of a spray or of exhaust steam. A spray consists of water particles of much larger size than fog particles and requires a velocity of movement that results in the production of imperfect shot. Exhaust steam at a

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temperature of 212° F. or more, raises the temperature of the tower, and thus defeats the purpose of the present invention, that is, the more rapid and efficient reduction of the temperature of the lead particles.

In practicing the process, a shot tower of usual construction with a perforated pan above it and a tank of water beneath it, is employed. I provide a number of nozzles to atomize the water and feed it to the tower in the form of a fog, at room temperature or below room temperature depending on the source of the water that is atomized. The individual shot pellets delivered into this atmosphere from the pan at the top of the tower are not only cooled by the temperature difference between the atmosphere and the pellets, but are additionally cooled by the extraction of heat from them to supply the latent heat of vaporization of water particles in the fog. In falling through the tower, the lead drops or pellets, which are at an initial temperature of about 600° F., will contact numerous tiny water particles and cause them to flash into steam. Thus, there is sufficient extraction of heat from the pellets to satisfactorily solidify and cool them so that they retain their spherical form on striking the water. The result is a rate of cooling which permits the manufacture of large sizes of shot at any temperature that is normally reached in the temperate zone at any time of the year.

In carrying out the invention the fog is produced by atomizing water. Water and air are fed to suitable spray nozzles which produce a fog consisting of water particles of about .0004" diameter suspended in air and this fog is delivered into the tower. The nozzles may be arranged in various ways, and the number of nozzles employed may also be varied.

In the accompanying drawing I have illustrated a tower of conventional construction with several arrangements of nozzles. In this showing:

Fig. 1 is a somewhat diagrammatic illustration of a shot tower in elevation, parts being shown in section;

Fig. 2 is an elevation of a portion of the tower showing a different arrangement of the nozzles from that illustrated in Fig. 1;

Fig. 3 is a horizontal, sectional view of a portion of the cylinder wall, on an enlarged scale, showing one arrangement of a nozzle; and

Fig. 4 is a similar view showing another nozzle arrangement.

The shot is formed primarily of lead. If "drop shot" is to be produced, the lead contains approximately 0.1 percent of arsenic. In the manufacture of "chilled shot," from 1 percent to 5 percent antimony is added. The metal from which the shot is to be made is heated in any suitable manner, generally in a fusion kettle (not shown) to a temperature about 650° F. and is delivered through feed pipe 2 to a drip pan 4 in molten condition. The pan is supported in a frame 6 arranged in an opening in the top floor 8 of the top of the shot tower. The bottom of the pan is provided with perforations 10 of a proper size for the shot which are to be made, the pan being removable from the frame to be replaced by one having perforations of another size, if another size shot is to be made. A suitable body 12 of the molten metal is retained in the pan at all times. By maintaining a "head" of metal, uniformity in the size of the shot is obtained. The tower 14, into which the metal particles fall, may be made of any suitable material and is generally an iron or steel cylinder about 5 feet in diameter and 180 feet high. As shown, the shot stream is in the center of the tower. Beneath the tower a water bath 18 is provided for the collection of the shot.

The parts heretofore described are of conventional construction and have been employed in the manufacture of shot for many years. In conventional practice the

cylinder 14 is filled with air and the individual pellets are sufficiently cooled by contact with the air at prevailing temperatures to sufficiently solidify the spheres before they enter the water in the collecting bath 18. To produce large sizes of shot, particularly in warm weather, I replace the atmospheres heretofore used in shot towers with a cold fog consisting of a suspension of water particles in air. The particles are of a diameter about .0004" and form a true suspension in the sense that they do not settle out but are carried along by air movement. This atmosphere is produced by feeding air and water to nozzles 20 arranged around the tube to deliver the atomized mixture of air and water particles into the tower. Air at a pressure of 10 to 20 pounds per square inch is delivered to nozzles through pipe 22 and water is delivered through pipe 24. Atomizing nozzles of a conventional construction, in which the air is discharged through small openings and syphons the water through a similar small opening causing thorough admixture and complete atomization, may be employed. As such nozzles may be purchased on the open market, a detailed description of them is deemed unnecessary.

