Sept. 21, 1948. W. E. JEWELL 2,449,745

SHOT BLASTING MACHINE

Filed April 1, 1947 2 Sheets-Sheet 1

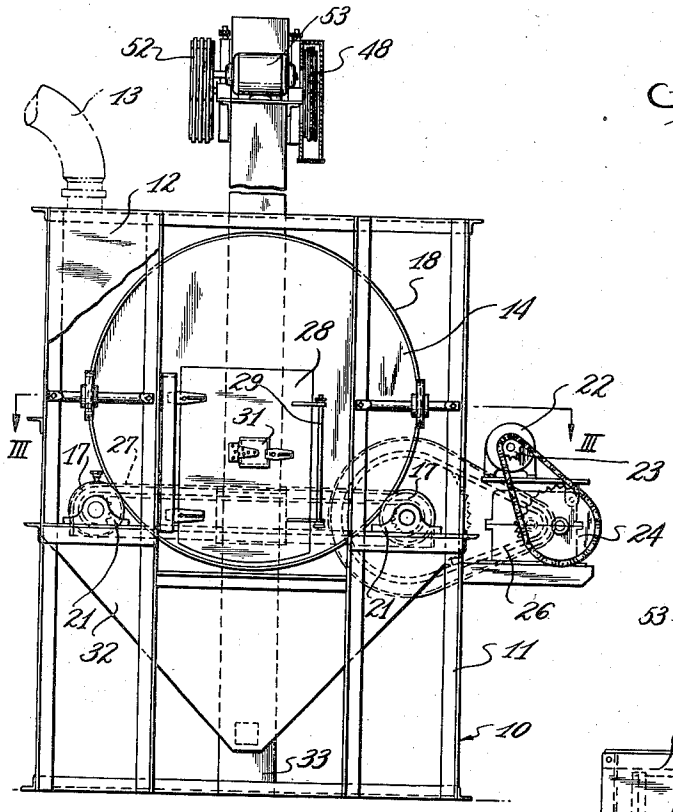

Fig. 1

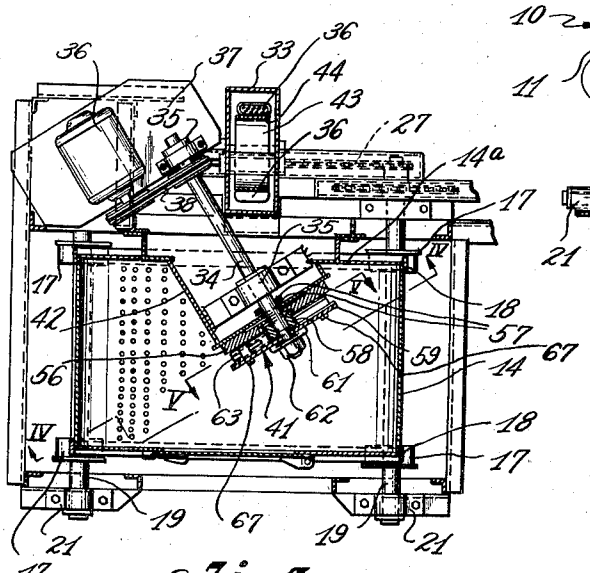

Fig. 3

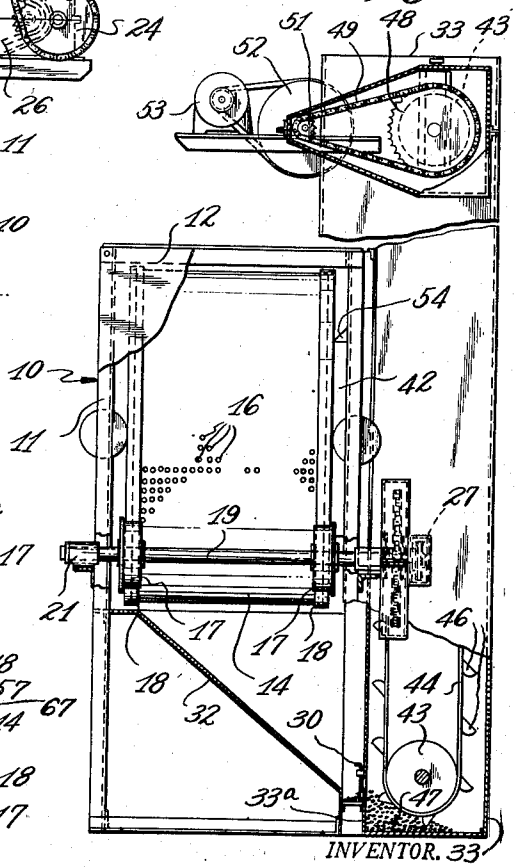

Fig. 2

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2 Sheets-Sheet 2

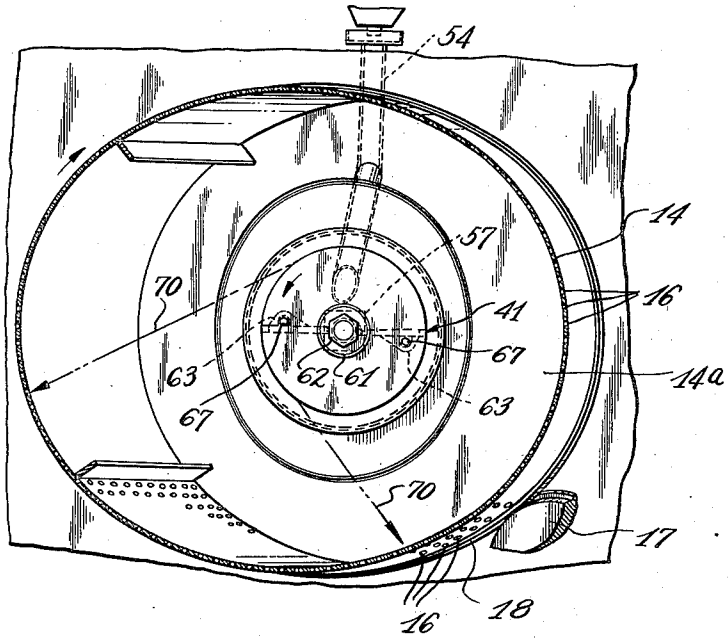

Fig. 4

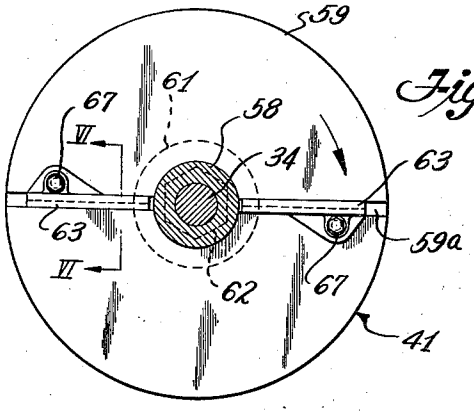

Fig. 5

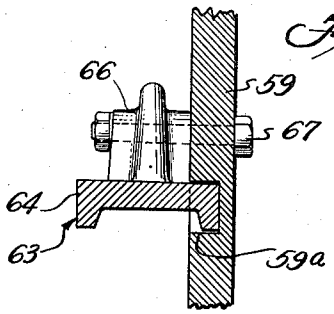

Fig. 6

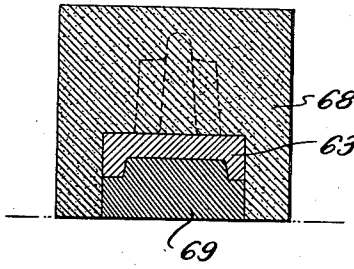

Fig. 7

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SHOT BLASTING MACHINE

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4 Claims. (Cl. 51—13)

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My invention relates to shot blasting machines, and more particularly to a shot blasting machine wherein the workpieces are tumbled while being exposed to the stream of a centrifugal shot-throwing wheel.

Shot blasting is widely used for the cleaning of hard objects such as ceramics or metal, and as such is often used as the equivalent of sand-blasting or as a replacement for sand-blasting operations. Shot blasting is particularly useful for cleaning sand castings and forgings, the impact of the shot knocking loose adhering sand particles or scale, as the case may be. All surfaces of the workpieces may be exposed to the shot blast by tumbling the workpieces in any conventional manner as by placing them inside of a rotating drum.

Prior shot blasting machines have generally employed a stream of air for carrying the shot to the objects to be blasted. Machines employing air blasts accordingly may include a plurality of movable or fixed nozzles which can be directed from a variety of angles towards workpieces that are generally carried on a conveyor belt or may be disposed upon a rotatable fixture. Also streams of shot for shot blasting have been obtained from rotating wheels having paddles or blades thereon that could centrifugally throw shot that is fed towards the center of the wheel from any convenient source, such as a chute. These centrifugal wheels are more efficient than the air blasts of shot, and employ a much more simple mechanism than that required for air blasts.

While several attempts have been made to combine centrifugal shot-throwing wheels with tumblers so that all surfaces of the workpieces may be exposed to the shot blast, these in general have not been successful. The principal difficulty has apparently been due to the fact that no suitable mechanism or device could be obtained for directing the shot into the tumbler. For example, tumblers have been formed of drums mounted for rotation upon a generally inclined or vertical axis, and the workpieces tumbled in the drums have been exposed to the blast of shot by having one end of the drum open. These structures, however, are not particularly satisfactory, since only a small quantity of workpieces may be tumbled efficiently at one time.

My invention seeks to overcome these defects of prior shot blasting machines by providing tumblers for workpieces that may include rotatable drums mounted on generally horizontal axes so that a large tumbling capacity may be obtained.

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Further, instead of opening one end of the drum so that an outside source of shot may be utilized, I have provided a shot-throwing mechanism that may be disposed within the tumbler itself. Inasmuch as such shot blasting mechanisms are particularly bulky and would interfere with the mounting of a drum that is supported upon a shaft, I have arranged my tumbling drum so that it may be supported at its periphery only upon driving rollers. This structure also permits the utilization of an extremely large charging door for the drum, which door may be situated at the end of the drum opposite from that in which the shot-throwing device is disposed.

The insertion of a shot-throwing device into the interior of a tumbling drum raises the added problem of adequately covering the entire axial length of the drum with the shot blast so as to obtain a uniform and efficient blasting of the tumbled workpieces. While it is theoretically possible to align an elongated shot-throwing wheel with the axis of the drum and to throw shot from the entire length of the wheel so as to cover the entire axial length of the drum, this structure is not practical at present. My invention, however, includes means for employing a simple shot-throwing wheel having a relatively thin width to the radial shot-throwing pattern in such a manner that the entire axial length of the drum will be adequately blasted. This structure may include a shot-throwing wheel having its axis of rotation at an angle to the axis of rotation of the drum, and when the wheel is disposed on the interior of the drum, it will direct a shot pattern generally aligned with the diagonal corners of the drum.

In ordinary tumbling operations, the workpieces preferably cover only the bottom portion of the tumbled drum so that all surfaces of the workpieces may be exposed to a shot blast with the fewest number of rotations. Accordingly, therefore, the shot-throwing wheel must be designed to deliver shot only over that part of the interior surface of the drum occupied by the workpieces, inasmuch as any shot that is directed towards parts of the drum not covered by the workpieces will quickly erode away the drum and render it unserviceable. My invention accordingly includes an improved shot-throwing wheel structure having a very directive shot pattern so that the life of the drum will be greatly extended.

It is a principal object of my invention to provide an improved shot blasting machine wherein

the workpieces may be automatically moved to present all surfaces to a single blast of shot.