I may employ a greater or lesser number of nozzles than shown in Fig. 1. There, I have shown two sets of three nozzles each, one arranged in a horizontal plane about 50 feet above the collecting bath 18 and the other arranged at least 100 feet above it. Or I may employ an arrangement in which the nozzles are helically positioned, as shown in Fig. 2. The specific arrangement of the nozzles may also be varied. I have obtained excellent results by providing openings 26 in the wall of the tube and placing the nozzles with their tips 1" or 2" outside of the tube wall as shown in Figs. 3 and 4. As indicated by the stream flowing from the nozzles in Figs. 3 and 4, the fog stream does not actually touch the outside of the tube but passes through the opening 26 into the tower.

The nozzles may be arranged substantially radially, as shown in Fig. 3, or in a position approaching a tangential direction, as shown in Fig. 4. This depends, to some extent, on the air pressure used. Employing air pressures from 10 to 20 pounds per square inch, and the number and location of nozzles shown in Fig. 1, I have obtained excellent results with the radial positioning shown in Fig. 3. The fog disperses approximately 18 to 20 inches from the tip of the nozzle and when it reaches the central portion of the tube where the individual pellets 16 form the shot column, it does not have any deleterious effect on the falling stream of hot pellets.

The number and arrangement of nozzles, the air pressure and other factors may be widely varied depending on the size of shot being produced, the height of the tower, the temperature of the water that is available, the prevailing temperature in the place where the process is being practiced and other conditions which may affect the speed of cooling of the molten particles delivered from the pan.

I employ cold water but the actual temperature of it may vary widely. Thus, if water at a very low temperature is available from wells, at the place where the shot tower is in use, it will be colder than water from a city supply piped through a water system. And the water from a city supply will vary in temperature, depending

on the prevailing atmospheric temperature. But in most instances, I have found that atomization of 5 to 20 gallons of water per hour provides the necessary cooling for the production of up to about 5,000 pounds per hour of "T" shot in the summer months. The evaporation of the water in the fog extracts about 1000 B. T. U. per pound of water, and thus appreciably increases the cooling effect of the passage of the metal spheres through the tube.

As stated, the air velocity is dissipated before the fog actually reaches the shot stream in the center of tube 14 and it, therefore, has no effect on the particles other than the desired effect of cooling them. When pellets of molten metal are not present, the shot tube is substantially filled with fog which emerges from the upper end of the tube. However, when the process of this invention is in normal operation, the fog is dissipated by vaporization of the fog particles so that the upper end of the tube is substantially free of fog.

The process of this invention is advantageous for the efficient manufacture of spherical shot from other metals and alloys such as zinc, tin, and solder, particularly for the manufacture of the larger sizes.

I claim:

1. The process of making shot which comprises separating molten lead into pellets, causing the pellets to fall through an atmosphere of cold fog a sufficient distance to solidify the pellets and form spheres, and collecting the spheres so formed.
2. The process of making shot which comprises separating molten lead into pellets, causing the pellets to fall through an atmosphere of cold fog a sufficient distance to solidify the pellets and form spheres, and collecting the spheres so formed in a tank of liquid.
3. The process of claim 1 in which the suspended water particles are of about .0004" in diameter.
4. The process of making shot which comprises delivering molten metal from the top of a tower in particles of proper volume to form spheres of a desired size, delivering water and air to nozzles around the tower, atomizing the water to provide an atmosphere in the tower of cold fog through which the lead particles fall and are cooled to form spheres, and collecting the spheres so formed at the bottom of the tower.
5. The process of claim 4 in which the suspended water particles are about .0004" in diameter.
6. The process of making shot which comprises delivering molten metal from the top of a tower in particles of proper volume to form spheres of a desired size, maintaining an atmosphere consisting of cold fog in the tower through which the pellets fall to form spheres, and collecting the spheres at the bottom of the tower.
7. The process of claim 6 in which the cold fog consists of water particles about .0004" in diameter suspended in air.

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