Another object of my invention is to provide an improved shot blasting machine wherein the workpieces are disposed within a drum for tumbling and wherein a shot-throwing device is disposed within the interior of the drum.

Still another object of my invention is to provide a shot blasting machine employing a tumbling drum wherein a shot-throwing wheel is disposed to deliver a shot pattern diagonally across the drum.

A further object of my invention is to provide an improved shot-throwing device for shot blasting machines.

Other objects and advantages of my invention will be apparent in the following description and claims, considered together with the accompanying drawings, in which

Fig. 1 is an elevation front view of a shot blasting machine embodying my invention and disclosing the driving mechanism for rotating the drum;

Fig. 2 is a side elevation view of the shot blasting machine of Fig. 1 and illustrating, among other things, the mechanism for delivering shot from the bottom of the machine to the top of the machine;

Fig. 3 is a sectional view along the line III—III of Fig. 1 showing the location and relative disposition of the shot-throwing wheel and the tumbling drum;

Fig. 4 is a sectional view through the tumbling drum taken along the line IV—IV of Fig. 3;

Fig. 5 is an elevation view of one side of the shot-throwing wheel as taken along the line V—V of Fig. 3;

Fig. 6 is a sectional view through the shot-throwing wheel as taken along the line VI—VI of Fig. 5; and

Fig. 7 is a sectional view through a chilled surface type of mold for casting the shot-throwing blades of the shot-throwing wheel of Fig. 5.

While my invention may be embodied in apparatus comprising essentially a drum, shot-throwing wheel, and means for feeding shot to the shot-throwing wheel, I prefer to add refinements thereto that increase the utility and efficiency of my shot blasting machine. Accordingly, referring to Figs. 1, 2, and 3, a shot blasting machine **10** may include a rectangular framework **11** formed of angle irons or other structural shapes of great strength. The entire rectangular frame **11** may be enclosed with sheet metal **12** so as to form a dust-proof case about the shot blasting machine, and the dust may be removed by any suitable mechanism, for example by a suction exhaust pipe **13**. A suitable door in the sheet metal case **12** may be provided for permitting access to the tumbling drum.

The tumbling drum may be in the form of a steel cylinder **14** having a plurality of perforations **16** in the cylindrical wall thereof. The drum may be mounted for rotation on, and may be driven by, a plurality of flanged driver wheels **17**, and each end of the drum **14** may be provided with heavy steel tires **18** for engagement with these drivers **17**.

The drivers **17** may be mounted upon two shafts **19** generally parallel to the axis of the drum **14**, and these shafts may be journaled in suitable bearings **21** mounted upon horizontal portions of the frame **11**. These shafts **19** may project from the rear of the sheet metal dust case **12** for a driving engagement by a gear train driven by a motor **22** which is preferably electric. A suitable

reduction in speed between the motor **22** and the drum **14** must be obtained inasmuch as the rotation of the drum is preferably on the order of about 1 R. P. M. Accordingly a small sprocket **23** on the motor **22** may engage a large sprocket **24** secured to a reduction gear box **26** from which may lead suitable belts or chains having a driving engagement with one of the shafts **19**. The two shafts **19** may be interconnected by a belt or chain drive **27** so that all four wheels **17** will drive the drum **14**.

The drum **14** may be charged with workpieces by means of a large charging door **28** hinged in any suitable manner, as by a rod **29**, to the drum itself. An inspection door **31** may be provided in this charging door if desired. Accordingly the door **28** may be opened and workpieces placed within the drum **14** and the door **28** may then be closed and securely locked. Thereafter the drum will be rotated and the workpieces will tend to rotate with the drum until they reach a point on their upward travel where the forces of gravity will cause them to roll down over the pile of workpieces within the drum and thus give rise to the tumbling action. The shot with which the workpieces are blasted, and the blasted particles of sand, scale, or other coating may fall through the small holes **16** into a hopper **32**. The shot may roll from the hopper **32** into the bottom part **33***a* of an elevator shaft **33** so that the bottom part **33***a* of the shaft acts as a bin for the shot. If desired, an air inlet opening may be formed adjacent the bin portion **33***a* of the elevator shaft **33** so that air will be sucked upwardly within the dust casing **12** to the exhaust pipe **13** and thereby clean the shot of scale and fine particles.

The shot-throwing mechanism is shown in general in Fig. 3, and has as its essential part a shot-throwing wheel **41** which will be described in more detail with reference to Figs. 4 through 7, inclusive. The wheel **41** may be mounted upon a generally horizontal shaft **34** journaled in bearings **35**. The shaft may be driven by an electric motor **36** mounted upon a platform **37** disposed at the rear of the shot blasting machine **10**. A drive may be effected between the motor **36** and the shaft **34** by any suitable device such as pulleys and one or more belts or chains **38**.

Also it will be noted that the rear end of the drum **14** may be centrally relieved so that only an annular end portion **14***a* remains. Projecting into the central opening formed by the annular end plate **14***a* may be a generally tubular member **42** to which the inner bearing **35** is secured, and this tubular member may be secured in turn to upright portions of the frame **11**. The horizontal shaft **34** may be located generally in the same horizontal plane that includes the axis of the rotatable drum **14**, but variations of small amounts may be made therein as will be apparent to those skilled in the art.

Shot may be supplied to the throwing wheel **41** by means of a continuous supply mechanism disposed within the elevator shaft **33**. For example, an endless belt may be employed for this purpose having buckets secured thereto as shown in Fig. 2. Accordingly pulleys **43** may be journaled in the bottom and top of the elevator shaft **33**, and an endless belt **44** may be passed about the pulleys and may have buckets **46** secured thereto which will dip into a pile of shot **47** formed in the bin portion **33***a* of the shaft **33**. The upper pulley **43** may be driven by any suitable mechanism such as a sprocket **48** connected by a chain **49** to

a sprocket 51 mounted on a cross shaft having a large pulley 52 driven by an electric motor 53. As the endless belt moves about the pulleys, it will pick up shot at the bottom of the shaft 33 and deliver it at the top of the shaft to a suitable supply mechanism such as a tube 54 (Fig. 4) leading from the top of the elevator shaft to the shot-throwing wheel 41. The rate of supply of shot to the centrifugal wheel 41 may be regulated by placing a sliding plate 30 or similar mechanism between the hopper 32 and the bottom 33a of the elevator shaft 33.

The construction of the shot-throwing wheel 41 may be best explained with reference to Figs. 3, 4, 5, and 6. Referring to Fig. 3, it will be noted that a relatively thick and heavy wear plate 56 may be secured to the end of the tubular projection 42, and the shot supply tube 54 may pass through an opening in this wear plate to deliver shot to the wheel 41. Apertured square plates 57 may be spaced from the end of the tubular portion 42 to trap shot that tends to ride along the shaft 34 to the outside of the machine. The wheel 41 may include an annular hub 58 resting upon a shoulder on the end of the shaft and a grooved plate 59 may be secured against the hub 58 by a washer 61 and a nut 62. Blades 63 may be secured to the circular plate 59 and may be partially disposed within the grooves of the plate 59.

The detailed construction of the centrifugal wheel 41 is best illustrated in Figs. 5 and 6, wherein it will be noted that the blades 63 may include a generally channel-shaped member 64 having a ribbed transverse boss 66 integrally formed thereon. One edge of the channel shape may be disposed within the grooves of the plate 59, which grooves may be designated as 59a. A bolt 67 may pass through the transverse boss 66 and through the plate 59 to securely fasten the blades 63 to the circular plate 59. The plate 59 is designed to rotate at a high rate of speed, for example 2,000 R. P. M., and as the shot rolls outwardly on the blades 63 they bear thereagainst very heavily due to the increased angular acceleration.

While the balls move outwardly with some rolling action, there is also a considerable sliding action, and the blades 63 are accordingly subject to strong forces that tend to wear the blades. Accordingly I prepare the blades 63 to accommodate these wearing tendencies, and I have found that a chill casting of the wear surface performs quite satisfactorily when the blades 63 are formed from high carbon iron. This casting technique is illustrated in Fig. 7, wherein a mold may include a sand portion 68 for the main body of the blades 63, but the portion of the mold forming the channel of the blades may be formed of a metal as at 69. Therefore if a high carbon iron alloy is used, for example cast-iron, the surface of the channel will be chilled during this casting operation due to the high thermal conductivity of the metal portion 69 of the mold. This chilling action will cause an alignment of metal grains perpendicular to the channel that give rise to great wear resistance.

The operation of the mechanism may be initiated by opening the charging door 28 and inserting therein any material that is to be shot blasted. For example, a tumbling drum approximately four feet in diameter and about three feet in axial length may be loaded with eight hundred to two thousand pounds of metal objects, and the door 28 may then be closed and securely locked. A supply of hard steel shot may be disposed in the bottom of the elevator shaft 33 until a substantial pile is formed, as indicated at 47 (Fig. 2). The drum rotating motor 22 may then be started, the shot-throwing motor 36 may then be started, and the elevator motor 53 may next be started. Also a suitable exhaust fan may be operated to withdraw air from the exhaust stack 13 (Fig. 1). The endless belt 44 thereafter continuously moves on the pulleys 43 and the buckets 46 on the belt deliver shot to the top of the elevator shaft 33, whereupon the shot is dumped into the delivery pipe 54. The delivery pipe 54 passes through the wear plate 56 (Fig. 3) and delivers shot to the rapidly whirling wheel 41. The blades 63 of this wheel take the shot which is delivered at their most inward end and give it a very rapid angular acceleration due to the high rate of rotation of the wheel 41 which may be of the order of 2,000 R. P. M. This angular acceleration gives rise to a radial movement of the shot, causing the shot to skid or roll along the channel portions of the blades 63 until they are delivered with a tangential trajectory to the interior of the drum 14. The angular spread of the tangential trajectory may be adjusted by any suitable means to substantially that shown by arrows 70 in Fig. 4. The charge within the drum 14 which is slowly rotating will occupy substantially this angular portion of the interior of the drum 14, and accordingly will be blasted by the shot with very little of the shot striking the drum interior itself of the drum 14.

The spent shot, together with the particles knocked off due to the impact with the workpieces, will pass through the holes 15 in the drum to be collected by the hopper 32. Any suitable mechanism (not shown) may be utilized for separating the blasted material from the shot, which shot may then be re-used for a great many cycles. This re-cycling of the shot occurs when it rolls from the hopper 32 down into the lower end of the elevator shaft 33 to form the shot pile 47. The operation is continuous for any desired length of time, and the usual blasting times are from five to twenty minutes, depending upon the type of material being cleaned or treated. When it is desired to remove the charge at the end of the run, the motors are turned off, the charging door 28 opened, and the material removed from the drum 14 which may be easily effected, for example by raking the material from the drum into a waiting truck or other receptacle.

The operation of the machine may be entirely dust free due to the enclosure of the drum 14 by the case 12, together with the exhausting operation performed by the stack 13. The machine accordingly may be placed in any type of shop without interfering with nearby operations requiring substantial freedom from dust and grit.

By referring to Fig. 3, it will be noted that the shot-throwing wheel 41 is disposed at an angle to the axis of the drum 14. Also by referring to Fig. 4 it will be noted that the angle between the shot-throwing limits 70 is such that the shot will be delivered from one corner of the drum and diagonally across the drum to the other corner. Thus all portions of the workpieces within the drum will be treated simultaneously. At one corner of the drum the pieces on the highest end of the constantly tumbling pile of workpieces will be treated, and the line of shot will traverse the pile until at the other diagonal corner of the drum the lower end of the tumbled pile will be blasted. As noted in Fig. 4, the relation of the feed tube 54 with respect to the centrifugal wheel

41 is such that the drum 14 should be rotated in an opposite direction to obtain proper coverage.

Hard steel shot is preferred as the blasting medium, and the wheel 41 may give this a velocity sufficient so that the shot is able to penetrate a wooden board, but not excessive so that it will mar the charge being cleaned. The positioning of the shot-throwing mechanism directly within the tumbling drum gives the most direct contact of the shot with the workpieces, and makes possible very close control of shot velocity with respect to the charge being treated. In this connection I have found that shot-throwing wheels employing two blades are greatly superior to those having a greater number of blades insofar as delivering a clean and direct shot pattern is concerned. This positioning of the shot thrower within the tumbler is made possible by mounting of and rotation of the drum upon driving wheels rather than by an axial shaft.

The drum 14 is preferably formed of heavy steel such as one-half inch steel, and the holes 16 therein may be drilled or punched. The heavy tires 18 which engage the driving wheels 17 may be made with considerable accuracy compared to the drum itself. In this connection it should be noted that the drum may be made of plates welded together into a general cylindrical shape, or may be formed of one or more sheets rolled into a circular cylindrical shape. The drivers 17 are preferably formed of very hard material such as chilled cast-iron. The moving parts are relatively few in number and when made with extreme ruggedness the final machine is free of operational breakdowns and the only substantial maintenance operation thereupon need be the replacement of the blades 63 on the centrifugal wheel 41. Further, the shot-throwing wheel is so constructed as to handle blasting particles other than shot. For example, the conventional grits often used in place of round shot may be employed.

While I have described my invention with respect to a particular embodiment thereof, I do not limit myself to this embodiment, since it is obvious that various modifications could be made therein without departing from the true spirit and scope of the invention. Accordingly I limit my invention only by the terms of the following claims.

I claim:

1. A shot blasting machine comprising a rotatable tumbling drum having a generally horizontal axis, a generally horizontal rotatable shaft projecting into the drum at one end thereof and at an acute angle to the drum axis, and a narrow shot-throwing wheel disposed on the shaft inside of the drum so that a shot pattern may be thrown diagonally across the drum to cover the entire axial length of the drum.

2. A shot blasting machine comprising a rotatable tumbling drum having a generally horizontal axis, a generally horizontal rotatable shaft projecting into the drum at one end thereof and at an acute angle to the drum axis, a narrow shot-throwing wheel secured to the shaft inside of the drum and characterized by having two shot-throwing blades, and means for supplying shot to the shot-throwing wheel so that a shot pattern may be thrown that covers the entire axial length of the drum but at an angle to the axis of the drum.

3. A shot blasting machine comprising a rotatable tumbling drum having a generally horizontal axis, a generally horizontal rotatable shaft projecting into the drum at one end and at an acute angle to the drum axis, a narrow shot-throwing wheel disposed on the shaft inside of the drum, rotatable wheels contacting the outer periphery of the drum for supporting and rotating the drum, means for supplying shot to the shot-throwing wheel, and a large charging door disposed in the other end of the drum.

4. A shot blasting machine comprising a framework, at least four rotatable wheels mounted within the framework, means for driving at least one of the wheels, a perforated drum disposed on the wheels and having a generally horizontal axis, a generally horizontal rotatable shaft projecting into the interior of the drum through one end thereof, means for rotating the shaft at a high rate of speed, a shot-throwing wheel disposed upon the shaft within the drum for throwing a pattern of shot diagonally across the drum, a hopper disposed below the drum for receiving shot that falls through the perforations of the drum, a dust-tight case secured to the frame about the drum and connected to the hopper, an elevator secured to the framework for lifting shot from the bottom of the hopper to a point above the shot-throwing wheel, a chute connecting the top of the elevator with the shot-throwing wheel, and means for passing air through the hopper and the dust-tight case, whereby foreign particles and dust may be removed from the shot and from the dust-tight case.

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